

The Axiidea (Crustacea, Decapoda) of Cocos (Keeling) and Christmas Islands, with description of a new species of *Eucalliax* Manning & Felder, 1991

Peter C. Dworschak

Abstract. Sampling of sedimentary habitats yielded 72 specimens of Axiidea belonging to five species collected from Cocos (Keeling) Islands, the most common of which was a new species, *Eucalliax inaequimana* (20 specimens), followed by *Paratrypaea bouvieri* (Nobili, 1904) with 18 specimens, and *Neocallichirus jousseaumei* (Nobili, 1904) with 13 specimens. *Corallianassa martensi* (Miers, 1884), new combination (formerly placed in *Glypturus*), and *Callianidea tya* H. Milne Edwards, 1837 were represented each by only two specimens. *Eucalliax inaequimana*, new species, differs from its most similar congener *E. aequimana* (Baker, 1907) by the unequal chelipeds, the shape of the male first pleopods, the absence of an appendix interna on the female second pleopods, and the absence of ovoid plates anterior to the pleopods. On Christmas Island, only one species, *C. tya* represented by 14 specimens, was collected. *Callianidea ryukyu* Sakai, 2011 is placed in the synonymy of the morphologically variable *C. tya*.

Key words. Callianassidae, Callianideidae, new species, synonymy, Cocos (Keeling) Islands, Christmas Island, ghost shrimp, Indian Ocean

INTRODUCTION

The infraorder Axiidea de Saint Laurent, 1979, formerly placed together with Gebiidea de Saint Laurent, 1979 under Thalassinidea Latreille, 1831, includes mainly burrowing, shrimp- or lobster-looking decapods. They live in marine, mostly soft-bottom sediments of primarily intertidal or subtidal (<200 m) areas and rarely range into greater depths (Dworschak, 2005).

During recent expeditions to Cocos (Keeling) and Christmas Islands in 2010, 2011, and 2012 organised by the National University of Singapore and Parks Australia, suitable sedimentary habitats were targeted for burrowing shrimp. This sampling revealed several new records and one undescribed species, which is described herein.

Specimens were collected by hand or with a bait suction (yabby) pump and preserved in 75% ethanol. All drawings were made using a camera lucida mounted on a stereomicroscope, digitised and then inked and composed in Adobe Illustrator (Coleman, 2003). Digital photographs were taken with a Nikon 995 camera mounted on a stereomicroscope. Stacks of several frames of different focal planes were fused using CombineZ5 (Haug et al., 2011).

Material is deposited in QM – Queensland Museum, Brisbane, Australia; ZRC – Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore; SMF – Forschungsinstitut Senckenberg, Frankfurt-am-Main, Germany; NMCR – National Museum of the Philippines, Manila; NHMW – Naturhistorisches Museum in Wien, Vienna, Austria; NMV – Museum Victoria, Melbourne, Australia.

Size (in mm) is given as total length (TL) and carapace length (CL) in the form (TL/CL). Other abbreviations used include: BLT, Shikoku University, Tokushima; Mxp3, third maxilliped; coll., collector; P1–5, first to fifth pereopods, respectively; Plp1–2, first and second pleopods, respectively; plma/plmi, palm length of the major/minor cheliped; phma, palm height of the major cheliped.

Classification follows De Grave et al. (2009). Only restricted synonymies are provided, those referring to the original description and to the major revisions with more extensive synonymy listings.

Terminology for the orientation of the limbs follows Poore (1997) where “upper” is used to describe the extensor (or anatomically anterior) margin and “lower” the flexor (or posterior) margin.

TAXONOMY

Axiidea de Saint Laurent, 1979

Callianideidae Kossmann, 1880

Callianidea H. Milne Edwards, 1837*Callianidea tya* H. Milne Edwards, 1837

(Figs. 1, 9a–e, 10a)

Callianidea tya H. Milne Edwards, 1837: 320, pl. 25bis, figs.

8–14; — Sakai, 2011: 203, fig. 40A–E [complete synonymy]

Callianidea ryukyu Sakai, 2011: 199, figs. 38, 39 [new synonymy]

Material examined. Christmas I.: 1 ovigerous female (45/10) (ZRC 2013.1127), 1 male (21/4.4) (ZRC 2013.1128), 1 female (22.1/5, broken) (ZRC 2013.1129), Ethel Beach (CI-13: 10°27.805'S, 105°42.443'E), sandy beach, near beach forest with limestone base rock, coll. P. K. L. Ng et al., 25 January 2010; –1 female (38.7/9.2) (ZRC 2013.1130), 1 male (39/8.0) (ZRC 2013.1131), Ethel Beach (CI-31: 10°27.805'S, 105°42.443'E) sandy beach, near beach forest with limestone base rock, coll. P. K. L. Ng et al., 2 February 2010; –1 male (40/8.7) (NHMW 25519), 1 m (27.8/6.7) (NHMW 25520), Ethel Beach (CI-09: 10°27.805'S, 105°42.443'E) sandy beach, near beach forest with limestone base rock, coll. H. H. Tan et al., 21 February 2011; –1 male (34.7/7.6) (ZRC 2013.1132), 1 female (15.7/3.71) (ZRC 2013.1133),

1 male (24.3/5) (ZRC 2013.1134), 1 male (–/6.9) (ZRC 2013.1135), Flying Fish Cove (CI-03-13: 10.429863°S, 105.667135°E), intertidal, coralline rocks, large boulders, mixed with coral rubble and sand, few live corals, coll. S. K. Tan, J. C. Y. Lai, J. C. E. Mendoza, 8 February 2012; –1 male (34.8/7.71) (ZRC 2013.1136), Waterfall Bay (CI-03-23: 10°27.54'S, 105°42.30'E), intertidal, mouth of freshwater stream, boulders, rocks and sand with pools at low tide; few live corals, coll. S. K. Tan, J. C. Y. Lai, J. C. E. Mendoza, 13 February 2012; –1 ovigerous female (40.4/8.4) (ZRC 2013.1137), 1 m (23.5/5) (ZRC 2013.1138), Flying Fish Cove (intertidal) (CI-03-25: 10.429863°S, 105.667135°E), coralline rocks, large boulders, mixed with coral rubble and sand, few live corals, coll. S. K. Tan, J. C. Y. Lai, J. C. E. Mendoza, 14 February 2012.

Cocos (Keeling) Is.: 1 ovigerous female (46.3/9.28) (NHMW 25525), 1 ovigerous female (34/7.14) (NHMW 25526), West Island, westward reef flats (CK-02-09: 12°11.297'S, 96°49.726'E), exposed intertidal reef flats with sea grass patches, coll. P. K. L. Ng, L. W. H. Tan, 6 February 2012.

Comparative material. 1 male (40/9.0) (NHMW 25510) Philippines, Bohol, Panglao I., Alona Beach, (M1: 9°32.9'N, 123°46.6'E), intertidal, coll. J. Y. C. Lai, 16 June 2004; –1 male (30/7.0) (ZRC 2013.1182), same collection locality 2 July 2004 (M1_Photo); –1 female (41/9.4) (NMCR 39098), same collection locality, coll. P. C. Dworschak, 15

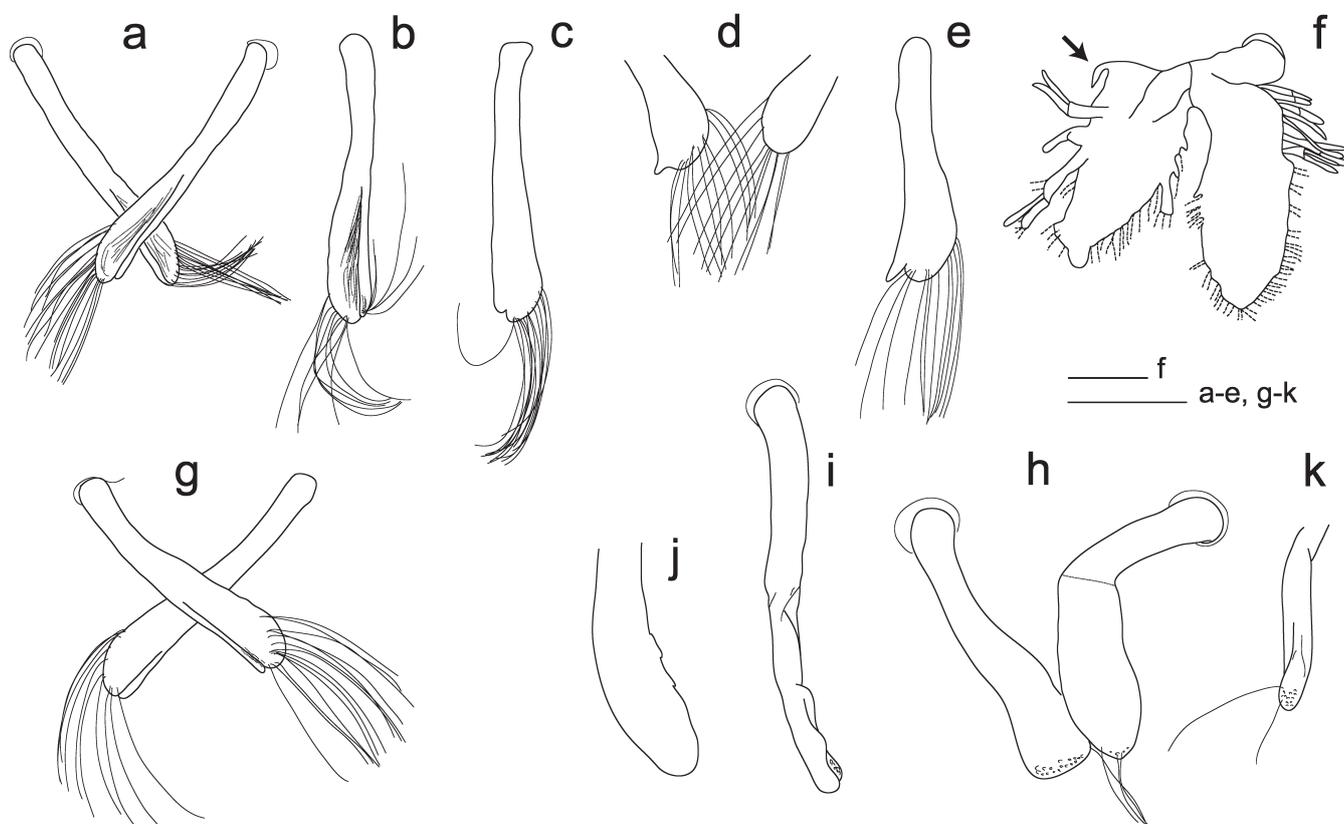


Fig. 1. *Callianidea tya* H. Milne Edwards, 1837, male first and second pleopods (Plp1–2): a, (34.7/7.6) (ZRC 2013.1132), both Plp1 in situ; b, same specimen, right Plp1 in posterior view; c, same, anterior view; d, (40/8.7) (NHMW 25519), tips of both Plp1 in situ; e, same specimen, left Plp1 in posterior view; f, same specimen, left PIP2 in posterior view (branchial filaments largely omitted, arrow pointing to appendix interna); g, (40/9.0) (NHMW 25510), tips of both Plp1 in situ; h, SMF 24918 (55/12, holotype of *Callianidea ryukyu* Sakai, 2011), both Plp1 in situ; i, left Plp1 in lateral view; j, same, tip in anterior view; k, tip of right Plp1 in lateral view. Scale bars = 1 mm.

June 2004 (M1_PD100); –1 female (-/8.0) (NHMW 6721), Samoa, Savai'i, coll. D. Reehinger, 1905; – male (55/12.0) (SMF 24918, holotype of *Callianidea ryukyu* Sakai, 2011) Taketomi-jima between the islands Iriomote and Ishigaki, Ryukyu Islands, Japan, coll. Uchida & Uda, 1–8 May 1973; –1 male (23.5/4.85 front damaged), 1 male (-/5.0, damaged, both P1 missing), 1 female (41/8.1, broken in 3 parts), 1 female (31/5.6, minor P1 missing) (SMF 32730, ex BLT 18238, paratypes of *Callianidea ryukyu* Sakai, 2011) Mitara, Iriomote-Jima, Ryukyu Islands, Japan, coll. H. O. Gusey, 15 June 2003.

Remarks. Poore (1997) noted some variation in his material of *C. typa*; for instance, some specimens had a more slender major cheliped and longer fingers. Komai & Tachikawa (2008) found some variation in the absence or presence of a spine on the dorsal surface of the uropodal endopod, between their material from Ogasawara Islands, the holotype of *C. typa* (with spine), and a specimen from Thailand (without spine). In the present material from Cocos (Keeling) and Christmas Islands, seven specimens have prominent spines on both sides, four have minute spines on both sides, three have only one spine on either left or right side, and two have no spines at all. Similarly, the spines on the uropodal endopod are variably developed in the Panglao specimens, which were collected from one location (Alona Beach): two specimens have weak spines (NHMW 25510, NMCR 39098), whereas one specimen has strong spines (ZRC 2013.1182). In the specimen from Savai'i, Samoa (NHMW 6721) reported by Dworschak (1992: fig. 17d), the spine is present only on the left side.

The major chelipeds show no conspicuous sexual dimorphism in their shape, although they are slightly larger in males (plma = 0.9818 CL - 0.6614, n = 11, r = 0.99; phma = 0.7618 CL - 1.1038, n = 11, r = 0.96) than in females (plma = 0.8362 CL - 0.9842, n = 10, r = 0.93; phma = 0.6869 CL - 1.2239, n = 10, r = 0.96).

In the present material, all males have a Plp1 consisting of a single, long article, lacking a projection, which conforms to the shape figured by H. Milne Edwards (1837: pl. 25bis, fig. 12) and Sakai (1992: fig. 5E; 2011: fig. 40C). In most males, the distal half of Plp1 has a depression with a ridge on the lateral border (Figs. 1a–c, g, 9a). In one male, only the left Plp1 bears a small lateral projection (Figs. 1d, e, 9b, c). This projection, however, is not distinctly separated from the preceding article, as shown in Poore (1997: fig. 1C, D) and Sakai (2011: fig. 40B). All males have Plp2 bearing a small process near the base of the endopod mesially, which could be interpreted as appendix interna (Fig. 1f), but no appendix masculina. This configuration is being more similar to that illustrated by Poore (1997: fig. 1G) than that of Sakai (2011: fig. 40D). It is notable that Sakai (1992: fig. 5F) could not detect appendices interna and masculina on male Plp2, contradicting his later observations. In females, the Plp2 has a broad appendix interna, as figured by Sakai (1992: fig. 5H).

Sakai (2011) described a new species *C. ryukyu* from the Ryukyu Islands and pointed out the shape of the first male pleopod as its only difference from *C. typa*: “... in *C. ryukyu* the Plp1 is uniramous, the distal segment is shorter than the proximal segment and fingerlike (fig. 39E), whereas in *C. typa* the male Plp1 is uniramous and the distal segment is elongate, bearing a small digitiform projection distolaterally (fig. 40B).” He listed his previous report of *C. typa* (Sakai, 1992: 12, figs 3–5) in the synonymy of *C. ryukyu*. This, however, would apply only to the figures of the female BLT 5689 (Sakai, 2011: figs 3, 4). No indication of the figured specimen is given for Sakai (2011: fig. 5); his figs. A–D, G, H may have been from the same female, but figs. 5E, F can only be from one of the males listed in the material examined. However, this material only includes two males from Indonesia that represent *C. typa*.

Close inspection of the holotype of *C. ryukyu* (SMF 24918) revealed that Sakai (2011) misinterpreted the morphology of Plp1. Firstly, Plp1 is not finger-like, but flattened (Fig. 1h–k, 9d, e), twice as wide as thick distally. Secondly, it consists of only one article, which is broken in the middle (more severely on the right side than on the left, see Fig. 1h, 9d). The Plp1 of the male paratypes of *C. ryukyu* (SMF 32730) are similar to those figured here for *C. typa* (Fig. 1a, g). In addition, none of the males has an appendix masculina on Plp2, which only bears an appendix interna similar to that of *C. typa* (Poore, 1997: fig. 1G). As the only difference between the two species is herewith invalidated, *C. ryukyu* is synonymised with *C. typa*.

Callianidea typa has been previously reported from Christmas Island (Gordon, 1935; Morgan, 2000), but is recorded here for the first time from Cocos (Keeling) Islands.

Callianassidae Dana, 1854

Neocallichirus Sakai, 1988

Neocallichirus jousseaumei (Nobili, 1904)

(Fig. 10b)

Callianassa (Cheramus) Jousseaumei Nobili, 1904: 236; 1906: 101, pl. 6 fig. 2 [type locality: Djibouti and Perim, Yemen]
Neocallichirus jousseaumei — Dworschak, 2011: 2, figs 1–4, 6F–H [complete synonymy]
 [Not *Neocallichirus jousseaumei* — Sakai, 2011: 458 (part = *Neocallichirus vaugelasi* Dworschak, 2011)]

Material examined. Cocos (Keeling) Is.: 1 female (70/17.6, minor P1 missing) (ZRC 2013.1156), 1 female (78/17.5, major P1 missing) (ZRC 2013.1157), 1 male (51/13.5, minor P1 missing) (ZRC 2013.1158), 1 female (70/18, both P1 missing) (ZRC 2013.1159), 1 male (50/14.2) (NHMW 25515), 1 female (49/12.4,) (NHMW 25516), 1 male (55/15.2,) (NHMW 25517), 1 male (60/15, major P1 missing) (ZRC 2013.1160), 1 male (17.4/17.4, major P1 missing) (ZRC 2013.1161), 1 female (61/16.5, maP1 missing) (ZRC 2013.1162), 1 ovigerous female (62/15.6, both P1 missing) (ZRC 2013.1163), 1 male (53/14, major P1 missing) (ZRC 2013.1164), 1 female (-/13, damaged, major P1 missing)

(ZRC 2013.1165), fragments (part of female carapace; P4, P5 pleon of female; pleomere 3–6; pleomeres 5–6; div. pereopods 3–5) (ZRC 2013.1166), detached chelipeds (5 left major P1; 2 right major P1; 1 right minor P1) (ZRC 2013.1167), West Island, Tanjong Puji, (CK-03: 12°11.589'S, 96°51.549'E), intertidal flat, coll. P. K. L. Ng et al., 20 March 2011; –1 male (80/21, both P1 missing) (ZRC 2013.1168), West Island, lagoon side from airport near meteorological station, (CK-26), extensive sea grass bed, coll. P. K. L. Ng et al., 24 March 2011.

Remarks. This species is widely distributed in the Indo-West Pacific and was recently redescribed by Dworschak (2011), who noted some variation in the shape of the male first pleopod. All males of the present material have bilobed first pleopods. This is the first record of *N. jousseaumei* for Cocos (Keeling) Islands.

Corallianassa Manning, 1987

Corallianassa martensi (Miers, 1884), new combination (Figs. 2, 10c)

Callianassa martensi Miers, 1884: 13–15, pl. 1 fig. 1 [type locality: Mauritius]; Nobili, 1906: 110, 111, fig. 7

Callianassa (Callichirus) martensi — Borradaile, 1903: 547; de Man, 1928: 29, 109, 171

Callianassa (Callichirus) martensi — Tirmizi, 1974: 286, figs. 1–4. *Callianassa martensi* — Sakai, 1984: 99, fig. 3; Dworschak, 1992: 200, fig. 8a–e.

Glypturus martensi — Sakai, 1988: 61; 1999: 83, fig. 19a–d; 2005: 142; 2011: 437

[not *Callianassa martensi* de Man, 1888: 482–483, pl. 21 fig. 1 = *Callianassa (Callichirus) assimilis* de Man, 1928: 28, 109]

Material examined. Cocos (Keeling) Is.: 1 male (51/11.4, minor P1 missing) (ZRC 2013.1139), 1 female (85/17.5, major P1 missing) (ZRC 2013.1140), West Island, lagoon side from airport near meteorological station, (CK-16), extensive sea grass bed, coll. P. K. L. Ng et al., 22 March 2011.

Description. Dorsal oval distinct, 0.8 length of dorsal carapace. Rostrum in form of acute spine (straight in male, slightly upturned in female), about as long as eyestalk (Fig. 2a, b, k, l). Lateral projections in form of acute spines directed upwards (less in female than in male), half length of rostrum, without non-calcified base. Eyestalks shorter than first antennular article; cornea large, subterminal. Antennular peduncle reaching to middle of ultimate antennal article. Third maxilliped (Fig. 2c) with ischium-merus 2.5 times as long as wide, merus shorter than ischium; ischium with distinct crista dentata mesially carpus articulating distolaterally on merus; propodus as wide as long, free distal margin slightly excavate; dactylus about 0.2 width of propodus, shorter than propodus. Major cheliped (of male) (Fig. 2d, e) with ischium proximally unarmed, distal ventral margin with three teeth distally increasing in size; merus with one proximal spine continuing by ventral ridge of blunt tubercles; carpus wider than long, less than half length of propodus; propodus smooth dorsally and ventrally, with dorsal crest on dorso-proximal half; cutting edge of fixed fingers sharp,

with triangular tooth proximally; dactylus stout, longer than fixed finger, cutting edge sharp, without teeth. Small cheliped (of female) (Fig. 2m) with ischium, merus without ventral spines; carpus, propodus elongate, carpus slightly longer than dorsal propodus; dactylus as long as carpus; cutting edges of fingers unarmed. Third pereopod propodus more than twice as long as high, heeled (Fig. 2f, n). Male first pleopod (Fig. 2g) composed of two-articles, second article broad, with strong terminal hook. Male second pleopod biramous, exopod slightly longer than endopod, without appendix masculina, with long and slender appendix interna cincinnuli (Fig. 2h). First female pleopod uniramous, second article with median shoulder. Second female pleopod biramous, exopod longer than endopod, notched terminally with long appendix interna (Fig. 2o). Second pleomere slightly longer than wide, slightly longer than sixth pleomere. Telson (Fig. 2j, r) trapezoidal, 1.5 times as wide as long, widest basally; dorsal surface convex (Fig. 2o), posterior border with weak convexity. Uropodal endopod (Fig. 2i, q) lanceolate, longer than telson, more than twice as long as wide; uropodal exopod (Fig. 2i, p) with strongly elevated dorsal plate, almost twice endopod length, medial edge concave, produced (more in female than in male).

Remarks. This species is represented in the Cocos (Keeling) Is. material by only two specimens. Unfortunately, the major cheliped is missing in the female, while the minor cheliped is missing in the male. Both specimens key out to *Glypturus martensi* in Sakai (1999, 2011) and agree in most characters with the description of the holotype provided by Miers (1884) and Sakai (1984), except for stronger spines on the ischium and merus of the major cheliped. The number and strength of spines, however, may vary greatly in other species of *Corallianassa* (pers. obs.). In *C. martensi*, the major cheliped was until now only known from the holotype.

Corallianassa was treated as a junior synonym of *Glypturus* Stimpson, 1866 in several studies by Sakai (1999, 2005, 2011). In this study, Ngoc-Ho (2005) is followed in adopting Manning's (1987) definitions of *Glypturus* and *Corallianassa* and treating *Corallichirus* Manning, 1992 as a synonym of *Corallianassa*.

The present material represents the first record of *C. martensi* for Cocos (Keeling) Islands.

Paratrypaea Komai & Tachikawa, 2008

Paratrypaea bouvieri (Nobili, 1904) (Fig. 10d)

Callianassa (Trypaea) Bouvieri Nobili, 1904: 236; 1906: 101, 105, pl. 6, fig. 3–3b [type locality: Djibouti]

Paratrypaea bouvieri — Dworschak, 2012: 45, figs. 1D, 5A–I, 6A–J, 7A, B [complete synonymy]

Gilvossius bouvieri — Sakai, 2011: 374; Sakai & Türkay, 2012: 735

Material examined. Cocos (Keeling) Is.: 1 male (26/6.1) (NHMW 25518), West Island, Tanjong Puji (CK-03: 12°11.589'S, 96°51.549'E), intertidal flat, coll. P. K. L. Ng

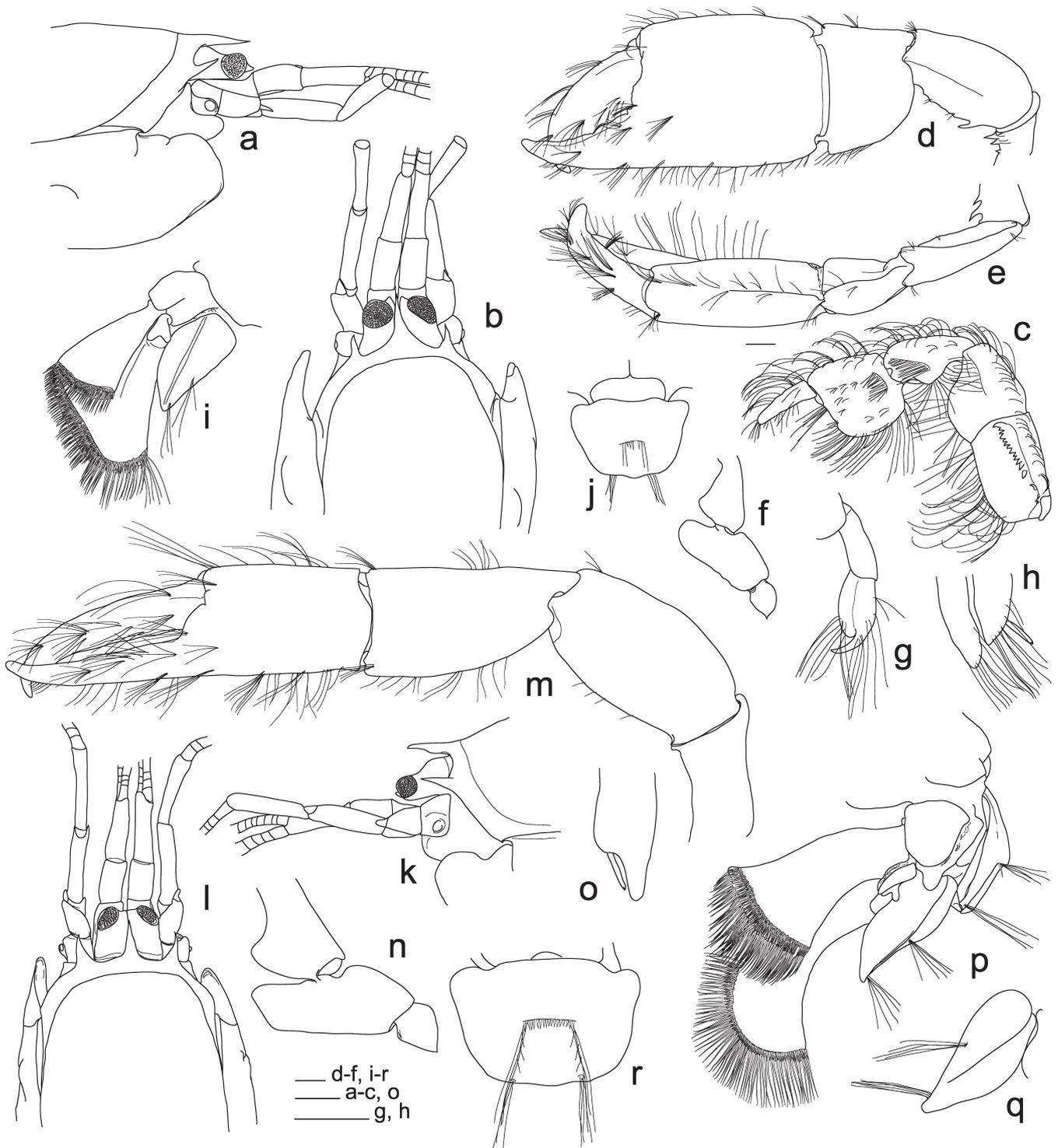


Fig. 2. *Corallianassa martensi* (Miers, 1884), male (51/11.4) (ZRC 2013.1139) (a–j), female (85/17.5) (ZRC 2013.1140) (j–r): a, k, front, lateral view; b, l, front, dorsal view; c, third maxilliped, mesial view; d, major cheliped, lateral view; e, same, dorsal view; f, n, distal articles of third pereopods, lateral view (setae omitted); g, first left pleopod, lateral view; h, distal part of right second pleopod, anterior view; m, minor cheliped, lateral view; o, distal part of right second pleopod endopod, posterior view (setae omitted); i, p, left uropods, lateral view; q, uropodal endopod, dorsal view; j, r, telson, dorsal view. Scale bars = 1 mm.

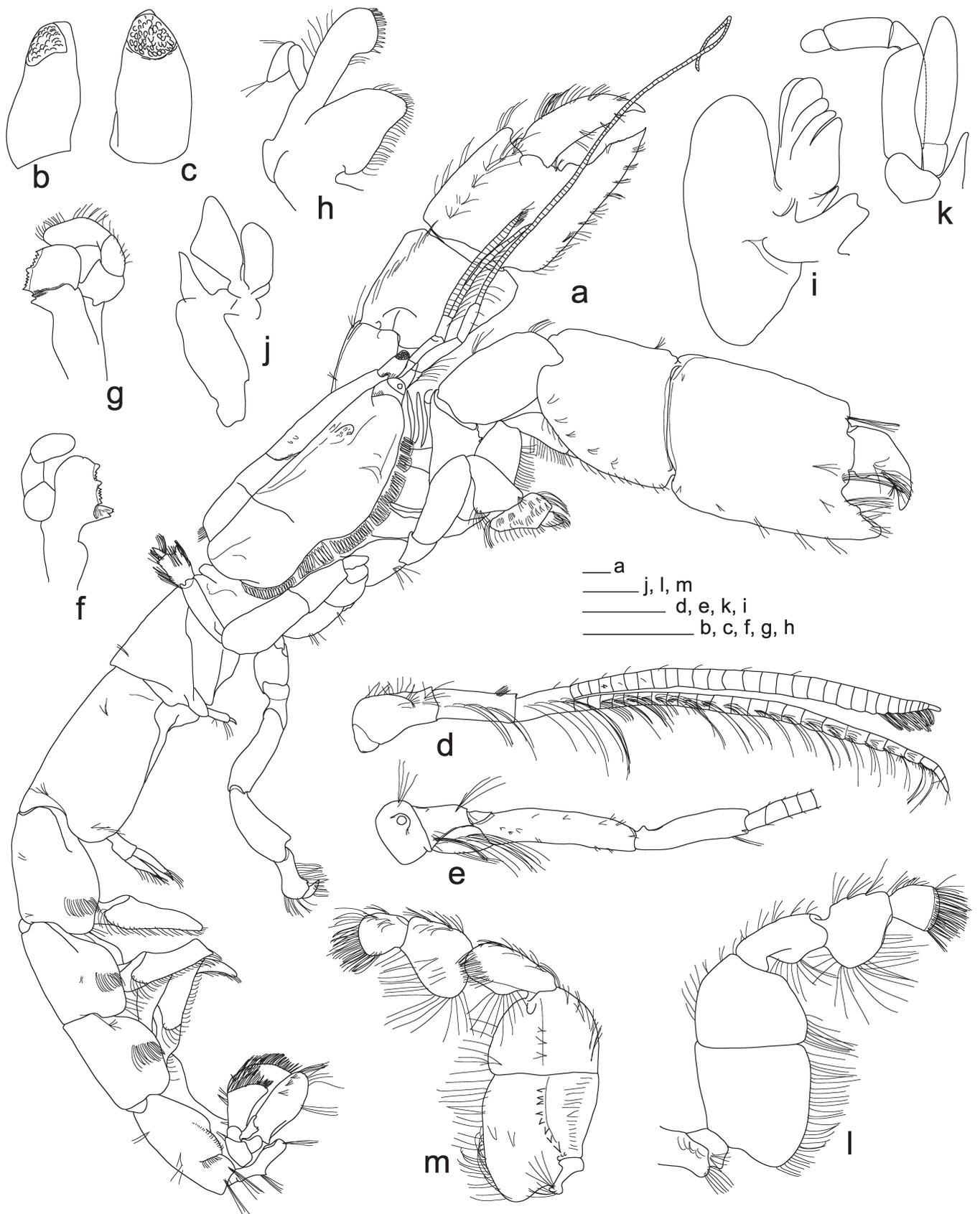


Fig. 3. *Eucalliax inaequimana* new species, holotype male (40/8.6) (QM W29204): a, entire specimen in lateral view; b, right eyestalk, lateral view; c, same, dorsal view; d, right antennule, lateral view; e, right antenna, lateral view; f, right mandible, lateral view; g, same, mesial view; h, first maxilla, lateral view; i, second maxilla, lateral view (setae omitted); j, first maxilliped, lateral view (setae omitted); k, second maxilliped, mesial view (setae omitted); l, third maxilliped, lateral view; m, same, mesial view. Scale bars = 1 mm.

et al., 20 March 2011; –1 male (21/4.7) (NHMW 25521), West Island, lagoon side from airport near meteorological station, (CK-16) extensive sea grass bed, coll. P. K. L. Ng et al., 22 March 2011; –1 male (11.9/3.07) (NHMW 25522), 1 ovigerous female (14.2/2.92) (NHMW 25523), 1 ovigerous female (15.6/3.2,) (NHMW 25524), The Rip, SW of Direction Island (CK-18: 12°05.675'S, 96°53.175'E), –5.7 m, narrow channel connecting lagoon and ocean., coll. P. K. L. Ng et al., 22 March 2011; –1 male (21/4.4) (ZRC 2013.1169), 1 male (22.7/5.1) (ZRC 2013.1170), 1 male (20/4.1) (ZRC 2013.1171), 1 female (0150/4.6, telson missing) (ZRC 2013.1172), 1 female (19.3/3.85) (ZRC 2013.1173), 1 male (18.2/4.14) (ZRC 2013.1174), 1 male (14.2/3.5) (ZRC 2013.1175), 1 damaged specimen (posterior pleomere 3 missing) (ZRC 2013.1176), 1 specimen (–/2.38, damaged, both P1 missing) (ZRC 2013.1177), West Island, lagoon side of airport (CK-15: 12°10.913'S, 96°49.804'E), disturbed sea grass bed, warms under stiff mud, coll. P. K. L. Ng et al., 22 March 2011; –1 female (12.5/2.8) (ZRC 2013.1178), 1 male (11.9/2.64) (ZRC 2013.1179), off Rumah Baru, boat launch (CK-22: 12°09.111'S, 96°50.357'E), –4.3 m, sandy bottom with corals, coll. P. K. L. Ng et al., 23 March 2011; –1 male (21.4/4.7) (ZRC 2013.1180), West Island, W-SW of Rumah Baru (boat launch), (CK-24: 12°10.492'S, 96°49.282'E) sandy beach, intertidal, coll. P. K. L. Ng et al., 24 March 2011; –1 fragment (major P1 and pleon) (ZRC 2013.1181) West Island, lagoon side from airport near meteorological station, (CK-26), extensive sea grass bed, coll. P. K. L. Ng et al., 24 March 2011.

Remarks. This common species, recently redescribed by Dworschak (2012), is widely distributed in the Indo-West Pacific and is here recorded for the first time from Cocos (Keeling) Islands.

Eucalliax Manning & Felder, 1991

Eucalliax inaequimana, new species

(Figs. 3–7, 9f, g, 10e, f)

Material examined. Type material: Cocos (Keeling) Is.: holotype: male (40.3/8.6, dissected) (QM W29204), West Island, lagoon side from airport near meteorological station (CK-16), extensive seagrass bed, coll. P. K. L. Ng et al., 22 March 2011; –allotype: female (36.4/8.1, front damaged) (QM W29205), West Island, lagoon side from airport near meteorological station, (CK-26), extensive seagrass bed, coll. P. K. L. Ng et al., 24 March 2011; –paratypes: 1 ovigerous female (40.8/8.7) (ZRC 2013.1143), 1 ovigerous female (41.7/9.1) (ZRC 2013.1141), 1 male (28.4/6.6) (ZRC 2013.1142), 1 ovigerous female (40.3/9.4) (ZRC 2013.1144), 1 ovigerous female (44/8.85) (ZRC 2013.1145), 1 ovigerous female (43.7/9.14) (ZRC 2013.1146), 1 ovigerous female (37.5/8.57) (ZRC 2013.1147), same collection data as for the holotype (CK-16); –1 male (32.1/7.71, damaged) (ZRC 2013.1148), 1 m (33.3/7.85, damaged) (ZRC 2013.1149), 1 female (27.8/5.71,) (ZRC 2013.1150), 1 male (42.4/10,) (ZRC 2013.1151), 1 ovigerous female (39.3/9.4, damaged) (ZRC 2013.1152), 1 ovigerous female (42.6/8.85, front damaged) (ZRC 2013.1153), 1 female (43/9.0, broken) (ZRC

2013.1154), 1 ovigerous female (damaged) (ZRC 2013.1155), same collection data as for the allotype (CK-26).

Non-type material: Cocos (Keeling) Is.: 1 ovigerous female (36/7.7) (NHMW 25512), 1 male (34/7.14) (NHMW 25513), 1 ovigerous female (41.3/8.4) (NHMW 25514), West Island, Tanjong Puji (CK-03: 12°11.589'S, 96°51.549'E), intertidal flat, coll. P. K. L. Ng et al., 20 March 2011; –1 ovigerous female (22/6.7) (NMCR 39097), Philippines, Bohol, Panglao I., Momo Beach, –3 to –7 m, reef platform with seagrass, (M07: 9°36.1'N, 123°45.2'E), coll. P.C. Dworschak, 1 June 2004 (M07_PD002).

Total material examined. 21 specimens, 6 males, 15 females, 12 of them ovigerous.

Comparative material. *Eucalliax aequimana* (Baker, 1907), 1 female (33/8.2) (NHMW 19365) Western Australia, Shark Bay, Freycinet Reach, Whalebone, sand, –2 to –3 m, yabby pump, coll. D. Abed-Navandi, 17 September 1998; –1 male (–/11.0), 1 female (–/11.3), (NMV J59651) South Australia, Dutton Bay, eastern shore, 6 March 2009 [photographs of Plp1 kindly provided by Gary Poore].

Diagnosis. Carapace lacking dorsal oval. Antennal peduncles overreaching antennular peduncles. Chelipeds dissimilar in size and shape in both males and females, without acute spines at distal corners of carpus. Telson twice as broad as long, with transverse carina.

Description of holotype. Dorsally, carapace shorter than pleomeres 1 and 2 combined (Figs. 3a, 4a). Frontal margin of carapace with broadly triangular rostrum, flanked by deeply excavated shoulders forming anteriorly produced prominences lateral to margins of eyestalks; rostrum extending to 1/6 visible length of eyestalks in dorsal view; lateral projections longer than rostrum, extending to 1/4 visible length of eyestalks in dorsal view, with setae dorsally. Carapace lacking distinct dorsal oval, cardiac prominence, and dorsal carina. Cervical groove distinct, disjunct near linea thalassinica. Linea thalassinica strong, parallel to midline of carapace. Weak hepatic boss in anterior 1/3 of carapace, ventral to linea thalassinica. Cardiac suture in middle posterior half of carapace well defined, incomplete across midline of carapace, extending anteroventrally to middle of carapace. Subantennular region of epistome bearing dense tuft of long setae.

Eyestalks (Fig. 3b, c) dorsally flattened, slightly curved ventrally, twice as long as wide at base, in dorsal view reaching beyond basal antennal article; mesial surfaces broadly triangular, flattened so eyestalks abutt closely at midline in proximal 3/4 length, lateral margin parallel to midline in proximal 2/3, distal margin tapering dorsolaterally to blunt tip; pigmented region distinct in distal 1/3 of dorsolateral surface.

Antennular peduncle shorter than antennal peduncle (Figs. 3a, d, 4a); basal article laterally and ventrally inflated; second article as long as basal article, with tuft of setae dorsally near

distal end, third article about 3/4 length of second; second and third articles with ventrolateral row of long, ventrally directed setae, continued onto ventral ramus of flagellum; ventral ramus slightly longer than dorsal, near seven times length of third article of antennular peduncle; dorsal ramus with sparse short setae, subterminal articles of dorsal ramus heavier than those of ventral ramus and with thick line of ventral aesthetascs (Fig. 3d).

Antennal peduncle 1.7 times length of antennular peduncle (Fig. 3e); basal article with dorsolateral carina forming lip above excretory pore; second article longer than first, distally with field of long setae below ventrolateral suture and another on dorsolateral surface; third article short, visible in lateral view as short triangle ventral to second article and vestigial antennal scale; fourth article elongate, longer than fifth or combined length of first two articles; fifth article narrower than fourth; flagellum sparsely setose, extending posteriorly to middle of pleonite 1 (Fig. 3a).

Mandible (Fig. 3g, f) with large, terminally setose, trisegmented palp, third article of palp terminally rounded; incisor process with one large median tooth and several well defined smaller teeth on cutting margin, internal surface with lip giving rise to toothed molar process proximal to incisor teeth; paragnath uncalcified, set against proximal surface of molar process.

First maxilla (Fig. 3h) with long, narrow endopodal palp, terminal article deflected proximally at articulation; proximal endite densely setose on straight margin, terminally with field of setae; distal endite elongate, terminally truncate and armed with stiff bristles; exopodite low, rounded.

Second maxilla (Fig. 3i) with endopod narrowed at distal end, terminus directed mesially, first, second endites each longitudinally subdivided, exopod forming large, broad, scaphognathite.

First maxilliped (Fig. 3j) with reduced, minute endopod; proximal endite triangular; distal endite elongate, external surface, all margins heavily setose, internal surface concave; exopod triangular, without transverse suture; distal part broad, with long marginal setation at mesial end, proximal part with field of mesially directed setae near mesial end; epipod large, broad, subdivided by weak transverse suture, anterior end tapered, angular.

Second maxilliped (Fig. 3k) with long, endopod; endopodal merus straight, flexor margin with dense fringe of long setae; carpus short; propodus weakly arcuate, length 2 times width, half length of merus; dactylus short, about half length of propodus, extensor margin arcuate, tip densely covered with serrate setae; exopod as long as endopodal merus and carpus combined, marginally fringed by long setae, subdivided by transverse suture at 1/5 length; epipod small, uniramous, arthrobranch (not shown) greatly reduced.

Third maxilliped (Fig. 3l, m) without exopod; endopod with long dense setation on mesial margin; endopodal ischium

subtriangular, longer than broad, proximomesial lip rounded, internal surface with medial longitudinally oriented elevation, bearing well-defined, curved row of eight sharp teeth; merus semicircular, broader than long; carpus strongly flexed in proximal third with setose lobe on flexor margin; propodus large, as broad as long; dactylus broad terminally, as long as broad, fringed with very dense field of stiff serrated setae on broad terminal margin.

Branchial formula includes exopods, epipods as described for first, second, third maxillipeds above; branchiae limited to single rudimentary arthrobranch on second maxilliped, pair of arthrobranches at third maxilliped, one pair of arthrobranches at each of first through fourth pereopods.

Major and minor chelipeds (P1) strongly developed, unequal in size, dissimilar in shape. Major cheliped (Figs. 3a, 5a, b) strongly calcified; ischium stout, upper margin almost straight, lower margin with small spines increasing in size distally, length about 1.7 times distal breadth; merus stout, length about 1.5 times breadth at mid-length, upper, lower margins smooth; carpus broad, broadest distally, lower margin arcuate and keeled terminating in round corner, upper margin straight with keel terminating in rounded corner distally; propodus stout, length (including fixed finger) about 1.5 times height, mesial surface of palm smooth; upper, lower propodal margins keeled, keel of lower margin mesially directed, becoming barely detectable beyond mid-length, absent on fixed finger, tufts of setae on mesial face below upper margin, also above lower margin, several semicircular ridges lateral to upper keel near articulation with dactylus; fixed finger longer than high, terminating in rounded tip, prehensile margin armed with one low rounded tooth at mid-length, area proximal to this tooth with microscopic tuberculation; weak unarmed excavation extending from below articulation with dactylus to below mesial tooth; dactylus stout, curved, line of six setose punctae on mesial side of upper margin, lateral face with four setose punctae along inferior border, cutting edge with one rounded tooth and one rectangular tooth in proximal half, tip somewhat twisted mesially.

Minor cheliped (Figs. 3a, 5c, d) smaller in size and slightly different in shape from major cheliped; ischium and merus as broad and long, carpus 0.9 times as long but same height, propodus 0.7 length and 0.9 height of these articles in major cheliped; upper and lower margins of carpus keeled, keel on upper margin thickened distally, low triangular tooth present on cutting edge of fixed finger, with microscopic serration distally, short prominent keel present on lateral face below articulation with dactylus lower and upper keel on propodus margins prominent, upper terminating in large blunt tooth above articulation with dactylus; dactylus longer, more slender than in major cheliped.

Second pereopod (Fig. 4b) chelate, most of lower margins of ischium, merus lined with evenly spaced long setae, similar setae restricted primarily to distal patches on lower margin in carpus, lower margin of propodus with similar setal patches, long proximally, progressively more reduced

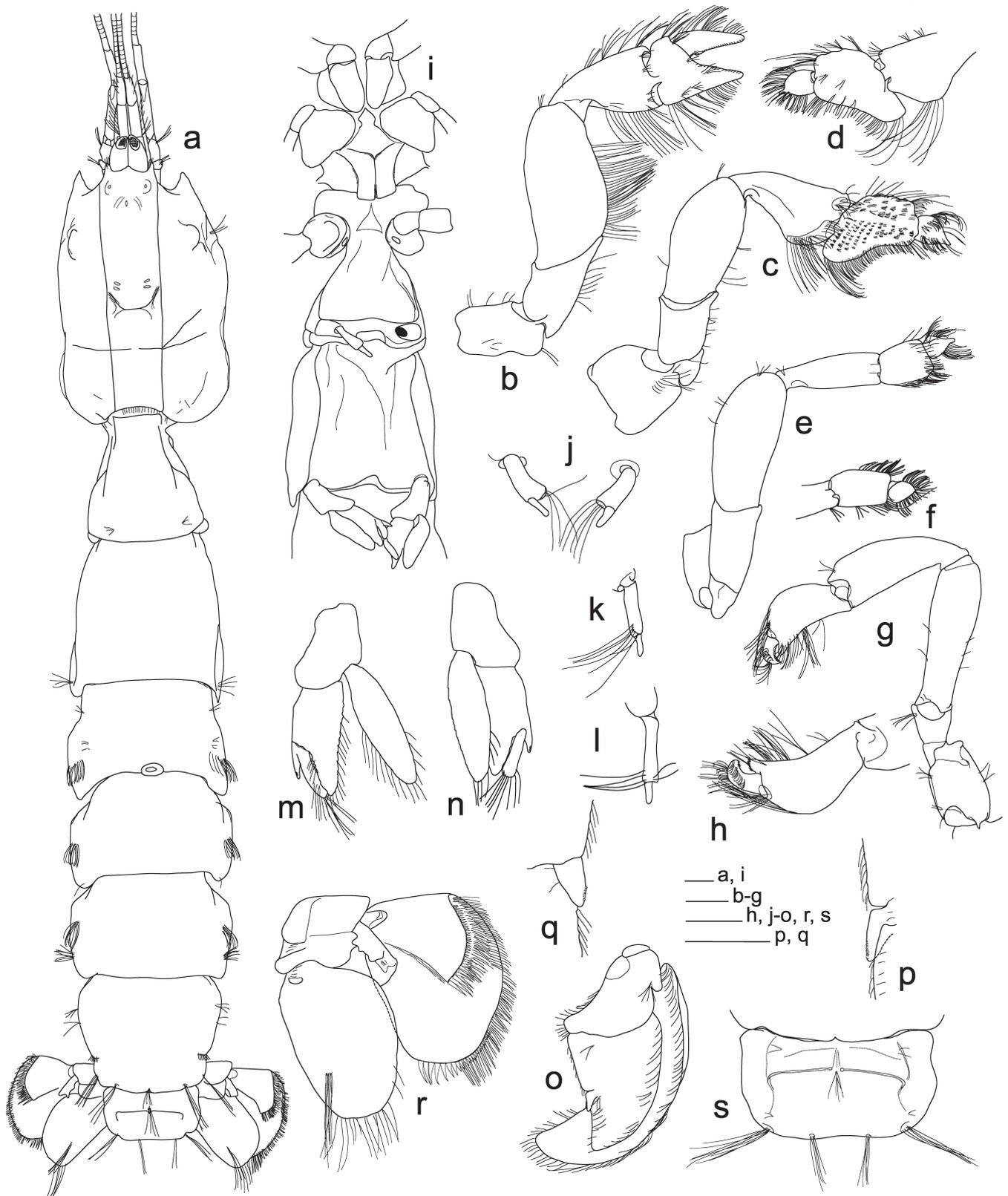


Fig. 4. *Eucalliax inaequimana* new species, holotype male (40/8.6) (QM W29204): a, body in dorsal view; b, second pereopod, lateral view; c, third pereopod, lateral view; d, same, distal articles, mesial view; e, fourth pereopod, lateral view; f, same, distal articles, mesial view; g, fifth pereopod, lateral view; h, same, distal articles, mesial view; i, thoracic sternites 6–8 and pleomeres 1–2, ventral view; j, first pleopods, ventral view; k, left first pleopod, mesial view; l, right first pleopod, lateral view; m, right second pleopod, posterior view; n, same, anterior view; o, third pleopod, posterior view; p, appendix interna, posterior view; q, same, anterior view; r, right uropods; s, telson, dorsal view. Scale bars = 1 mm.

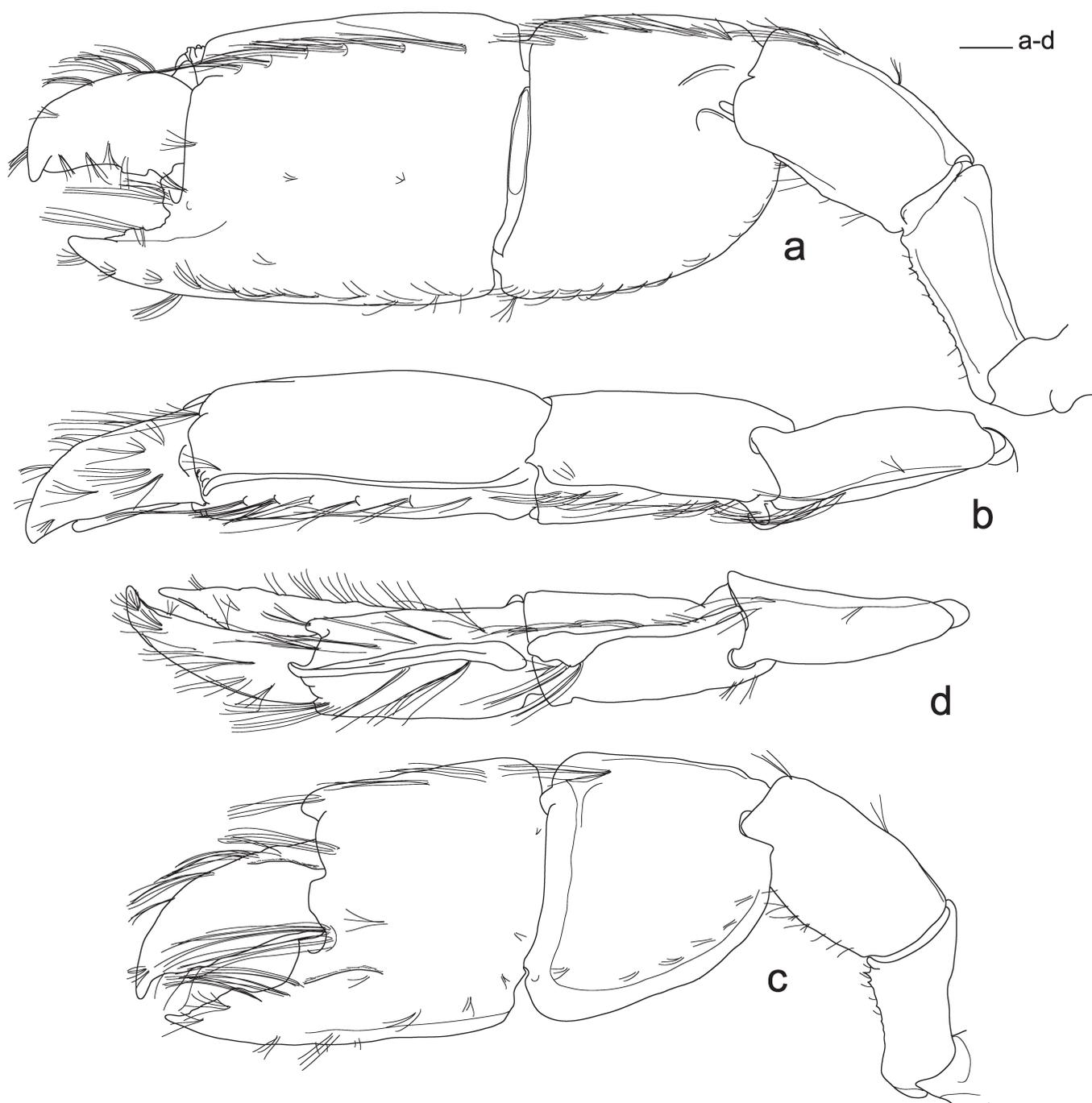


Fig. 5. *Eucalliax inaequimana* new species, holotype male (40/8.6) (QM W29204): a, major cheliped, mesial view; b, same, dorsal view; c, minor cheliped, lateral view; d, same, dorsal view. Scale bar = 1 mm.

in length, stiffened distally, subterminally becoming dense patch of short, stiff bristles; prehensile margins of both fingers corneous, finely serrated along straight edge over most of length; upper margin of dactylus straight, with patches of stiff, arched bristles becoming increasingly reduced in length, and more arched distally.

Third pereopod (Fig. 4c, d) with ischium short, half-length of merus; merus about twice as long as wide, lower margin weakly sinuous, with two tufts of setae; carpus broadly flared distally forming strong lower lobe, this lobe's width about 2/3 its length, terminally with field of long arched setae, diminishing in length toward articulation with propodus; propodus with weak, proximally directed lobe on lower

margin, lobe terminally with field of long arched setae diminishing distally along margin, becoming shorter bristles slightly longer at distal extreme, upper margin with tufts of long arched setae, lateral face with patterned tufts of more slender setae; dactylus tear-shaped length about 1.2 times width, terminating in narrow corneous tip hooked laterally, lower margin sinuous, lateral face crossed by fields of short, slightly hooked setae with longest setae situated near upper margin, with separate, dense field of slightly stouter, short, weakly hooked setae along lower lateral face, lower margin.

Fourth pereopod (Fig. 4e, f) not subchelate, lower distal corner of propodus rounded, without evidence of fixed finger; dense setation on lateral surface of both propodus

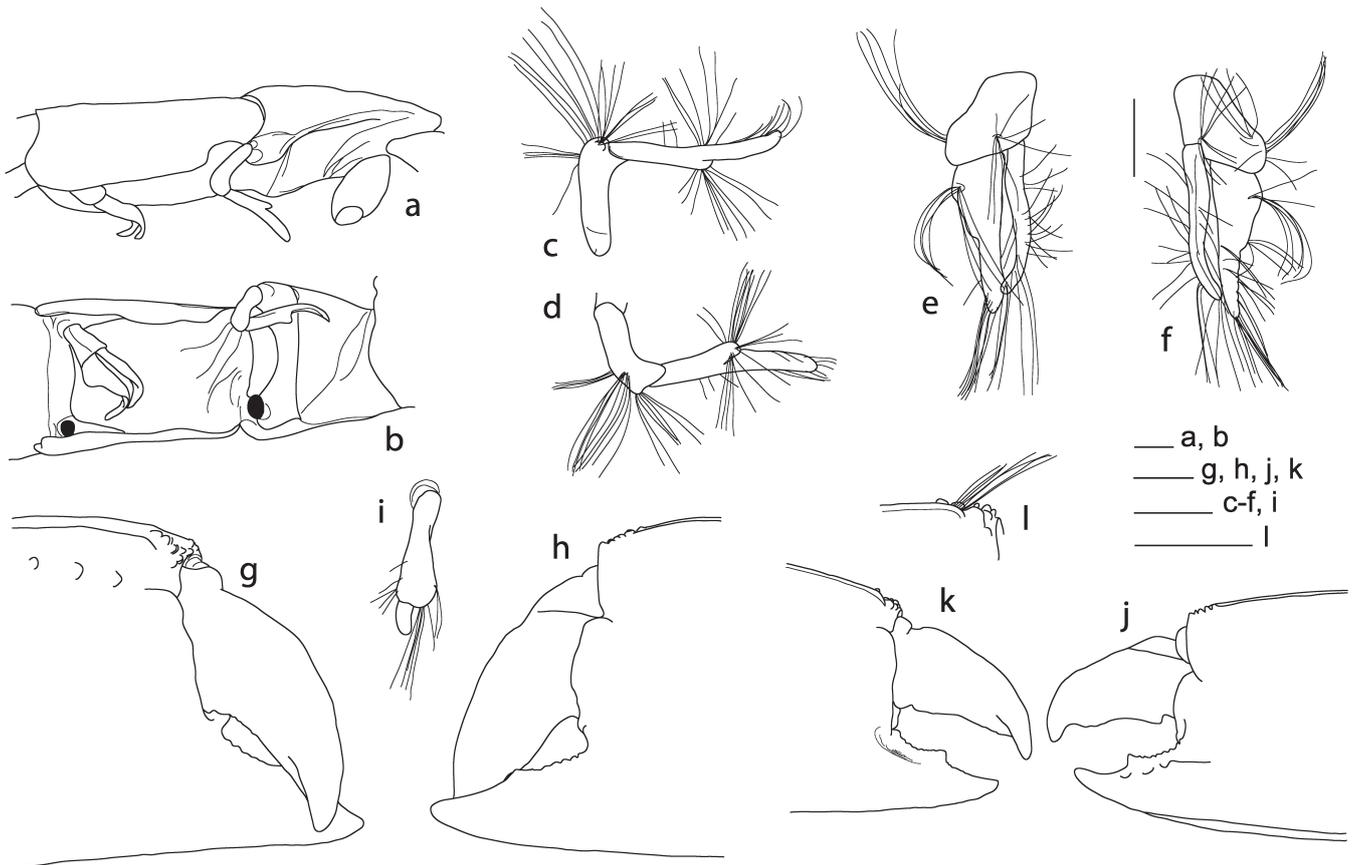


Fig. 6. *Eucalliax inaequimana* new species, allotype female (36/8.1) (QM W29205): a, pleomeres 1–2, lateral view; b, same, ventral view; c, first left pleopod, posterior view; d, same, anterior view; e, second left pleopod, anterior view; f, same, posterior view. Paratype male (42/10) (ZRC 2013.1151): g, fingers of left major cheliped, mesial view; h, same, lateral view; i, first right pleopod, anterior view. Non-type male (34/7.1) (NHMW 25513): j, fingers of left major cheliped, lateral view; k, same, mesial view; l, same, distodorsal margin of propodus. Scale bar = 1 mm.

and tear-shaped dactylus divided into upper, lower fields, setae slightly stronger in lower fields of both, densest on dactylus, especially on and near lower margin; mesial surface of propodus with single, large, very long seta, originating from near upper margin reaching distally well beyond tip of dactylus.

Fifth pereopod (Fig. 4g, h) minutely subchelate, opposable surfaces of propodus, small dactylus excavate, terminally rounded, forming beak-like subchela obscured by dense setation on distal half of propodus and upper surface of dactylus.

Pleon long (Figs. 3a, 4a); dorsal length ratio (along midline) of first to sixth pleomeres 1.0: 1.2: 0.92: 0.80: 0.80: 0.92. First pleomere narrowed anteriorly; pleuron triangular with straight ventral margin; posterior half ventrally without pair of conspicuous ovoid plates of thickened integument. Second pleomere with concave anterior margin; posterior margin expanded posterolaterally, with two setal rows near the posterior margin. Third to fifth pleomeres each distinctly shorter than second pleomere; pleura each with tuft of short setae mid-laterally and on posteroventral margin. Sixth pleomere subrectangular in dorsal view, slightly narrowed posteriorly, with lateral constriction in posterior 1/3; ventral margin of pleurite with short setae, posterior margin and posterolateral margin with two tufts of long setae.

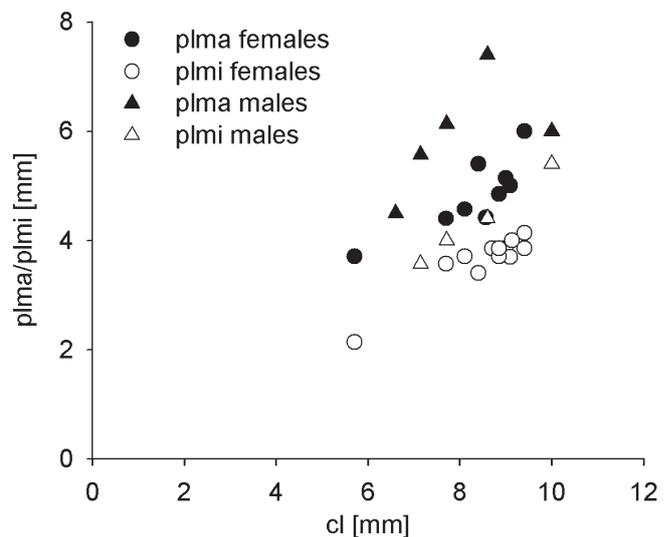


Fig. 7. *Eucalliax inaequimana* new species: palm length of major (plma, filled symbols) and minor (plmi, open symbols) chelipeds in relation to carapace length.

First male pleopod half as long as second pleopod, uniramous (Figs. 4j–l, 9f, g), composed of two articles; proximal article three times as long as distal, widening distally, with long setae mesially; distal article inserting laterally on proximal article, without setae or cincinnuli.

Second male pleopod biramous, with appendix interna (Fig. 4m, n); dense setation largely restricted to distal extreme of exopod, distal lobe of endopod and appendix masculina; appendix masculina not overreaching distal lobe of endopod; small appendix interna with cincinnuli mesially.

Third to fifth pleopod pairs (Fig. 4o) forming large, posteriorly cupped fans when cross-linked by hooked setae of appendices internae on opposed margins of subtriangular endopods. Appendices internae stubby, movably articulated with mesial margin of endopod (Fig. 4p, q).

Telson (Fig. 4s) about twice as broad as long, broadest in proximal 2/3, posterolateral margin rounded, with one tuft of setae each near lateral margin and one tuft each on posterior margin; dorsal surface with sharp, transverse carina interrupted in mid-length by depression, latter posteriorly marked by tuft of long setae.

Uropod with oval endopod (Fig. 4r), 1.6 times as long as broad, overreaching telson, dorsal surface with one tuft of long setae posteriorly and numerous setae on posterior margin; exopod with anterodorsal plate falling short of distal endopod margin, distal edge of plate lined with short, thick spiniform setae grading to longer and more slender setae of exopod margin, long, stiff, spiniform setae at posterodistal corner of plate; distolateral margin of exopod with dense setal fringe grading to large curved, spiniform setae on distal margin.

Description of female allotype. Body, appendages generally similar to that of male holotype with the following exceptions: First pleopod of female (Fig. 6c, d) uniramous, L-shaped, composed of two articles; proximal article about 0.6 times length of distal, with long setae distally; distal article with long setae on broad shoulder at mid-length, short setae distally. Second pleopod of female (Fig. 6e, f) biramous, basipod with weak rounded extension mesially; endopod

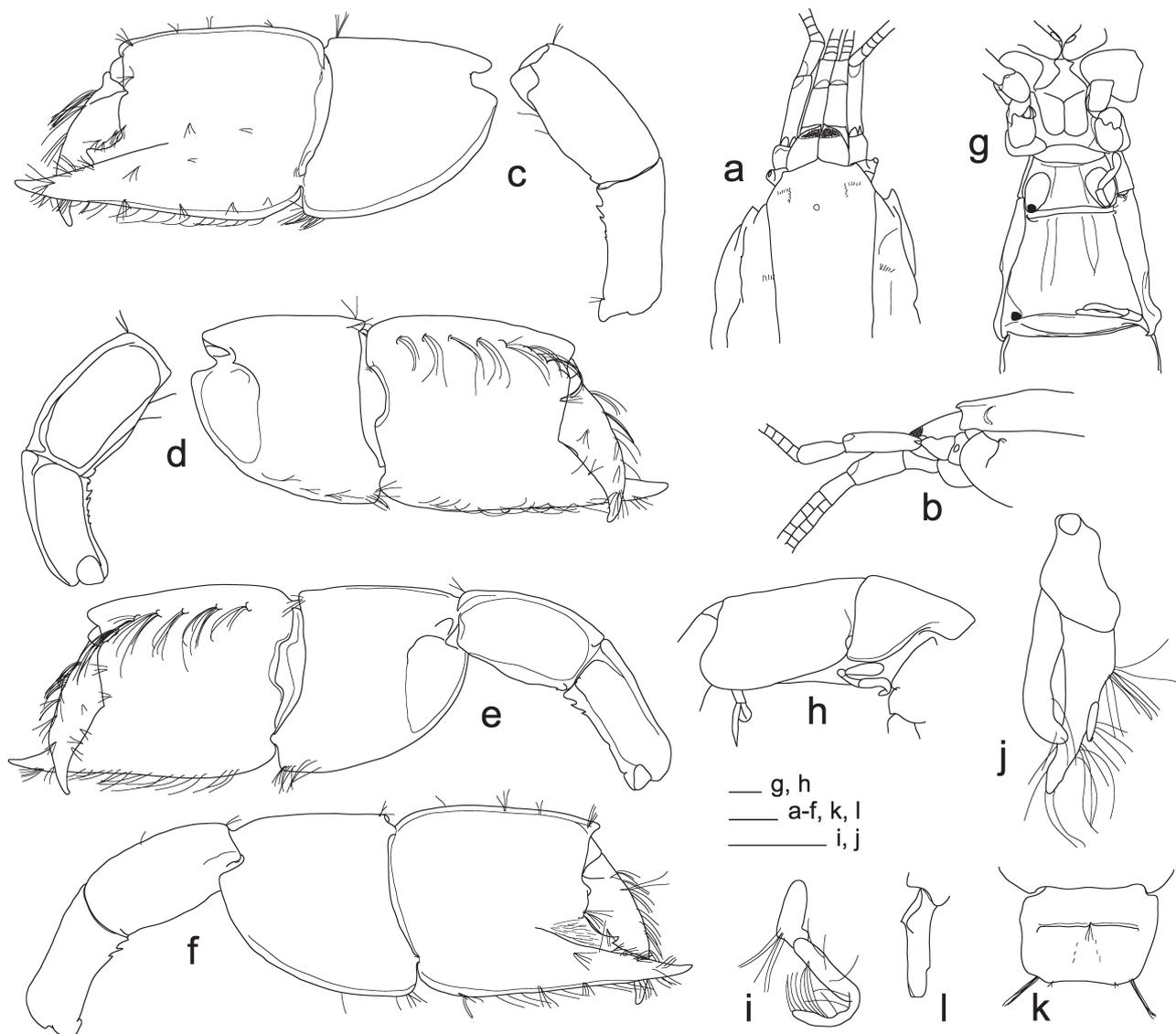


Fig. 8. *Eucalliax aequimana* (Baker, 1907) female (33/8.2) (NHMW 19365): a, front, dorsal view; b, same, lateral view; c, left cheliped, lateral view; d, same, mesial view; e, right cheliped, mesial view; f, same, lateral view; g, thoracic sternite 7 and pleomeres 1–2, ventral view; h, pleomeres 1–2, lateral view; i, first right pleopod, posterior view; j, second right pleopod, anterior view; k, telson, dorsal view; l, same, lateral view (setae omitted). Scale bars = 1 mm.

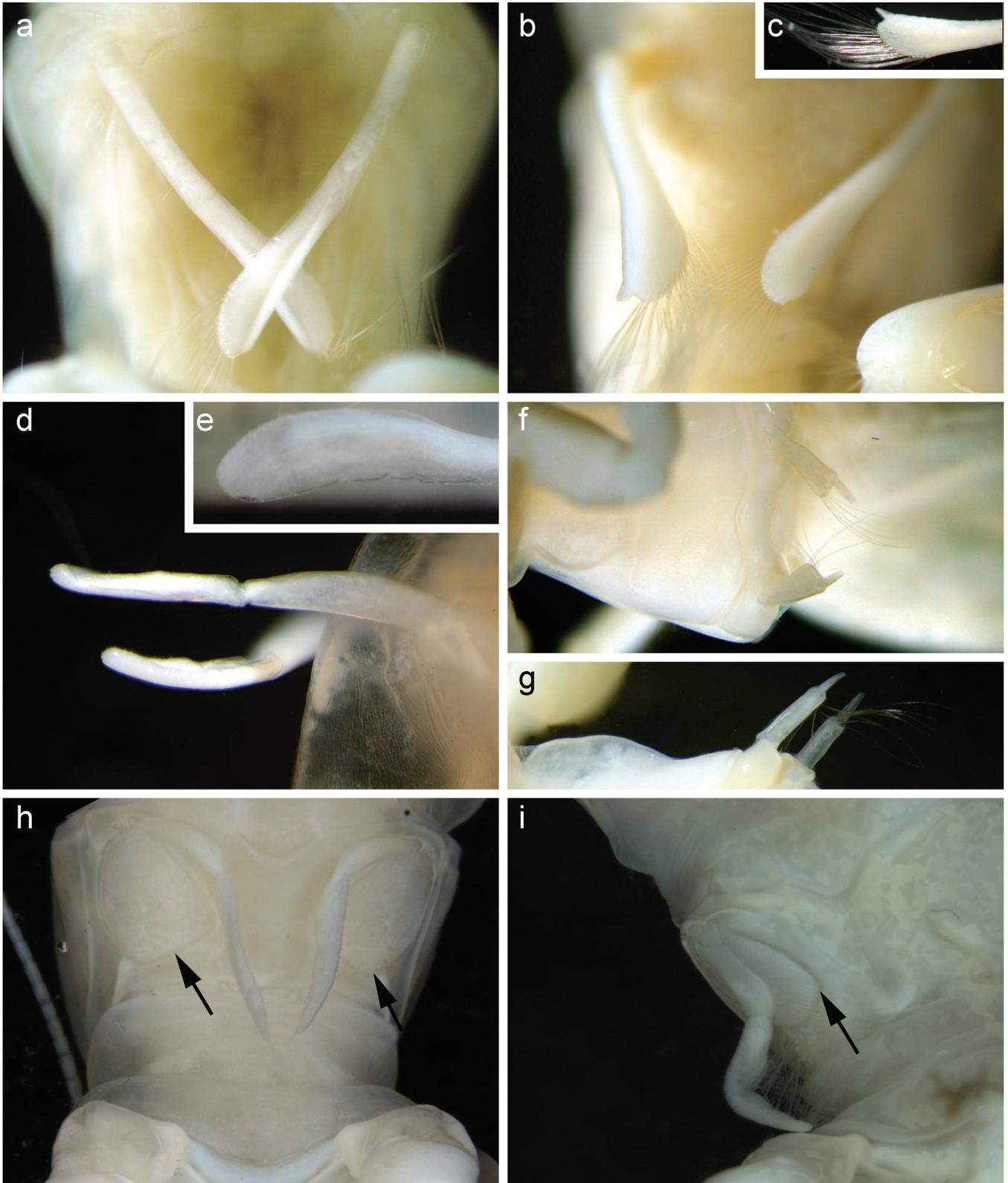


Fig. 9. First pleopods: a–e, *Callianidea typa* H. Milne Edwards, 1837: a, male (35/7.6) (ZRC 2013.1132); b, c, male (40/8.7) (NHMW 25519); d, e, SMF 24918 (holotype of *Callianidea ryukyu* Sakai, 2011); f, g, *Eucalliax inaequimana*, new species: male holotype (40/8.6) (QM W29204); h, i, *Eucalliax aequimana* (Baker, 1907), NMV J59651: h, male (–/11.0); i, female (–/11.3) (photographs: G. Poore); a, b, f, h, i, lateral view; d, e, left Plp1, anterior view; c, left Plp1, posterior view, e, left Plp1, anterior view; all specimens oriented front down or to left; arrows pointing to ovoid plates. Not to scale.



Fig. 10. Fresh specimens: a, *Callianidea typa* H. Milne Edwards, 1837, male (27.8/6.7) (NHMW 25520); b, *Neocallichirus jousseaumei* (Nobili, 1904), male (55/15.2) (NHMW 25517); c, *Corallianassa martensi* (Miers, 1884), male (51/11.4) (ZRC 2013.1139); d, *Paratrypaea bouvieri* (Nobili, 1904), male (26/6.1) (NHMW 25518); e, f, *Eucalliax inaequimana*, new species, holotype male (40/8.7) (QM W29204). Photographs: T. Naruse and H. H. Tan. Not to scale.

triangular, tapering distally, without appendix interna; long setae on mesial margin of basipod and endopod, exopod slightly shorter than endopod.

Variation. Minor variations related to sex and age. Generally, the major and the minor chelipeds of females are smaller than those of males of about the same size (Fig. 7).

Major chelipeds are characterised by the presence of several ridges at the mesial corner of the propodus, above the articulation with the dactylus (Figs. 5a, 6g, k, l). The tooth on the cutting edge of the fixed finger can be low, as in the holotype (in 2 males), or more prominent (in 3 males and 12 females, see Fig. 6j, k). The keel on the lateral surface of the propodus below the fixed finger can be conspicuous (4 females), weak (3 males, 7 females, Fig. 6j) or not detectable (holotype and another large male).

The minor chelipeds are characterised by the prominent rounded corner of the upper propodus margin, above the articulation with the dactylus. The keel on the lateral surface of the propodus below the fixed finger is present in all

individuals examined. A low tooth on the cutting edge of fixed finger is present only in the holotype, lacking in all other specimens.

Twelve individuals (3 males, 9 females) have the major cheliped on the right side, seven (2 males, 5 females) on the left side.

Size. Holotype: tl ~40 mm, cl 8.6 mm; female allotype: tl ~36 mm, in cl 8.1 mm; paratypes: tl range 22 to 44 mm, cl range 6.6 to 9.1 mm; embryos measuring between 570 μ m and 710 \times 1000 μ m.

Colour. Pale, carapace, first, third and sixth pleomeres and tailfan white, second pleomere translucent, chelipeds hyaline-white.

Distribution range. Presently known from the type locality, Cocos (Keeling) Islands, and Panglao, Bohol, the Philippines.

Habitat. Intertidal and shallow subtidal, in burrows in seagrass beds.

Etymology. The new species' name *inaequimana* is a combination of Latin words, "in", meaning not, and "aequimana", meaning equal hands, derived from its difference from and at the same time resemblance with its congener *Eucalliax aequimana* (see below); the name is used as an adjective.

Remarks. Seven genera have been described so far in the callianassid subfamily Eucalliinae Manning & Felder, 1991: *Calliax* de Saint Laurent, 1973, *Eucalliax* Manning & Felder, 1991 (type species), *Paraglypturus* Türkay & Sakai, 1995, *Calliaxina* Ngoc-Ho, 2003, *Andamanacalliax* Sakai, 2011, *Eucalliixiopsis* Sakai, 2011, and *Pseudocalliax* Sakai, 2011. Sakai (1999, 2005) synonymised *Eucalliax* with *Calliax* and also did not recognise *Calliaxina* (Sakai, 2005). However, both genera were recognised by this author later in a new sense (Sakai, 2011): *Eucalliax* was restricted to *E. quadracuta* (Biffar, 1970), whilst *Calliaxina* was characterised by the presence of a cardiac suture. Thus, in Sakai's (2011) classification, five genera are monospecific (including *Eucalliax*), two species are placed in *Calliax*, while nine morphologically rather heterogenous species are placed in *Calliaxina*. However, here the generic concepts and arrangements of Manning & Felder (1991), Ngoc-Ho (2003) and Poore (2013) are followed rather than that of Sakai (2011).

Eucalliax inaequimana, new species, resembles *E. aequimana* (Baker, 1907) in having a transverse carina on the telson, a similar front of the carapace, and the shape of the chelipeds. However, the new species differs from *E. aequimana* by:

- 1) the configuration of the first male pleopods, which consist of one long proximal and one short and slender, distal article (vs. uniramous, biarticulate, with distal article medially lobed and twice as long as proximal article in *E. aequimana*; cf. Poore & Griffin, 1979: 247, fig. 13j; G. C. B. Poore, pers. comm. May 2013; Fig. 9h).
- 2) the absence of appendices internae on female second pleopods (vs. their presence in *E. aequimana*; cf. Poore & Griffin, 1979: fig. 13h; Fig. 8j).
- 3) the absence of conspicuous ovoid plates of thickened integument on the first pleomere, anterior to insertion of the first pleopods, in both males and females (vs. with these ovoid plates in both sexes in *E. aequimana*; G. C. B. Poore, pers. comm. May 2013; Figs. 8g, h, 9h, i).
- 4) the chelipeds unequal in size and dissimilar in shape in both sexes, and with several semicircular ridges lateral to upper keel near articulation with dactylus in major cheliped (vs. equal and similar in both sexes, and without ridges lateral to upper keel near articulation with dactylus in major cheliped in *E. aequimana*; cf. Poore & Griffin, 1979: 247, fig. 12d, j, l; Figs. 7, 8c–f).
- 5) the lateral projections of the carapace exceeding rostrum (vs. shorter or as long as rostrum in *E. aequimana*; cf. Poore & Griffin, 1979: fig. 12a, i, k; Fig. 8a).

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