

A new subfamily and species of Ostracoda (Cylindroleberididae, Myodocopa) from the Chatham Rise (New Zealand)

I Karanovic & A-N Lörz

To cite this article: I Karanovic & A-N Lörz (2012) A new subfamily and species of Ostracoda (Cylindroleberididae, Myodocopa) from the Chatham Rise (New Zealand), *New Zealand Journal of Zoology*, 39:4, 265-290, DOI: [10.1080/03014223.2011.648200](https://doi.org/10.1080/03014223.2011.648200)

To link to this article: <https://doi.org/10.1080/03014223.2011.648200>



Published online: 14 Dec 2012.



Submit your article to this journal [↗](#)



Article views: 273



View related articles [↗](#)



Citing articles: 1 View citing articles [↗](#)

A new subfamily and species of Ostracoda (Cylindroleberididae, Myodocopa) from the Chatham Rise (New Zealand)

I Karanovic^{a*} and A-N Lörz^b

^aDepartment of Life Science, Hanyang University, Seoul, South Korea, and Institute of Marine and Antarctic Studies, University of Tasmania, Tasmania, Australia; ^bNational Institute of Water and Atmospheric Research (NIWA), Wellington, New Zealand

(Received 3 August 2011; accepted 5 December 2011)

The second species of the genus, *Macroasteropteron chathamensis* sp. nov. is described in the present paper. It was collected from 1000 m depth during the New Zealand national biodiversity programme Ocean Survey 20/20 to the Chatham Rise and the Challenger Plateau. To accommodate this genus, a new subfamily Macroasteropteroninae is described herein. It is defined by the following autapomorphies: locking system on the shell; very small second segment on the second antenna (bearing no dorsal bristles); square shaped third and fourth segments on the same appendage; absence of dorsal bristles on the third segment of the male clasping organ; reverse position of the alpha and beta bristles on the maxillula; almost square shaped skirt on the sixth limb; and a bulbous terminal part of the seventh limb, which, in addition, does not have any bell-bearing bristles. A key to the four subfamilies of Cylindroleberididae is provided.

Keywords: Ostracoda; New Zealand; taxonomy; new subfamily; *Macroasteropteron chathamensis* sp. nov; key of Cylindroleberididae

Introduction

According to the checklist of recent Cylindroleberididae (Syme & Poore 2006), there are 219 described species grouped into 32 genera, five tribes and three subfamilies: Cylindroleberidinae Müller, 1906; Cyclasteropinae Poulsen, 1965; and Asteropteroninae Kornicker, 1981. Four major autapomorphies define the family (Müller 1906; Kornicker 1993; Syme & Poore 2008):

- (1) Overlapping flat gills at the posterior-dorsal body (although these are reduced or absent in some species);
- (2) A sword-shaped, distally branched, coxa endite on the mandible;
- (3) A setal-comb (so-called 'baleen-comb') on the maxillula and the fifth limb; and
- (4) A hatchet-shaped sixth limb.

Presently, the subfamilies are defined by the combination of the characters related to the carapace ornamentation, shape of the incisor, shape of the adductor muscle scars, first antenna and maxillula (Kornicker 1981a). It is hypothesised that the family is more than 400 million years old: a recent fossil discovery from the Silurian has been assigned to the family and possesses remarkably well preserved soft parts, including apparent gills (Siveter et al. 2003).

Phylogenetic analysis based on the morphological characters of the family Cylindroleberididae has been carried out twice. Kornicker (1981a) used Hennigian principles in which derived (apomorphic), rather than primitive (plesiomorphic) character states are considered important in grouping taxa (Henning 1966). He used only 10 morphological characters and the

*Corresponding author. Email: ivana.karanovic@utas.edu.au

three existing subfamilies as terminals, which resulted in a tree in which Asteropteroinae is a sister taxon of Cyndroleberidinae and Cyclasteropinae. Syme (2007), on the other hand, used the probability model (Lewis 2001). She coded a total of 66 morphological characters of 141 Cyndroleberididae species (seven outgroup taxa) and analysed the data set using Bayesian likelihood, in the program MrBayes v3.1 (Huelsenbeck & Ronquist 2001). The result was poor resolution at the genus level, but support for the monophyly of Cyndroleberididae. In contrast to Kornicker (1981a), Cyndroleberidinae is a sister taxon of Asteropteroinae and Cyclasteropinae, with Asteropteroinae being paraphyletic. Syme (2007) also analysed molecular data, using two genes (16s and 28s) and a very limited number of species (28), resulting in Cyndroleberidinae being paraphyletic with respect to Asteropteroinae, and the placement of Cyclasteropinae uncertain. Syme & Oakley (in press) combined morphological and molecular data (although they had only a few more species than Syme 2007) and got a tree which, in general, supports Kornicker's (1981a) view of the phylogeny of Cyndroleberididae, but also corresponds to Syme's (2007) molecular results with the respect to Cyclasteropinae. The contradicting results of Kornicker (1981a) and of Syme (2007), in both molecular and morphological data, indicate that the phylogeny of Cyndroleberididae is still an open question.

While the nominotypical subfamily can be found in the 1–4500-m depth range (Kornicker 1975), the other two subfamilies are mostly restricted to the continental shelf (0–200 m), living mostly in the upper 100 m (Kornicker 1981a) with the exception of *Pteromeniscus intensi* Kornicker, 1981, found off Mauritania at 270–699 m (Kornicker 1981a), and *Macroasteropteron mindax* Kornicker, 1994, collected at 996 m off New South Wales (Kornicker 1994). The habitat of Cyndroleberididae is predominantly benthic and they are able to form burrows in the sediment (Horne 2003).

The majority of the known Cyndroleberididae species have been described from sampling programmes in particular geographic regions: Antarctic (Kornicker 1975), southern Australia (Kornicker 1994; Kornicker & Poore 1996), northern Australia (Kornicker 1996), the Indo-Pacific (Kornicker 1996), western Indian Ocean (Kornicker 1992), eastern Atlantic (Kornicker 1976, 1989; Kornicker & Caraion 1974), Scandinavia (Sars 1870; Skogsberg 1920), western Atlantic (Kornicker 1986), West Indies (Kornicker 1958, 1981b), the Pacific (Kornicker 1991a,b), and from many places combined (Poulsen 1965; Kornicker 1981a).

At present, 356 recent ostracod species are recorded from the New Zealand Exclusive Economic Zone (EEZ): 278 belonging to the subclass Podocopa and 78 to Mydocopa (Eagar 2010). Of these, 30% Mydocopa and 23% Podocopa species are endemic, with six Podocopa and only one Mydocopa endemic genus. The following Cyndroleberididae species are known so far: *Bathyleberis oculata* Kornicker, 1975; *Cycolleberis bradyi* Poulsen, 1965; *Diasterope grisea* (Brady, 1898); *Dolasterope johansonii* Poulsen, 1965; *Leuroleberis zealandica* (Baird, 1850); *Parasterope pectinata* Poulsen, 1965; *P. quadrata* (Brady, 1898); *P. crinita* Kornicker, 1975; and *Synasterope empoulsenii* Kornicker, 1975. All nine species have never been found elsewhere. The low number of known Mydocopa in New Zealand is because this group has never been studied here systematically. All the data come from a very limited number of studied samples from very few localities (Baird 1850; Brady 1898; Poulsen 1965; Kornicker 1979).

In 2006, the New Zealand government initiated the Ocean Survey 20/20 programme of annual seabed mapping and biodiversity surveys to address the lack of knowledge and promote research leading to a better understanding of marine processes across the EEZ. During expeditions in 2007 to the Chatham Rise and the Challenger Plateau 21 stations were sampled with a Brenke epibenthic sledge and more than 80,000 invertebrates collected from about 1 meter above the seafloor (Lörz

2011). Until now, few invertebrate groups have been studied to species level in this region, e.g. in the order Tanaidacea 77% of the species are new to science.

The Chatham Rise is at the confluence of two different oceanographic environments: cold, nutrient-rich subantarctic waters, moving north in the Southland Current, and warm, nutrient-poor waters from lower latitudes. The Challenger Plateau is mostly influenced by warm oligotrophic water masses and is less productive. Lörz (2011) analysed the benthic boundary assemblages collected by epibenthic sledge during the Ocean Survey 20/20 and found that animal abundance is indeed higher on the Chatham Rise, and assumed that the biodiversity of other invertebrate groups will be similar to that found for Tanaidacea. The ostracod fauna of New Zealand remains understudied, with many species new to science.

A total of 5258 ostracod specimens were collected during the survey: 3925 from the Chatham Rise and 1333 from the Challenger Plateau. Ostracods represent one of the most abundant suprabenthic taxa, suggesting that this component of the marine fauna, in the benthic boundary layer, may play a significant role in ecosystem functioning (Lörz 2011).

One of the most interesting species is described in this paper. It belongs to *Macroasteropteron* Kornicker, 1994, a monospecific genus known from a single female specimen collected off New South Wales (Kornicker 1994). The New Zealand species confirmed some very peculiar characters of the antennula, maxillula and seventh limb in *Macroasteropteron*, prompting us to erect a new subfamily to accommodate the genus and its two species. We are here also revising the key to the subfamilies of Cyndroleberididae proposed by Kornicker (1981a).

Methods

Recent ostracod collections were made during the Ocean Survey 20/20 voyages via RV *Tangaroa* to the Chatham Rise east of New

Zealand (TAN0705) and the Challenger Plateau west of New Zealand (TAN0707). Ostracoda were collected by means of an epibenthic sledge, Brenke sledge (Brenke 2005). Specimens were immediately sorted on deck, fixed in 98% ethanol and later transferred to 70% ethanol.

Specimens were dissected and mounted on microscope slides in Gum-Chloral medium, which was prepared following the procedure of Pantin (1964), and dissected appendages were then covered with a coverslip. The animals were dissected under the Leica MZ125 (plan) dissecting microscope and observed under the Nikon eclipse E600 (plan) compound microscope. The line drawings were prepared with the aid of a drawing tube attachment (Nikon Y-IDT).

Scanning electron micrographs (SEM) photos were taken with Philips XL30 at the School of Medicine (Hanyang University).

Standard terminology for myodocopid ostracods is used here, except for the uropodal lamellae, which follows recent observations of Meisch (2007) on the homologies of the most posterior appendage in different ostracod lineages. In this paper, Meisch (2007) proposes the term 'uropodal lamellae' for the previously used 'furca', which is accepted here. Hemipenis is labelled according to Cohen & Morin (1993).

All material is deposited in the Marine Invertebrate Collection at the National Institute of Water and Atmospheric Research (NIWA), Wellington.

Abbreviations used in the texts: A1, antennula; A2, antenna; BO, Bellonci Organ; Md, mandibula; Mx1, maxillula; L5, fifth limb; UL, uropodal lamellae; L, length; H, height.

Results

The study of Myodocopa ostracods revealed around 30 different species belonging to six families: Cypridinidae, Cyndroleberididae, Philomedidae, Sarsiellidae, Halocyprididae, Polycopidae. All families were collected on the Chatham Rise as well as on the Challenger

Plateau (Fig. 1). The new subfamily, Macroasteropteroninae, was found at the northern and southern flank of the Chatham Rise (Fig. 1)

Systematics

Subclass Myodocopa Sars, 1866
 Order Myodocopida Sars, 1866
 Suborder Myodocopina Sars, 1866
 Family Cyllindroleberididae Müller, 1906
 Subfamily: Macroasteropteroninae subfam. nov.
 Type (and only) genus: *Macroasteropteron* Kornicker, 1994
 Type species: *Macroasteropteron mindax* Kornicker, 1994

Other species: *Macroasteropteron chathamensis* sp. nov.

Diagnosis of subfamily as for genus. Carapace usually well ornamented, but without ridges. At least two clear infold bristles present at rostral end (and sometimes posterior end). Rostrum of RV conspicuous and almost square. LV and RV anterior and posterior parts asymmetrical, functioning as a lock system. L more than 1 mm, males slightly smaller than females. Flange part of shell well developed and usually broad. Muscular scar imprints consisting of rounded, densely concentrated, individual scars. A1: second segment very short, without any bristles dorsally; third segment with one dorsal and one ventral bristle. Third and forth

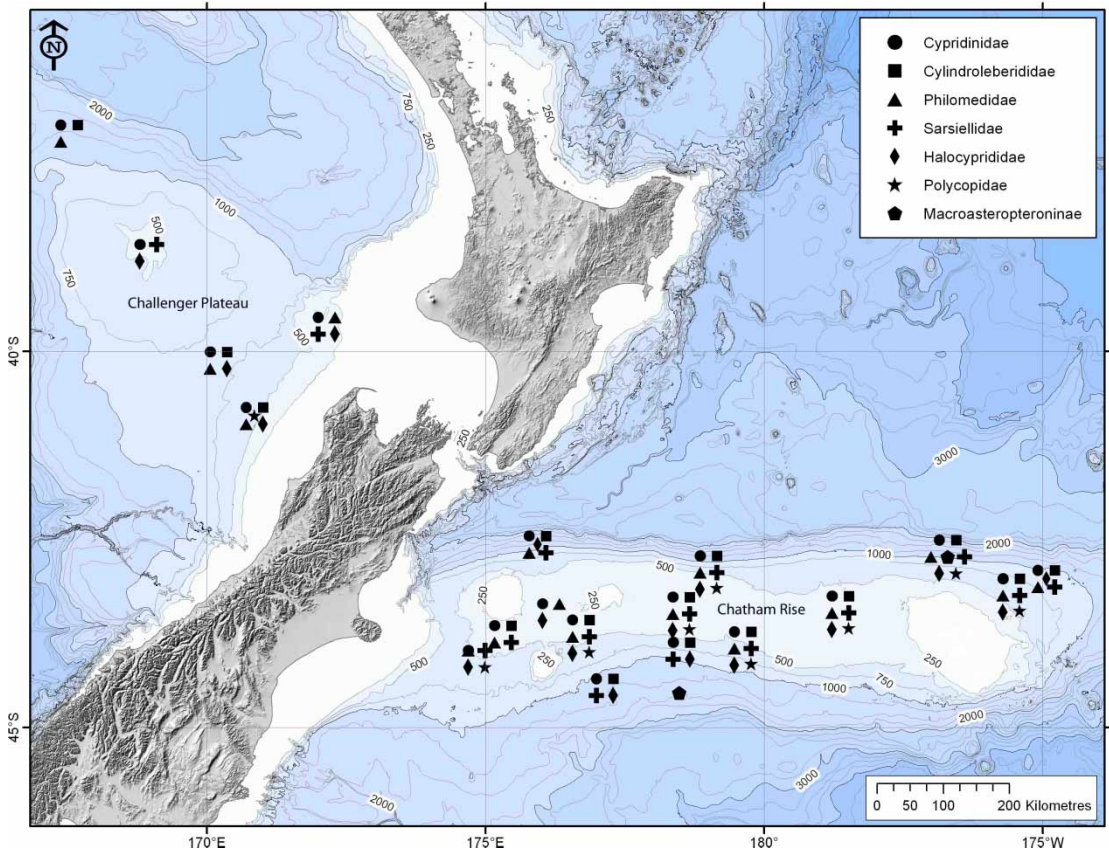


Figure 1 Sampling localities of Myodocopa Ostracoda on the Chatham Rise and the Challenger Plateau during the RV Tangaroa expeditions TAN0705 and TAN0707. Six families and the new subfamily Macroasteropteroninae (pentagon symbol) of Myodocopa are symbolised.

segment not conical, but square. Male sensory bristle on fifth segment not much different from female: in male there are four distal filaments; in female number of filaments varies, but they are distributed along sensory bristle. Sixth segment fused with the fifth one. Bristle 'a' in both sexes is poorly developed, not claw like. Bristle 'b' also poorly developed in both sexes. Bristle 'd' completely reduced, while 'e' long. Bristles 'f', 'g' and 'c' in males covered with numerous, long filaments. Protopod of A2 with one distal bristle. Endopod in female without terminal bristle, sometimes divided with a thin suture. Endopod in males transformed in clasping organ, 3-segmented and without dorsal bristle on the last segment. Md with prominent coxal endite; exopod as long or slightly longer than the dorsal margin of the first endopodal segment, simple, with two distal bristles; endopod 2-segmented, terminal segment with three claws and one bristle. Mxl with short epipod and very long baleen-comb (extending until the first endopodal segment). Basis with few (1–4) bristles: 1–2 dorsal and 1–2 medial. Exopod absent. Endopod conspicuous: 3-segmented with alpha bristle situated on the posterior and beta bristle on the anterior side; terminal segment with three bristles of different L. L5 with baleen-comb with continuous rows of ventral bristles; epipod well developed. L6 with continuous row of anterior bristles, skirt short with rounded anterior and posterior ends. Both L5 and L6 same in males and females. L7 with bulbous terminal, which, in addition, without any bell-bearing bristles. UL without bristles between claws, and without secondary claws between primary ones, instead claws gradually decreasing in L. Body terminating in conical, hirsute, process. Genital field in females well chitinised and prominent. Male copulatory organ constituted of three parts. Anterior part (outer lobe) with well chitinised anterior-most margin, and distally with four ringed short bristles. Distal to these a cylindrical process (central lobe) present with two terminal bristles. Posterior part (inner lobe) of copulatory organ more complex and with two

distal extensions, both with row of 7–9 teeth; more anterior one with addition of seven groups of serrated plaques; more posterior one with two groups of three ringed and smooth bristles each. Group of four ringed and smooth bristles present medially on copulatory organ. Upper lip without any spines. BO a single thick process, sometimes subdivided.

Macroasteropteron chathamensis sp. nov.

(Figs 2–13)

Etymology: The species is named after the area it was collected: the Chatham Rise east of New Zealand.

Material examined

Holotype (female): dissected on one slide (NIWA 71169), shell also mounted on the same slide in a drop of Faure's medium. Collected at site A004, TAN0705/99, Chatham Rise, New Zealand, 10 April 2007, longitude start to end: $-178.4762^{\circ}\text{W}$ to $-178.4830^{\circ}\text{W}$, latitude start to end: -44.5607°S to -44.5592°S , depth = 1076–1103 m.

Paratypes: 2 males dissected on two slides (NIWA 71174), 1 female dissected on one slide (NIWA 71177), shells not kept; 2 valves and soft parts of 1 male mounted on SEM slide (NIWA 71177), 3 juveniles in 80% alcohol (NIWA 71177); 3 females, 4 juveniles in 100% alcohol (NIWA 71174). Collected at site A003, TAN0705/160, Chatham Rise, New Zealand, 16 April 2007, longitude start to end: $-176.7152^{\circ}\text{W}$ to $-176.7042^{\circ}\text{W}$, latitude start to end: -42.7820°S to -42.7817°S ; depth = 1023–1026 m.

Description

Female. Carapace oval in lateral view (Figs 3B, 4B) with both dorsal and ventral margins rounded, ventral one more so than dorsal. Valves closing anteriorly and posteriorly (Fig. 3D) in a conspicuous way. Anterior margin of RV (Figs 4A, D) with square rostral end edged with small marginal teeth. Anterior end of LV (Figs 2A, 3C) with triangular rostral process,

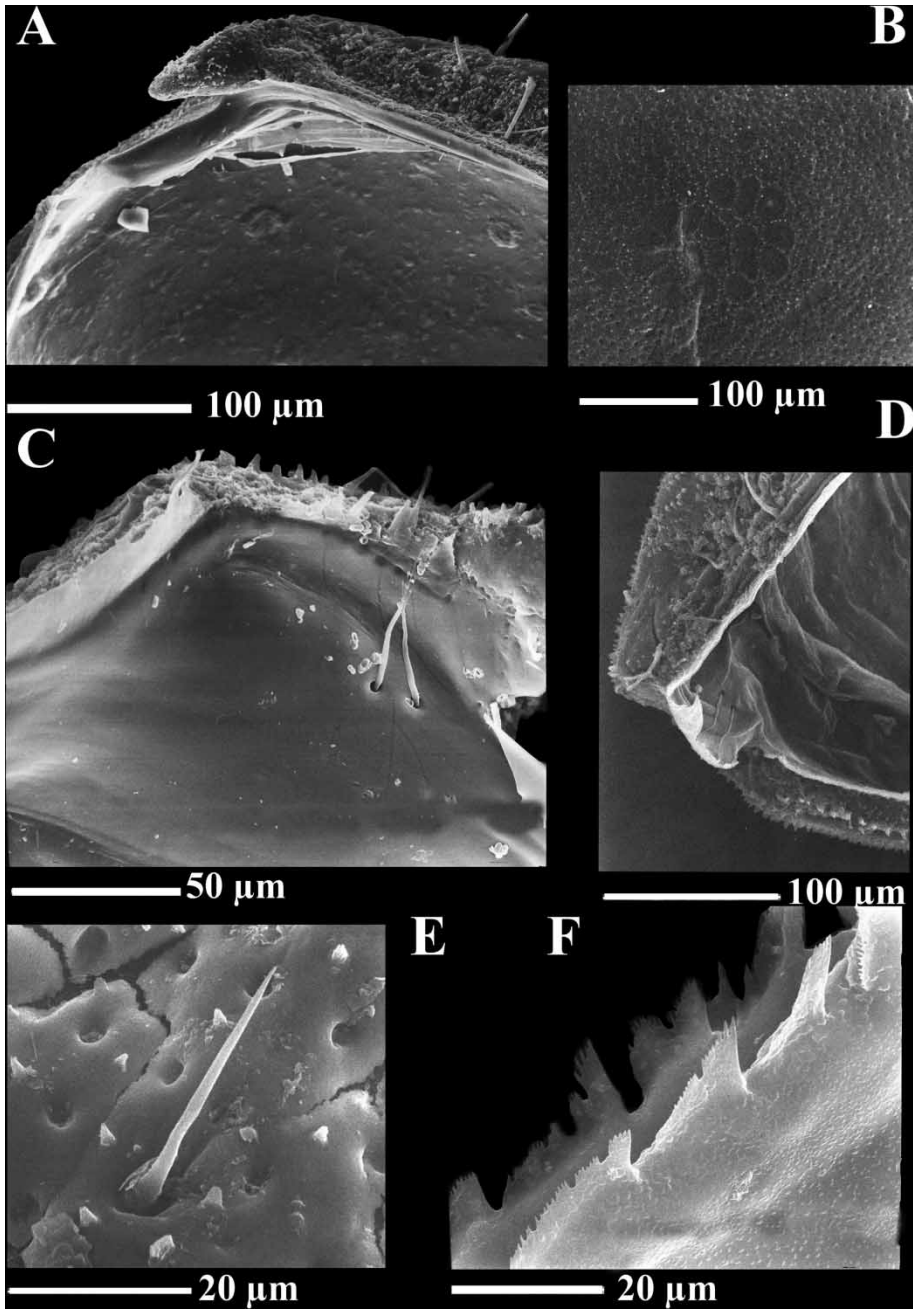


Figure 2 SEM of *Macroasteropteron chathamensis* sp. nov. A–E Paratype, unknown sex (NIWA 71177); F Paratype male (NIWA 71177). A, LV, anterior end, inside view. B, Muscular scar imprints, LV. C, RV, posterior end, inside view, most posterior part missing on the photo. D, RV, anterior end, inside view. E, Detail of the surface ornamentation. F, Posterior margin of the UL, from the proximal to the distal end of the margin.

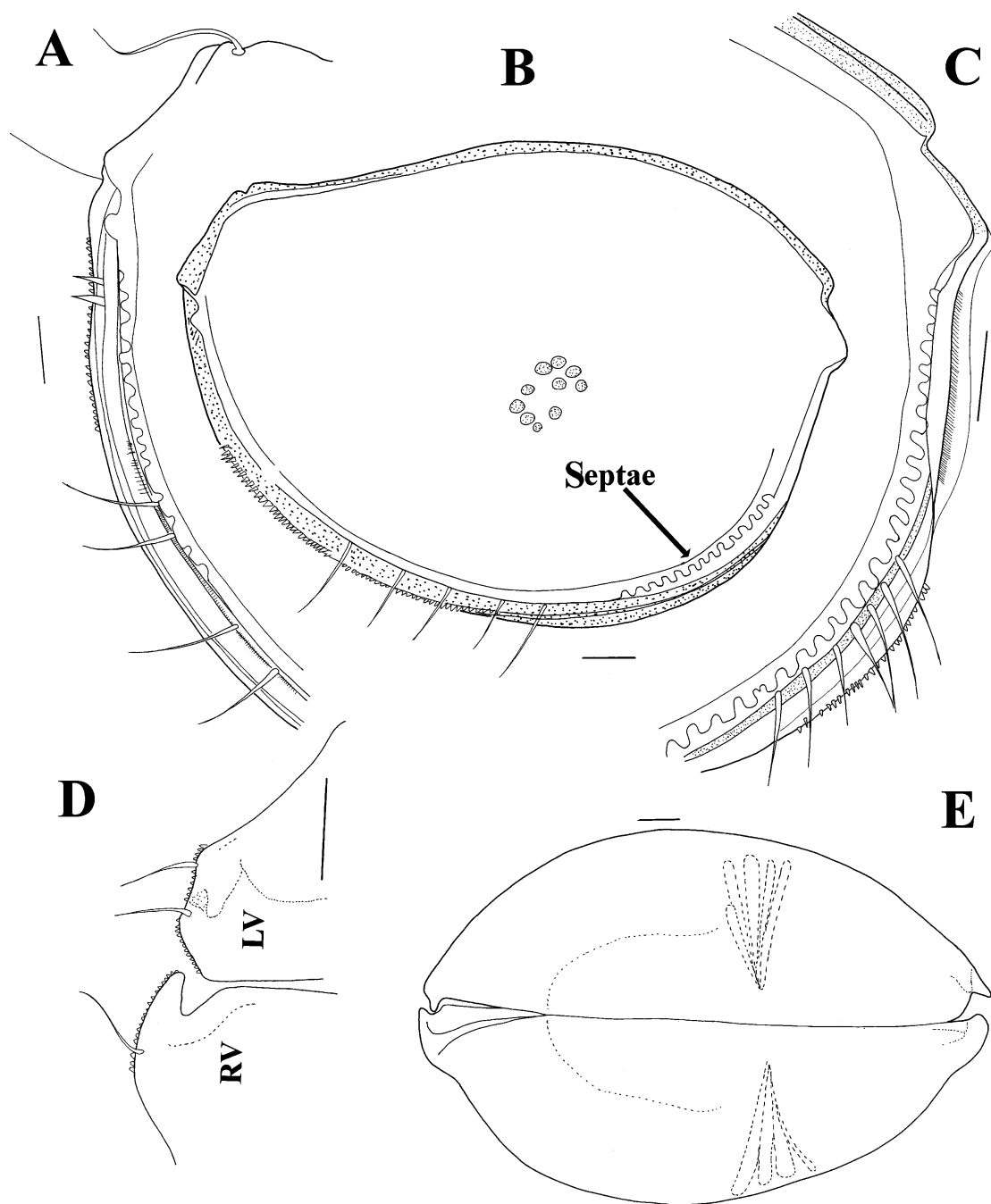


Figure 3 *Macroasteropteron chathamensis* sp. nov. Paratype female (NIWA 71177). **A**, LV, posterior end, inside view, detail. **B**, LV, inside view. **C**, LV, anterior end inside view, detail. **D**, Posterior end of the shell, dorsal view, detail. **E**, Dorsal view of the shell. Scales = 0.1 mm.

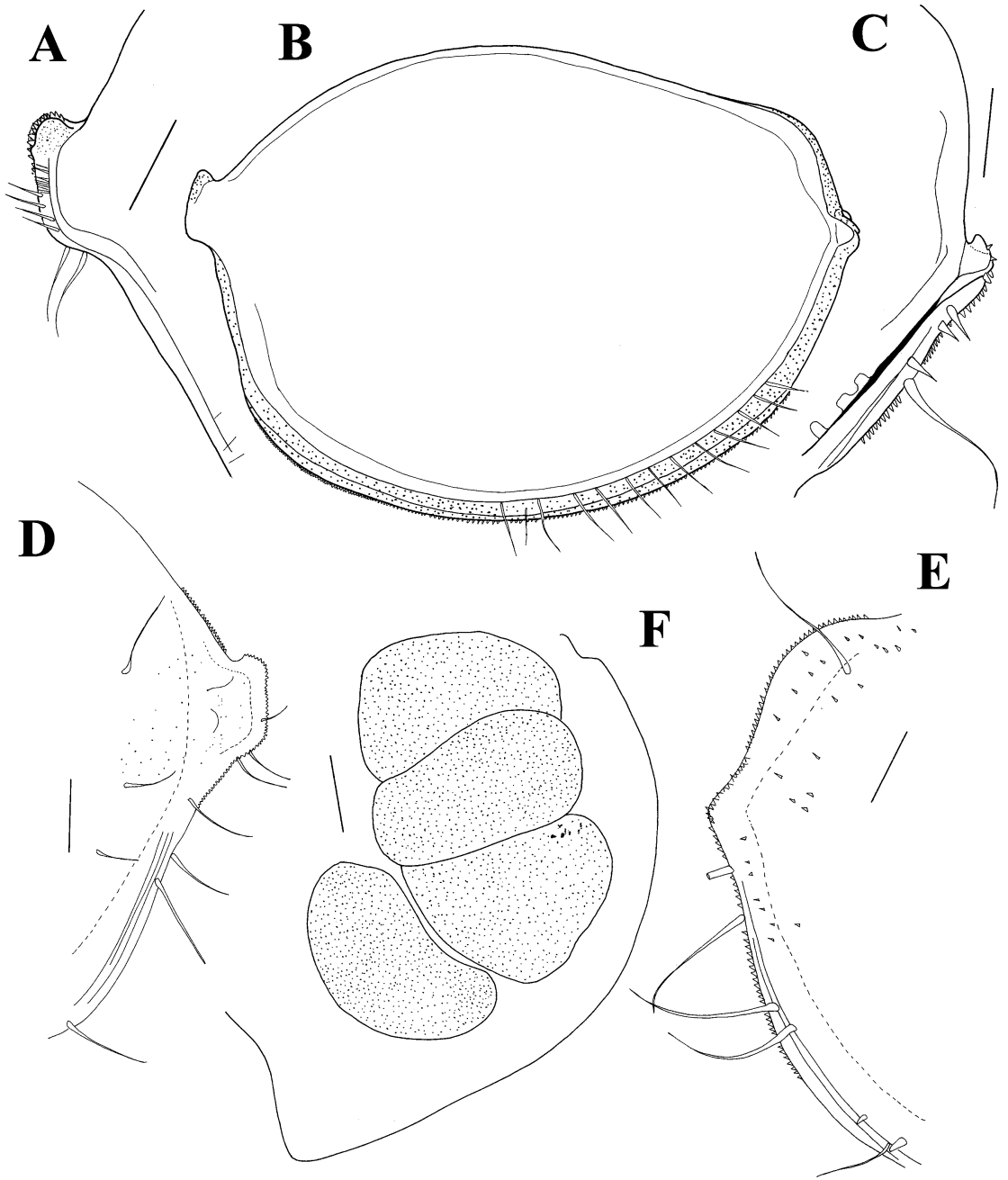


Figure 4 *Macroasteropteron chathamensis* sp. nov. Paratype female (NIWA 71177). **A**, RV, anterior end, inside view, detail. **B**, RV, inside view. **C**, RV, posterior end, inside view, detail. **D**, RV, anterior end, outside view, detail. **E**, RV, posterior end, outside view. **F**, Part of the ovaries. Scales = 0.1 mm.

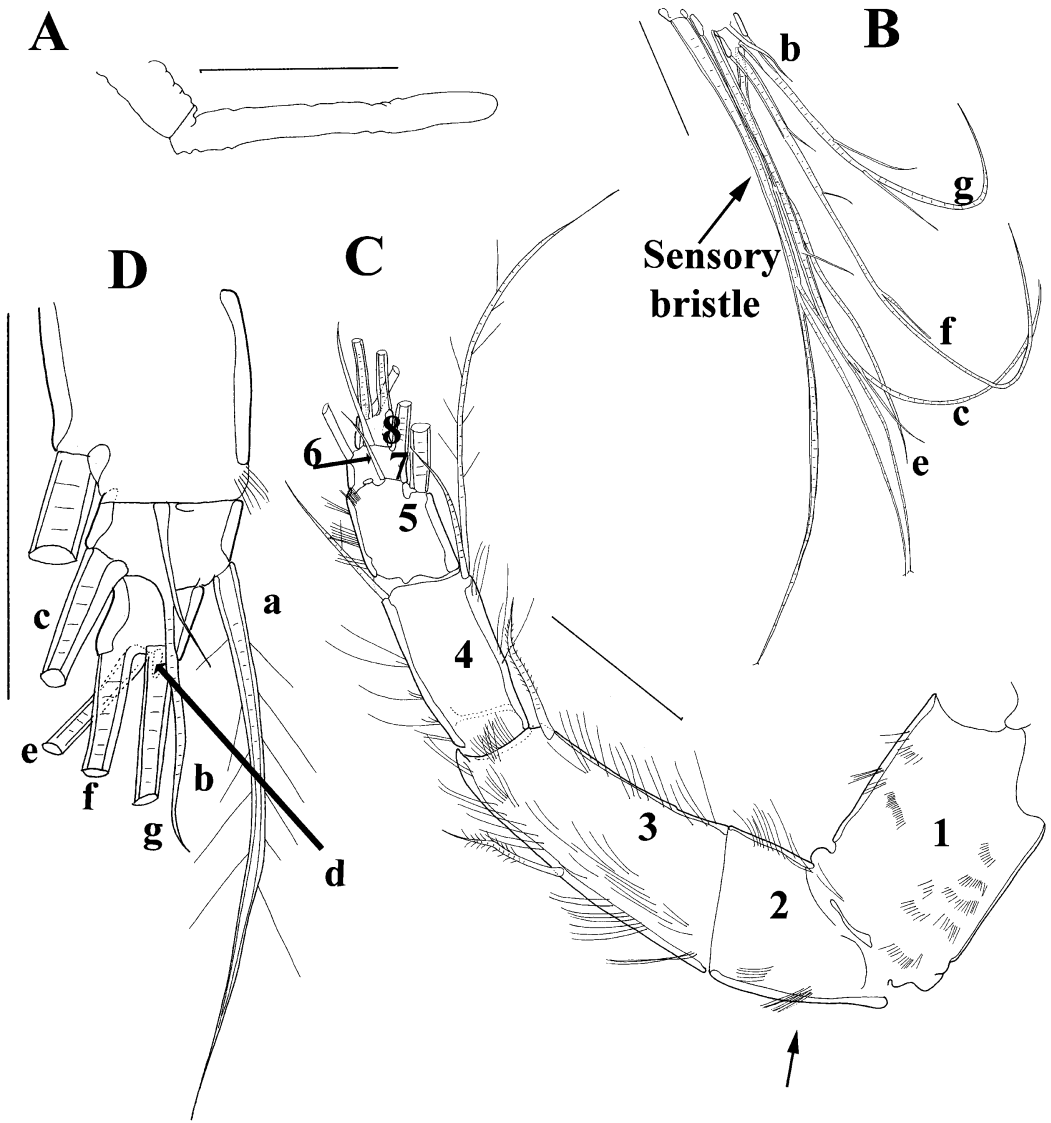


Figure 5 *Macroasteropteron chathamensis* sp. nov. Holotype female. **A**, BO. **B**, Bristles on the segments 5–8 of right A1, b, c, e, f, g, bristles on the segments 7–8. **C**, Right A1, lateral view, arrow pointing the missing dorsal bristle. **D**, Detail of the segments 5–8 of the A1, a–g, bristles on the segments 7–8. Scales = 0.1 mm.

ventral to which lies a row of small, short setulae, and ventral to this row the margin has small spines. Posterior end of RV (Figs 4C, E) with relatively small triangular process, edged also with small spines. Triangular process on RV fits opposite groove on LV when carapace is

closed (Fig. 3D). Posterior end of LV (Fig. 3A) without triangular process, only with the groove. Ventral margins of both valves with continuous row of small spines, LV also with row of tiny setulae. LV with septa-like structure ('scalloped margin?') situated all along the

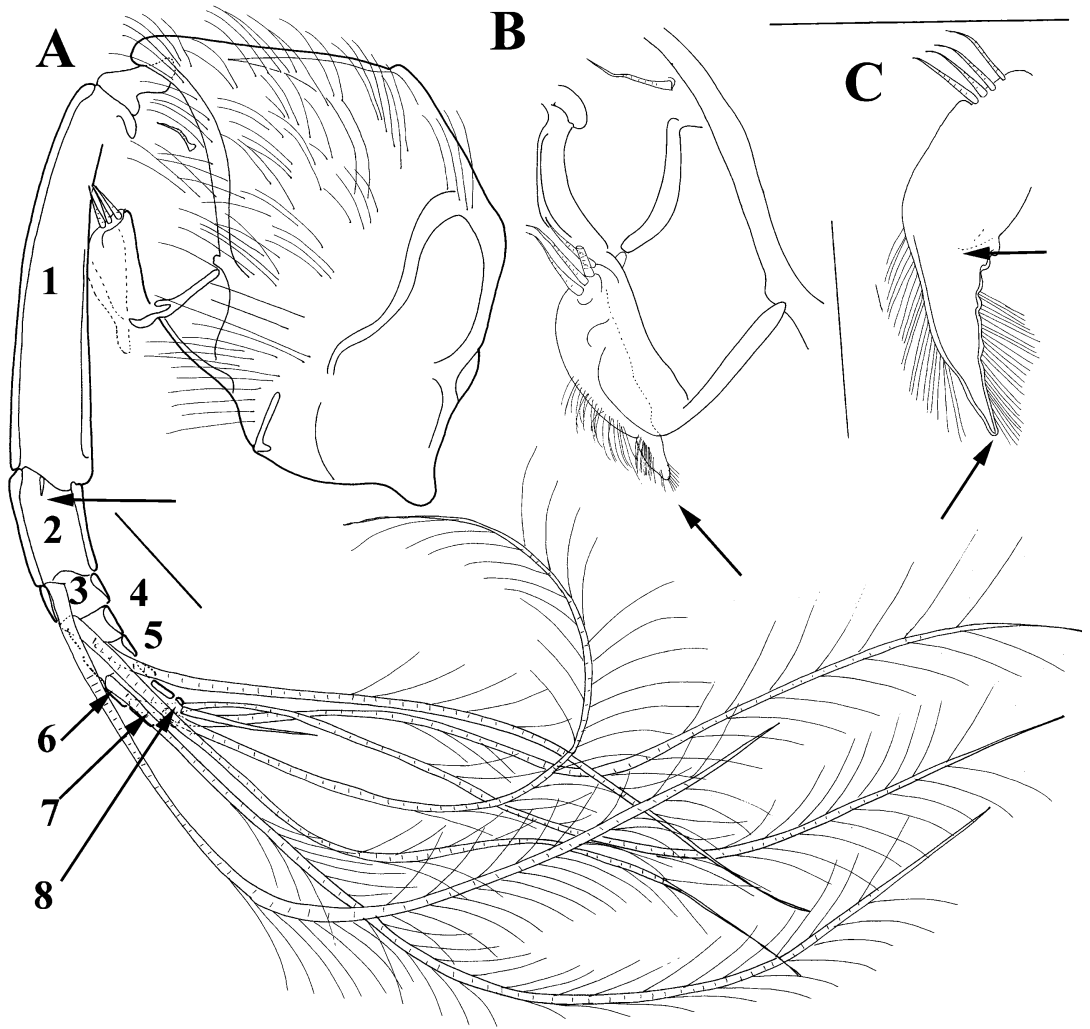


Figure 6 *Macroasteropteron chathamensis* sp. nov. Holotype female. **A**, Left A2, arrow pointing the small bristle on the first segment of exopod, numbers 1–8 showing segments. **B**, Endopod A2, arrow pointing the missing distal bristle. **C**, endopod A2, upper arrow pointing the lack of any suture, lower arrow pointing the lack of distal bristle. Scales = 0.1 mm.

ventral margin (Figs 3A–C). RV without those septa less developed (Fig. 4C). Flange (outer side of the shell which is folded inwardly) well developed and very thick, lined with long setulae, some of which are transformed into longer spines (Figs 3A, 4C and D). Infold of rostrum and also posterior one both with two prominent bristles (Figs 2C, D). Surface of shell rough, with dense, small pits. Sparse setulae also present as well as tiny spines (Fig. 2E). No ridge

or other surface processes present. Central musculature scar (Fig. 2B) consisting of rounded individual scars arranged in rosette. LV = 1.35 mm, H = 0.84 mm; RV = 1.37 mm, H = 0.86 mm.

A1 (Fig. 5): First segment with rows of setulae on lateral and medial surfaces and along ventral margin (Fig. 5C). Second segment with slightly longer setulae on lateral and medial surface and along ventral margin, no dorsal

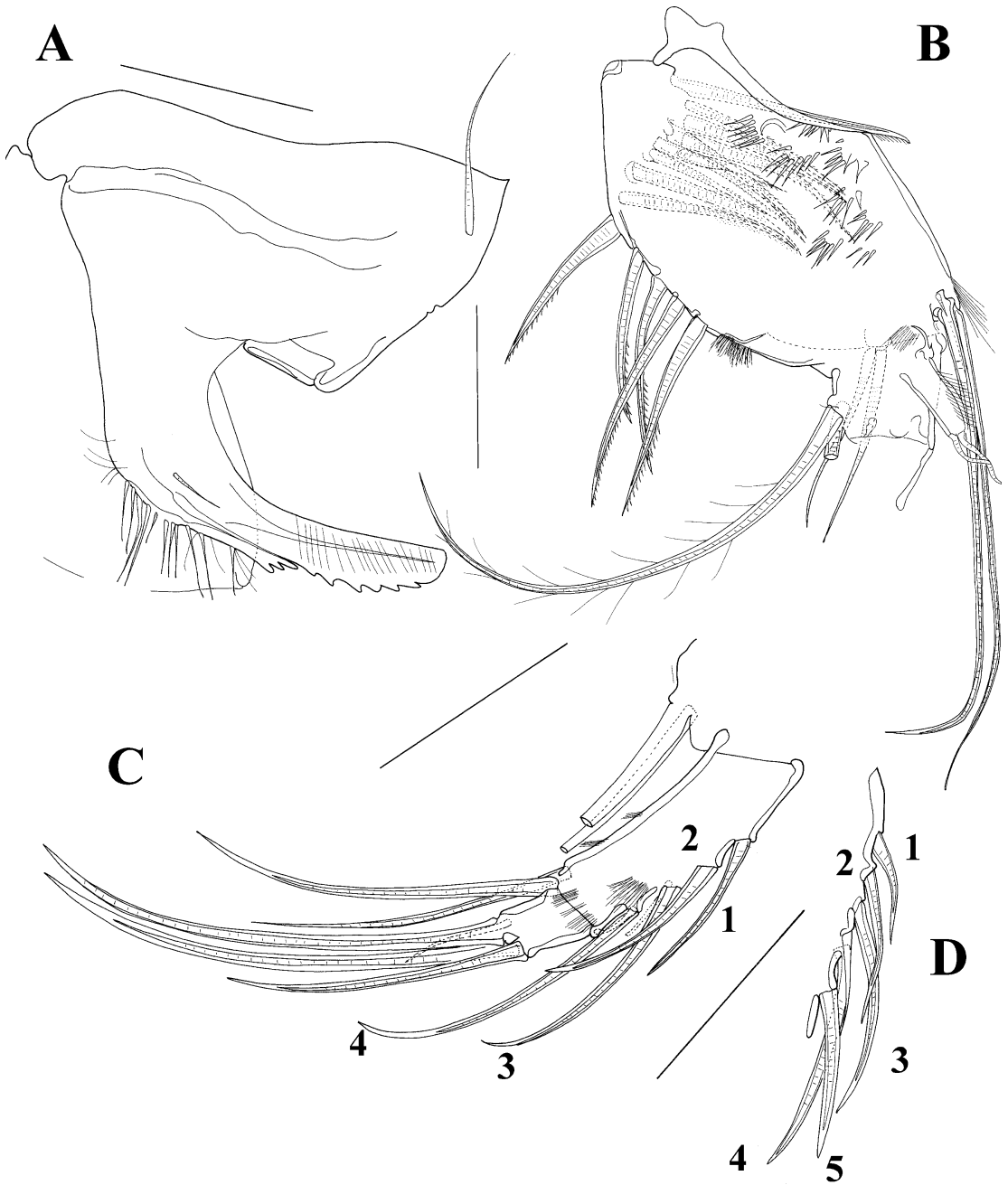


Figure 7 *Macroasteropteron chathamensis* sp. nov. Holotype female. **A**, Coxale endite Md. **B**, Basis, first endopodal segment and exopod of Md. **C**, Second, third and fourth segments of Md endopod, numbers 1–4 showing the main bristles. **D**, Dorsal margin of the second endopodal segment of Md, numbers from 1–5 showing the main bristles. Scales = 0.1 mm.

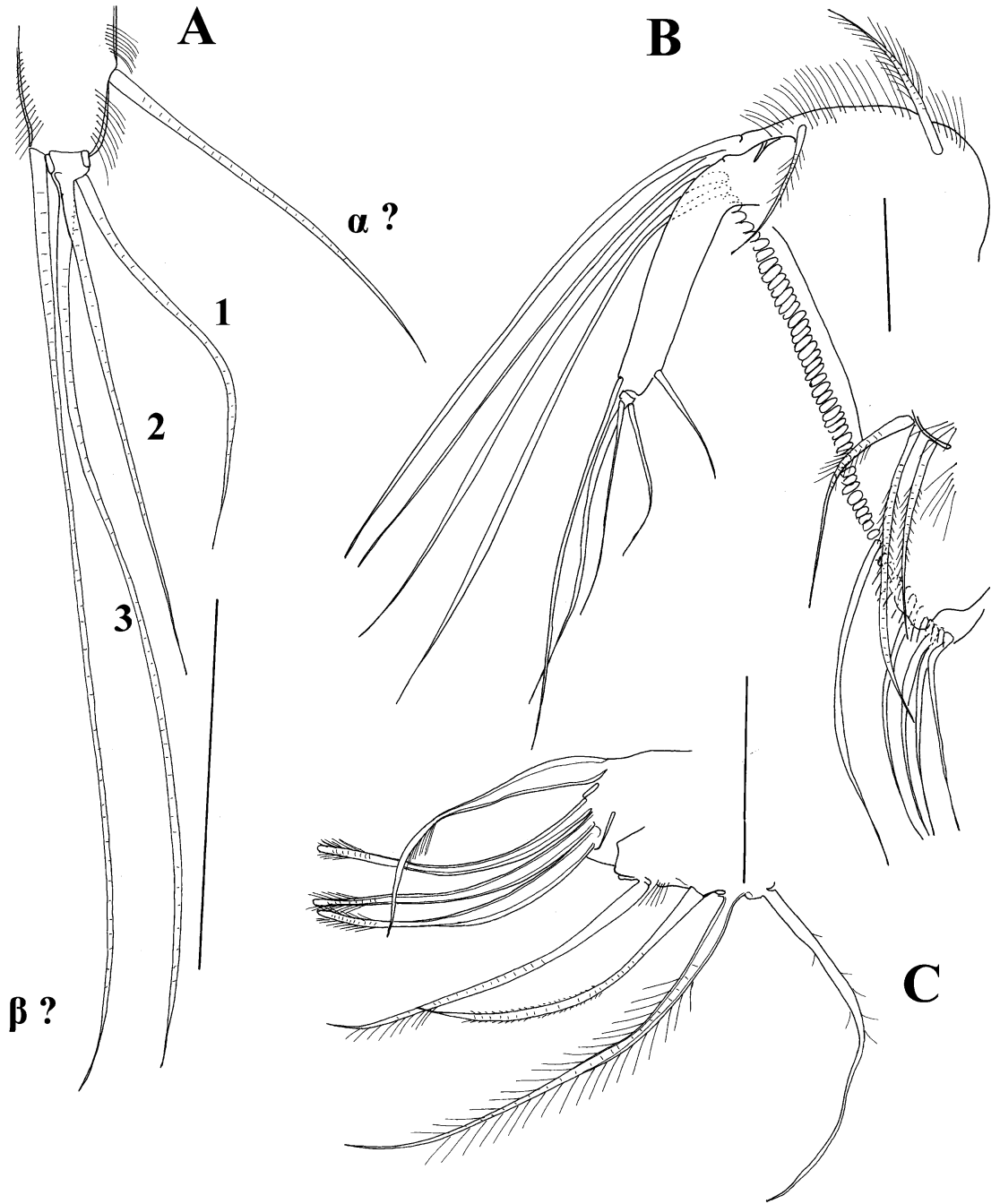


Figure 8 *Macroasteropteron chathamensis* sp. nov. Holotype female. **A**, Distal end of Mxl, part of the first and the second segments, showing the reverse positions of α and β bristles. **B**, Mxl, baleen comb only party presented. **C**, Proximal part and detail of the Mxl coxale. Scales = 0.1 mm.

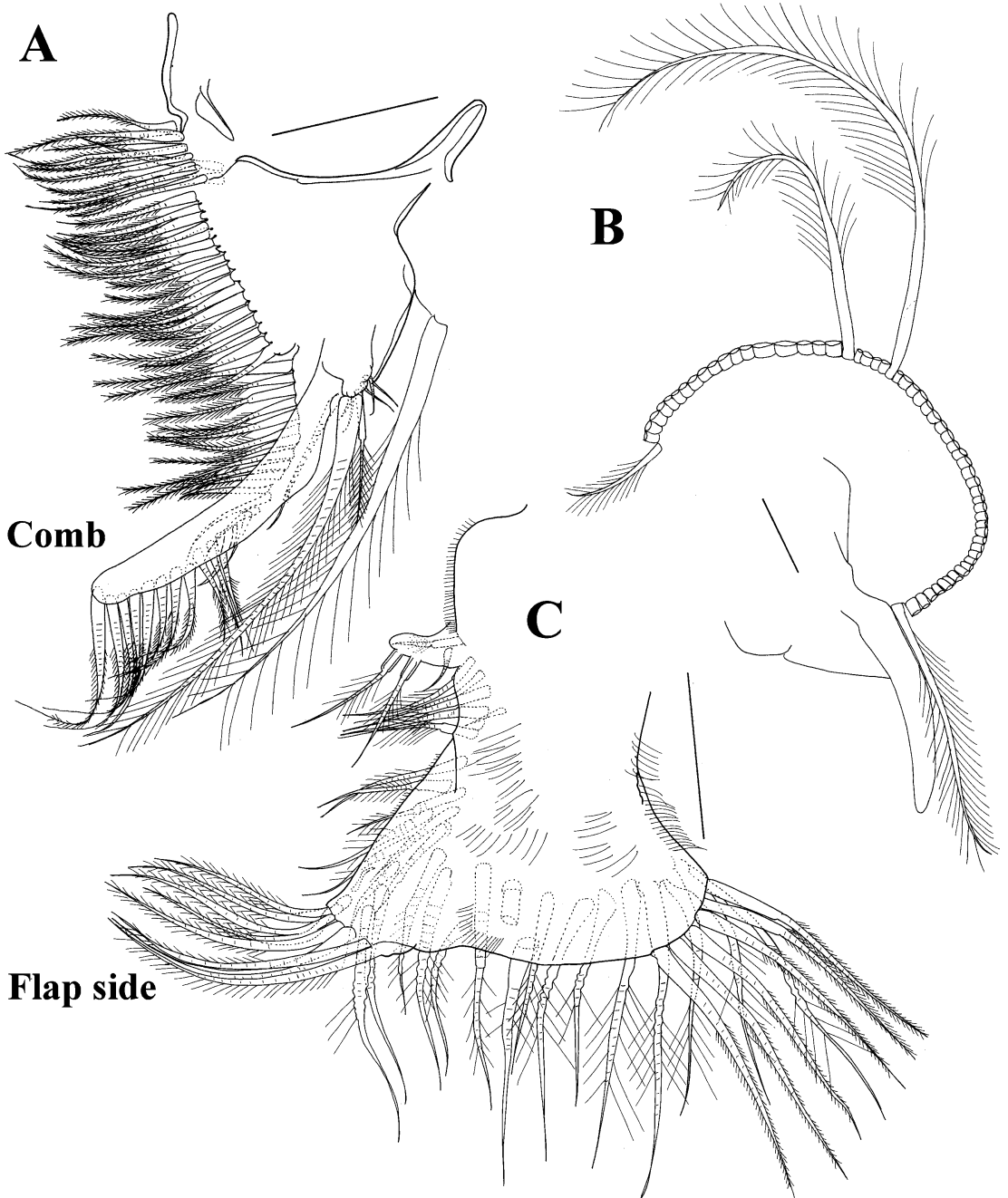


Figure 9 *Macroasteropteron chathamensis* sp. nov. Holotype female. **A**, Left L5. **B**, Epipodite of L6. **C**, Right L6. Scales = 0.1 mm.

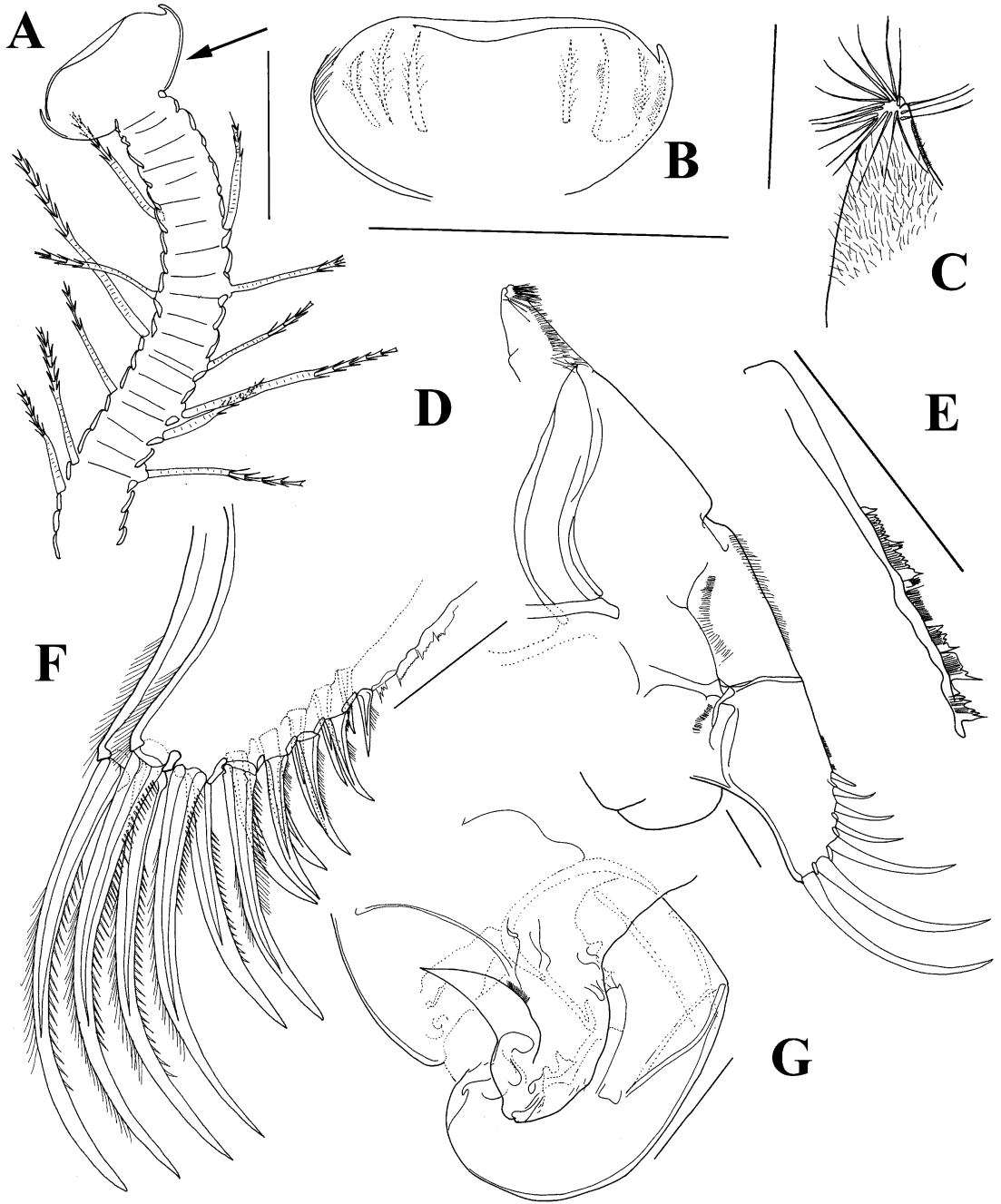


Figure 10 *Macroasteropteron chathamensis* sp. nov. Holotype female. **A**, L7, arrow pointing the missing bell-bearing bristles. **B**, Bulbous ending of L7. **C**, Detail of the posterior end of body. **D**, Left UL. **E**, Detail of the posterior margin of the UL. **F**, UL, proximal part missing on the figure. **G**, Genital apparatus. Scales = 0.1 mm.

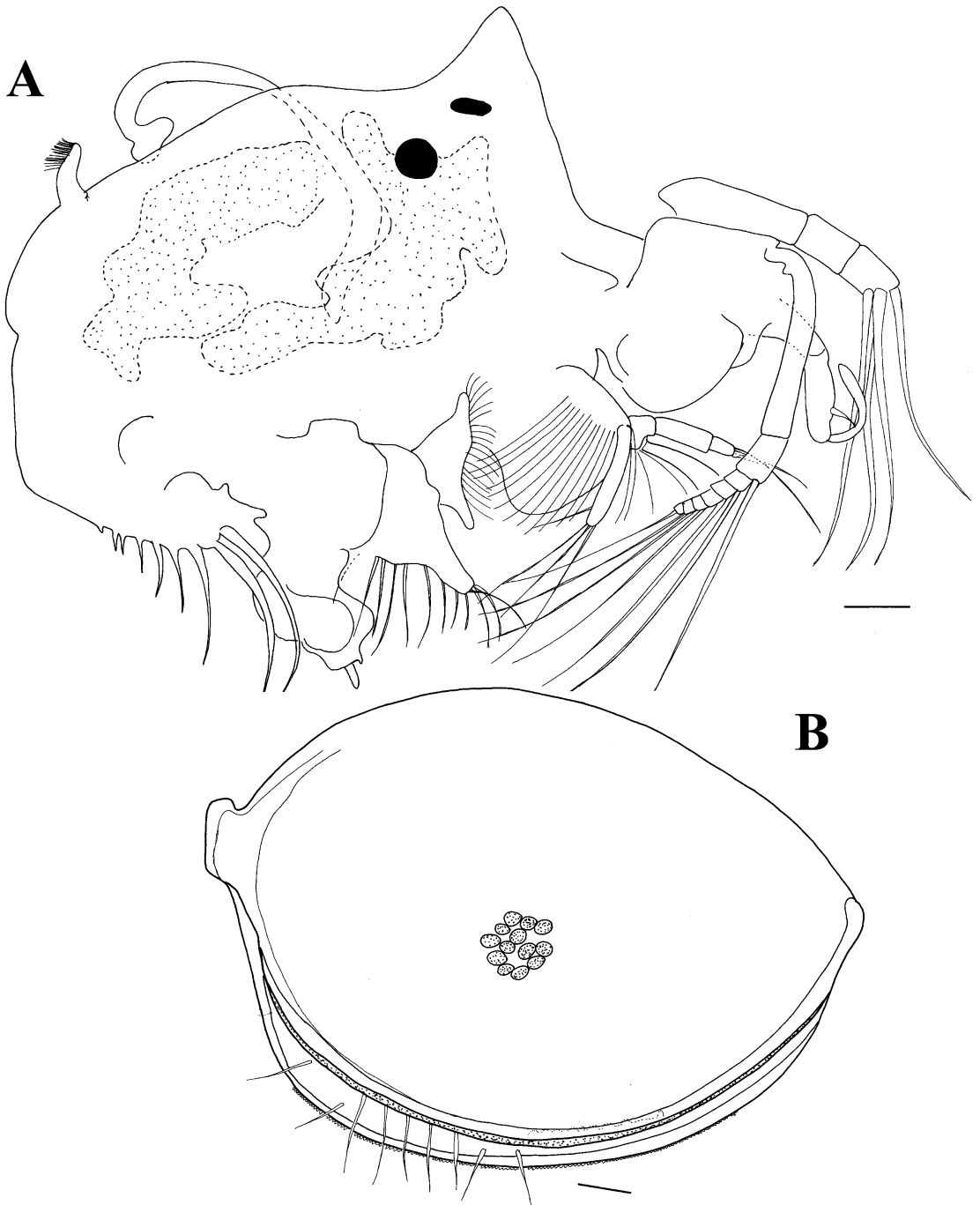


Figure 11 *Macroasteropteron chathamensis* sp. nov. Paratype male (NIWA 71174). **A**, Lateral view of the animal. **B**, LV, inside view. Scales = 0.1 mm.

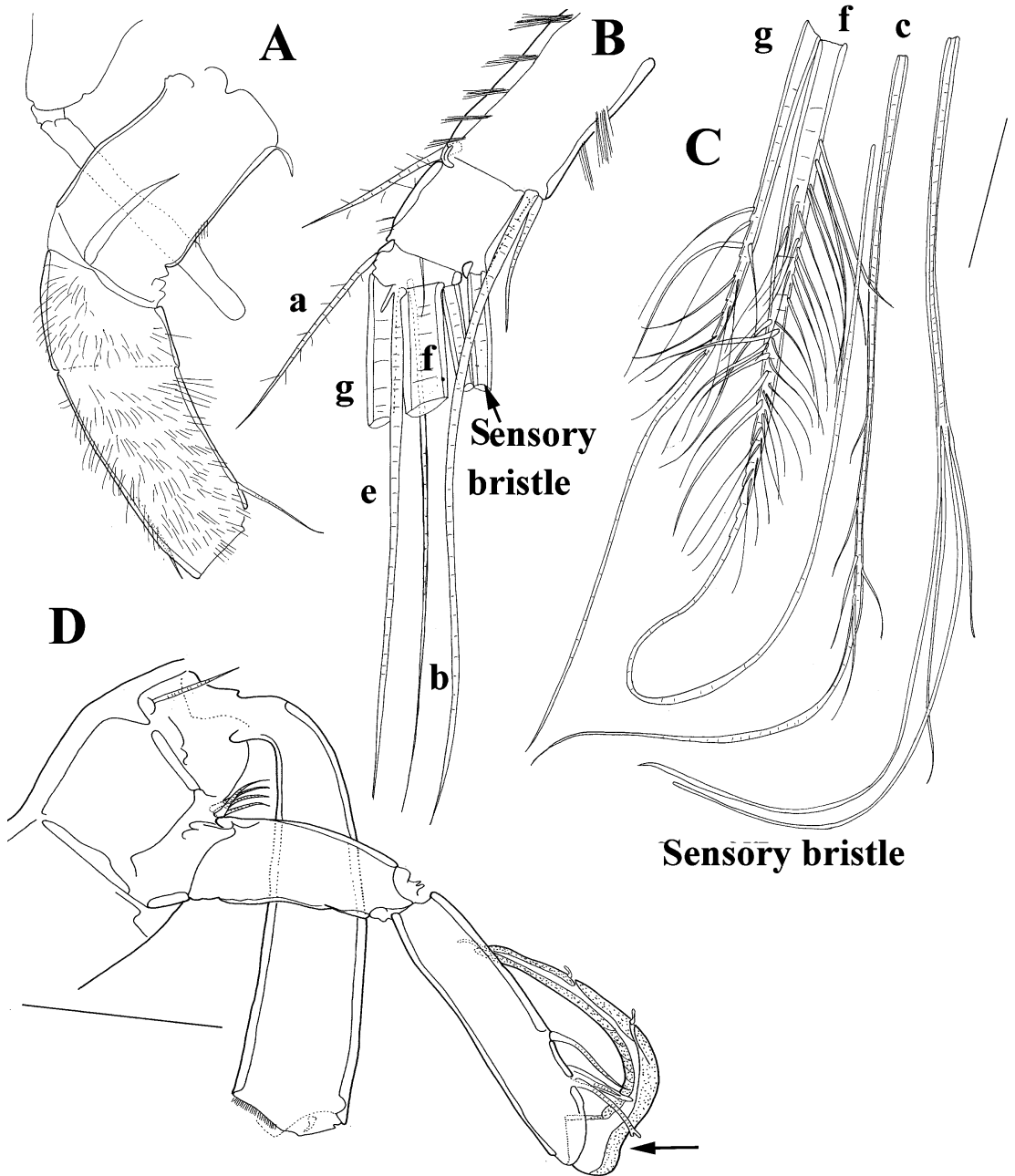


Figure 12 *Macroasteropteron chathamensis* sp. nov. Paratype male (NIWA 71174). **A**, First, second and third segments of the right A1 and BO. **B**, Fourth to eighth segment of the right A1, a, b, e, f, and g setae on the segment 7–8, small bristle ‘d’ not labelled. **C**, Bristles on the segment 5–8 of the right A1. **D**, Endopod of left A2 and part of the exopod, arrow pointing the lack of the bristle. Scales = 0.1 mm.

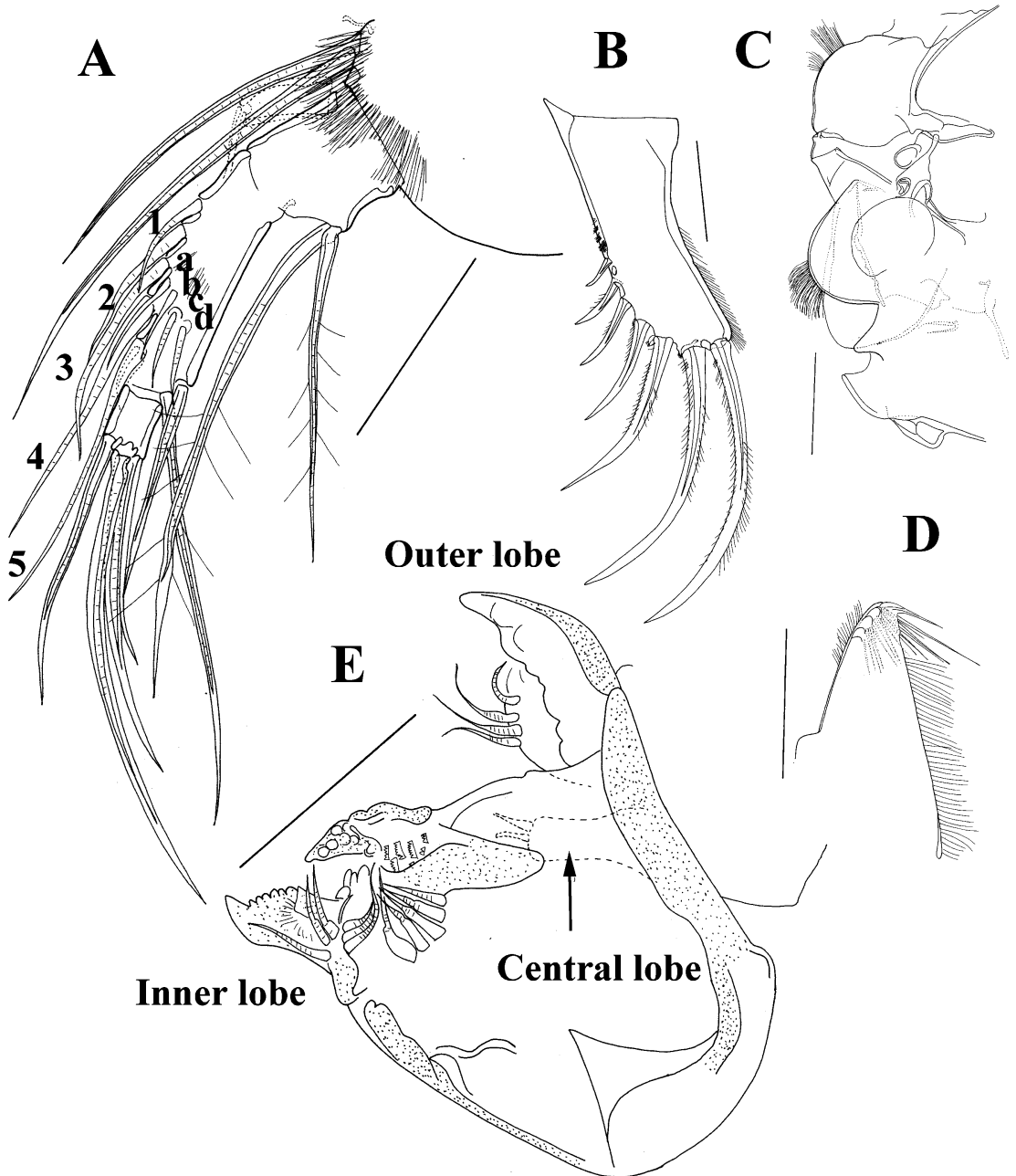


Figure 13 *Macroasteropteron chathamensis* sp. nov. Paratype male (NIWA 71174). **A**, Endopod and exopod, latter dotted, 1–5 showing the main bristles, a–d showing the second row of small bristles. **B**, Right UL. **C**, Upper lip and frontal part of the body. **D**, Detail of the posterior end of the body. **E**, Hemipenis. Scales = 0.1 mm.

bristle present (Fig. 5C). Third segment with long setulae on dorsal and ventral margin and on lateral and medial surface; one ringed bristle present dorso-medially that does not reach distal end of same segment; this bristle with short setulae; one bristle also present ventro-distally; this seta also ringed, with short setulae, overpassing middle of following segment. Fourth segment with three groups of setulae dorsally and two ventrally; one ringed bristle present dorso-distally, overpassing distal end of following segment, this bristle with only scarce setulae; fourth segment also with two ringed bristles ventro-distally, one short, just overpassing distal end of sixth segment, the other longer than combined length of fourth and fifth segments together; only the long bristle with some sparse, and relatively long setulae (Fig. 5D). Fifth segment with one ventro-distal sensory bristle with two lateral filaments situated at middle L of this bristle and very close to each other, not reaching tip of sensory bristle, both filaments and tip of bristle terminally bifurcate; fifth and sixth segments fused (without suture) and with terminal medial very short and bare bristle (usually present on sixth segment), only slightly exceeding distal end of terminal segment. Seventh segment with 'a' bristle spinous, ringed and with long setulae; 'b' bristle reduced, very short, but also ringed; 'c' bristle carrying two lateral filaments: one situated at middle L, the other more distally, both filaments short. Eighth segment very short, with two bristles 'f' and 'g': one with three short filaments, the second with only two filaments but these longer than on accompanying bristle; terminal segment with bristle 'e' well developed and bristle 'd' very small and almost completely reduced (Fig. 5B). L ratios between segments equals: 8:5:8.6:5.7:3.6:1:1.

BO (Fig. 5A): 2-segmented, second segment much longer and with rounded tip. BO reaching first third of third segment of A1.

A2 (Fig. 6): Protopod extremely hirsute (Fig. 6A), with one very short, ringed bristle situated distally on segment. Exopod 8-segmented: first segment longest, carrying only one spine-like

bristle medially on distal margin. Segments 2–7 with one ringed and feathered bristle each; eighth segment with two bristles, one like those on preceding segments, the other very short and bare. Segments on exopod not hirsute. Endopod conical in shape, hirsute: all setulae very long, situated only beyond midlength (Figs 6B, C); endopod with four equally long, ringed, smooth bristles at basis, no other bristles present (Figs 6B, C). Segments on the endopod not visible (Fig. 6C).

Md (Fig. 7): Ventral branch of coxal endite (Fig. 7A) with row of fine setulae proximally (approximately 12), terminating in a tip carrying three equally long spines, and one bristle near its basis; ventral margin of dorsal branch with six nodes, this branch terminating in rounded tip. Basale (Fig. 7B) with group of 10 strong, ringed and finely serrated bristles situated medially; with lateral group of eight clusters of spine-like setulae; ventral margin of basis with five almost equally long bristles, all ringed and with pointed tips, distally carrying small spines (stronger than on more proximal group of bristles), most proximal one may belong to dorsal bunch of bristles; distal to these bristles a bunch of hair-like setulae present. Dorso-distal corner of basis with two, equally long, ringed bristles almost reaching distal end of the second endopodal segment; two additional ringed bristles present medially on distal margin of basis, these bristles twice as long as first endopodal segment. Exopod rectangular, as long as first endopodal segment and distally carrying two worm-like bristles, these not longer than exopod. Endopod 3-segmented (Figs 7B, C): first segment with two ventro-distal bristles, one of them longer and far exceeding distal end of terminal segment, the other bristle slightly shorter; both bristles ringed and carrying sparse, long, setulae. Second endopodal segment with two bristles ventro-distally; these bristles ringed and carrying sparse setulae, one almost reaching tip of longest claw of terminal segment, the other slightly shorter. Dorsal margin with five (Fig. 7D) or four (Fig. 7C) ringed spine-like bristles;

if five, then one additional short non-ringed bristle present, beyond the spine-like bristle (counting from proximal end); if four, then two short, sensory-type bristles present: one following third claw, the other parallel to fourth bristle. Terminal segment with two central claws that are subequally long; dorsal to these claws is one more claw about half as long, and ventral to two main claws is a short, smooth bristle. L ratio between the three terminal claws (dorsal–ventral) 1:1.5:1.5.

Mxl (Fig. 8): Epipod (not shown in the figure) conical, possibly with thin suture dividing last third, epipod reaching only to $\frac{1}{4}$ of basis. Endite I of coxa with four long bristles: the proximal-most spinous, with bunch of setulae only medially, this bristle not ringed; three other bristles ringed only in distal third, with setulae covering only that part; tips of these three bristles rounded. Endite II with four bristles: the proximal-most ringed in lower two-thirds, with a row of setulae on the last third; the following bristle ringed in almost the same way, but covered with very small setulae from middle L downwards; the following bristle spinous, almost entirely ringed, also with long setulae; distal-most distal bristle not ringed, with only sparse setulae in first half (Fig. 8C). Basis with group of three long bristles lying distally and medially on segment: these bristles ringed and covered with short setulae. These three bristles not present on other Mxl, and on other specimens only one, therefore possibly two of these three bristles belong to baleen comb, or coxa. Baleen comb strongly developed (Fig. 8B), extending beyond first endopodal segment. All bristles of comb smooth, not ringed, of approximately same L and distally swollen. Approximately 58 such bristles in all. Dorsally on basis one distal and one proximal bristle. Dorsal margin of basis hirsute. Exopod not present. Endopod 2-segmented. First segment elongated, with one short bristle (alpha-bristle) on posterior side and long terminal (beta) bristle on anterior side (Fig. 8A). Both these bristles ringed but smooth. Terminal segment minute, with three ringed bristles. One

of them twice as long as other two. All bristles on terminal segment smooth. Penultimate segment also hirsute.

L5 (Figs 9A, B): Epipod with approximately 58 bristles, all heavily feathered (Fig. 9B). Comb with 27 ringed bristles lying along dorsal margin, all covered with short setulae. Dorsal to comb a group of seven bristles present: one of the bristles very long, reaching distal end of comb; one bristle also ringed and covered with setulae but much shorter, and five very short, smooth bristles. Distal to comb, ventral margin of L5 with row of densely lined ringed and plumed bristles.

L6 (Fig. 9C): Protopod an almost continuous row of 11 ringed and plumose bristles. Proximal process on Fig. 11A only an artefact of dissection, not present on other leg or other specimens. Endopod armature can be divided into three layers: bristles originating more medially on segment (22); bristles on anterior flap (eight); and bristles originating from margin (six), lying only on posterior end of appendage. All these bristles ringed and covered with setulae: setulae on medial bristles much longer, but sparser than on flap, while setulae on posterior end are very short and dense. L6 very hirsute.

L7 (Figs 10A, B): Vermiform with distal part carrying four recurved spinous teeth on each side. Bulbous terminal part without any bell-bearing bristles. Six bristles on each side of distal part of L7, each terminating in 3–6 bell-like structures.

UL (Figs 10C–F): Lamellae asymmetrical: left lamella with seven and right lamella with eight claws (Fig. 10F); all claws of primary type, covered on their posterior side with spines, and on anterior side with thin setulae. Claws decreasing in L towards posterior end (Fig. 10D). Following last claw, margin of UL with four groups of serrated processes: each group consisting of 2–5 in-groups separated from each other by a small depression and groups lying proximally lower than distal groups (Fig. 10E). Body terminating in conspicuous extension (Fig. 10C), densely hirsute

proximally, with a bunch of setulae distally. Each UL can also bear seven claws.

Upper lip: Consisting of 2 hirsute lobes.

Genital field (Fig. 10G): Well chitinised, rounded process frontal to UL. This structure without canals, but with numerous different chitinised structures.

Lateral eye: Present and small.

Medial eye: not observed.

Male (Figs 11A, B). Carapace (Fig. 11B): Slight sexual dimorphism present, postero-dorsal margin slopes more in male than in female, and the ventral margin has more prominent flange zone. RV = 1.28 mm, H = 0.83 mm; LV = 1.26 mm, H = 0.8 mm.

A1 (Figs 12A–C): First and second segments without any bristles (Fig. 12A). First hirsute ventrally, second and third on entire surface. Third segment with one medio-dorsal bristle and one ventro-distal. Fourth segment (Fig. 12B) with two ventro-distal bristles: one much shorter than other, ringed and smooth, and one short ringed dorso-distal bristle. Fifth segment with one sensory ventro-distal bristle (Figs 12B, C), this medially divided in four filaments, two long and two short. Bristle representing sixth segment present. Seventh and eighth segments completely fused. Bristle 'a' short, spinous, ringed; bristle 'b' thin, but ringed; bristle 'c' (Fig. 12C) with five short filaments medially. Both 'f' and 'g' bristles with filaments, the former much thicker and with longer and more numerous filaments than the latter bristle (Fig. 12C).

A2 (Fig. 12D): Protopod and exopod as in female. Endopod 3-segmented. First segment carrying four short ringed bristles. Second segment dorso-distally with three bristles: most proximal one simple, ringed and smooth; next one thick, claw-like, smooth; distal-most one ringed and thin, with subdivided tip. Terminal segment elongated and reflexed on second segment with three bristles: two on dorsal margin and one on its tip.

Md (Fig. 13A): Some sexual dimorphism noticed. Five main bristles present along distal margin. Above fourth bristle a row of four short bristles (a, b, c, d) extending medially on

segment; also two similar small bristles present parallel to fifth bristle. In comparison to female, claws on terminal segment appearing stronger and L ratio between them different than in female. L ratios between the claws (dorsal to ventral) 1:1.7:1.1.

L7: Number of bell-like bristles different than in female: one male with five on each side, other with four.

UL (Figs 2F, 13B): Similar to female, but both lamellae always with seven main claws. Claws and lamellae ornamented in same way as in female. Body also terminating in conspicuous process (Fig. 13D).

Copulatory organ (Fig. 13E) of two parts. Anterior part (outer lobe) with well chitinised anterior-most margin, distally with four short, ringed bristles. Distal to these a cylindrical process present carrying two bristles distally (central lobe). Posterior part (inner lobe) of copulatory organ more complex, with two distal extensions, both with a row of 7–9 teeth; more anterior additionally with seven groups of serrated plaques; more posterior one with two groups of three ringed, smooth bristles. Group of four ringed and smooth bristles present medially on copulatory organ main body.

Upper lip (Fig. 12C): Appearing smaller than in female.

Other appendages same as in female.

Remarks. The new species differs from *M. mindax* Kornicker, 1994 from New South Wales in having a more pronounced, square rostral incision on the RV. The new species has two undivided bristles on both the rostral and posterior infolds, while only the rostral infold carries two divided bristles in *M. mindax*. The two species also differ in the structure of the sensory bristle on the fifth segment of the A1: there are only two lateral filaments in the new species, three in *M. mindax*, the proximal filament is missing in the new species. The morphology of the A2 is also quite different. The endopod of the female A2 is unsegmented in *M. chathamensis* sp. nov. and does not have any bristles except at the basis of the first segment, while in the other species the sutures

between segments are prominent and sometimes there can be a small bristle on the distal margin of the second segment and some probable sensory-type small bristles on the terminal segment. The new species has no bristles on the first segment of the exopod A2, unlike the Australian species, in which there is a '1st joint with small, slightly curved, tubular, medial, terminal bristle' (Kornicker 1994: p. 184). It is, however, possible that what Kornicker was referring to is the same structure found in *M. chathamensis* on the second segment, and that he probably erroneously labelled the second segment as the first one. Unfortunately, Kornicker (1994) did not provide any drawing of this character. The Australian species has nine exopodal segments, and the last one carries three bristles. In the new species, there are only eight segments and the terminal one has two bristles. There are also some differences in the morphology of the Md endopod, especially the dorsal side of the first endopodal segment, the number of basal bristles on the Md and the number of bell-like bristles on the L7, but these are found to be variable in *M. chathamensis*, so they need to be taken with caution, although there is no overlapping of variation in the new species and the number of bristles in *M. mindax*. Finally, the New Zealand species has seven claws on the UL, and although in the Holotype female one lamella has seven while the other has eight claws, there are only seven claws on both lamellae in all other specimens examined. The Australian species has eight claws on both lamellae. Unfortunately, the males of *M. mindax* are unknown, so the comparison between the male sexual characters is not possible. Kornicker (1994) states that the Australian species lacks the lateral eye, but it has the medial one, while the new species has a clear lateral eye, and we could not observe the medial one.

Discussion

Macroasteropteron mindax was described from only one female specimen, and in the descrip-

tion Kornicker (1994) noticed that the alpha bristle on the first segment of the Mx1 endopod is positioned posteriorly while the beta bristle is positioned anteriorly. In all other representatives of the family Cylindroleberididae the position of these two bristles is opposite. The difference between the alpha and beta bristles is in their position on the segment's margin and their L: alpha is much shorter and situated close to (but not at) the distal margin of the first endopodal segment, while the beta-bristle is much longer and always situated distally on the same segment. Kornicker (1994) discarded the possibility that the appendage was twisted on the slide, since both left and right Mx1 had the same bristle orientation. Therefore, he referred this to the possible abnormality of the specimen. The new species, *M. chathamensis* sp. nov., has the same position of the Mx1 bristles as in *M. mindax*. We have checked this character on each dissected specimen and on both left and right Mx1. In the present paper, we decided to keep the names 'alpha' and 'beta' for the two bristles in question, but they are probably not homologous with the equivalent bristles in other representatives of the family. The second unusual morphological feature of this species was, according to Kornicker (1994), the appearance of the L6. In *Macroasteropteron* L6 has a very short end joint lacking processes. All the other representatives of the family have (at least at one end) an extension on the so-called 'skirt', whereas in *Macroasteropteron* the skirt is almost square (Fig. 9C). It is worth noting that the appearance of the skirt is more similar to Cylindroleberidinae than to the other two subfamilies.

The generic diagnosis included, among other features: a locking system on the valves; the second segment of the A1 is very short and without a dorsal bristle; and the terminal segment of Mx1 carries three bristles. No further comments on these outstanding character combinations were given, in spite of the fact that the three known subfamilies are divided on the basis of the last two characters—one dorsal bristle on the second

segment of A1, and one (rarely two) on the terminal segment of the Mx1 protopod in *Cylindroleberidinae*; and two or more dorsal bristles on the A1, and 3–7 distal bristles on the Mx1, in *Cyclasteropinae* and *Asteropteroninae* (Poulsen 1965; Kornicker & Caraion 1974; Kornicker 1975, 1981a, 1986). Instead, Kornicker (1994) included *Macroasteropteron* in the subfamily *Asteropteroninae*.

In Syme's (2007) cladistic tree of the family *Cylindroleberididae*, *Macroasteropteron* clusters within the *Asteropteroninae* and is the sister taxon of the paraphyletic *Asteropterygion* Kornicker, 1981/*Actinosetosa* Kornicker, 1958 group. The presence of the locking system on the valves and the position of the alpha and beta bristles on the Mx1 were not coded. Indeed, if these characters are ignored, it is very easy to assume that *Macroasteropteron* has lost all dorsal bristles only from the second segment of A1 but retained the number of terminal bristles on the Mx1, common for the subfamily. However, if we look more closely at the other details of the shell (lack of strong ornamentation and lateral processes, for example), the structure of the A1, and chaetotaxy of the endopod A2 (in both males and females) and L7, it is easy to come to the conclusion that, in fact, the position of *Macroasteropteron* in the *Asteropteroninae* adds to the polyphyletic nature of this subfamily and that a new subfamily, *Macroasteropteroninae*, needs to be created to accommodate this genus.

The unusual locking system in *Macroasteropteron* is present both anteriorly and posteriorly on the valves, but it is indeed more pronounced on the posterior end. No anterior locking system has ever been recorded in any representative of the family *Cylindroleberididae*, while the dorsal, complex, locking system that extends to the posterior end is described in the asteropteronin genus *Asteropterygion* (see Kornicker 1981, plates 124–132, 134C, 146a). In this genus, LV dorsally overlaps the RV, while in *Macroasteropteron* the RV overpasses the LV caudally and no dorsal locking system is

present. Most of the asteropteronin representatives are heavily ornamented with nodes and ridges, sometimes extending well beyond the shell margins, and *Macroasteropteron* does not have coarse ornamentation except for the pits on the surface. The muscular scar imprint is indeed much more similar to *Asteropteroninae* than to the other two subfamilies, and it consists of rounded individual scars.

The exceptional features of the A1 include not only that lack of dorsal bristles on the second segment, but especially its unusual shortness and the shape of the third and fourth segments. In all other species of the family, the two segments are conical while in *Macroasteropteron* they are square and resemble the A1 of the families *Rutidermatidae* and *Sarsiellidae*. The second segment also lacks lateral bristles, while in other subfamilies there are one or two. The 'a' bristle on the seventh segment is very poorly developed, as in the asteropteronin genera *Microasteropteron* Poulsen, 1965 and *Pteromeniscus* Kornicker, 1981 and the cyclasteropin genus *Alphaleberis* Kornicker, 1981. The sensory bristle ventrally on the fifth segment A1 is quite similar in both sexes, which is rare in the family but still present in *Actinoseta* Kornicker, 1958 (*Asteropteroninae*) and *Homasterope* Kornicker, 1975 (*Cylindroleberidinae*).

The endopod of female A2 lacks bristles on the last segment, which is shared with *Microasteropteron*. In all the other species of the subfamily, there is always one (rarely two) bristle. In the description of *Macroasteropteron mindax*, Kornicker (1994) mentioned a very short process distally on the third segment, but this looks more like a sensory structure and it is not present in *M. chathamensis*. The male endopod also lacks the dorsal bristle situated proximally on the terminal segment of the clasping organ, which is present in all other *Cylindroleberididae* species for which the males have been described. Whether it is present in *Microasteropteron* is not known, since the species are based only on the females.

The last autapomorphic feature of the new subfamily is the appearance of the terminal part of L7, which is bulbous and without any bell-bearing bristles on its margins. The morphology of this part of L7 is a generic character in the family, and the general shape somewhat resembles the state in *Asteropella* Poulsen, 1965, although the terminal process is not that bulbous, but in this genus there are always some bell-bearing bristles.

We did not observe the gills of the new species, while Kornicker (1994) described three rudimentary gills in *M. mindax*. Gills are usually present in the entire family, but sometimes they can be reduced, or absent, as in the tribe Bruniellini (subfamily Cyclasteropinae) proposed by Kornicker & Harrison-Nelson (2005).

The posterior of the body terminates in a prominent finger-like process as in the Asteropteroninae, *Microasteropteron* excepted, in which this process is more similar to the other two subfamilies.

Many species are known only from females, the reason partly being because the males are smaller and may be overlooked in samples. Even if they are known, however, no illustration or description of the male copulatory organ is provided, and only the secondary sexual characters (endopod A2, sensory bristles on A1, bristles on the shell) are known. According to the available data, the copulatory organ of Cyclasteropinae is very small (Cohen & Morin 1990, Fig. 3A), whereas it is well pronounced and prominent in the new subfamily (Fig. 9B) and bears some resemblance to Sarsiellidae. There is always little or no information on the copulatory organ of Myodocopa in general. This is unfortunate, because the copulatory apparatus in both males and females may carry important phylogenetic information, especially as in Ostracoda they may have originated from the fusion of several appendages (Martens 2003; Tsukagoshi et al. 2006), and careful study of its structure may yield some useful conclusions regarding the homology of ostracod appendages.

Considering the morphological characters of the four subfamilies, we think that the new subfamily is most closely related to Asteropteroninae. We also think that the phylogenetic tree presented by Kornicker (1981), in which Asteropteroninae is the sister taxon of Cyclasteropinae and Cyclasteropinae, is more correct than the one proposed by Syme (2007), in which the Cyclasteropinae and Asteropteroninae cluster together. Recently Syme & Oakley (in press) proposed a phylogenetic tree of the family, combining molecular and morphological data, and in that tree Asteropteroninae is a sister taxon of Cyclasteropinae and Cyclasteropinae, although the latter two subfamilies are polyphyletic. The phylogeny of the family is far from being resolved. The tree constructed from molecular data (Syme 2007) gives even less information on the relationships between the subfamilies, and two genera of Cyclasteropinae cluster on two different branches of the tree—*Leuroleberis surugaensis* Hiruta, 1982 is a sister taxon of *Cylindroleberis* (Cylindroleberidinae) while *Tetraleberis* sp. clusters within Asteropteroninae. It is interesting to note that the same results were given in Syme & Oakley (in press), with the difference that they had molecular data for one more *Leuroleberis* species, while the molecular data for *Tetraleberis* are the same. The morphological difference between *Leuroleberis* Kornicker, 1981 and *Tetraleberis* Kornicker, 1981 is so great that Kornicker (1981) placed the two genera in different tribes, Tetraleberidini and Cycloleberidini. In our opinion the diagnoses for Asteropteroninae and Cyclasteropinae are too broad. The latter definitely needs to be revised and the tribes should probably be raised to subfamily levels. In fact, Cyclasteropini and Cycloleberidini were already subfamilies (Poulsen 1965; Hartmann 1974), but did not include the same genera.

The new species and *M. mindax* were both collected from depths close to 1000 m, which is very unusual for the subfamily Asteropteroninae, but not so for the Cyclasteropinae. The new subfamily seems to be endemic to the southwestern Pacific.

Key to subfamilies of Cyindroleberididae

The key is modified after Kornicker (1981) to accommodate the newly described subfamily.

- | | | |
|----|---|--------------------------------------|
| 1. | Surface of carapace usually ornamented, second segment of A1 very short and without bristles, third and fourth segments square, alpha bristle positioned posteriorly on first segment of Mx1; terminal segment of Mx1 with three bristles | Macroasteropteroninae subfam. nov. |
| – | Surface of carapace ornamented or smooth, second segment of A1 not short and carrying at least one dorsal bristle, third and fourth segments conical; alpha bristle on first endopodal segment of Mx1 positioned anteriorly; terminal segment with 1–7 bristles | 2 |
| 2. | Surface of carapace smooth, without ornamentation, second segment of A1 with one dorsal bristle; terminal segment of the Mx1 with one (rarely two) bristles | Cyindroleberidinae
Müller, 1906 |
| – | Surface of carapace either smooth or ornamented, second segment of A1 with two or more dorsal bristles; terminal segment of the Mx1 with 3–7 bristles | 3 |
| 3. | Carapace with slit-like incision, surface smooth except for minute fossae, central adductor muscle insertion of many elongated scars | Cyclasteropinae
Poulsen, 1965 |
| – | Carapace with small incisor forming right or acute angle, surface rarely smooth, often with ridges and nodes; central adductor muscle insertion forming ovoid scars | Asteropteroninae
Kornicker, 1981. |

Acknowledgements

A visit of the senior author to NIWA, during which she studied the ostracod collection from the Chatham Rise and Challenger Plateau, was supported by the International Mobility Fund, Royal Society of New Zealand, project IMF10-B13. Ostracod specimens were collected as part of the Ocean Survey 20/20 Chatham/Challenger Biodiversity and Seabed Habitat Project, jointly funded by the New Zealand Ministry of Fisheries, Land Information New Zealand, NIWA and the New Zealand Department of Conservation. We wish to thank Dr Kareen Schnabel and Ms Sadie Mills (NIWA, Wellington) for their kind support during the senior author's stay. James Sturma (NIWA) created the map. We thank Dr Dennis Gordon (NIWA) for critical comments to an earlier version of the manuscript. This research was funded by NIWA's Biodiversity & Biosecurity programme Co1X0502 of the New Zealand Science Foundation, project BBDB1202.

References

- Baird W 1850. Description of a new crustacean. Proceedings of the Zoological Society of London 18: 102.
- Brady GS 1898. On new and imperfectly known species of Ostracoda, chiefly from New Zealand. Transactions of the Zoological Society of London 14: 429–452.
- Brenke N 2005. An epibenthic sledge for operations on marine soft bottom and bedrock. Marine Technology Society Journal 39: 10–21.
- Cohen AC, Morin JG 1990. Patterns of reproduction in ostracodes: a review. Journal of Crustacean Biology 10: 184–211.
- Cohen AC, Morin JG 1993. The cypridinid copulatory limb and a new genus *Kornickeria* (Ostracoda: Myodocopida) and four new species of bioluminescent ostracods from the Caribbean. Zoological Journal of the Linnean Society 108: 23–84.
- Eagar SH 2010. Class Ostracoda: seed shrimps, mussel shrimps. In: Gordon DP ed. New

- Zealand inventory of biodiversity Volume Two. Kingdom Animalia: Chaetognatha, Ecdysozoa, Ichnofossils. Christchurch, Canterbury University Press. Pp. 129–132, 216–218, 228–230.
- Hartmann G 1974. Zur Kenntnis des Eulitorals der afrikanischen Westküste zwischen Angola und Kap der Guten Hoffnung und der afrikanischen Ostküste von Südafrika und Mocambique unter besonderer Berücksichtigung der Polychaeten und Ostracoden. Teil III, Die Ostracoden des Untersuchungsgebiets. Mitteilungen der Hamburgischen Museum und Institut 69: 229–25.
- Henning W 1966. Phylogenetic systematics. Translated by D. Davis and R. Zangerl. University of Illinois Press, Urbana.
- Horne DJ 2003. Key events in the ecological radiation of the Ostracoda. In: Park LE, Smith AJ ed. Bridging the gap: trends in the ostracode biological and geological sciences. The Paleontological Society Papers. Pp. 181–201.
- Huelsenbeck JP, Ronquist FR 2001. MRBAYES: Bayesian inference of phylogenetic trees. *Bioinformatics* 17: 754–755.
- Kornicker LS 1958. Ecology and taxonomy of recent marine Ostracodes in the Bimini Area, Great Bahama Bank. *Publications of the Institute of Marine Science* 5: 194–300.
- Kornicker LS 1975. Antarctic Ostracoda (Myodocopina). *Smithsonian Contributions to Zoology* 163: 1–720.
- Kornicker LS 1976. Myodocopid Ostracoda from Southern Africa. *Smithsonian Contributions to Zoology* 214: 1–39.
- Kornicker LS 1979. The marine fauna of New Zealand: benthic Ostracoda (Suborder Myodocopina). *New Zealand Oceanographic Institute Memoir* 82: 1–58.
- Kornicker LS 1981a. Revision, distribution, ecology, and ontogeny of the Ostracode subfamily Cyclasteropinae (Myodocopina: Cyndroleberididae). *Smithsonian Contribution to Zoology* 319.
- Kornicker LS 1981b. Benthic marine Cypridinoidea from Bermuda (Ostracoda). *Smithsonian Contributions to Zoology* 331: 1–15.
- Kornicker LS 1986. Cyndroleberididae of the Western North Atlantic and the Northern Gulf of Mexico, and Zoogeography of the Myodocopina (Ostracoda). *Smithsonian Contributions to Zoology* 425: 139.
- Kornicker LS 1989. Bathyal and abyssal myodocopid Ostracoda of the Bay of Biscay and vicinity. *Smithsonian Contributions to Zoology* 467: 1–134.
- Kornicker LS 1991a. Myodocopid Ostracoda of Enewetak and Bikini Atolls. *Smithsonian Contributions to Zoology* 505: 1–140.
- Kornicker LS 1991b. Myodocopid Ostracoda of hydrothermal vents in the eastern Pacific Ocean. *Smithsonian Contributions to Zoology* 516: 46.
- Kornicker LS 1992. Myodocopid Ostracoda of the Benthedi Expedition, 1977, to the NE Mozambique Channel, Indian Ocean. *Smithsonian Contributions to Zoology* 531: 243.
- Kornicker LS 1993. Antarctic and Subantarctic Myodocopina (Ostracoda). *Koeltz Scientific Books, Koenigstein*.
- Kornicker LS 1994. Ostracoda (Myodocopina) of the SE Australian Continental Slope, Part 1. *Smithsonian Contribution to Zoology* 553.
- Kornicker LS 1996. Ostracoda (Myodocopina) from shallow waters of the Northern Territory and Queensland, Australia. *Smithsonian Contributions to Zoology* 578: 1–97.
- Kornicker LS, Caraión FE 1974. West African Myodocopid Ostracoda (Cyndroleberididae). *Smithsonian Contributions to Zoology* 179: 78.
- Kornicker LS, Poore GCB 1996. Ostracoda (Myodocopina) of the SE Australian continental slope, part 3. *Smithsonian Contributions to Zoology* 573: 1–186.
- Kornicker LS, Harrison–Nelson E 2005. Ostracoda from Johnston Atoll, Pacific Ocean and Proposal of a new tribe Bruuniellini (Myodocopina: Cyndroleberididae). *Pacific Science* 59: 323–362.
- Lewis PO 2001. A likelihood approach to estimating phylogeny from discrete morphological character data. *Systematic Biology* 50: 913–925.
- Lörz AN 2011. Biodiversity of an unknown New Zealand habitat: bathyal invertebrate assemblages in the benthic boundary layer. *Marine Biodiversity* 41: 299–312.
- Martens K 2003. On a remarkable South African giant ostracod (Crustacea, Ostracoda, Cyprididae) from temporary pools, with additional appendages. *Hydrobiologia* 500: 115–130.
- Meisch C 2007. On the origin of the putative furca of the Ostracoda (Crustacea). *Hydrobiologia* 585: 181–200.
- Müller GW 1906. Die Ostracoda der Siboga Expedition. *Siboga–Expedition* 30.
- Pantin CFA 1964. Notes on microscopical technique for zoologists. Cambridge, University Press.
- Poulsen EM 1965. Ostracoda–Myodocopa part 2: Cypridiniformes–Rutidermatidae, Sarsiellidae and Asteropidae. *Dana Report* 65: 1–483.
- Sars GO 1870. Nye Dybvandscrustaceer fra Lofoten. *Forhandlinger I Vidensk.– Selskabet I Christiania*. 12 (1869): 167–174.
- Skogsberg T 1920. Studies on marine Ostracoda. *Zoologiska Bidrag fran Uppsala* 1: 784.

- Siveter D, Sutton MD, Briggs DEG, Siveter D 2003. An ostracode crustacean with soft parts from the Lower Silurian. *Science* 302: 1751–1749.
- Syme AE 2007. A Systematic Revision of the Cyndroleberididae (Crustacea: Ostracoda: Myodocopa). Unpublished PhD thesis, Zoology Department, the University of Melbourne.
- Syme AE, Poore GCB 2006. A checklist of species of Cyndroleberididae (Crustacea: Ostracoda). *Museum Victoria Science Report* 9: 1–20.
- Syme AE, Poore GCB 2008. A supplementary description of *Cypridina mariae*, type species of *Cyndroleberis*, and rediagnosis of the genus (Ostracoda: Myodocopa: Cyndroleberididae). *PLoS ONE* 3: e1960.
- Syme AE, Oakley THO in press. Dispersal between shallow and abyssal seas and evolutionary loss and regain of compound eyes in cyndroleberidid ostracods: conflicting conclusions from different comparative methods. *Systematic Biology*.
- Tsukagoshi A, Okada R, Horne D 2006. Appendage homologies and the first record of eyes in platycopid ostracods, with the description of a new species of Keijcyoidea (Crustacea: Ostracoda) from Japan. *Hydrobiologia* 559: 255–274.