

**COPIDOGNATHUS (HALACARIDAE: ACARI) FROM WESTERN AUSTRALIA.
DESCRIPTION OF TWELVE SPECIES OF THE *GIBBUS* GROUP**

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ABSTRACT

Approximately 30 species of the genus *Copidognathus* were found in the intertidal and subtidal zones of Rottnest Island, southwestern Australia. Twelve new species are described in the present paper: *Copidognathus ampliatus* sp. nov., *C. bispinus* sp. nov., *C. bistriatus* sp. nov., *C. caelatus* sp. nov., *C. canaliculifer* sp. nov., *C. crassispinus* sp. nov., *C. dubiosus* sp. nov., *C. laminifer* sp. nov., *C. multiporus* sp. nov., *C. nasutus* sp. nov., *C. punctellus* sp. nov., and *C. strigellus* sp. nov. They all belong to the *gibbus* group. A key to the species is presented. The majority of species have closely related congeners in the Atlantic and Pacific oceans. Two couples, *bispinus-laminifer* and *ampliatus-caelatus*, are almost identical in dorsal aspect.

INTRODUCTION

The genus *Copidognathus* presently includes nearly 300 species, which is about one-third of the halacarid mites described. Amongst the halacarids collected during the Fifth International Marine Biological Workshop: The Marine Flora and Fauna of Rottnest Island, Western Australia, the genus *Copidognathus* was represented by almost 30 species. The majority of species can be attributed to natural groups, and twelve species proved to belong to the *gibbus* group, these are *C. ampliatus* sp. nov., *C. bispinus* sp. nov., *C. bistriatus* sp. nov., *C. caelatus* sp. nov., *C. canaliculifer* sp. nov., *C. crassispinus* sp. nov., *C. dubiosus* sp. nov., *C. laminifer* sp. nov., *C. multiporus* sp. nov., *C. nasutus* sp. nov., *C. punctellus* sp. nov., and *C. strigellus* sp. nov.

MATERIALS AND METHODS

Samples of 100-500 cm³ of various substrates such as green, brown and red algae, sea-grasses, colonial and encrusting organisms, macrofauna, and sandy deposits, collected from various beaches and tidal and subtidal zones, were taken to the laboratory, washed with fresh water over a 100 µm sieve. The material retained in the sieve was scanned for halacarid mites. The mites were stored in ethanol, cleared in lactic acid and mounted in glycerine jelly.

The figures were drawn using a camera lucida. Each scale line represents 50 µm.

When indicating the position of appendages on the legs and palps, the terms 'medial' and 'lateral' are used in accordance with descriptions by Viets (1939/40) and Newell (1947). Compared with the terminology in Newell (1984), 'medial' corresponds to 'anterior' on palps, leg I and II, but a 'medial' position on leg III and IV corresponds to a 'posterior' site.

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Holotypes and other representatives are deposited in the Western Australian Museum in Perth (WAM), other specimens in the author's halacarid collection (IB).

SYSTEMATICS

Subfamily Copidognathinae Bartsch

Genus *Copidognathus* Trouessart

Diagnosis

Female and male similar in dorsal aspect. AD, OC and PD present. AE with epimeral pores. Female GA with 3 pairs of pgs and 1 pair of sgs. Male GA with 4 or more pairs of pgs and 3-4 (rarely 2) pairs of sgs. Palps 4-segmented. P-3 lacks seta or spine. P-4 with 3 setae in the basal whorl; apically with minute seta plus 2 spurs. Tibiae I and II each with 3 ventral bristles, tibiae III and IV each with 2 ventral bristles. All tarsi with parambulacral setae. Tarsus I with 3 ventral setae, tarsi II-IV lack ventral setae (occasionally, one of the pas may be moved to ventral position). Solenidion on tarsus I and II in dorsolateral position. Lateral claws generally large, median claw present though small.

Remarks

The majority of the 300 species described can be attributed to widely spread natural groups. One of these is the *gibbus* group (Newell 1971), characterized by the combination of: legs with large lamellae; trochanters III and IV with triangular dorsal process; basifemora with small ventral lamellae; telofemora with large ventrolateral and smaller ventromedial lamellae; tibiae with posterior articular lamellae; tarsi I and II with large lateral membranes of claw fossa; tarsi III and IV slender. General chaetotaxy, from trochanter to tibia: leg I, 1, 2, 5, 4, 7; leg II, 1, 2, 5, 4, 7; leg III, 1, 2, 2, 3, 5; leg IV, 0, 2, 2, 3, 5. I-5 and II-5 each with 2 bipectinate ventromedial setae, III-5 and IV-5 with one bipectinate ventromedial seta; glp-1 and ds-1 inserted more or less adjacent. Male genital sclerites with 3-4 pairs of sgs, 2-3 of them seta-like and one spur-like. In the majority of species the AD is characterized by an 'A'-shaped internal sclerite.

Key to Western Australian species of *Copidognathus*

1. Dorsal and ventral plates adjacent or fused 2
Dorsal and ventral plates widely separated *C. dubiosus*
2. Dorsal plates with foveae and porose areolae 6
Dorsal plates rather uniformly punctate, distinctly demarcated porose areolae lacking ... 3
3. AD with distinct frontal spine and anterolateral lamellae (Figures 16, 24, 38). Width of PD less than 1.5 times its length 4
AD with minute frontal spine; anterolateral lamellae lacking. PD more than 1.5 times longer than wide *C. strigellus*
4. AE and PD fused, AE and GA separated *C. canaliculifer*
AD and PD separated 5

5. AE and GA separated *C. bispinus*
 AE and GA fused *C. laminifer*
6. Porose areolae distinctly set off from reticulate or foveate remainder of plate 7
 Both porose areolae and remainder of AD and PD foveate (Figure 47) *C. punctellus*
7. AD with raised triangular area and without or with only small anterolateral lamellae
 which do not extend to tip of frontal spine (Figures 56, 68) 8
 Anterolateral lamellae extending from frontal spine almost to lateral corner of AD
 (Figures 83, 91, 105) 10
8. AD with small anterolateral lamellae, pair of areolae 2 pores wide 9
 AD without anterolateral lamellae. Pair of porose areolae triangular in outline, setae ds-4
 to ds-6 generally conspicuously stout *C. nasutus*
9. AD with stout frontal spine; longitudinal costae on PD 2 pores wide *C. crassispinus*
 Frontal spine on AD present though small; longitudinal costae on PD 1 pore wide
 *C. bistriatus*
10. Median porose costae on PD 3–5 pores wide. AE, GA and PE fused *C. multiporus*
 Porose costae between ds-4 and ds-5 1(-2) rosette pores wide 11
11. AE and GA fused laterally but separated in the median *C. caelatus*
 AE and GA fused *C. ampliatus*

Description of species

The arrangement of description of the twelve species follows the sequence in the key.

Copidognathus dubiosus sp. nov.

Figures 1–8

Holotype

♀, Nancy Cove, Rottnest Island, Western Australia, Australia, sediment and algae on intertidal shore-line platform, 12 January 1991, I. Bartsch (WAM 93/2141).

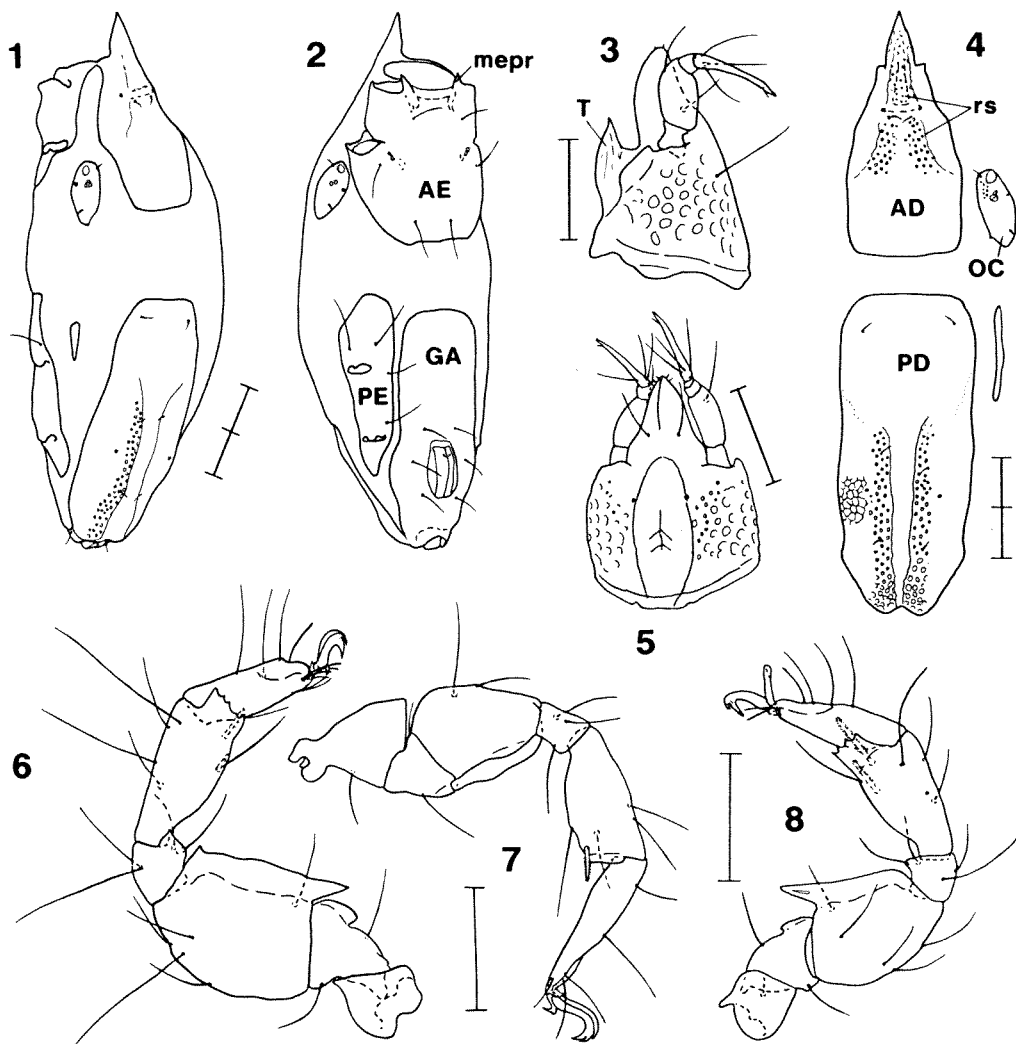
Paratypes

Australia: Western Australia: 1 ♀, type locality and date (WAM 93/2142); 2 protonymphs, same data as holotype (IB Au372).

Description

Female: Idiosoma length 564 µm. Dorsum with wide areas of membraneous integument (Figure 1). AD 212 µm long; with median, gable-like portion slightly raised, areas lateral and posterior to raised portion reticulate, lateral part of AD coarsely reticulate and posterior part of AD minutely reticulate. Raised area extending into pointed frontal spine. Rosette-pores on gable-like area with rather wide ostia and canaliculi. AD with internal transverse bar level with insertion of leg I. Gland pores placed just lateral to that bar. Dorsal portion of AE surpassing insertion of leg I. OC 67 µm long. Posterior cornea divided into 2–3 lenses; gland

pore level with posterior cornea, pore canaliculus separated from gland pore by slightly less than width of OC. Red eye pigment present beneath corneae. PD 266 μ m long. Posterior part of PD with raised costae which anteriorly extend to level of insertion of leg III. Costae 2-3 rosette pores wide. Anterior rectangular part of PD with evenly scattered canaliculi, PD between costae delicately and lateral to costae coarsely reticulate (Figure 4). Narrow triangular (holotype) or oblong (paratype) sclerite present within striated integument and lateral to anterior part of PD.



Figures 1-8 *Copidognathus dubiosus* sp. nov., female, 1, idiosoma, dorsal aspect; 2, idiosoma, ventral aspect; 3, gnathosoma, lateral aspect; 4, dorsal plates; 5, gnathosoma, ventral aspect; 6, leg I, paratype, lateral aspect; 7, leg III, paratype, medial aspect; 8, leg I, holotype, lateral aspect.

AE and PE with dorsal portions reticulate; marginal portions of AE, PE and GA with wide rosette pores; ventral portions of the plates minutely reticulate, each mesh with 1–3 canaliculi. Medial eprI sharply pointed (Figure 2); lateral eprI present though inconspicuous. GA 253 μm long; GO 58 μm long. Distance from anterior margin of GO to that of GA twice length of GO; distance from posterior margin of GO to end of anal cone almost same as length of GO.

Gnathosoma 118 μm long. Ventral and marginal flank of gnathosoma with wide rosette pores (Figure 5). Tectum with sharp spine and slightly raised crest (Figure 3). P-4 somewhat longer than P-2. Ventral margin of P-2 crenulate.

Width of ventrolateral lamellae on telofemora less than half length of that segment (Figures 6, 7). Lamellae on telofemora I and II with reticulate sculpturing; ventral margin truncate, and with spine-like and backward directed process (Figure 8). Lateral articular lamellae on genua I and II small; that lamella on I-5 and II-5 quadrangular, on I-5 about half as long as high and with its distal margin bearing 6 lamellar dents (Figure 6), on II-5 about as long as high and ending in 4 lamellar dents. Medial articular lamellae on tibiae I and II much smaller. Posterior part of tibiae with short lateral and medial lamellae. Solenidion on tarsus I and II slender, seta-like. Tarsi III and IV slender, somewhat longer than both tibiae and telofemora; each with 4 dorsal setae.

Claws on tarsi I and II stout; claws on tarsi III and IV slightly longer. Accessory process with minute tines.

Protonymph: Idiosoma length 540 μm . Dorsal and ventral plates small, reticulate. AD with large frontal spine. OC in outline similar to that of female. Anterior PD ovate. Setae ds-2 and ds-3 inserted within membranous integument. Tectum rounded, spine and crest lacking. Telofemora with ventrolateral lamellae; lamellae on I-3 and II-3 with backward directed spine-like process. Distolateral lamella on tibia I and II serrate.

Remarks

Copidognathus dubiosus differs from all other species in the *gibbus* group by the presence of a very stout frontal spine, dorsal and ventral plates being separated by large areas of striated integument, and unusually short OC.

The OC resemble those generally found in nymphs and larvae.

The pointed, backward extended process on I-3 and II-3 is supposed to be correlated with the mode of life and habitat and may help the specimens to anchor in the substrate.

Copidognathus strigellus sp. nov.

Figures 9–15

Holotype

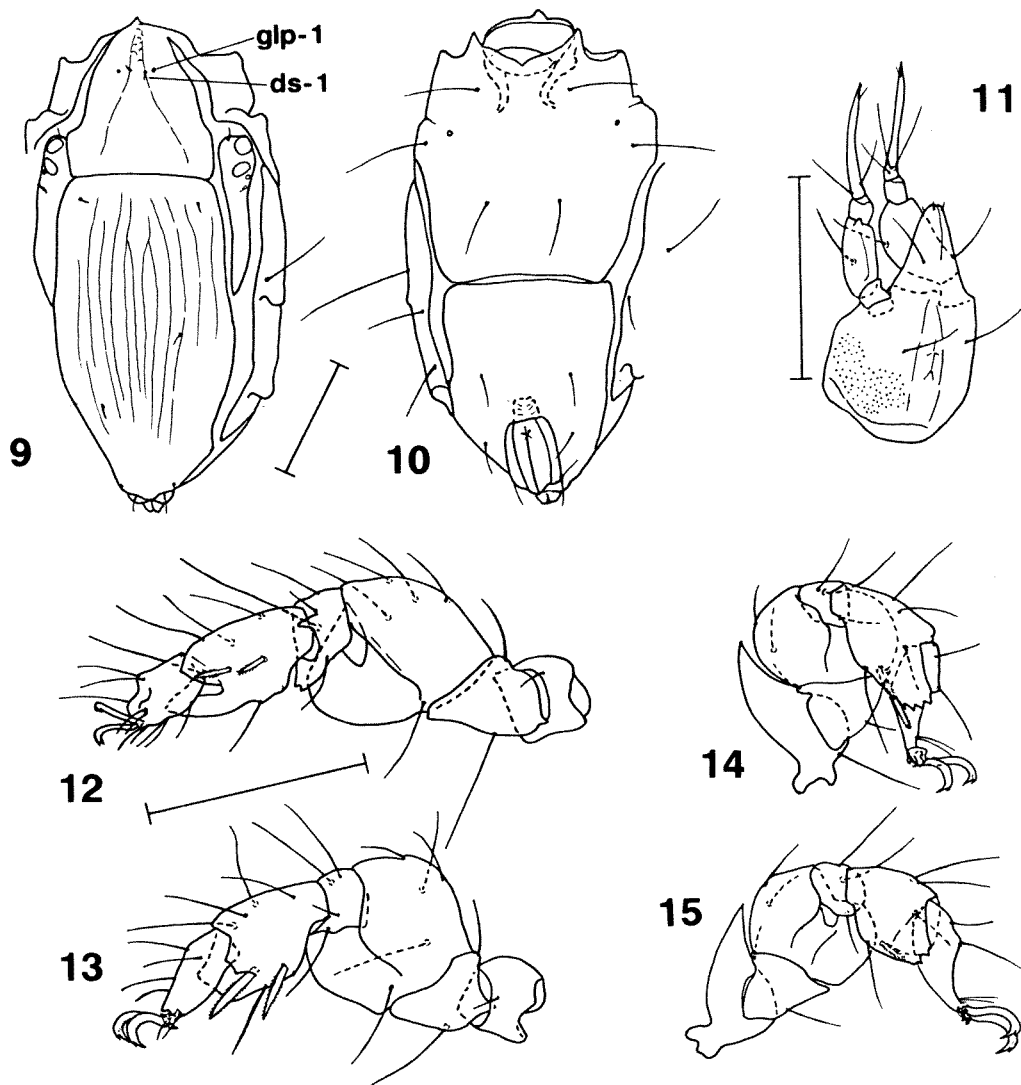
♀, Fish Hook Bay, Rottnest Island, Western Australia, Australia, 1–1.5 cm thick corallines (*Amphiroa*) on edge of shore-line platform, 9 January 1991, I. Bartsch (WAM 93/2151).

Description

Female: Idiosoma length 202 μm . With narrow striae of membranous integument between the plates. Dorsal plates delicately pannelled. AD 64 μm long, 60 μm wide, with minute frontal spine and slightly raised gable-like portion (Figure 9). No internal transverse or gable-like sclerite present beneath anterior part of AD, instead there are faint sclerites along lateral margin of AD. Setae ds-1 and glp-1 close together. OC 68 μm long, 15 μm wide. Margins of

posterior part of OC evenly tapering, not tail-like. Anterior cornea large, posterior cornea smaller; gland pore near posterolateral margin of posterior cornea, pore canaliculus just posterior to gland pore. Setae ds-2 at anterior margin of OC. PD 132 μ m long, 75 μ m wide, with longitudinal striae.

Ventral plates with canaliculi. All ventral plates separated. AE 80 μ m long, 98 μ m wide.



Figures 9–15 *Copidognathus strigellus* sp. nov., female, 9, idiosoma, dorsal aspect; 10, idiosoma, ventral aspect; 11, gnathosoma, lateral aspect; 12, leg I, ventromedial aspect; 13, leg II, medial aspect; 14, leg III, lateral aspect; 15, leg IV, lateral aspect.

Medial eprI large, pointed, medial eprII lamellar, lateral eprI and eprII inconspicuous. Apodemes posterior to camerostome large, crescentic (Figure 10). PE elongate, anteriorly extending beyond posterior cornea; portion anterior to insertion of leg III much longer than that between legs III and IV. GA 92 μm long, 68 μm wide. GO 29 μm long, 22 μm wide. Distance from anterior margin of GA to that of GO twice length of GO. Three pairs of pgs inserted as figured.

Ventral and marginal flanks of base of gnathosoma pierced by canaliculi (Figure 11). Tectum only slightly curved. Rostral sulcus extending just beyond pair of mxs. P-4 as long as P-2. The 3 basal setae on P-4 inserted adjacent. P-2 with stout seta situated near middle of segment.

Ventrolateral lamellae on telofemora I and II with delicately reticulate sculpturing. Lateral articular lamellae on genua I and II scale-like, that on II-4 longer than high, medial lamella triangular and pointed (Figures 12, 13). Lateral articular lamella on I-5 larger than medial one, both lamellae wide and triangular. Lateral articular lamella on II-5 subrectangular, medial lamella smaller. Medial lamella on III-5 and IV-5 slightly larger than lateral one. Ventral margin of tibiae I and II bulging and with very minute dent-like process. Ventromedial setae on II-5 remarkably wide, ensiform. Ventral setae on III-5 and IV-5 rather large, ventromedial bristle on III-5 long, on IV-5 short, both delicately bipectinate. Tarsi III and IV about as long as tibiae and telofemora; each tarsus with 4 dorsal setae (Figures 14, 15).

Claws with accessory process but no long pecten.

Remarks

Copidognathus strigellus is rather slender, the dorsal plates are panelled but lack porose areolae, and the tectum is not conspicuously enlarged. This combination of characters is also found in *C. felicis* Newell, *C. remipes* (Trouessart) and *C. subgibbus* Newell. *C. felicis* and *C. subgibbus* are known from the southeast Pacific (Newell 1971), *C. remipes* occurs in the eastern North Atlantic and the Mediterranean (Bartsch 1985a). *C. subgibbus* is separated from *C. strigellus* and the other three species in having shorter OC (relative to their width) which posteriorly extend less beyond anterior margin of PD.

C. felicis and *C. remipes* are closely related to *C. strigellus*. In *C. felicis*, the raised triangular area on the AD is much wider than in *C. strigellus* and *C. remipes*. *C. remipes* has a pair of short, narrow costae on the PD and the females have 2 pairs of pgs anterior to the GO, in contrast, *C. strigellus* has one pair of pgs anterior and 2 pairs on either side of the GO, and the PD lacks costae.

Copidognathus canaliculifer sp. nov.

Figures 16–23

Holotype

♂, Fish Hook Bay, Rottneest Island, Western Australia, Australia, small bushy algae (*Zonaria*, Phaeophyta) from edge of rocky platform, 0.5 m depth, 15 January 1991, I. Bartsch (WAM 93/2138).

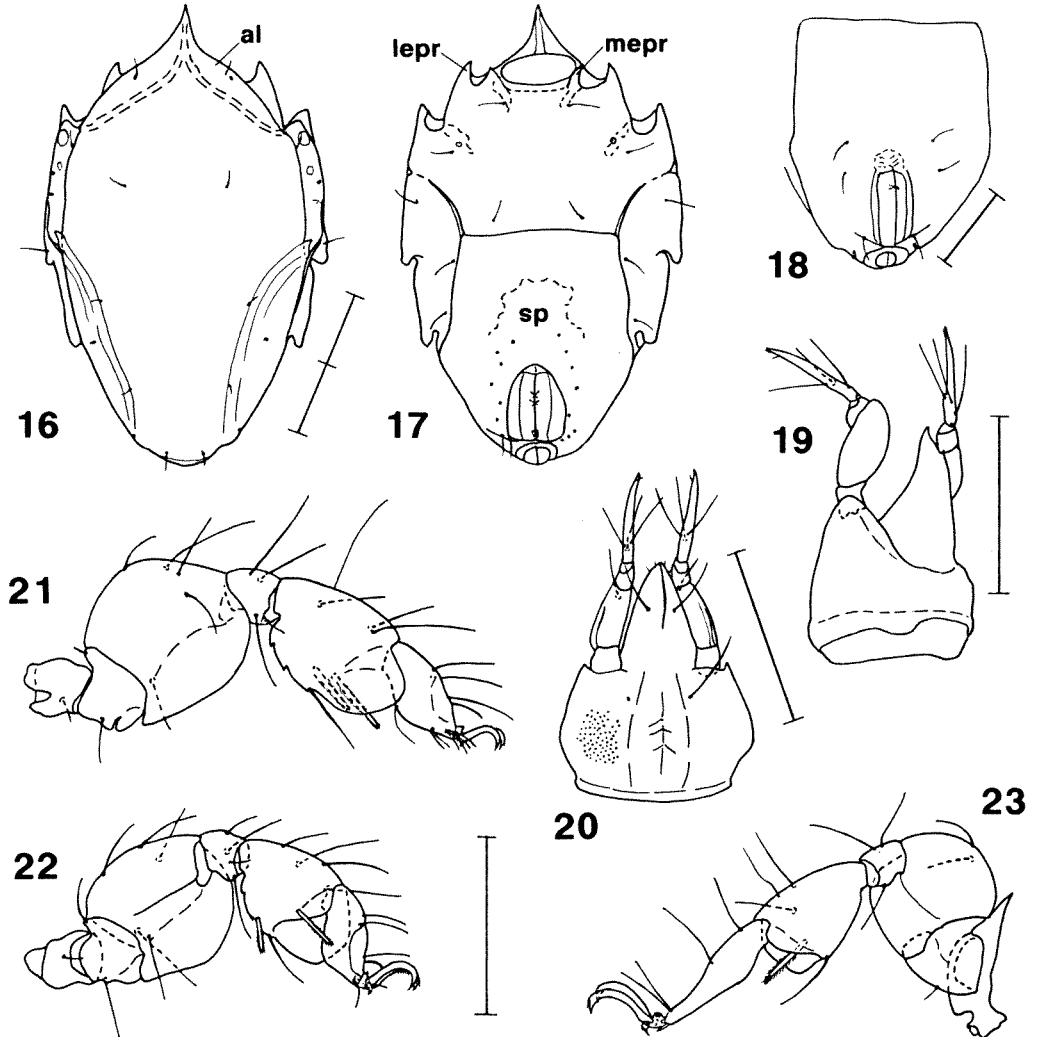
Other Material Examined

Australia: Western Australia: 1 ♀, Salmon Point, sediment from 1.5 m depth, I. Bartsch, 18 January 1991 (WAM 93/2139).

Description

Male: Idiosoma 306 μm long, 186 μm wide. Dorsal and ventral plates densely and almost

uniformly pierced by canaliculi. AD and PD completely fused (Figure 16); AD and OC joined, with sutures indicating outline of plates; striae with membranous integument lacking. Idiosoma with pointed frontal spine. Area corresponding to AD with internal sclerite and large anterolateral lamellae. OC with large anterior and smaller posterior smooth area (corneae). Area of PD with diverging striae which, in form of very short lamellae, anteriorly extend beyond posterior part of OC. Dorsal setae small. Setae ds-1 and adjacent small glp-1



Figures 16–23 *Copidognathus canaliculifer* sp. nov., 16, idiosoma, dorsal aspect, male; 17, idiosoma, ventral aspect, male; 18, genitoanal plate, female; 19, gnathosoma, dorsolateral aspect, male (dorsal seta on P-2 omitted); 20, gnathosoma, ventral aspect, female; 21, leg I, lateral aspect, female; 22, leg II, medial aspect, female; 23, leg IV, medial aspect, female.

on margin of anterolateral lamella. Setae ds-2 on OC in medial position. Setae ds-3 to ds-6 on PD.

AE and GA contiguous, with distinct suture but without intermediate membranous integument. PE and AE anteriorly fused and posteriorly with delicate striae of membranous integument (Figure 17). AE 92 μm long, 174 μm wide. Epimeral processes present medially and laterally. Medial eprI pointed; medial eprII small, lamella-like; lateral eprI and eprII large. GA 156 μm long, 128 μm wide; with 7–8 pairs of slender pgs. GO 52 μm long. Spermatopositor large, extending beyond GO for length of GO.

Gnathosoma 75 μm long. Tectum enlarged, with median crest (Figure 19). Integument of tectum delicate when compared with that of gnathosoma base and rostrum. Insertion of maxillary setae same as illustrated in Figure 20. Palps with small ventral lamella. P-4 slightly longer than P-2. Two of the setae in the basal whorl separated from basalmost seta by more than width of P-4.

Telofemur I with almost smooth ventrolateral lamella. Ventromedial lamella replaced by small crest. Articular lamellae on genua inconspicuous, those on tibiae large. Tibia I short, its ventral margin bulging and bearing 2 dent-like processes (cf. Figure 21); tibia II with less conspicuous processes (cf. Figure 22). Tarsi III and IV (cf. Figure 23) slender, each with 4 dorsal setae.

Pecten on tarsi II distinct, on tarsi III delicate and on tarsi I and IV inconspicuous.

Female: Idiosoma 290 μm long and 174 μm wide. In dorsal aspect similar to male. Ventral plates contiguous, similar to those of male. GA 142 μm long, 117 μm wide. GO 42 μm long, 22 μm wide. Interval between anterior margin of GA and that of GO equalling twice the length of GO. Second pair of pgs inserted level with anterior end of GO (Figure 18).

Remarks

Copidognathus canaliculifer is very similar to *C. scutellus* Bartsch, a species recorded from the Philippines (Bartsch 1985a). Both species have a large, densely porose dorsal shield and contiguous ventral plates. The most marked difference between the two species is the length of the rostrum. The rostrum in *C. scutellus* is short, as long as wide, in *C. canaliculifer* it is 1.4 times longer than wide.

Copidognathus bispinus sp. nov.

Figures 24–35

Holotype

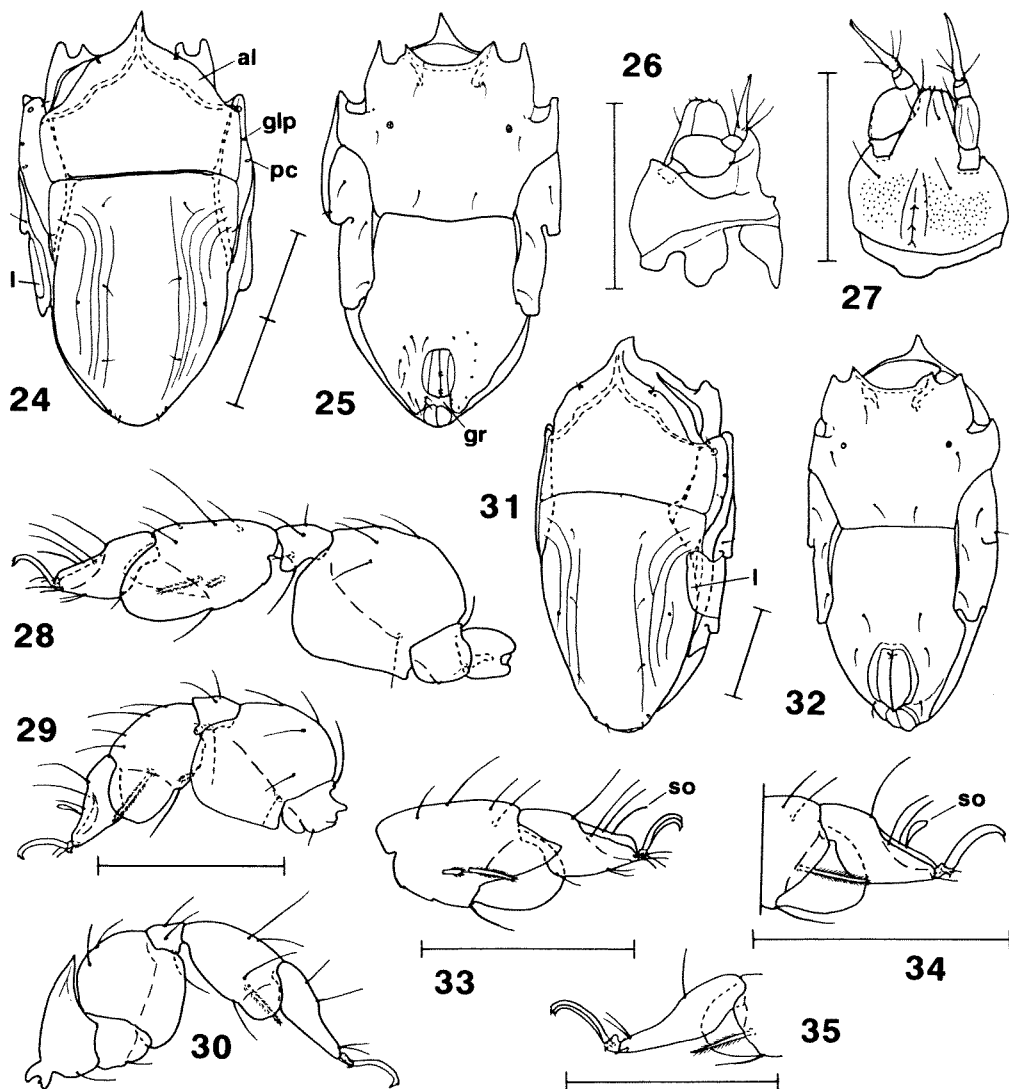
♂, Duffield Ridge, Rottnest Island, Western Australia, Australia, sediment from 30 m depth, 17 January 1991 sorted by I. Bartsch, (WAM 93/2129).

Paratypes

Australia: Western Australia: 1 ♀, type locality and date (WAM 93/2130); 3 ♀, type locality and date (IB Au323).

Description

Male: Idiosoma length 219 μm . Integument of dorsal plates with rather uniform and delicate porosity. AD 85 μm long, 93 μm wide; with gable-like internal sclerite extending anteriorly into lamellar frontal spine, and laterally into lamellae which surpass medial margin of OC (Figure 24). Anterolateral lamellae large, extending from frontal spine to lateral processes;



Figures 24–35 *Copidognathus bispinus* sp. nov., 24, idiosoma, dorsal aspect, male; 25, idiosoma, ventral aspect, male; 26, gnathosoma, dorsolateral aspect, female; 27, gnathosoma, ventral aspect, female; 28, leg I, lateral aspect, female; 29, basifemur to tarsus II, lateral aspect, female; 30, leg III, lateral aspect, female; 31, idiosoma, dorsal aspect, female; 32, idiosoma, ventral aspect, female; 33, tibia, tarsus I, medial aspect, female; 34, distal tibia and tarsus II, medial aspect, female; 35, distal tibia and tarsus IV, medial aspect, female.

lamellae with gland pores and small ds-1. OC elongate, 94 μm long, 25 μm wide; posterior corner slightly set off from remainder of plate. OC with small and rather inconspicuous anterior cornea, gland pore and pore canaliculus in lateral margin, and ds-2 in anteromedial margin. Red-brown pigment present beneath OC and AD within the angle between internal sclerites. PD 130 μm long, 100 μm wide; with 4 pairs of sinuose longitudinal striae but without raised costae. AD and PD with thin lateral lamellae which surpass and cover medial margin of OC. Setae ds-3 to ds-5 inserted on PD; a pair of gland pores level with insertion of leg IV.

Ventral plates with rather delicate porosity. All ventral plates separated (Figure 25). AE 82 μm long, 122 μm wide. Lateral and medial epimeral processes prominent. Medial eprII lamellar, lateral eprII (in dorsolateral position) similar to lateral eprI. Posterior trochanters flanked by rounded lateral and small lamellar medial eprIII and eprIV. PE with dorsal lamella (Figure 24). GA 111 μm long, 88 μm wide; with deep groove posterior to GO. GO 26 μm long and 19 μm wide. Nine pgs on either side of GO and genital groove (Figure 25). Spermatopositor large, extending beyond GO for more than 1.5 times the length of GO.

Gnathosoma 50 μm wide, 52 μm long. Ventral and lateral flank of gnathosoma base with delicate porosity. Rostrum short and wide. Maxillary setae as illustrated in Figure 27. Rostral sulcus extending beyond mid of rostrum. Tectum with long but very narrow crest. Palps short. P-2 flattened (Figure 26), only slightly longer than high, with rather stout dorsal seta.

Lamellae on legs large but thin and without distinct ornamentation. Ventrolateral lamella on I-3 with ventral margin distally evenly rounded, otherwise truncate throughout its length (cf. Figure 28). Ventral seta on I-4 bristle-like; other 3 setae on I-4 delicate. Ventral margin of I-5 with 2 minute, dent-like processes. Ventromedial setae on I-5 bipectinate, ventral seta slightly smaller than bristle on I-4. Tibia II (cf. Figure 29) smaller but else similar to I-5. Solenidion on I-6 slender (cf. Figure 33), that on II-6 shorter and club-shaped (cf. Figure 34). III-6 with 4 (cf. Figure 30) and IV-6 with 3 dorsal setae (cf. Figure 35).

Claws slender. All with accessory process.

Female: Idiosoma length 219–242 μm . Dorsal and ventral plates separated, ornamented as in male, and AD, PD and PE with thin lamellae (Figure 31). GA (paratype, WAM) 108 μm long, 72 μm wide. GO 36 μm long, 28 μm wide, placed in posterior part of GA; distance from anterior margin of GO to that of GA 1.8 times the length of GO. Three pairs of pgs inserted as illustrated (Figure 32).

Remarks

Copidognathus bispinus is most similar to *C. laminifer*. Distinguishing characters are discussed below, after description of *C. laminifer*.

Copidognathus laminifer sp. nov.

Figures 36–44

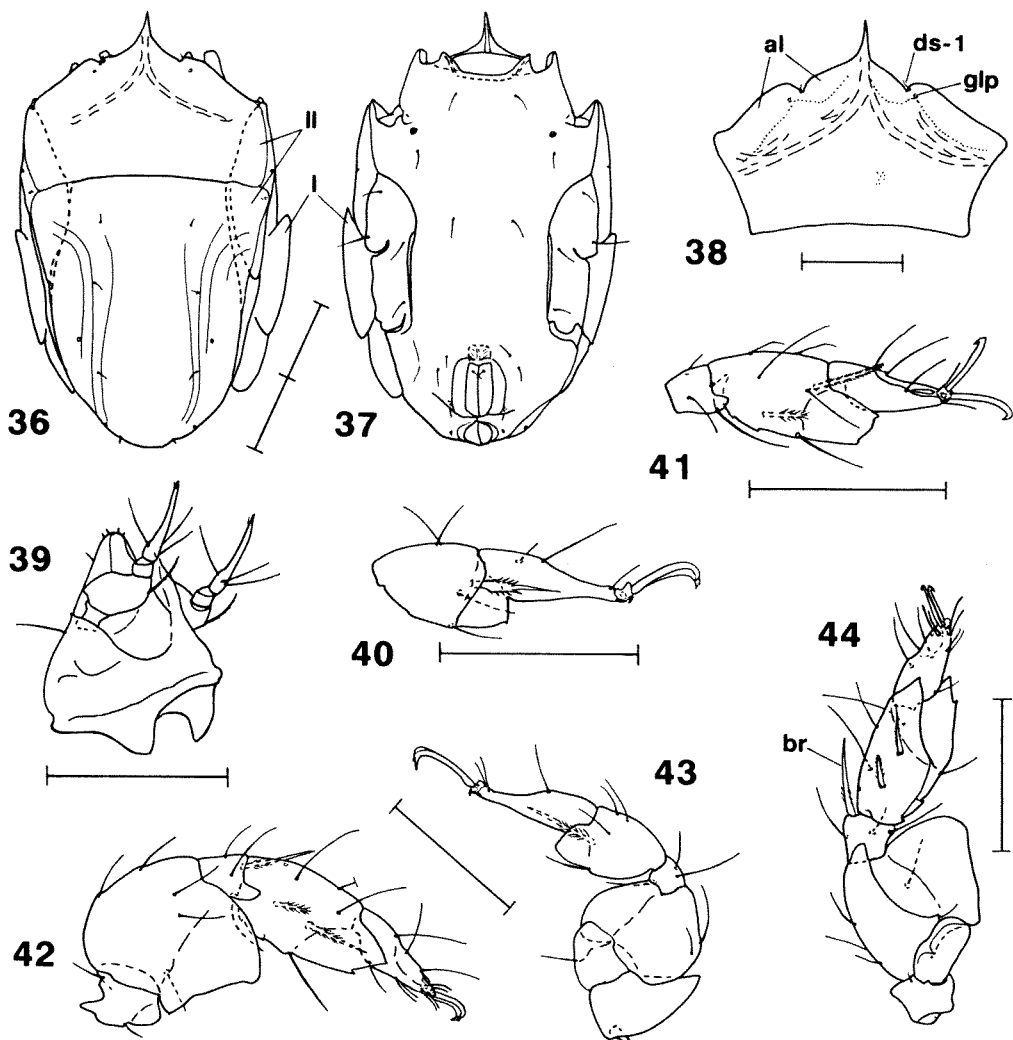
Holotype

♀, Duffield Ridge off Rottnest Island, Western Australia, Australia, sediment from 30 m depth, 17 January 1991, sorted by I. Bartsch (WAM 93/2143).

Description

Female: Idiosoma length 260 μm . Idiosoma with delicate marginal lamellae. Dorsal plates

contiguous but not fused. Integument of all dorsal plates pierced by evenly scattered canaliculi. AD very wide, 92 μ m long, 140 μ m wide; with crest-like frontal spine, a rather narrow, gable-like internal sclerite, conspicuous anterolateral lamellae with distinct indentation level with ds-1 (Figure 38), and very delicate lateral lamellae partly concealing the OC (Figure 36). Pore glp-1 inserted on anterolateral lamellae; ds-1 situated at margin of these lamellae and adjacent to gland pores. OC elongate, anteriorly prolonged and extending beyond trochanter II. No



Figures 36-44 *Copidognathus laminifer* sp. nov., female, 36, idiosoma, dorsal aspect; 37, idiosoma, ventral aspect; 38, anterior dorsal plate (lateral lamellae omitted); 39, gnathosoma, dorsolateral aspect; 40, tibia and tarsus III, medial aspect; 41, genu, tibia and tarsus II, lateral aspect; 42, basifemur to tarsus I, lateral aspect; 43, leg IV, lateral aspect; 44, leg I, ventromedial aspect.

cornea but faint brown eye pigment present beneath OC. Lateral margin of OC with gland pore and pore canaliculus. PD 169 μm long, 126 μm wide, with very delicate lateral lamellae and with longitudinal striae but no raised costae. Dorsal setae very delicate, arising from distinct pores. PD with a pair of gland pores level with insertion of leg IV, and a pair of delicate glp posteriorly.

AE and GA fused to a ventral shield (Figure 37). PE with thin lateral lamellae (Figure 37). Posterior part of PD (posterior to insertion of leg IV) may be joined with GA. Else, PE and ventral shield contiguous but not fused, with striae of membraneous integument present between area of GA and PE. Ventral plates with almost uniformly scattered canaliculi, porosity in marginal portions of the plates slightly denser and deeper than in median areas. Epimeral processes present. Lateral eprI in dorsolateral position; medial eprI triangular, slightly smaller than lateral eprI. Lateral eprII elongate, extending beyond trochanters II. Posterior epimera with rounded ventrolateral lamellae, medial epr forming small, raised crests posterior to insertion of legs. GO 36 μm long, 30 μm wide. Ventral setae delicate. Anterior pairs of pgs close together.

Gnathosoma short, 57 μm long. Venter of gnathosoma base with canaliculi, dorsum with faint reticulation. Tectum with narrow crest. Rostrum short. Maxillary setae slender, rostral setae spur-like. Palps short, flattened (Figure 39). P-2 with delicately plumose dorsal bristle. P-4 with all 3 setae inserted near base of segment.

Legs with huge lamellae which are delicate and only faintly reticulated. Ventrolateral lamella on I-3 with slightly sinuate ventral margin. Genua I (Figure 42) and II with small lateral articular lamellae; medial lamellae absent. Tibia I with large lateral and medial lamellae; lateral lamellae on tibiae II, III and IV moderately large, medial lamellae very small. Medial bristle on genu I very large, spine-like (Figure 44). Ventral margin of I-5 with 2 small dents; ventral bristle slender, ventromedial bristles bipectinate. Ventromedial bristle on tibiae III and IV stout, its basal shaft bipectinate, its apex sharply pointed; ventral bristle on tibiae III and IV slender. Tarsi III and IV slender, else outline resembling that of anterior tarsi. Tarsus III with 4 dorsal setae, tarsus IV (Figure 43) with 3 setae.

Claws very slender, with delicate accessory tooth but without pecten. Median claws minute.

Remarks

No other halacarid species is known to have such large lateral lamellae along the idiosoma.

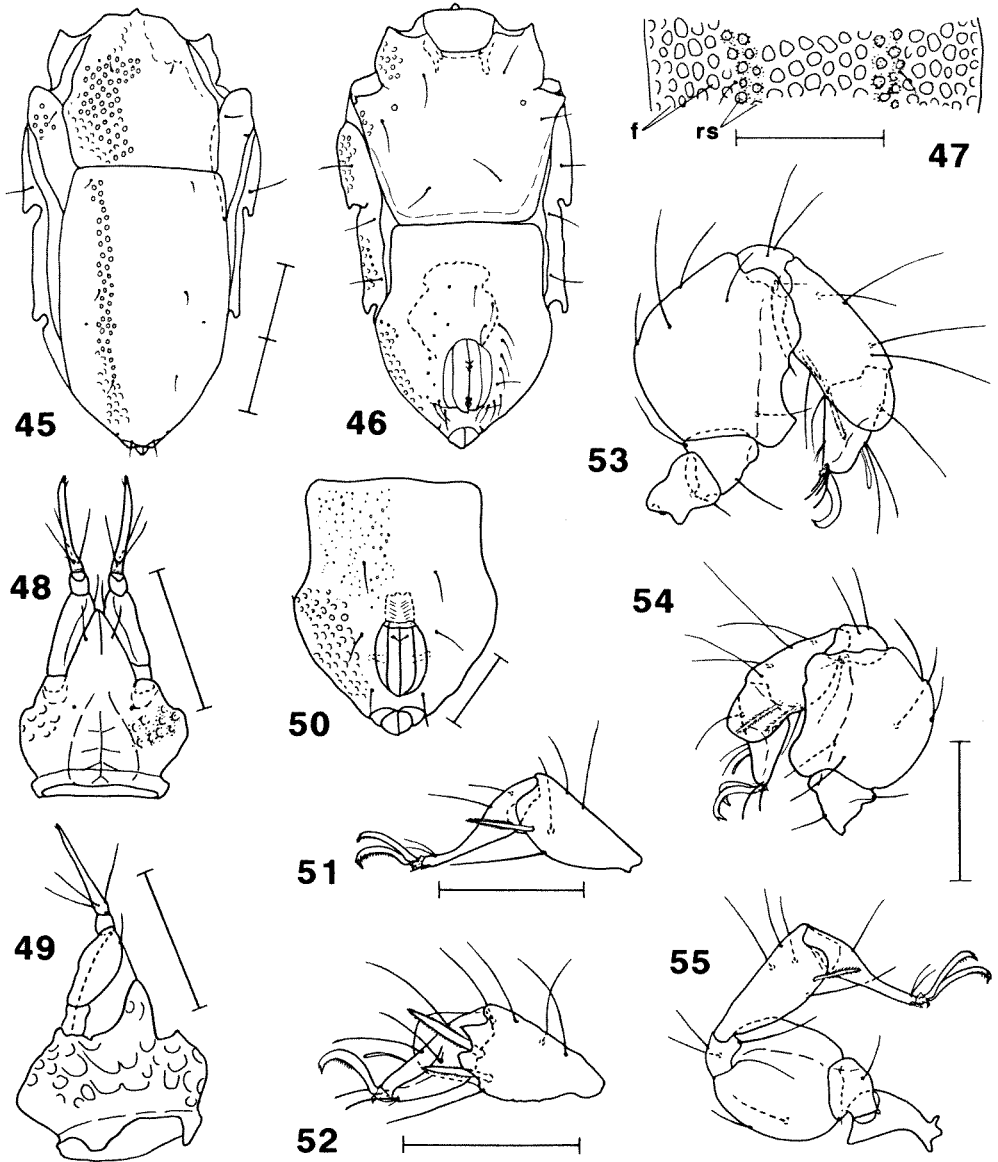
C. laminifer is closely related to *C. bispinus*. Adults are easily separated as AE and GA are fused in *C. laminifer* but separated in *C. bispinus*. Other distinguishing characters are: *C. laminifer* has a very prominent dorsal seta on P-2, whereas *C. bispinus* has a more slender seta and its P-2 is remarkably flattened and lamellar; in *C. laminifer* the medial seta on I-4 is unusually large. Such a large, spine-like seta on I-4 is unique within the *gibbus* group and may also help when identifying juveniles.

Copidognathus punctellus sp. nov.

Figures 45-55

Holotype

♂. Nancy Cove, Rottnest Island, Western Australia, Australia, shore-line platform, sand and algae (*Cystophora*, Fucales) with dense epiflora and epifauna. 12 January 1991, I. Bartsch (WAM 93/2149).



Figures 45–55 *Copidognathus punctellus* sp. nov., 45, idiosoma, dorsal aspect, male; 46, idiosoma, ventral aspect, male; 47, portion of PD level with ds-4, male; 48, gnathosoma, ventral aspect, male; 49, gnathosoma, dorsolateral aspect, female; 50, genital and anal plates, female; 51, tibia and tarsus III, medial aspect, male; 52, tibia and tarsus II, medial aspect, male; 53, leg I, lateral aspect, male; 54, basifemur to tarsus II, lateral aspect, male; 55, leg IV, medial aspect, male.

Other Material Examined

Australia: Western Australia: ♀, Little Armstrong Bay, Rottneest Island, sand from lower slope (near water table), 16 January 1991, I. Bartsch (WAM 93/2150).

Description

Male: Length of idiosoma 287 μm , width 152 μm . All dorsal plates contiguous though not fused. Plates foveate; integument within slightly raised areolae both foveate and densely punctate (canaliculi from rosette pores) (Figure 47). AD 102 μm long, 100 μm wide; with minute, delicately raised frontal spinelet (Figure 45); integument within arch-like areola pierced by numerous canaliculi. First pair of gland pores in anterolateral raised areola. OC 90 μm long, 28 μm wide, with small porose areola; remainder of plate reticulate. No cornea present. Gland pore almost inconspicuous. Pore canaliculus in lateral margin. PD 177 μm long, 115 μm wide. Two longitudinal areolae with foveae (ostia from rosette pores) surrounded by 12–14 canaliculi; areolae in anterior and posterior parts of PD 2–3 and 4 foveae wide. Foveae punctate. Pair of minute gland pores lateral to porose areolae, on level with insertion of leg IV. Dorsal setae small. Setae ds-1 on AD medial to gland pores; ds-2 on median margin of OC well removed from anterior margin of the plate; ds-3 to ds-6 on PD.

Ventral plates contiguous but not fused. Dorsal areas of AE and PE foveate, marginal areas with rosette pores. Porosity on median part of AE coarser than on GA, median part of AE with small pores arranged in groups (polygons). AE 112 μm long, 137 μm wide. Medial epimeral processes lacking, lateral epimeral processes inconspicuous. GA 147 μm long, 115 μm wide; marginal GA with rosette pores, median plate with very delicate pits but without deep canaliculi. GO 48 μm long, 39 μm wide; with 11–12 pairs of pgs. Spermatopositor large, surpassing GO for length of GO (Figure 46).

Gnathosoma 61 μm long, 58 μm wide. Tectum large, triangular (cf. Figure 49). Dorsum of gnathosoma base coarsely reticulate, venter with rosette pores (Figure 48) and sharp lateral carinae. Palps with ventral carinae.

Dorsal and lateral flank of I-3, II-3 and I-5 pierced by scattered canaliculi. Ventrolateral lamella on I-3 and II-3 with reticulate ornamentation; ventral margin of lamellae irregularly sinuate, with projecting lobes (Figures 53, 54). Ventrolateral lamellae on telofemora III and IV (Figure 55) with rather truncate ventral margin. Lateral articular lamella on I-5 about as long as wide, medial lamella slightly smaller. Medial lamella on tibia II with deep indentation for posterior pectinate seta (Figure 52). Solenidion on tarsi I and II slender, slightly clavate. Tarsus III with 4 dorsal setae (Figure 51), tarsus IV with 3 setae.

All lateral claws with accessory process and claw pecten. Tines of pecten largest near apex of claws.

Female: Idiosoma length 309 μm . In dorsal aspect similar to male. Median AE with coarser porosity than in male; pores resembling rosette pores. GA 157 μm long, 117 μm wide. Median GA with delicate pits, canaliculi lacking; marginal GA with rosette pores. GO 47 μm long, 31 μm wide. Ovipositor surpassing GO (Figure 50). Three pairs of pgs inserted as illustrated.

Remarks

Copidognathus punctellus is easily distinguished from the other representatives of the *gibbus* group on the basis of the rather uniformly foveate dorsal plates, with only slightly raised areas which are both foveate and pierced by canaliculi, the porose telofemora I and II,

and the sinuose ventral margin of the ventrolateral lamellae. The ornamentation of the dorsal plates resembles that described for *C. simplipes* Newell, a species recorded from the southeastern Pacific near Chile (Newell 1984). The combination of: posterior margin of AD truncate, ds-4 inserted just anterior to insertion of leg IV, medial eprI absent, and ventrolateral lamella on I-3 sinuose, distinguish *C. punctellus* from *C. simplipes*.

C. punctellus is thought to inhabit water-logged sandy deposits. The ornamentation of the dorsal plates resembles that found in the epibenthic living *Copidognathus rhodostigma* (Gosse), a species common in the surface layers of shallow water sandy deposits (Bartsch 1979, 1985b, c); and both specimens may colonize similar habitats.

Copidognathus nasutus sp. nov.

Figures 56–63

Holotype

♂, Fish Hook Bay, Rottneest Island, Western Australia, Australia, corallines (*Amphiroa*) from undercut of shore-line platform, just beneath low water edge, 15 January 1991, I. Bartsch (WAM 93/2146).

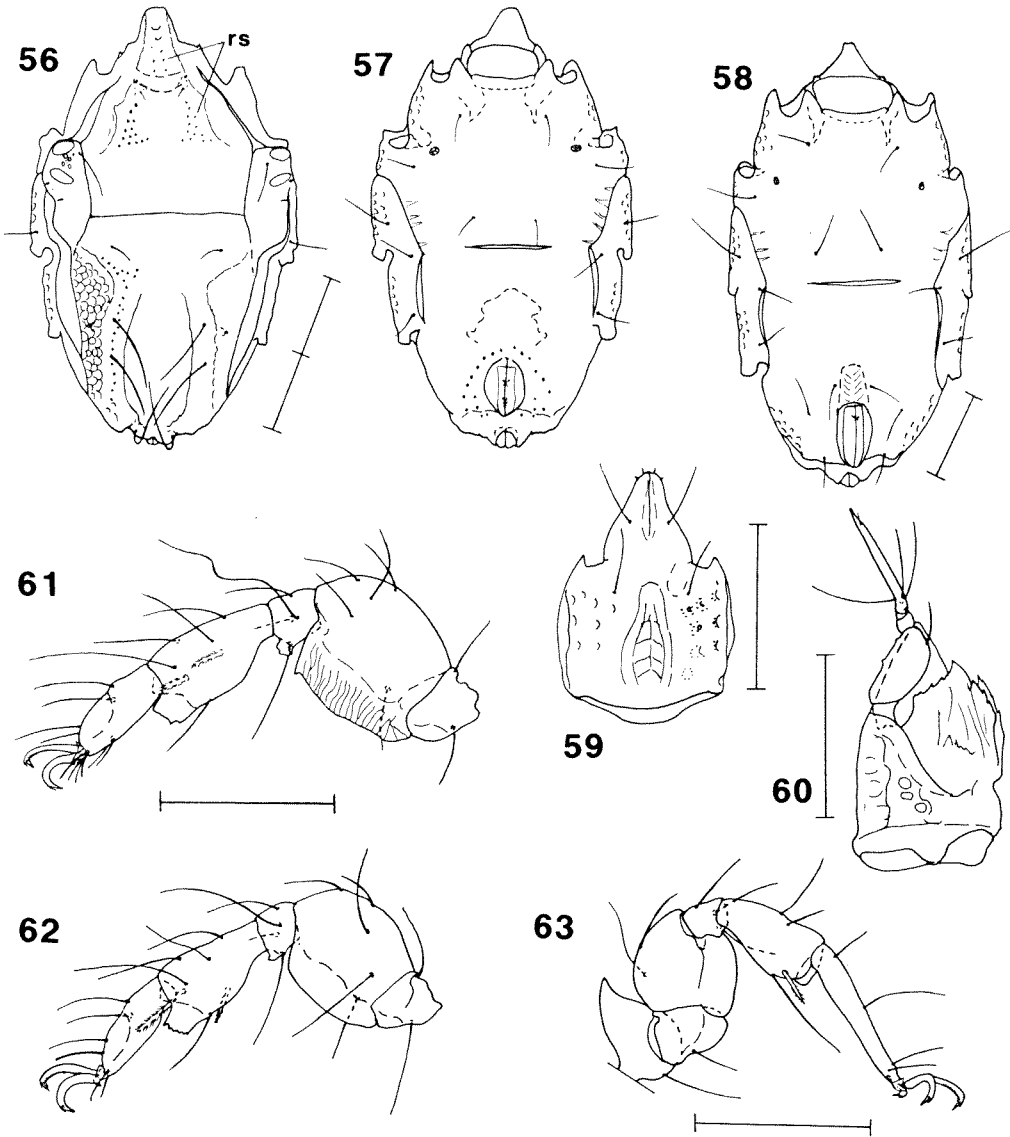
Other Material Examined

Australia: Western Australia: 1♀, 1♂, Nancy Cove, corallines from shore-line platform, low water, 20 January 1991, I. Bartsch (WAM 93/2147–2148); 2♀, Nancy Cove, 20 January 1991, I. Bartsch (IB Au97, Au351).

Description

Male: Idiosoma length 260–265 µm, holotype 265 µm. Dorsal plates contiguous, AD and OC, and OC and PD partly fused. AD 126 µm long, 105 µm wide; with raised, bluntly ending frontal process; raised area extending posterior, diverging, and ending level with ds-2. AD with internal 'A'-shaped structure. Pair of posterior porose areolae triangular in outline, with 12–13 rosette pores; unpaired anterior areola with 6 rosette pores (Figure 56). Frontal process with deep ostia but without canaliculi. Rosette pores on AD, OC and PD with small surficial ostia and canaliculi in deeper integumental layers. Reticulate integument lateral to raised area set off abruptly. OC 80 µm long, 30 µm wide; medial raised margin with 2 corneae; area between corneae with rosette pores; posterolateral margin of OC raised and with foveate sculpturing; large porus from gland pore on lateral protrusion of OC and small pore canaliculus just posterior to protrusion. Medial part of OC lacks distinct ornamentation. Posterior part of OC tail-like. PD and AD broadly contiguous but not fused. PD 135 µm long, 110 µm wide. Longitudinal costae anteriorly with narrow, curved crests which extend to lateral margins of PD. Arrangement of rosette pores as figured. Anterior part of PD with fine reticulate ornamentation; lateral part of PD coarsely reticulate and rather abruptly set off from costae; median part of PD groove-like. Gland pore, level with insertion of leg IV, not included in costae. Setae ds-1 slender, inserted on AD, ds-2 in anteromedial part of OC, ds-3 on PD well removed from anterior margin. Setae ds-4, ds-5 and ds-6 conspicuously large, ds-4 and ds-5 turned backward, ds-6 forward (Figure 56).

AE and GA laterally fused but medially separated by striated integument; AE and PE contiguous; PE and GA partly separated by median wedge of striated integument (Figure 57). Ventral plates with rosette pores near margins whereas large ventral areas have scattered and very delicate canaliculi or are almost smooth. AE 95 µm long, 155 µm wide, with bulbous anterior apodemes. Dorsolateral margin of camerostome with small triangular processes. Lateral eprI enlarged dorsolaterally. Medial eprII lamellar, lateral eprII inconspicuous. GA



Figures 56–63 *Copidognathus nasutus* sp. nov., 56, idiosoma, dorsal aspect, male; 57, idiosoma, ventral aspect, male; 58, idiosoma, ventral aspect, female; 59, gnathosoma, ventral aspect, female; 60, gnathosoma, dorsolateral aspect, female; 61, basifemur to tarsus I, lateral aspect, male; 62, basifemur to tarsus II, lateral aspect, male; 63, leg III, medial aspect, female.

117 μm long, 108 μm wide; GO 33 μm long, 27 μm wide. GO in posterior part of GA, distance to anterior margin of GA equalling twice the length of GO. Genital sclerites with 3 pairs of sgs.

Gnathosoma 70 μm long. Venter of gnathosoma base foveate (ostia from rosette pores), canaliculi in holotype lacking (in a paratype female present). Maxillary setae inserted as illustrated in Figure 59. Tectum with abruptly raised large crest bearing a pair of carinae (cf. Figure 60). P-2 with small, lamellar ventral dent. P-4 slender, longer than P-2, with 3 setae inserted near base of P-4. Dorsal seta on P-2 stout.

Ventrolateral lamellae on all telofemora and ventral lamellae on basifemora reticulate and with transverse striae along ventral margin (Figure 61). Lateral articular lamellae on tibiae I and II with coarsely serrate edges (Figures 61, 62), their length less than half height of the segment. Lamellae on tibiae III (cf. Figure 63) and IV small. Right tarsus of holotype with 3, left tarsus (Figure 61) with 2 ventral seta. Tarsi III and IV slender, longer than telofemur and tibia, each tarsus with 4 dorsal setae.

Claws with accessory processes bearing tines. Claw pecten with delicate tines present on posterior half of claws.

Female: Idiosoma length 248–266 μm . In dorsal aspect similar to male. Ventral plates contiguous as in males, AE and GA separated medially but fused laterally (Figure 58). GA 113 μm long, 103 μm wide, separated from anterior margin of GA by almost twice the length of GO. Setae pgs inserted as illustrated. Ovipositor surpassing anterior pair of pgs.

Remarks

Copidognathus nasutus is characterized by its truncate frontal process and the ornamentation of the dorsal plates. A similar outline of porose areolae is known from *C. acanthophorus* Viets, *C. cristatus* Viets, *C. majusculus* (Trouessart), and *C. mesomorphus* André. *C. acanthophorus* lives in western Antarctica and adjacent areas (Viets 1950; Newell 1984), *C. cristatus* in the Caribbean area (Viets 1936), *C. majusculus* in the Mediterranean (Bartsch 1985a), and *C. mesomorphus* has been recorded from Egypt (André 1959). A long and truncate frontal spine as in *C. nasutus* is not found in any of the other species.

C. nasutus has remarkably large ds-4, ds-5 and ds-6. Slightly enlarged ds-5 are present in *Copidognathus gibbus* and *C. majusculus*. In populations of *C. gibbus* from the Mediterranean, studied by the author, both specimens with small ds-5 (of about same size as anterior setae) and with enlarged ds-5 were observed, in both males and females, independent of depth or season.

Enlarged ds-4 and ds-5, similar to those in *C. nasutus*, are recorded from *C. neptuneus* Bartsch. That species is not closely related to the *gibbus* group (Bartsch 1992).

Copidognathus crassispinus sp. nov.

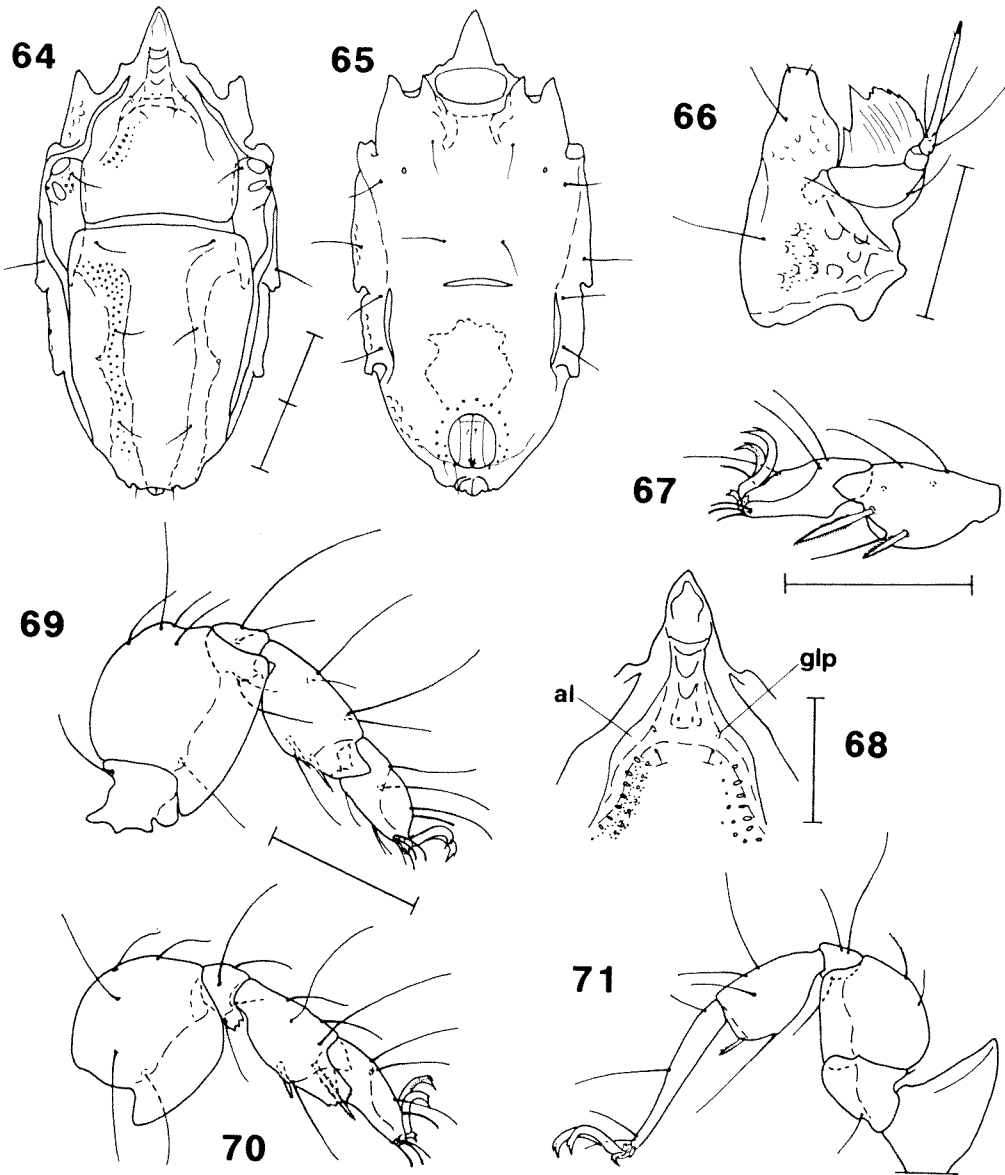
Figures 64–71

Holotype

♂, Little Armstrong Bay, Rottneest Island, Western Australia, Australia, sediment from slope, 30 cm sediment depth, 23 January 1991, I. Bartsch (WAM 93/2140).

Description

Male: Idiosoma length 335 μm . Dorsal plates adjacent, with narrow striae of membranous



Figures 64–71 *Copidognathus crassispinus* sp. nov., male, 64, idiosoma, dorsal aspect; 65, idiosoma, ventral aspect; 66, gnathosoma, lateral aspect; 67, tibia and tarsus II, medial aspect; 68, anterior AD; 69, basifemur to tarsus I, lateral aspect; 70, telofemur to tarsus II, lateral aspect; 71, leg IV, lateral aspect.

integument between the plates. AD, OC and PD with porose areolae, remainder of plates reticulate. AD 145 μm long, 113 μm wide, with long and thick frontal spine (Figure 64). Internal sclerite anteriorly with 2 parallel longitudinal bars, followed by transverse bar and then diverging (Figure 68). Anterior portion of raised area with large foveae, posterior portion with porose longitudinal areolae that are 2 rosette pores wide, inner (medial) row of pores with small ostia at surface of plate and 5–7 canaliculi in deeper layers, lateral row of pores with ovate ostia each with 8–10 canaliculi. Narrow anterolateral lamellae present level with internal transverse bar (Figure 68); lamellae no more than 6 μm wide. Porus of first pair of glands opening beneath lamella. OC 84 μm long, 28 μm wide. Posterior part of OC tail-like. Anterior cornea large, posterior cornea smaller. Small porose area present medial to corneae. Gland pore on lateral edge of OC, pore canaliculus posterior to gland pore. Setae ds-2 placed near anterior cornea. PD 177 μm long, 115 μm wide, with 2 raised and sinuose porose areolae. Porose costae anteriorly 4 rosette pores wide, posteriorly 1–2 pores wide. Pair of gland pores at margin of costae, level with insertion of leg IV and in posterior part of PD. Plate lateral to costae coarsely reticulate, median part of PD faintly reticulate.

Dorsal areas of ventral plates foveate, marginal areas with rosette pores, ventral areas with scattered delicate canaliculi. AE 112 μm long, 159 μm wide, GA 145 μm long, 117 μm wide, with 50 μm wide wedge of striated integument between AE and GA, else plates fused (Figure 65). Medial eprI triangular, slightly smaller than eprI in dorsolateral position. Two blunt dents on dorsolateral margin of camerostome. Lamellar medial eprII and lateral eprII (in dorsolateral position) prominent. Pair of vs-3 inserted distinctly removed from posterior margin of AE (Figure 65). GO 40 μm long, 36 μm wide, 11–12 pairs of pgs arranged very close around GO. Genital sclerites in the single male available with one anterior and two posterior pairs of sgs. Spermatopositor large. GO removed from anterior margin of GA for somewhat more than 2 times the length of GO.

Gnathosoma 82 μm long. Ventral and marginal areas of gnathosoma base with rosette pores. Tectum spine-like, with large crest (Figure 66). P-4 slender, longer than P-2. P-4 with 3 long setae inserted near base of segment. P-2 with small ventral dent.

Ventrolateral lamellae on I-3 and II-3 rather smooth, with slightly convex ventral margin (Figures 69, 70). Lateral articular lamella on I-4 scale-like, that on I-5 slightly shorter than high. Lamellae on II-4 and II-5 about as long as corresponding lamellae on leg I but with coarsely serrate margin. Distal bipectinate setae on tibia II enlarged. Tarsus II with small ventral knob (Figure 67). Solenidion on both tarsus I and II slender and seta-like. Tarsi III and IV (Figure 71) slender, much longer than tibiae and telofemora, each with 4 dorsal setae.

Claws rather long and slender. Pecten with few delicate tines.

Remarks

Copidognathus crassispinus is distinguished from other species found around Rottneest Island on the basis of the long spine. *C. nasutus* has a stout frontal spine, too, but that of *C. crassispinus* is longer, the spine lacks rosette pores, there are small anterolateral lamellae level with the transverse internal bar, and the outline of the porose areolae is different from that of *C. nasutus*.

C. crassispinus is very similar to *C. longispinus* Bartsch and Iliffe, a species recorded from the islands of Bermuda (Bartsch and Iliffe 1985). *C. longispinus* differs from *C. crassispinus* in having the anterior pair of gland pores and ds-1 being widely separated and bearing rosette pores anterior to the ds-1.

Copidognathus bistriatus sp. nov.

Figures 72–82

Holotype

♂. Fish Hook Bay, Rottneest Island, Western Australia, Australia, 1–1.5 cm high corallines, edge of rocky platform, tidal low water edge, 9 January 1991, I. Bartsch (WAM 93/2131).

Paratypes

Australia: Western Australia: 1 ♀, type locality and date (WAM 93/2132); 1 ♀, 1 ♂, type locality and date (WAM 93/2133–2134).

Other Material Examined

Australia: Western Australia: 2 ♀, 2 ♀, 1 protonymph, Nancy Cove, corallines and colonies of polychaetes on concrete piers, lower tidal edge, 12 January 1991, I. Bartsch (IB Au368); 1 ♀, 1 ♂, Little Armstrong Bay, epiflora on the seagrass *Amphibolis*, 0.5–1.5 m depth, 16 January 1991, I. Bartsch (IB Au360). 1 ♀, Nancy Cove, corallines, tidal low water edge, 20 January 1991, I. Bartsch (IB Au351).

Description

Male: Length of idiosoma 248–263 µm, that of holotype 248 µm. Dorsal aspect similar to female (cf. Figure 72). Dorsal plates separate, with narrow striae of membraneous integument between plates. AD (holotype) 97 µm long, 93 µm wide. Median part of AD and frontal spine prominently raised, with 'A'-shaped porose areolae and 'A'-shaped internal sclerite. Porose areolae with rosette pores, posterior 'legs' of 'A' 2 pores wide. Remainder of plate lightly reticulated. Pair of glp-1 level with transverse internal bar. OC elongate, 73 µm long, 20 µm wide (holotype), with 2–3 rosette pores medial to the 2 corneae; gland pore and pore canaliculus in lateral margin. PD 144 µm long, 105 µm wide. Pair of costae with rosette pores, costae anteriorly 2(–3) pores wide, else 1 pore wide (cf. Figure 75). Plate lateral to costae coarsely foveate; median and anterior PD lightly reticulated. Pair of gland pores present in lateral, foveate plate, level with insertion of leg IV. Dorsal setae delicate, ds-1 adjacent to glp-1, ds-2 in anteromedial margin of OC, ds-3 near anterior margin of PD, ds-4 and ds-5 within costae anterior and posterior to level of gland pore.

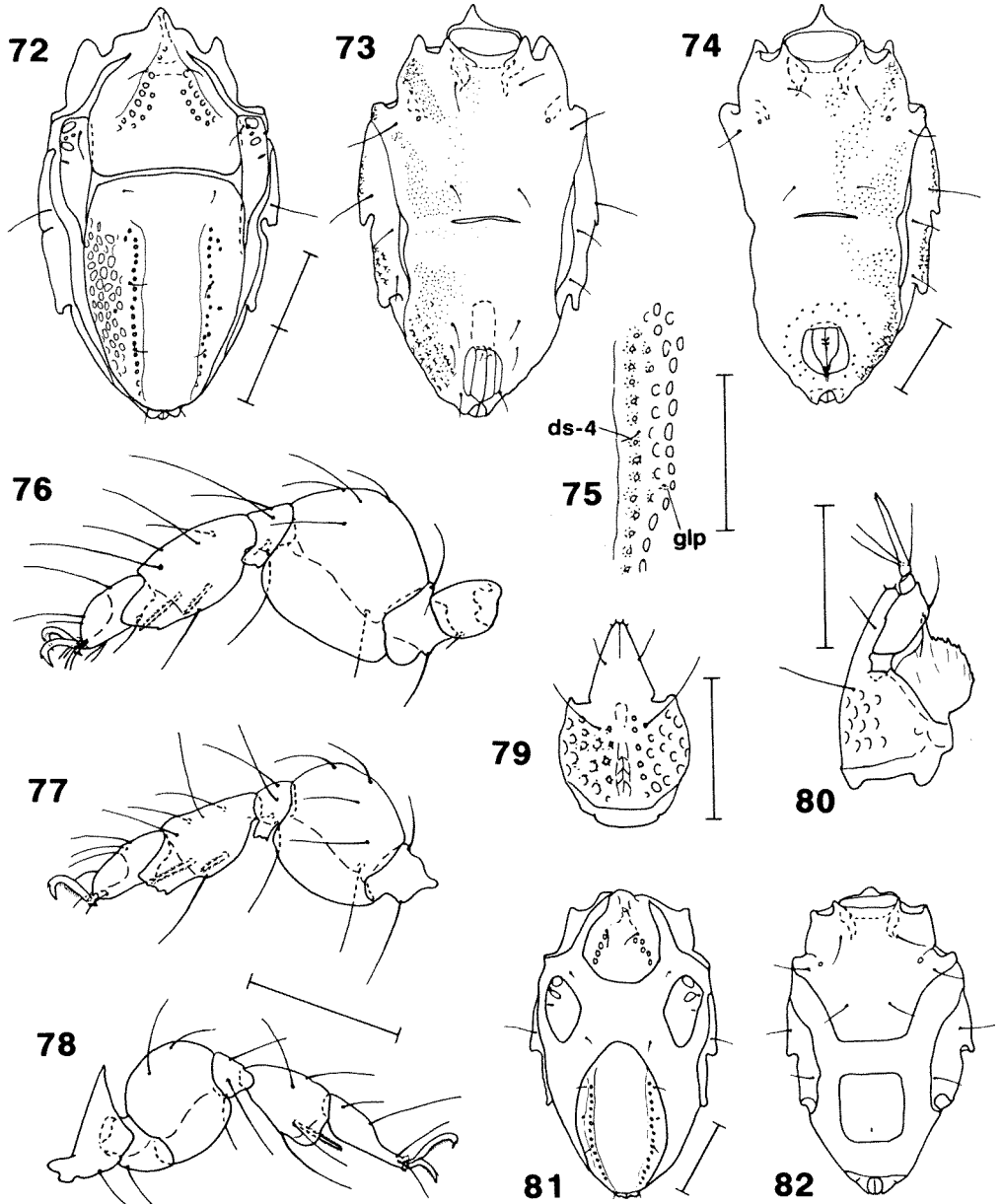
Median part of AE and GA separated by striae of membraneous integument but fused in posterolateral and anterolateral corners (Figure 74). AE and GA with rosette pores near margin, adjacent areas with canaliculi, median part of AE and GA with almost smooth integument. GA 117 µm long, 96 µm wide. GO 32 µm long, 30 µm wide, surrounded by 13–14 pairs of pgs. Distance from GO to anterior margin of GA almost twice the length of GO.

Gnathosoma 73 µm long. Tectum with huge serrate crest (Figure 80). Ventral flank of gnathosoma base with rosette pores (Figure 79), dorsal flank roughly reticulate and with dorsolateral lamellae. P-4 with 3 setae in basal whorl inserted adjacent to each other.

All telofemora with large ventrolateral lamellae (Figures 76–78); these lamellae delicately and finely reticulate; anteromedial flank of I-3 with numerous delicate striae. Height of telofemora more than length of segment. Tibiae shorter than telofemora. Tibiae I and II with large lateral and distinctly smaller medial articular lamella. Tarsi III with 4 and tarsi IV with 3 dorsal setae.

Claws with accessory process and long pecten.

Female: Idiosoma length 248–254 µm. Similar to male except for genital region. AE and GA as in male fused laterally but separated in the median (Figure 73). GA (paratype) 121 µm long, 102 µm wide. GO 38 µm long, 25 µm wide, its distance to anterior margin of GA equalling twice the length of GO. Setae pgs inserted as figured. Ovipositor surpassing GO for less than length of GO, but extending beyond anterior pair of pgs.



Figures 72–82 *Copidognathus bistriatus* sp. nov., 72, idiosoma, dorsal aspect, female; 73, idiosoma, ventral aspect, female; 74, idiosoma, ventral aspect, male; 75, portion of right PD with ds-4, female; 76, leg I, lateral aspect, male; 77, basifemur to tarsus II, lateral aspect, male; 78, leg III, lateral aspect, male; 79, gnathosoma, ventral aspect, male; 80, gnathosoma, lateral aspect, male; 81, idiosoma, dorsal aspect, protonymph; 82, idiosoma, ventral aspect, protonymph.

Protonymph: Idiosoma length 198–201 μm . Dorsal plates smaller than those of adults. AD and PD with rounded posterior and anterior margin (Figure 81). Setae ds-3 inserted within striated integument. Ventral plates delicately and minutely reticulate. Outline of plates as illustrated (Figure 82). Gnathosoma similar to that of adults. Telofemora with ventrolateral lamellae. Tibiae I and II with a single (the distal one) bipectinate seta.

Remarks

Copidognathus bistriatus is closely related to *C. incarinatus* Newell and *C. areolatus* Bartsch. The two latter species are known from the eastern Pacific Ocean near Chile (*C. incarinatus*) and the Hawaiian Islands (*C. areolatus*) (Newell 1984; Bartsch 1989). *C. incarinatus* has wider costae on the PD (costae two pores wide). The AD of *C. areolatus* shows a second transverse bar with a sculpturing differing from remainder of the plate; such bar is lacking in *C. bistriatus*.

In the samples taken around Rottnest Island, *C. bistriatus* is an abundant representative of the *gibbus* group. The species was found within scrubs of corallines and colonies of tube-building polychaetes in tidal and shallow subtidal areas.

Copidognathus multiporus sp. nov.

Figures 83–90

Holotype

♂, Little Armstrong Bay, Rottnest Island, Western Australia, Australia, seagrass *Amphibolis* with dense epiflora and epifauna and sediment, 0.5–1.0 m depth, 16 January 1991, I. Bartsch (WAM 93/2144).

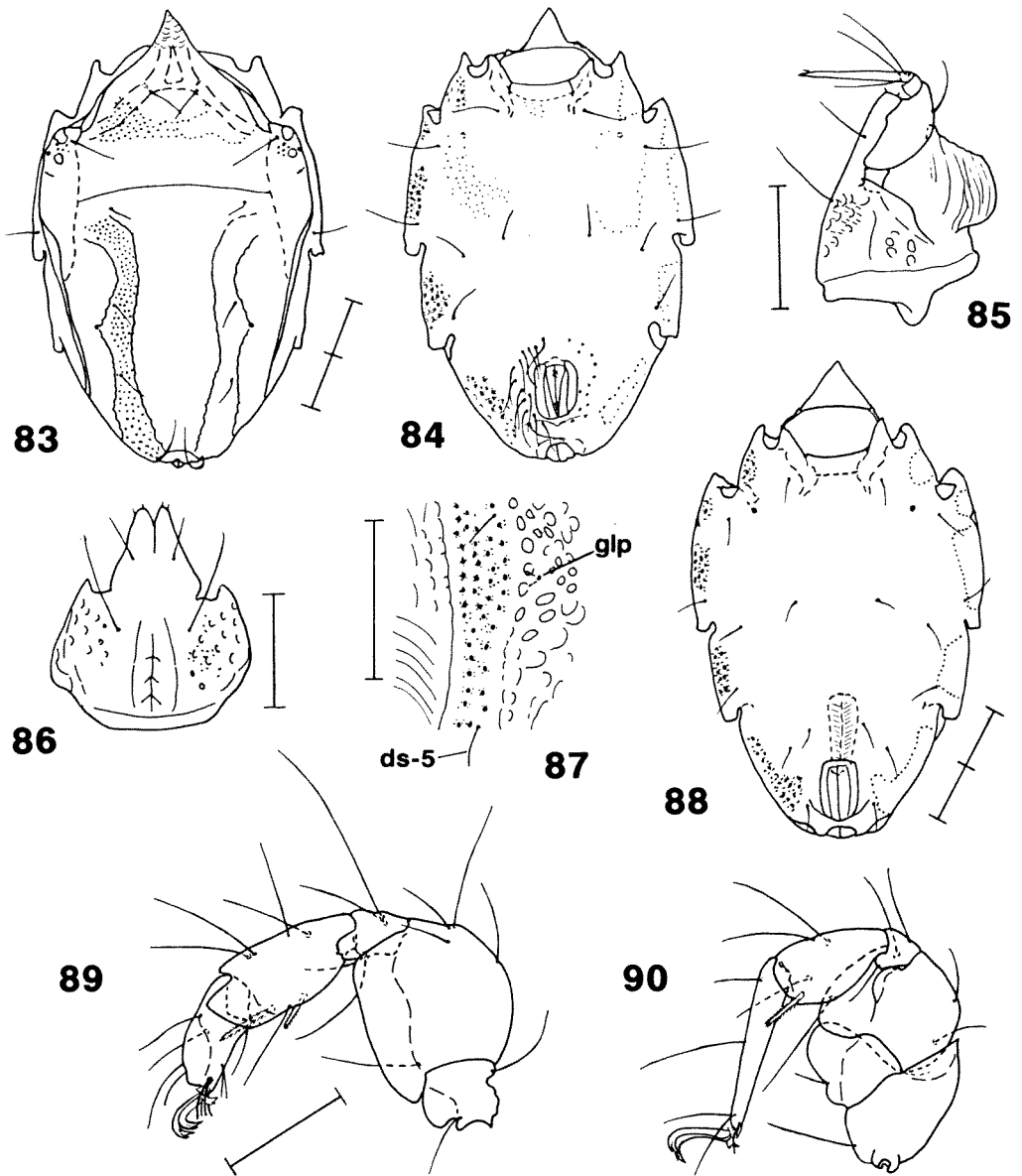
Paratypes

Australia: Western Australia: 1 ♀, type locality, date and collector (WAM 93/2145); 1 ♂, 1 ♀, type locality, date and collector (IB Au389).

Description

Male: Idiosoma length 372–396 μm , holotype 396 μm . Dorsal plates contiguous, partly but not completely fused. AD (holotype) 155 μm long, 179 μm wide. Frontal spine and median AD raised, with 'A'-shaped internal sclerite, porose areolae with rosette pores and wide anterolateral lamellae (Figure 83). Integument of frontal spine foveolate. Each rosette pore with very small surficial ostium and 3–4 canaliculi in deeper layers. OC 130 μm long; with large anterior and small posterior cornea, 10–12 rosette pores medial to corneae, and gland pore and pore canaliculus in lateral margin. PD 235 μm long, 204 μm wide; with 2 sinuose, sharply raised and porose costae. Gland pore at margin of costae (Figure 87). Anterior part of costae 3–4 pores wide; costae just posterior to gland pores 2 rosette pores wide; posterior part of costae 4–5 pores wide. Lateral part of PD with reticulate sculpturing. Median part of PD with very delicate, scattered canaliculi, else rather smooth. Dorsal setae long and slender; ds-1 inserted on AD on one level with transverse bar of 'A'-shaped internal sclerite; ds-2 on anteromedial margin of OC; ds-3 to ds-5 on PD, ds-3 anterior to raised costae, ds-4 and ds-5 within raised costae.

All ventral plates fused to a ventral shield (Figure 84); only internal apodemes from muscle strings give evidence of margins of plates. Marginal areas of ventral shield with rosette pores, adjacent areas with groups of canaliculi, median shield with scattered, very delicate canaliculi. Epimeral processes large, medial and lateral eprI triangular, median process slightly shorter



Figures 83–90 *Copidognathus multiporus* sp. nov., 83, idiosoma, dorsal aspect, male; 84, idiosoma, ventral aspect, male; 85, gnathosoma, lateral aspect, male; 86, gnathosoma, ventral aspect, male; 87, portion of right PD with ds-4 and ds-5, male; 88, idiosoma, ventral aspect, female; 89, basifemur to tarsus I, lateral aspect, male; 90, leg III, medial aspect, male.

than lateral process. Lateral eprII distinct. GO 52 μm long, 35 μm wide; 13–14 pairs of pgs arranged around GO; two posterior pairs of pgs bristle-like. Spermatopositor large.

Gnathosoma very wide, 97 μm long, 82 μm wide. Gnathosoma base with rosette pores (Figure 86). Tectum with large, sharply raised crest (Figure 85). Palp with small ventral process. P-4 with 3 long setae inserted near base of segment.

Dorsal projection on trochanters III and IV large. Basifemora III and IV with large ventral lamellae. Telofemora slightly longer than high; with large, very delicately reticulated ventrolateral lamellae. Lateral articular lamella on I-5 distinctly larger than medial lamella. II-5 with small, triangular and flap-like medial lamella; lateral lamella long and wide (Figure 89). Tibiae III and IV with lateral lamellae somewhat smaller than medial lamellae. Ventromedial (bipectinate) seta on III-5 short when compared with very long ventral bristle-like seta. Tarsi III (Figure 90) and IV conspicuously long and slender, longer than tibiae plus genua; each tarsus with 4 dorsal setae.

Claws slender. Accessory process with delicate tines.

Female: Idiosoma length 378–390 μm . In dorsal aspect similar to male. Ventral plates fused to a ventral shield (Figure 88). GO 48 μm long, 30 μm wide. Ovipositor surpassing GO for slightly more than length of GO.

Remarks

Copidognathus multiporus is most easily identified on the basis of the combination of: all ventral plates fused to a ventral shield; AD with transverse bar, PD with 2 longitudinal areolae, each with numerous rosette pores, rosette pores having small ostia at the surface of the plates and 3–4 canaliculi in deeper layers; tarsi III and IV very long and slender.

In dorsal aspect, there is a slight similarity with *C. cataphractus* (Trouessart), a species recorded from the western Indian Ocean (André 1959). The shape of the AD, its anterolateral lamellae and the transverse porose areola are similar in both species, but the outline of the porose costae on the PD is distinctly different.

Copidognathus caelatus sp. nov.

Figures 91–99

Holotype

σ , Bickley Point, Rottnest Island, Western Australia, Australia, *Amphiroa* and other corallines from vertical rock surface, 0.5 m depth, 18 January 1991, I. Bartsch (WAM 93/2135).

Paratypes

Australia: Western Australia: 1 ♀ , same data and collector as for holotype (WAM 93/2136); 1 σ , type locality and date (WAM 93/2137).

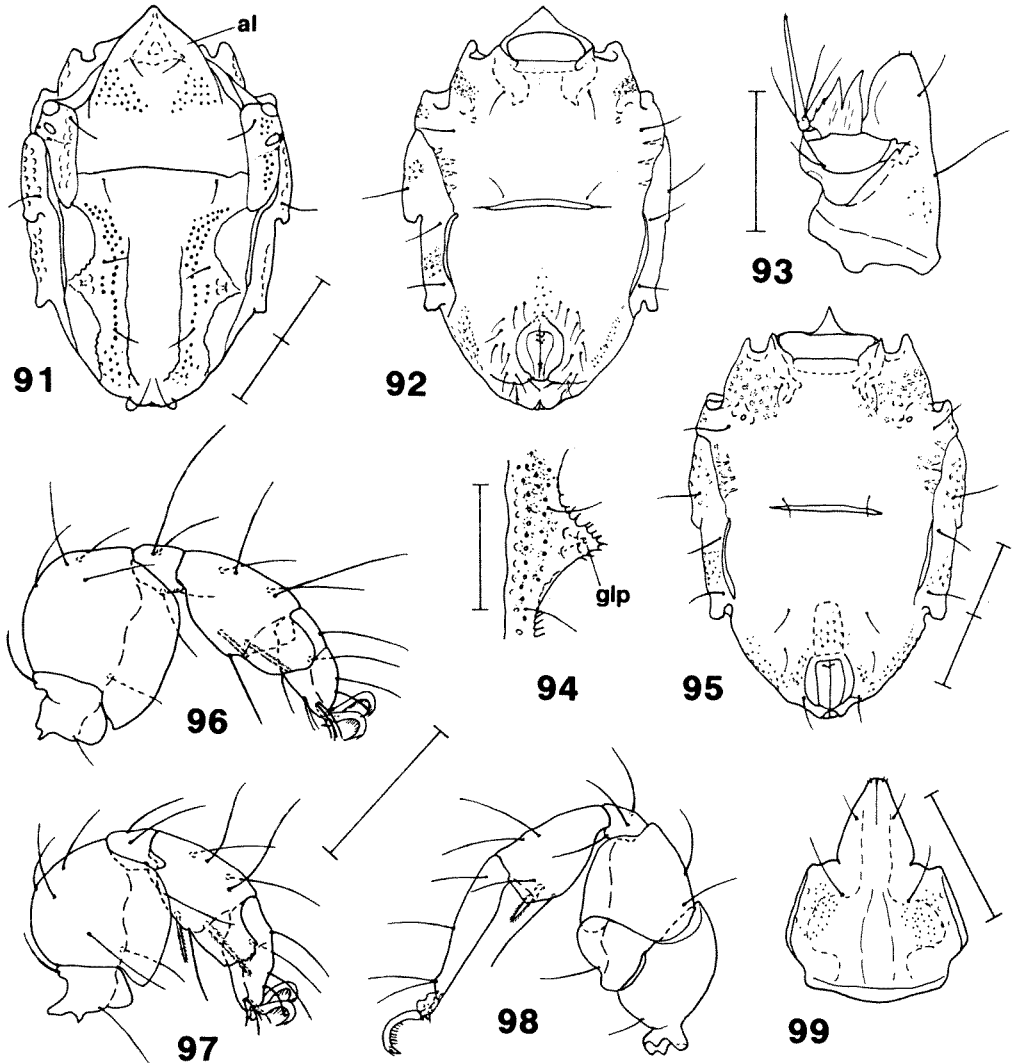
Other Material Examined

Australia: Western Australia: 2 σ , Little Armstrong Bay, seagrass *Amphibolis*, 0.5 m depth, 16 January 1991, I. Bartsch (IB Au390).

Description

Male: Idiosoma 276–278 μm long, holotype 278 μm long. Idiosoma intensely armoured; dorsal plates contiguous, partly overlapping, margins of plates present but plates often not separated by striated integument. Porose areolae generally with small surficial ostia and

numerous canaliculi in deeper integumental layers. Remainder of plates (outside porose areolae) with very faint reticulate ornamentation. AD (holotype) 122 μ m long, 117 μ m wide, with 'A'-shaped, solid internal sclerite. Wide anterolateral lamellae extending from frontal spine almost to level of ds-2 (Figure 91). Scattered canaliculi within anterior angle of 'A'-



Figures 91–99 *Copidognathus caelatus* sp. nov., 91, idiosoma, dorsal aspect, male; 92, idiosoma, ventral aspect, male; 93, gnathosoma, lateral aspect, male; 94, portion of right PD with ds-4 and ds-5, male; 95, idiosoma, ventral aspect, female; 96, basifemur to tarsus I, lateral aspect, male; 97, basifemur to tarsus II, lateral aspect, male; 98, leg III, lateral aspect, male; 99, gnathosoma, ventral aspect, male.

shaped sclerite. The 2 triangular areolae each with about 25 rosette pores. First pair of gland pores rather inconspicuous, level with transverse bar of internal 'A'-shaped sclerite. OC 89 μm long, 30 μm wide, not distinctly separated from AD and PD, and linked with dorsal AE; posterior part of OC tail-like. Lateral part of OC raised; with 2 large corneae, rosette pores between corneae and on 2 rows along lateral margin of OC. Medial part of OC excavated and without prominent sculpturing. Gland pore and pore canaliculus lateral to posterior cornea. PD 149 μm long, 117 μm wide. With longitudinal sinuose porose costae; costae with lateral protrusions both level with insertion of leg III and leg IV (Figure 91); median part of PD slightly excavated, lateral part of PD abruptly set off from raised costae. Solid internal sclerites present beneath costae. Anterior porose areolae with small ostia; posterior areolae with larger ostia. Large gland pore within lateral protrusion (Figure 94). Dorsal setae long, ds-1 inserted adjacent to 'A'-shaped sclerite, ds-2 in medial margin of OC, ds-3 close to anterior margin of PD, ds-4 and ds-5 within costae just anterior and posterior to level of leg IV.

AE 96 μm long, 174 μm wide. Anterior apodemes very prominent (Figure 92). Medial eprI triangular, lateral eprI somewhat larger and extending dorsolaterally, medial eprII scale-like. Dorsal and marginal parts of AE and PE with rosette pores; ventral plates with distinctly demarcated porose areolae. AE with pair of triangular areolae posterior to leg I, small areolae posterior to leg II and scattered canaliculi posterior to camerostome. PE with ventral porose areolae both anterior to leg III and leg IV. Lateral part of GA with pair of porose areolae and few scattered pores anterior to GO. Remainder of AE and anterior part of PE incompletely fused, with margins of the plates still visible and epicuticula somewhat overlapping. GA 140 μm long, 137 μm wide. AE and GA fused posterolaterally and anterolaterally for about 30 μm ; median 70 μm wide wedge with striated integument (Figure 92). GO 45 μm long, 32 μm wide; anterior foramen overlaid by a membrane. Pgs slender, 11–12 on either side of foramen. Spermatopositor large.

Gnathosoma 80 μm long. Ventral and lateral base of gnathosoma with rosette pores and canaliculi (Figure 99). Tectum with long spine which bears a high crest (Figure 93). P-4 slender, longer than P-2; 3 setae inserted near base of segment. Dorsal seta on P-2 rather stout.

Ventrolateral lamella on I-3 and II-3 with very delicate reticulate sculpturing, both with ventral margin somewhat convex (Figures 96, 97). Lateral articular lamellae on I-5 and II-5 much larger than small medial lamellae. Articular lamellae on posterior tibiae rather small (Figure 98). Solenidion on both tarsus I and II slender, seta-like. Tarsi III and IV slender, longer than tibiae and telofemora, tarsus III with 4 dorsal setae, tarsus IV with 3 setae.

Claws with accessory process and pecten. Tines on pecten long and rather delicate.

Female: Idiosoma length 266–267 μm . Dorsal aspect similar to male. AE with apodemes flanking camerostome smaller than in male. Porose areolae on ventral plates larger than in male. AE and PE partly fused, GA and PE separated via striated integument (Figure 95). AE and GA fused in their outer edges but separated in the median. GA 135 μm long and 120 μm wide. GO 38 μm long, 32 μm wide, distance to anterior margin of GA about 2.5 times the length of GO. Ovipositor extending beyond GO for about length of GO.

Remarks

With the wide idiosoma, the anterolateral lamellae on the PD and the porose areolae on the dorsal plates, *C. caelatus* resembles *C. cataphractus* (Trouessart), a species recorded from

Djibouti (Trouessart 1899), and *C. mesomorphus* André, recorded from Egypt (André 1959). In *C. cataphractus*, the integument outside the raised porose areolae is coarsely foveate whereas in *C. caelatus* the integument is smooth or delicately reticulate. In *C. mesomorphus* the raised area on the AD is much more narrow and extends posteriorly distinctly beyond the mid of the AD.

In *C. caelatus*, as in several other species of the *gibbus* group, the lateral PD is deeply excavated, the excavations are flanked by the raised longitudinal costae. The excavations are fitted to take up trochanters and telofemora of leg III and IV. Trochanters and telofemora of the anterior legs can be hidden beneath the anterolateral membrane of the raised AD.

***Copidognathus ampliatus* sp. nov.**

Figures 100–109

Holotype

♂, Little Armstrong Bay, Rottneest Island, Western Australia, Australia, seagrass *Amphibolis* overgrown with epiflora and epifauna, 0.5 m depth, 16 January 1991, I. Bartsch (WAM 93/2127).

Paratypes

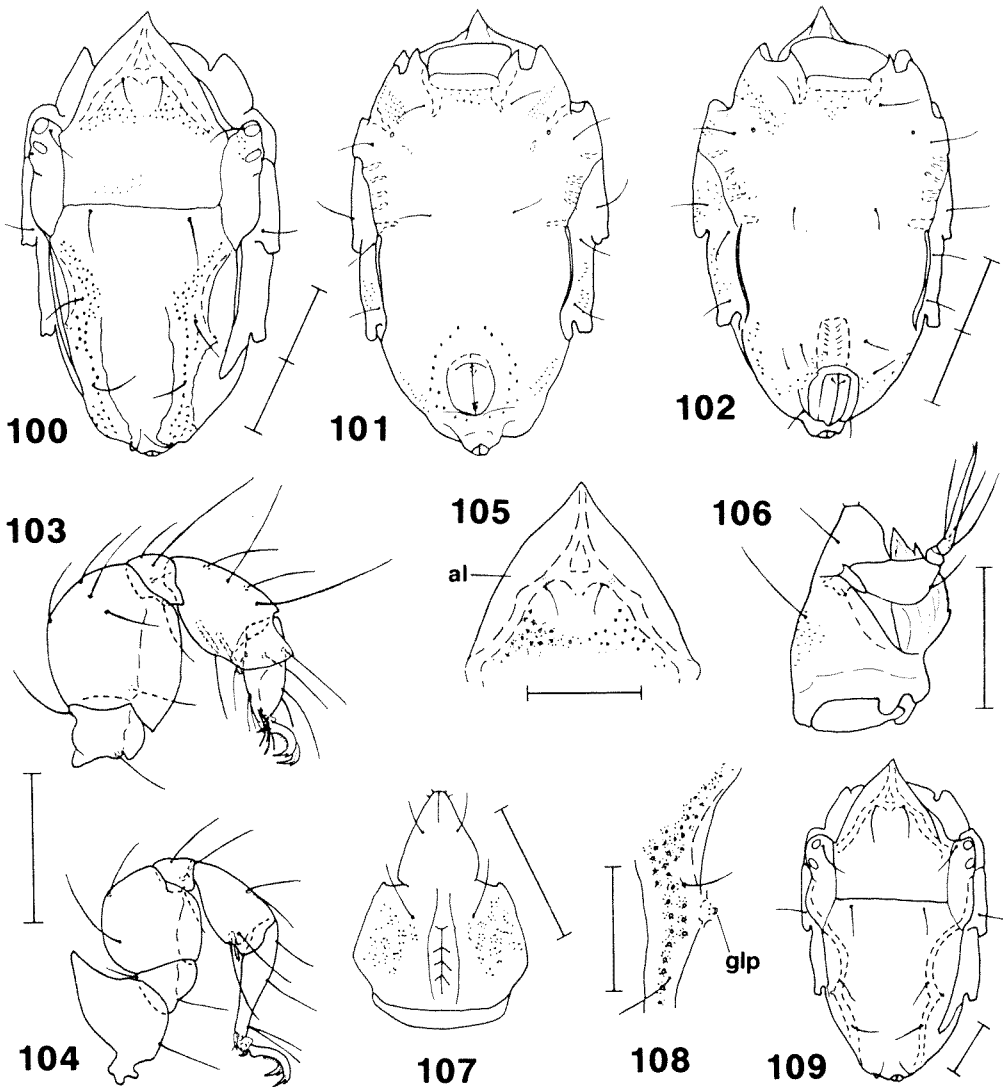
Australia: Western Australia: 1 ♀, same data as for holotype (WAM 93/2128); 2 ♂ and 3 ♀, same data as for holotype (IB Au359, Au360, Au390).

Description

Male: Idiosoma length 276–281 µm, that of holotype 281 µm. AD (holotype) 123 µm long, 135 µm wide. Anterolateral lamellae extending from frontal spine to level of ds-2. Internal sclerite as figured (Figure 105). Pair of triangular porose areolae almost fused medially. Porose areolae with small ostia at surface and 5–7 canaliculi in deeper layers. Posterior part of AD with groups of canaliculi (Figure 100). AD and OC contiguous. OC 98 µm long, with 2 large corneae; anterior porose areola with about 15 rosette pores; posterolateral margin of OC raised and with foveate sculpturing but without rosette pores. Medial part of OC not raised, its ornamentation faint. Posterior part of OC tail-like. Anterior part of PD and posterior part of OC fused though margin of plates still present. PD 145 µm long, 122 µm wide; with 2 pairs of longitudinal sinuose costae. Lateral part of PD with reticulate sculpturing set off abruptly from longitudinal costae. Anterior part of PD faintly reticulate, median and posterior parts of PD excavated and only delicately ornamented. Internal sinuose sclerites beneath costae (Figure 109). Rosette pores in anterior part of costae with small ostia; middle part of costae 1–2 rosette pores wide (Figure 108), ostia slightly larger than in anterior part of costae. Gland pore level with insertion of leg IV. Dorsal setae long. Setae ds-3 inserted near anterior margin of PD.

AE and GA completely fused, with only 10 µm long lateral apodemes indicating margin between plates (Figure 101). Ventral shield 230 µm long, 162 µm wide. AE and PE contiguous though margins of plates still present. GA separated from PE by striae of membranous integument. AE with rather large triangular porose areolae, moreover, scattered canaliculi present posterior to leg II. PE with small porose areolae anterior to legs III and IV. Camerostome surrounded by internal sclerites. Medial eprI large, triangular, as long as lateral (dorsolateral) eprI. GO 42 µm long, 33 µm wide; with 11–12 pairs of slender pgs.

Gnathosoma 78 µm long. Tectum with crest-like spine (cf. Figure 106). Ventral and marginal flank of gnathosoma base porose (cf. Figure 107). P-4 slender, longer than P-2. Seta



Figures 100–109 *Copidognathus ampliatus* sp. nov., 100, idiosoma, dorsal aspect, male; 101, idiosoma, ventral aspect, male; 102, idiosoma, ventral aspect, female; 103, basifemur to tarsus I, lateral aspect, female; 104, leg III, lateral aspect, female; 105, anterior AD, male; 106, gnathosoma, lateral aspect, female; 107, gnathosoma, ventral aspect, female; 108, portion of right PD with ds-4 and ds-5, male; 109, idiosoma, internal sclerites at dorsal aspect, male (porose areolae omitted).

on P-2 bristle-like. Basal whorl of setae inserted near base of P-4.

Ventrolateral lamellae on I-3 and II-3 delicately reticulate, ventral margin evenly convex (cf. Fig 103). Lateral articular lamellae on I-5 large, and triangular, those on II-5 rounded-rectangular, medial lamellae on both tibiae small. Lateral and medial lamellae on tibiae III (cf. Figure 104) and IV small. Tarsi III and IV slender, longer than tibiae and telofemora. III-6 with 4 dorsal setae, IV-6 with 3 setae.

Claws with accessory process and pecten. Pecten almost reaching to base of claws.

Female: Idiosoma length 278–308 μm . Similar to male in dorsal and ventral aspect. AE, PE and GA fused, but PE and GA separated by wedge of striae (Figure 102). Lateral apodemes from PE extending medially. GO 40 μm long and 35 μm wide. Ovipositor extending beyond GO for slightly less than length of GO, and surpassing anterior pairs of pgs.

Remarks

In dorsal aspect, *C. ampliatus* is very similar to *C. caelatus*. There are small differences in outline of the porose areolae and the number of rosette pores; *C. caelatus* has larger porose areolae than *C. ampliatus*, and several rosette pores along the lateral margin of the OC posterior to the corneae. At ventral aspect, adults of the two species are easily distinguished; *C. caelatus* has a median wedge with membranous integument between AE and GA whereas in *C. ampliatus* the two plates are completely fused. Intermediate forms have not been found in the material examined. Outline of porose areolae with rosette pores and presence or absence of sutures between the plates may be influenced by sclerotization of the plates, which in turn is influenced by environmental parameters (unpublished observations). Detailed studies on more material is needed.

DISCUSSION

Bartsch (1985a) gave a brief survey on species of the *gibbus* group, 19 species were known at that time, since then, another eight species have been described, viz., *C. areolatus* Bartsch, *C. chilensis* Newell, *C. glareus* Newell, *C. incarinatus* Newell, *C. longispinus* Bartsch and Iliffe, *C. lubricus* Bartsch, *C. simplipes* Newell, *C. ventriscutatus* Bartsch (Newell 1984; Bartsch and Iliffe 1985; Bartsch 1986, 1989).

Around Rottneest Island, 12 species of this group have been found. *C. dubiosus* is unique in several characters, with no closely allied species described as yet. *C. canaliculifer* is very similar to the Philippine species *C. scutellus*. Even when sorting a sample at low magnification, both species are discriminated from all the others on the basis of the wide dorsal shield which lacks surficial sculpturing. *C. bispinus* and *C. laminifer* resemble *C. canaliculifer* in general facies such as wide idiosoma and the plates being rather smooth except for canaliculi and longitudinal striae, but, *C. bispinus* and *C. laminifer* have lateral lamellae arising from the PE. Similar lamellae have not been recorded from any other *Copidognathus*.

The other species found around Rottneest Island have closely related congeners in other regions of the world. *C. strigellus* is allied to *C. felicis* and *C. remipes*; *C. felicis* was collected in the southeastern Pacific, *C. remipes* is rather abundant in the northeastern Atlantic and the Mediterranean. *C. punctellus* demonstrates close similarity with the Chilean *C. simplipes*, and *C. crassipinus* with the Bermudian *C. longispinus*. *C. bistratus* resembles

the Pacific species *C. incarinatus* and *C. areolatus*. *C. ampliatus* and *C. caelatus* are most similar to *C. cataphractus* and *C. mesomorphus*, both recorded from the eastern African coast.

Amongst the halacarid material collected around Rottneest Island is a high number of sibling species (unpublished). Amongst others, the pairs *C. laminifer/C. bispinus*, and *C. ampliatus/C. caelatus* are almost identical in dorsal aspect, but *C. laminifer* and *C. ampliatus* have AE and GA fused whereas in *C. bispinus* and *C. caelatus* AE and GA are separated at least in the median. Though the dorsal aspect of the idiosoma, the form of plates, their ornamentation and outline of porose areolae and size of pores is highly characteristic for a given species, the dorsal aspect alone is insufficient when determining halacarid species.

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Abbreviations used in text and figures

AD	anterior dorsal plate	mepr	medial epimeral process
AE	anterior epimeral plate	mxs	maxillary setae
al	anterolateral lamella	OC	ocular plate(s)
br	bristle	P	palp, P-2, 2nd palpal segment
ds	dorsal setae on idiosoma, ds-1, first pair of dorsal setae	pas	parambulacral setae
epr	epimeral process, eprI, epimeral process of first epimeron	pc	pore canaliculus
f	foveae	PD	posterior dorsal plate
GA	genitoanal plate	PE	posterior epimeral plate
glp	gland pore, glp-1, first (anteriormost) gland pore	pgs	perigenital setae
GO	genital opening	rs	rosette pores
gr	groove	sgs	subgenital setae
l	lamella	so	solenidion
lepr	lateral epimeral process	T	tectum with crest
ll	lateral lamella	vs	ventral seta on idiosoma.

Legs numbered I to IV, leg segments 1 to 6, I-1 to I-6, trochanter, basifemur, telofemur, genu, tibia and tarsus on leg I.

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