

Two new species of *Oithona* (Copepoda: Cyclopoida) from mangrove waters of North Queensland, Australia

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Abstract: Copepods of the genus *Oithona* dominate the mesozooplankton of inshore waters and mangrove waterways in North Queensland, Australia. This contribution describes 2 new species, *Oithona nishidai* and *O. robertsoni*, from these areas. *Oithona nishidai* is similar to *O. australis* Nishida, 1986, but differs in having 3 setae rather than 2 on the endopod of the maxillule, the dorsal surface of the thoracic somite 5 hirsute, and a ratio of caudal ramus length:width of 3 rather than 4. *Oithona robertsoni* has 5 setae on the endopod of the mandible, but differs from other members of the genus sharing this character in its body shape and proportion. Tabular comparisons with co-occurring and related species are presented as aids to identification.

Key words: Copepoda, Cyclopoida, *Oithona*, new species, mangrove, Australia

Introduction

Despite the growing recognition of the importance of copepods of the genus *Oithona* in the world's oceans, there remains considerable taxonomic uncertainty at the species level, particularly with coastal-water species. In the Americas, this uncertainty has been ameliorated (Bowman 1975; Ferrari 1977; Ferrari & Bowman 1980; Ferrari & Orsi 1984; Rocha 1986). Ferrari (1977, 1981) and Nishida & Ferrari (1983) clarified the taxonomy of some Pacific species, and Nishida's (1985) review synthesised our knowledge of species occurring in the the Indo–West Pacific. However, there remains much to be done in the area, particularly with coastal water species (Nishida 1986a).

McKinnon & Klumpp (1998a) described the zooplankton communities of mangrove rivers in North Queensland, Australia. Copepods belonging to the genus *Oithona* dominated the plankton in all rivers studied, but the two most common species did not match any published material. The fact that these species have not been previously recorded is due in large part to their small size and superficial similarity to other species. This contribution describes the 2 new species, and compares them to other species of the genus occurring in North Queensland.

Materials and Methods

Sampling methodology is given in McKinnon & Klumpp (1998a). Samples were preserved in dilute formalin and animals subsequently stained with chlorazol black E to aid dissection, and placed in lactic acid. Drawings were made with an Olympus BH-2 microscope fitted with Nomarski optics and a camera lucida. Armament formulae are presented from basis to most distal segment, and for swimming legs as outer margin first; Roman numerals indicate spines, Arabic numerals setae. Terminology is that of Huys & Boxshall (1991). Material for scanning electron microscopy (SEM) was post-fixed in either OsO₄ or Bouin's fixative, dehydrated in an alcohol series, critical point dried and gold-coated. Type material is deposited in the Australian Museum, Sydney, Australia (AMS) and the National Museum of Natural History, Smithsonian Institution (USNM), U.S.A.

Family Oithonidae *Oithona nishidai* sp. nov. (Figs 1–6)

Type material

Holotype: AMS-P 58370, female, 0.58mm, Haughton River, Queensland, Australia (19°28'S, 147°03'E), 19 April 1996. Allotype: AMS-P 58371, male, 0.56 mm, type locality. Paratypes: 20 females AMS-P 58372, 20 males AMS-P

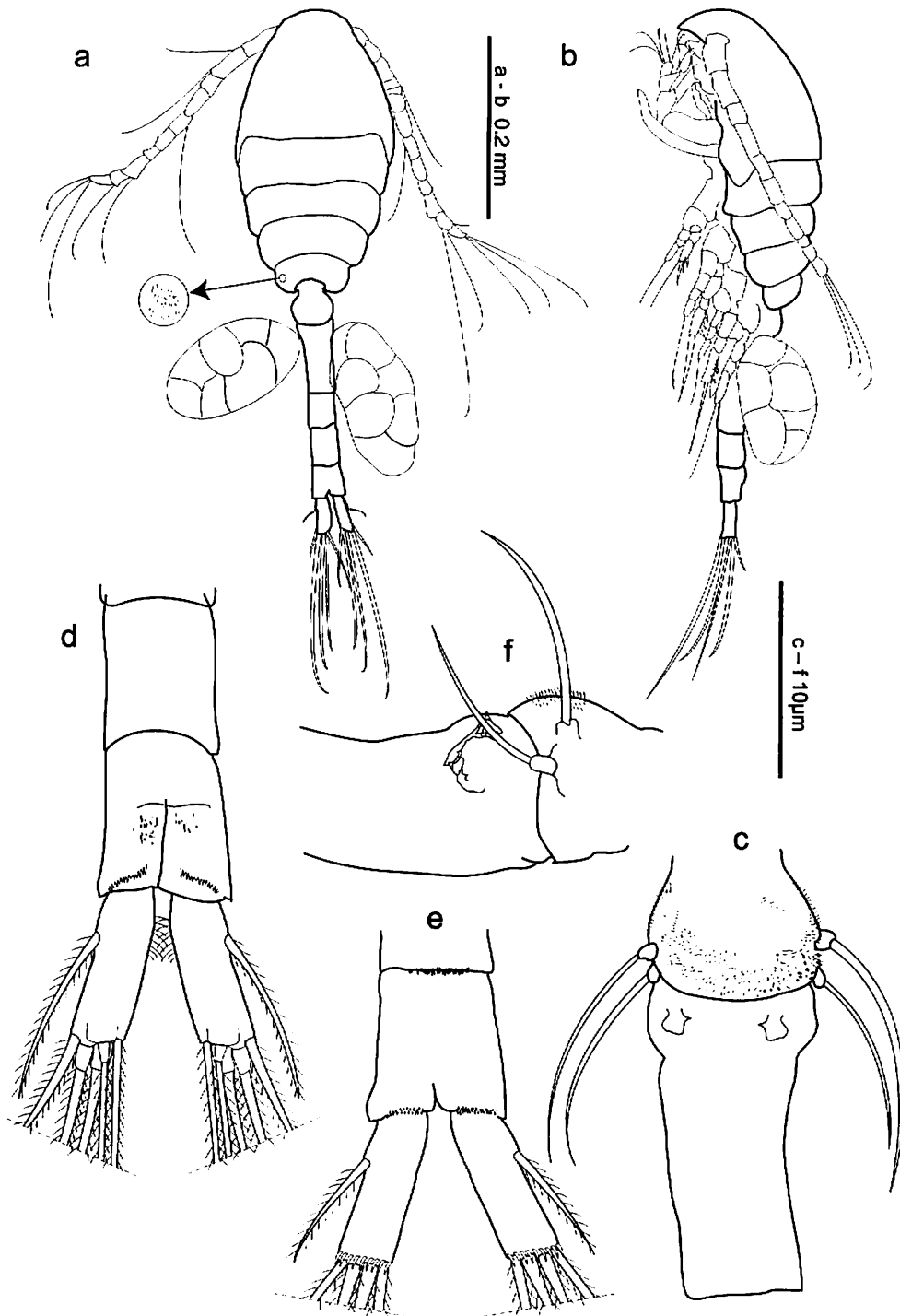


Fig. 1. *Oithona nishidai* sp. nov., female. a. Habitus, dorsal. b. Habitus, lateral. c. Urosome somites 1 and 2, dorsal. d. Urosome somites 4 and anal somite, dorsal. e. Anal somite, ventral. f. Genital complex and leg 5, lateral.

58373; 10 females USNM-296411, 10 males USNM-296412.

Female

Total length (holotype) 0.58 mm (seasonal range 0.55 mm [February 1994]–0.66 mm [July 1993]). Prosome (Fig.

1a, b) comprises cephalosoma and 4 thoracic segments, greatest width at posterior margin of cephalosoma, length 1.74 times width, 1.13 times urosome. Head rounded in dorsal view, produced antero-ventrally into simple, strong rostrum. Urosome (Fig. 1c, d) with 5 somites, proportional lengths (with caudal ramus) of 0.86: 1.83: 0.89: 0.82: 1.00:

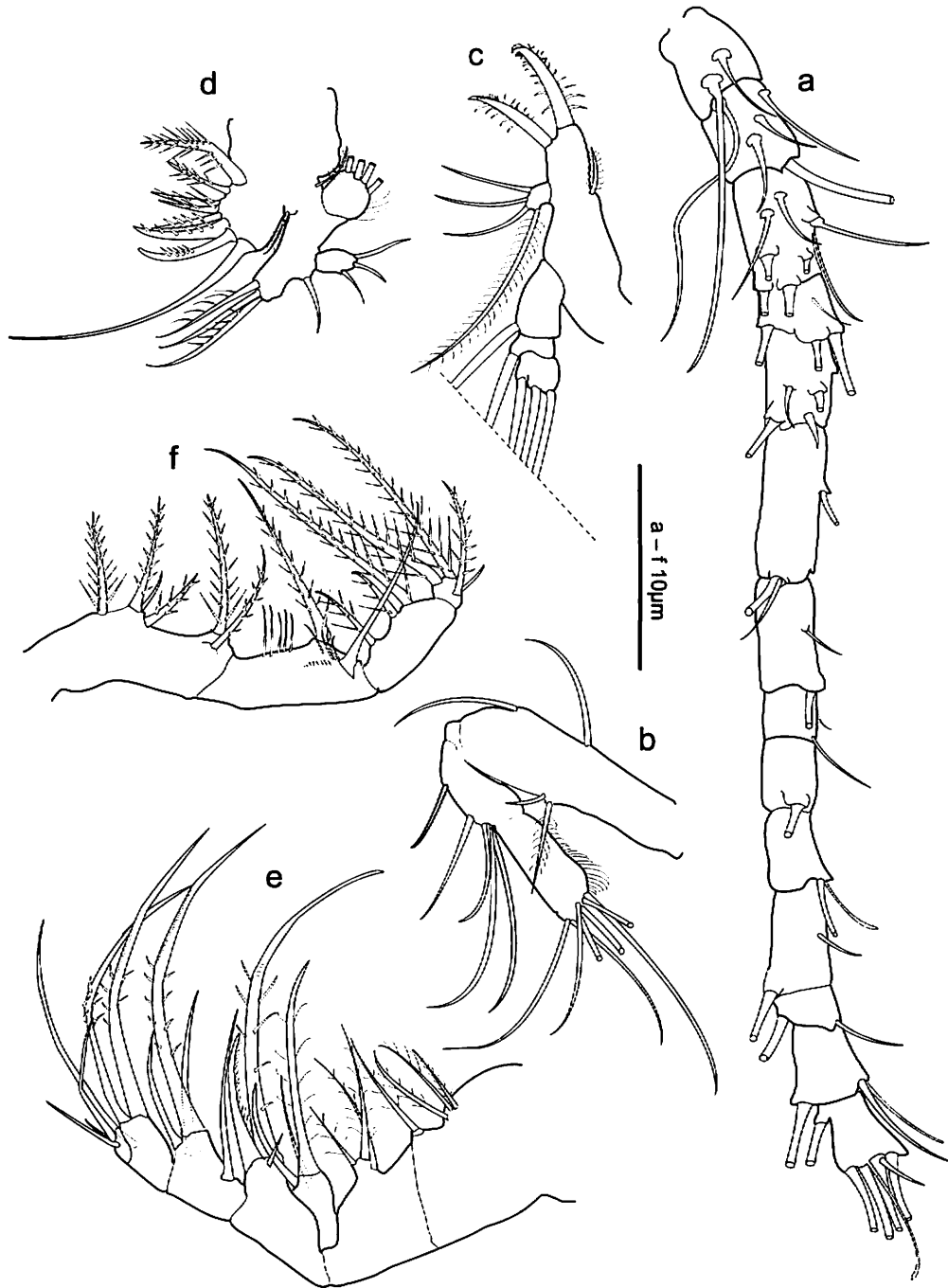


Fig. 2. *Oithona nishidai* sp. nov., female. a. Antennule. b. Antenna. c. Mandible palp. d. Maxillule. e. Maxilla. f. Maxilliped.

1.00. Thoracic somites (Th) 4 and 5 hirsute, short hairs covering the postero-dorsal margin and lateral faces in particular. Vento-posterior margin of urosomal somite 4 and anal somite with setules, comb extending on to the dorsal surface of anal somite. Caudal ramus length 3 times width. Pedestal of dorsal seta does not extend beyond posterior margin of ramus. Dorsal seta thick, 2 middle apical setae thick, with distinct basal portion.

Antennule (Fig. 2a) symmetrical, extending to mid-way

down third pedigerous somite in dorsal view, 14-segmented. Setation pattern 2,5,8,4,4,3,2,2,1,1+1 aesthetasc (ae), 2,2,2+1 ae, 6+1 ae. Antenna (Fig. 2b) basipod with 1 seta on outer margin at mid-length, another seta more distally. Inner surface with 2 setae medially. First endopod segment with 1 proximal, 1 medial, 3 terminal setae, second with 7 terminal setae. Mandible (Fig. 2c) basis bearing 2 sharp recurved spines, each armed with spinules. Endopod with 4 setae, outermost hirsute. Exopod 3-segmented, with

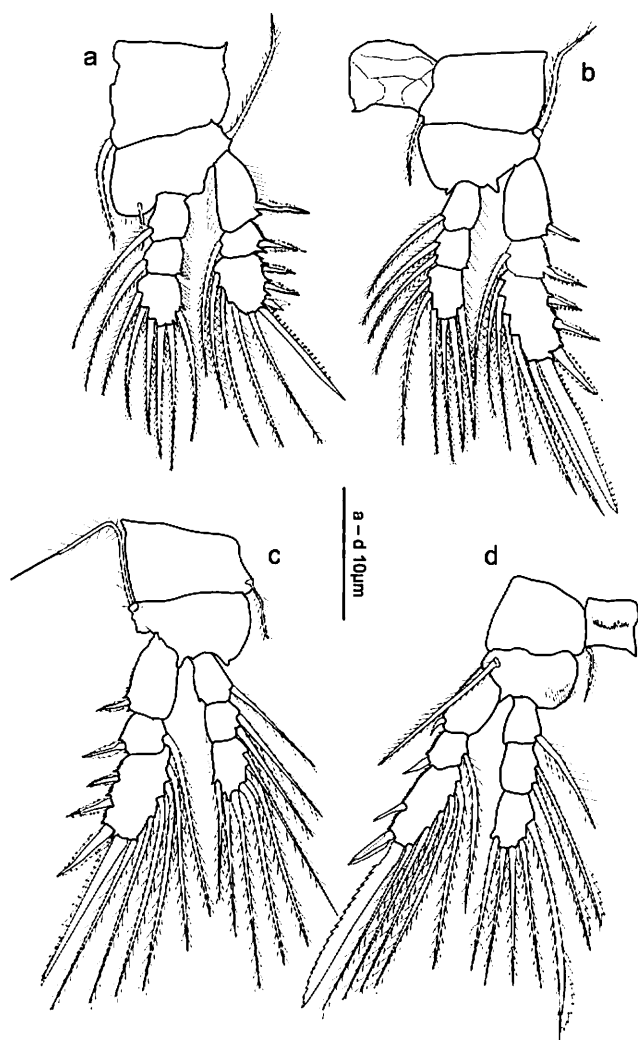


Fig. 3. *Oithona nishidai* sp. nov., female. a. Leg 1. b. Leg 2. c. Leg 3. d. Leg 4.

1,1,3 setae. Maxillule (Fig. 2d) praecoxal endite with 8 spiniform setae, the most distal very long. Coxal endite with plumose seta. First basal endite with 3 setae, 2 plumose. Second basal endite with seta, endopod with 3 setae, exopod with 4. Praecoxal epipodite with plumose seta. Maxilla (Fig. 2e) praecoxa with proximal group of 3 setae and 1 seta distally. Coxa with proximal endite, distal arthrite, each armed with 3 setae. Basis with 3 setae, 1 spinulate. Endopod segment 1 with 1 proximal, 3 distal setae (1 spinulate). Endopod segment 2 with 2 spinulate setae, 1 non-spinulate seta. Endopod segment 3 with terminal group of 3 setae. Maxilliped (Fig. 2f) coxa with proximal seta, group of 3 setae at mid-length, group of 2 distally. Basis with row of spinules on inner surface, 2 setae distally. Endopod segment 1 with 1 proximal, 2 distal setae, segment 2 with 4 setae.

Rami of all legs 3-segmented (Fig. 3a–d). Swimming legs with armament formulae as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-1	1-0, I-1, III-1-4	0-1, 0-1, 1-2-3
Leg 2	0-1	1-0	1-0, I-1, III-1-5	0-1, 0-2, 1-2-3
Leg 3	0-1	1-0	1-0, I-1, III-1-5	0-1, 0-2, 1-2-3
Leg 4	0-1	1-0	1-0, I-1, II-1-5	0-1, 0-2, 1-2-2

Two inner setae of leg 4 endopod segment 2 and proximal seta of endopod segment 3 modified, with denticulate membranous flange on medial tip. Intercoxal plate of leg 4 with comb of spines on posterior surface. Female leg 5 (Fig. 1f) comprises dorsal seta of basis and exopod segment with crown seta.

Male

Total length (allotype) 0.56 mm (seasonal range 0.52 mm [March 1994]–0.60 mm [July 1993]). Prosome (Fig. 4a) ovoid, greatest width at Th1, length 1.87 times width, 1.57 times urosome. Head broad and flat in dorsal view, blunt in lateral view (Fig. 4b). Urosome with 6 somites, proportional lengths (with caudal ramus) 1.33, 2.07, 1.40, 1.13, 1.13, 1.06, 1.00. Genital somite length 1.15 times width. Urosome somite 5 distal margin coarsely denticulate (Fig. 4c, d), anal somite (Fig. 4c, d) length 0.85 times width, with comb of spines both dorsally and ventrally. Caudal ramus length 1.79 times width, 1.12 times anal somite.

Cephalosome-flap organ (Fig. 4b) extending beyond Th2. Pore signature pattern belonging to type B of Nishida (1986b), with 12 columns of 6–8 nested integumental organs, each comprising a raised shield-like structure surrounding long cilia (Fig. 5a–d). The dorsal margin of the organ has a row of protuberances, each terminating in a cilium (Fig. 5a–d). The integumental organs on the ventral margin comprise simpler pits, each containing a cilium (Fig. 5c, d).

Antennule (Fig. 4f) 17 articulating segments. Setation pattern 2,5,4,2,2,2,2,1,2,0,3,1,1,2,1,1,7+1 aesthetasc. Antenna (Fig. 6a) similar to female, but endopod elongate, fused into one segment. Mandible (Fig. 6b) endopod 1 distinctly articulated from basis, bearing 2 elongate denticulate spines somewhat sharper and straighter than in female. Maxillule (Fig. 6c) with long seta on praecoxal epipodite adjacent to articulation of exopod. Maxilla and maxilliped as in female.

First to fourth swimming legs as in female, but with inner marginal seta on exopod segment 1 reduced (Fig. 6d–g), and without modified setae on leg 4 endopod. Leg 5 (Fig. 4e) similar to female, leg 6 a single seta originating from ventro-lateral process on genital somite.

Etymology

For Dr. Shuhei Nishida, in recognition of his contribution to the taxonomy of the genus *Oithona*.

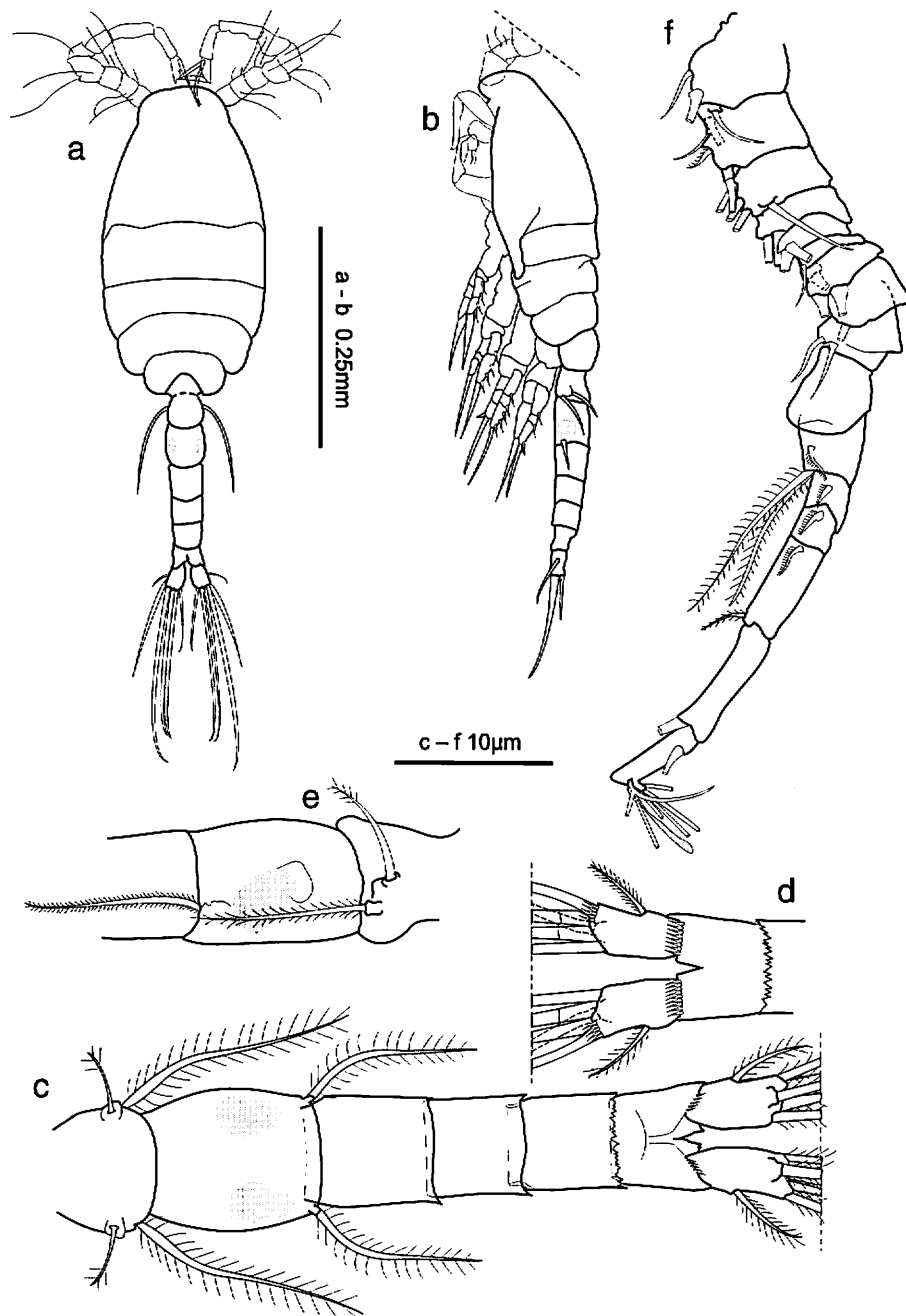


Fig. 4. *Oithona nishidai* sp. nov., male. a. Habitus, dorsal. b. Lateral. c. Urosome, dorsal. d. Anal somite, ventral. e. Genital somite and legs 5 and 6, lateral. f. Antennule.

Remarks

Oithona nishidai is very closely related to *Oithona australis* Nishida, 1986a but differs in having 3 setae rather than 2 on the endopod of the maxillule of both sexes. Females can be discriminated by the following characters: (1) the dorsal surface of the female Th 5 hirsute, (2) a ratio of female caudal ramus length to width of 3 rather than 4. In addition, *O. nishidai* lacks the 2 points on the rostrum and the swollen posterior mid-dorsal thoracic segment 1 and

genital complex characteristic of *O. australis*.

Oithona nishidai is one of a group of species characterised by the possession of an elongate distal seta on the praecoxal arthrite of the maxillule: *O. aruensis* Fruchtl, 1923, *O. attenuata* Farran, 1913, *O. australis*, *O. davisae* Ferrari & Orsi, 1984, and *O. wellershausi* Ferrari, 1981. This character serves to distinguish *O. nishidai* from other superficially similar oithonids common in coastal waters, such as *O. brevicornis* Giesbrecht, 1891. The occurrence of this character in *O. attenuata* implies that it has been second-

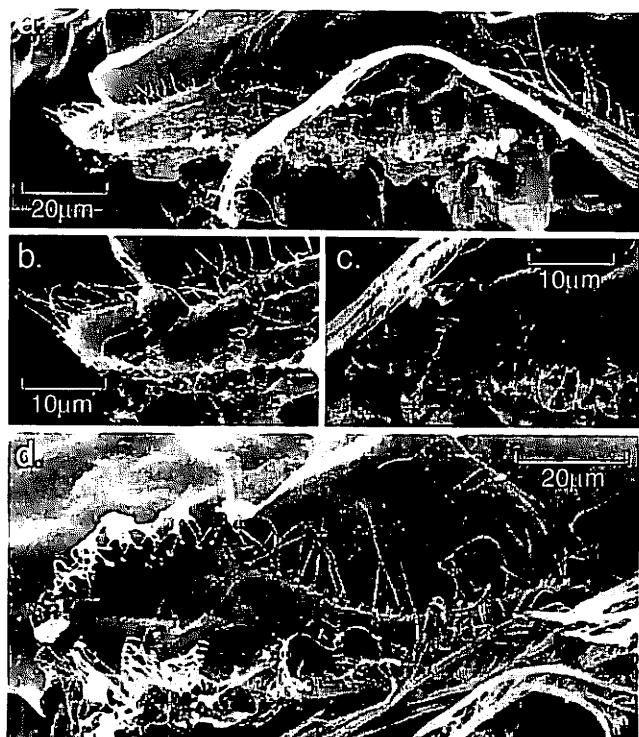


Fig. 5. *Oithona nishidai* sp. nov., male cephalosome-flap organ. a. Lateral. b. Posterior margin. c. Nested shield-like integumental organs containing sensilla. d. Antero-lateral, another specimen, showing anterior sensilla.

darily derived in this species, given its close relationship to *O. nana* Giesbrecht, 1892 (Nishida 1985). However, for the remaining species this character and the presence of 2 long spinulose setae on the second endopodal segment of the maxilliped are probably indicative of membership of an Indo-West Pacific species group found principally in riverine systems (see Nishida 1986a; Ferrari & Orsi 1984).

***Oithona robertsoni* sp. nov.**
(Figs 7–12)

Type material

Holotype: AMS-P 58374, female, 0.54 mm, Pascoe River, Queensland, Australia (12°30.35'S, 143°15.45'E), 15 June 1995. Allotype: AMS-P 58375, male, 0.51 mm, type locality. Paratypes: 20 females AMS-P 58376, 20 males AMS-P 58377; 10 females USNM-296409, 10 males USNM-296410.

Female

Total length (holotype) 0.54 mm (range 0.54–0.60). Body (Fig. 7a, b) comprises cephalosome and 4 thoracic somites, greatest width at posterior margin of cephalosome, length 2.0 times width, 1.15 times urosome. Head rounded in dorsal view, rostrum blunt. Urosome (Fig. 7c) with 5 somites, proportional lengths (with caudal ramus) of 0.86: 1.93:

0.86: 0.93: 0.79: 1.00. Urosome somites glabrous, unornamented. Caudal ramus slender, length 3.50 times width. Pedestal of dorsal seta does not extend beyond posterior margin of ramus. Dorsal seta thick, 2 middle apical setae thick, with distinct basal portion.

Antennule (Fig. 8a) symmetrical, extending to mid-way down third pedigerous somite, 14 articulating segments. Setation pattern 2,5,7,4,4,3,2,1,1,1+1 ae, 2,2,2+1 ae, 6+1 ae. Antenna (Fig. 8b) basipod with seta on inner margin at mid-length, another seta more distally. Outer surface with 2 setae. First endopod segment with 1 proximal, 1 medial, 3 terminal setae, second segment with 7 terminal setae. Mandible (Fig. 8c) basis bearing 2 sharp recurved spines, each armed with spinules. Endopod with 5 setae, proximal hirsute. Exopod 3-segmented, with 1,1,3 setae. Maxillule (Fig. 8d) praecoxal endite with 8 spiniform setae. Coxal endite with plumose seta. Praecoxal epipodite with plumose seta. First basal endite with 3 setae, 2 plumose, second basal endite with seta. Endopod with 3 setae; exopod with 4. Maxilla (Fig. 8e) praecoxa with proximal group of 3 setae and distal seta mid-length. Coxal endites bearing 3 setae each. Basis with 3 setae, most proximal very strong, spinulate. Endopod segment 1 with 1 proximal, 3 distal setae (1 spinulate). Endopod segment 2 with 2 strong spinulate setae, 1 weaker seta. Endopod 3 with terminal group of 3 setae. Maxilliped (Fig. 8f) praecoxa distinct, with seta. Coxa with proximal group of 3 setae and group of 2 distally. Basis with row of setules on inner surface, 2 setae distally. Endopod segment 1 with 1 proximal, 2 distal setae; segment 2 with 4 setae.

Rami of all legs 3-segmented (Fig. 9a–d). Swimming legs with armament formulae as in *O. nishidai*.

Two inner setae of leg 4 endopod segment 2 and proximal seta of endopod segment 3 modified, with denticulate membranous flange on medial tip. Intercoxal plate of leg 4 with long setules. Female leg 5 (Fig. 7d) comprises dorsal seta of basis and exopod segment with crown seta.

Male

Total length (allotype) 0.51 mm (range 0.51–0.54). Prosoma (Fig. 10a) ovoid, greatest width at Th1, length 2.33 times width, 1.45 times urosome. Head blunt in dorsal and lateral views (Fig. 10b). Urosome with 6 somites, proportional lengths (with caudal ramus) 0.92: 1.50: 1.08: 0.96: 0.79: 0.96: 1.0. Genital somite length 1.20 times width. Urosome somites 3, 4, 5 distal margins coarsely denticulate (Fig. 10c, d). Anal somite (Fig. 10d) length 1.0 times width, with comb of spines ventrally. Caudal ramus length 2.30 times width, 1.09 times anal somite.

Cephalosome-flap organ extending to the posterior margin of Th2. Pore signature pattern (Fig. 12a, b) similar to that described for *Oithona nishidai* (Fig. 5). Cilia have been lost from the integumental organs in specimens prepared for SEM, but some fragments remained adhered to the integument (Fig. 12b) suggesting a similar arrangement of

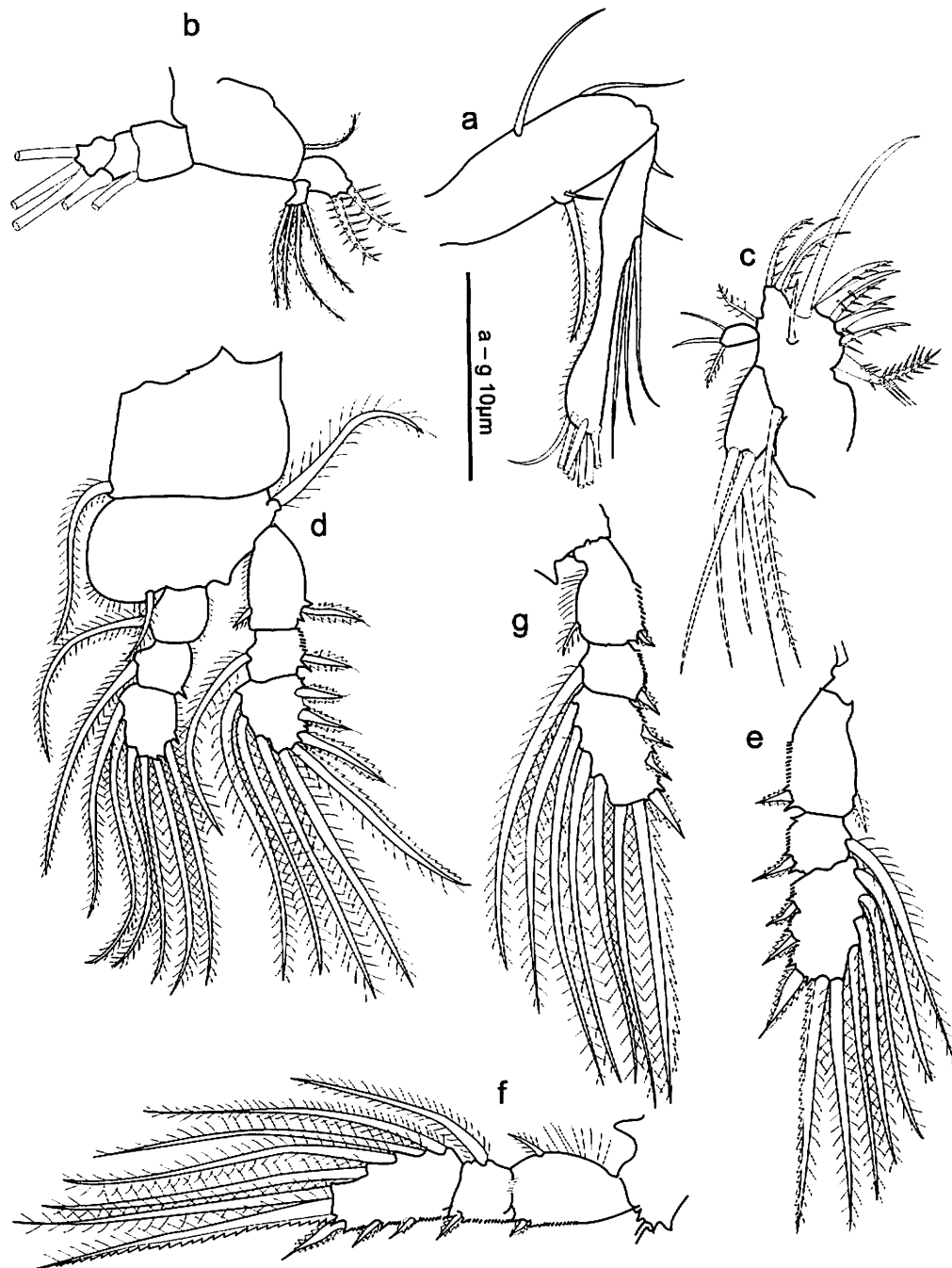


Fig. 6. *Oithona nishidai* sp. nov., male. a. Antenna. b. Mandible palp. c. Maxillule. d. Leg 1. e. Leg 2 exopod. f. Leg 3 exopod. g. Leg 4 exopod.

cilia within integumental organs to that seen in *O. nishidai*.

Antennule (Fig. 10f) 13-segmented, setation pattern 2,5,4,2,2,1,0,3,1,1,1,1,6+1 aesthetasc. Second antenna (Fig. 11a) similar to female, but endopod elongate, fused into one segment. Mandible (Fig. 11b) endopod 1 distinctly articulated from basis, bearing 2 elongate denticulate spines somewhat sharper and straighter than in female. Maxillule (Fig. 11c) with long seta on praecoxal epipodite adjacent to articulation of exopod. Maxilla and maxilliped as in female.

Legs 1–4 as in female, but with inner marginal seta on exopod segment 1 reduced (Fig. 11d–g) and without modified setae on leg 4 endopod. Leg 5 (Fig. 10e) similar to female. Leg 6 (Fig. 10e) represented by 2 setae originating from ventro-lateral process on genital somite.

Etymology

For Alistair Robertson, in recognition of his contribution

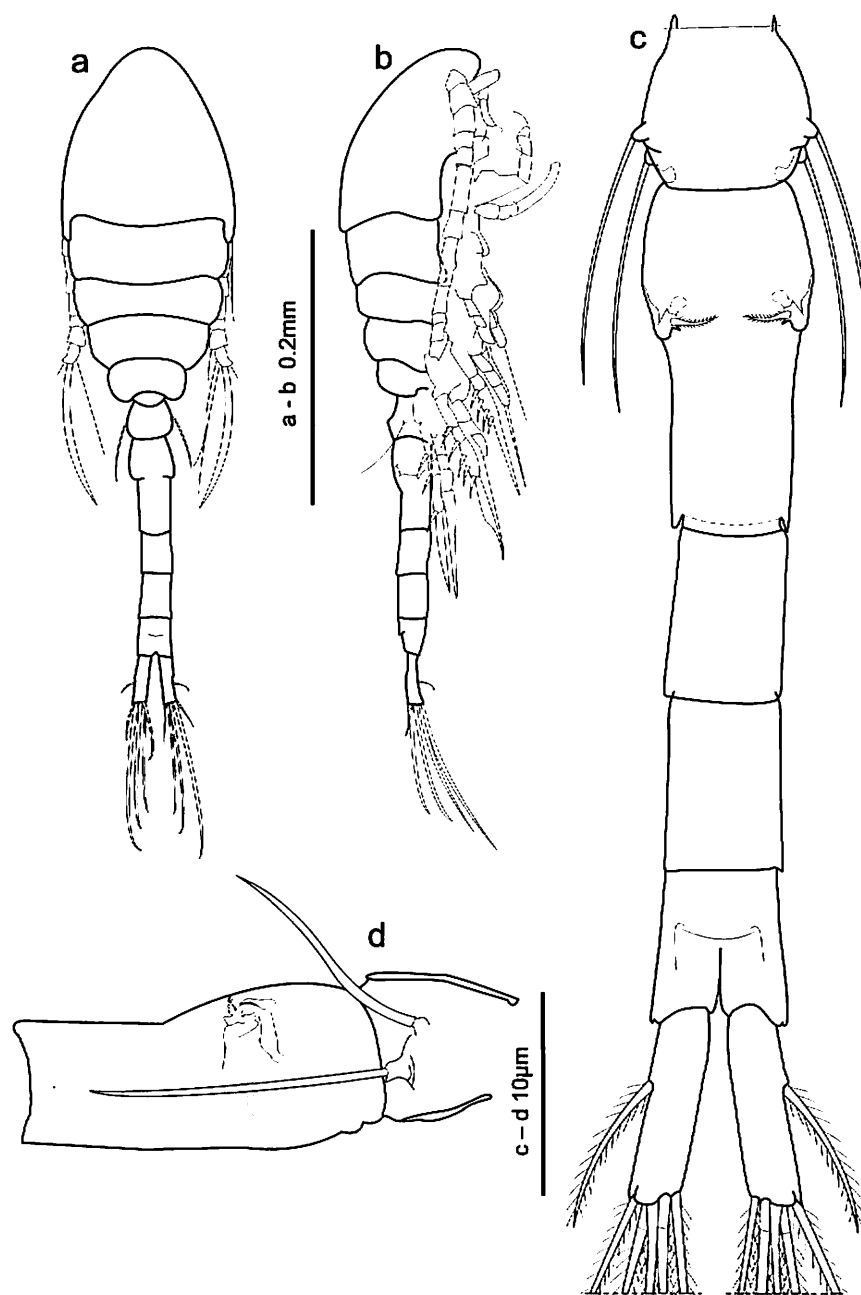


Fig. 7. *Oithona robertsoni* sp. nov., female. a. Habitus, dorsal. b. Habitus lateral. c. Urosome, dorsal. d. Genital complex and leg 5, lateral.

to the study of the ecology of Queensland mangrove ecosystems.

Remarks

Oithona robertsoni is one of the 5 species of *Oithona* sensu stricto (i.e. excluding *Dioithona*) having 5 setae on the endopod of the mandible, the others being *O. amazonica* Burckhardt, 1912, *O. colcarva* Bowman, 1975, *O. dissimilis* Lindberg, 1940 and *O. ozwaldocruzi* Oliveira, 1945.

Oithona fonsecae Ferrari & Bowman, 1980 has 6 setae on the endopod of the mandible, 5 around the apex and 1 small seta near the base. Differences in morphology to aid the diagnosis of *O. robertsoni* from other species with 5 setae on the mandible endopod are given in Table 1. The possession of 5 setae on the endopod of the mandible, together with body size, ratio of prosome to urosome length, length to width ratio of the caudal ramus and the length of the distal seta of the praecoxal arthrite of the maxillule serve to distinguish *O. robertsoni* from co-occurring species (Table 2).

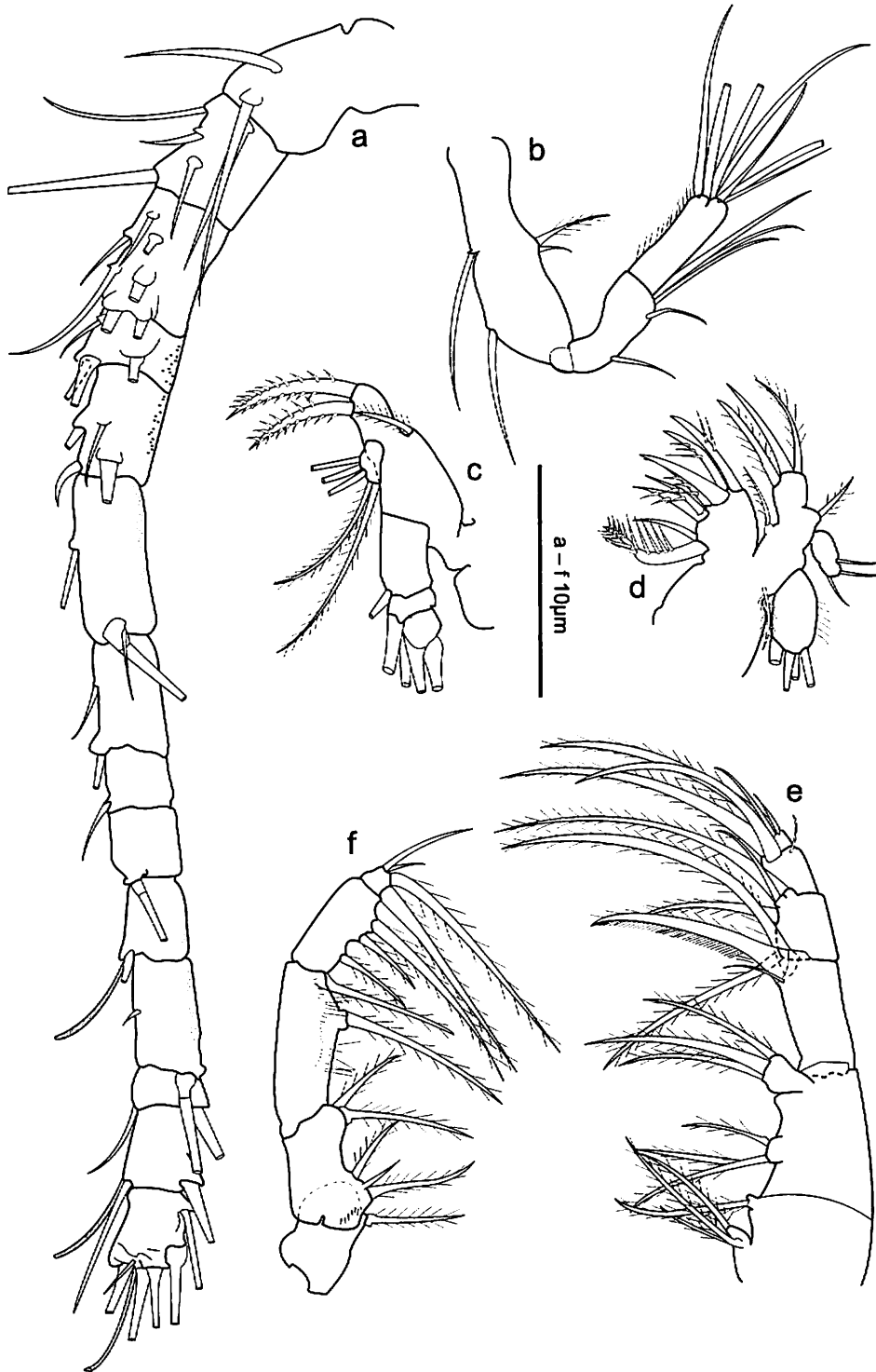


Fig. 8. *Oithona robertsoni* sp. nov., female. a. Antennule. b. Antenna. c. Mandible palp. d. Maxillule. e. Maxilla. f. Maxilliped.

It is difficult to ascertain the taxonomic affinities of *Oithona robertsoni*, though it has characters in common with *O. aruensis*, *O. brevicornis*, *O. davisae*, *O. spinulosa* Lindberg, 1947 and *O. wellershausi*. In general body form it is most similar to the smaller form of *O. brevicornis* described by Nishida (1985) and to *O. aruensis*. However, the

blunt rostrum of *O. robertsoni* and the structure of the mouthparts is quite different. Of the Indo-Pacific species, only *O. dissimilis* resembles *O. robertsoni* in the possession of 5 setae on the endopod of the mandible.

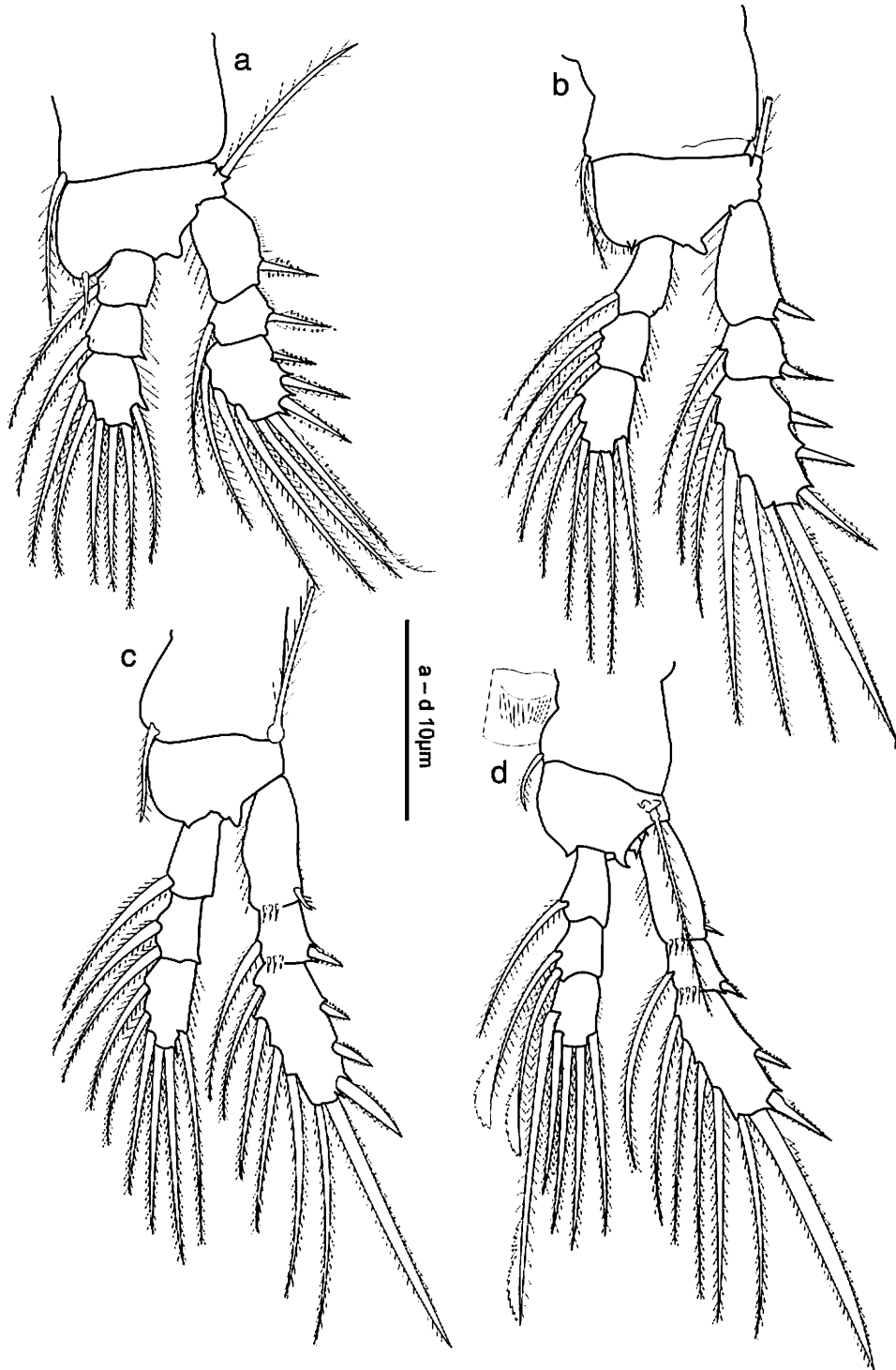


Fig. 9. *Oithona robertsoni* sp. nov., female. a. Leg 1. b. Leg 2. c. Leg 3. d. Leg 4.

Discussion

Oithona nishidai sp. nov. is the dominant oithonid, and indeed often the dominant copepod, in mangrove estuaries from Townsville to the Daintree River (Robertson et al. 1988, as *O. australis*; McKinnon & Klumpp 1998a, b, as

Oithona sp. 1). *Oithona australis* is important in coastal embayments in South-East Australia (Tafe & Griffiths 1983, as *O. brevicornis* [part]; Kimmerer & McKinnon 1985, as *Oithona* sp.), and occurs at least as far north as the Brisbane River (Nishida 1986a). To the north, it appears that *O. nishidai* has a contiguous distribution with *O.*

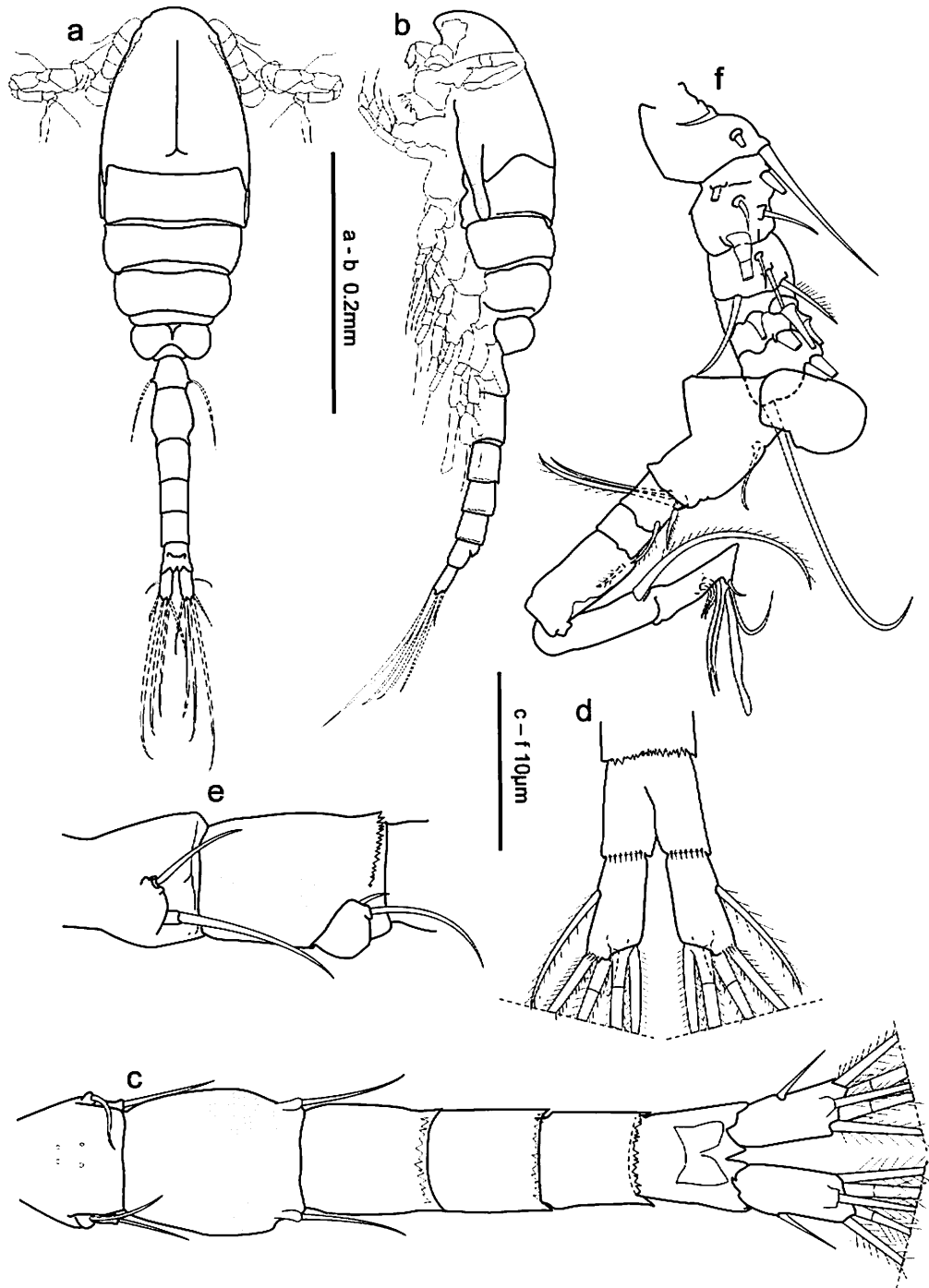


Fig. 10. *Oithona robertsoni* sp. nov., male. a. Habitus, dorsal. b. Habitus, lateral. c. Urosome, dorsal. d. Anal somite, ventral. e. Genital somite and legs 5 and 6, lateral. f. Antennule.

robertsoni sp. nov. (as *Oithona* sp. 2, McKinnon & Klumpp 1998a, b). The smaller *O. aruensis* co-occurs with all three species (Nishida 1986a; McKinnon & Klumpp 1998a). All these species have a distribution that is centred on riverine systems. Details of the distribution and abundance of *Oithona nishidai* and *O. robertsoni* are given in McKinnon & Klumpp (1998a), and of egg production rates and feed-

ing ecology in McKinnon & Klumpp (1998b).

In North Queensland coastal waters seven species of *Oithona* occur in addition to those described here. They are *O. aruensis*, *O. attenuata*, *O. fallax* Farran, 1913, *O. nana*, *O. oculata* Farran, 1913; *O. rigida* Lindberg, 1950 and *O. simplex* Farran, 1913. Table 2 lists morphological characteristics useful in discriminating between these, together

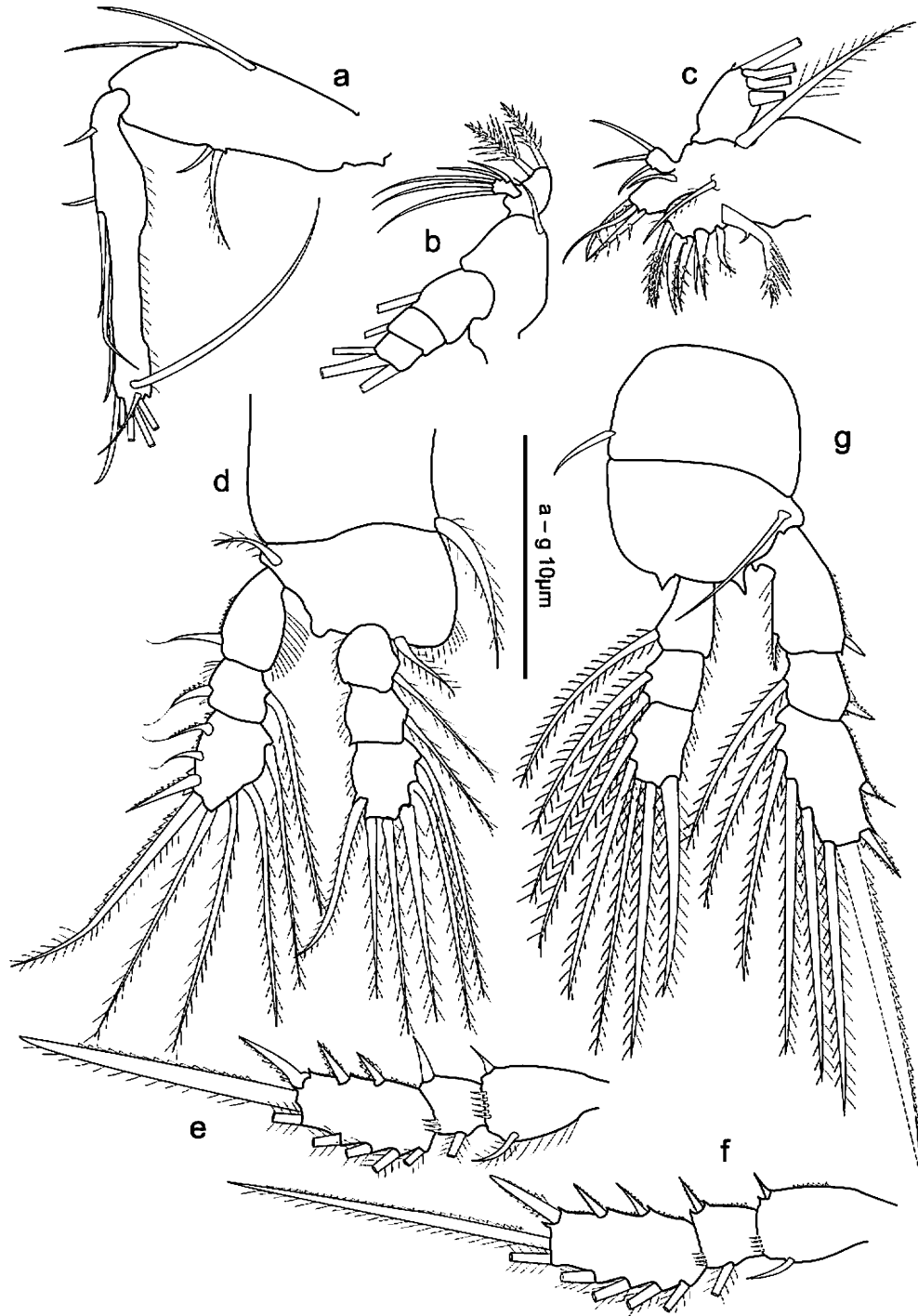


Fig. 11. *Oithona robertsoni* sp. nov., male. a. Antenna. b. Mandible palp. c. Maxillule. d. Leg 1. e. Leg 2 exopod. f. Leg 3 exopod. g. Leg 4.

with *O. australis*, which may overlap with these in the northern part of its range. *Oithona oculata* and *O. rigida* are widely referred to the genus *Dioithona* Kiefer, 1935 on the basis of having two setae on the free segment of leg 5. Despite this genus being synonymised with the genus *Oithona* by Vervoort (1964), the generic rank of *Dioithona* has become widely used especially in recent ecological lit-

erature.

Acknowledgments

I thank the crew of the R.V. *The Harry Messel* for assistance during the cruises to the Cape York rivers, Paul Dixon and Janet Ley for collecting additional samples from these

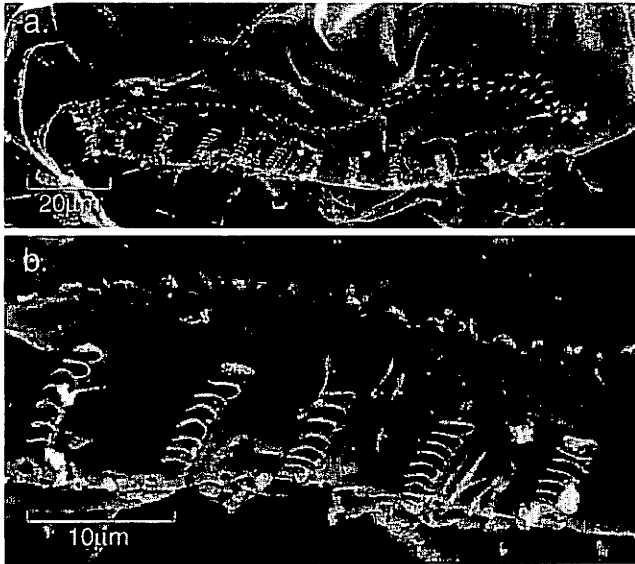


Fig. 12. *Oithona robertsoni* sp. nov., male cephalosome-flap organ. a. Lateral. b. Nested shield-like integumental organs, with remnants of sensilla.

ivers, and Janelle Lane for final preparation of the figures. Heather Windsor and Darren Mylrea of the Advanced Analytical Centre (James Cook University of North Queensland) assisted with the SEM work. I am especially grateful to Dr. Frank D. Ferrari and an anonymous reviewer for their fastidious editing of an earlier version of the manuscript.

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