

Species of the Lophogastrid Genera *Lophogaster* M. Sars, 1857 and *Paralophogaster* Hansen, 1910 (Crustacea: Lophogastrida: Lophogastridae) Collected from the West Pacific and Eastern Indian Oceans

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Abstract Specimens of the marine crustacean genera *Lophogaster* M. Sars, 1857 and *Paralophogaster* Hansen, 1910 (Lophogastrida, Lophogastridae) collected from the West Pacific Ocean including its marginal seas as well as the eastern part of the Indian Ocean were examined. Five species of *Lophogaster* and two species of *Paralophogaster* were identified in this study, and they are taxonomically discussed and illustrated. Keys to the Indo-West Pacific species of *Lophogaster* and all the known species of *Paralophogaster* are provided.

Key words: Crustacea, *Lophogaster*, *Paralophogaster*, taxonomy, marine bio-diversity, Indo-West Pacific.

Introduction

Members of the lophogastrid crustacean genera *Lophogaster* M. Sars, 1857 and *Paralophogaster* Hansen, 1910 (Peracarida, Lophogastrida, Lophogastridae) are widely distributed in the tropical to boreal waters across the globe and in depths from the shallow to bathyal zones (cf., Müller, 1993).

These animal groups are well-defined in morphology at the generic level. However, it is often hard to speciate individuals definitely owing to a rather broad range of intra-specific variations, ontogenetic changes as well as sexual dimorphisms in some species. In addition, members of these genera exhibit lesser inter-specific differences (e.g., Fage, 1941, 1942; O. S. Tattersall, 1960; Casanova, 1993, 1996). To date, 23 species of *Lophogaster* and 10 species of *Paralophogaster* are recorded from the oceans of the world

(WoRMS, accessed in March 2024).

Our knowledge on these animal groups has undoubtedly been concentrated in eastern Asia, in particular the South-east Asian waters and its neighbouring regions (see Yolanda *et al.*, 2023a, b), although it still remains sporadic and fragmentary in the North-western Pacific including the waters around Japan (cf., W. M. Tattersall, 1951; Murano, 1970; Liu and Wang, 2000; Fukuoka, 2009).

To address this information gap, this paper aims to report species of *Lophogaster* and *Paralophogaster* collected over the decades from the West Pacific and the eastern part of the Indian Oceans.

Materials and Methods

The materials used in this study have multiple origins, majority of which had been collected by the second author (MM) during his on board surveys over decades, including those gathered from the research cruises by the R/Vs “*Hakuho-Maru*”

(KH) and “*Tansei-Marui*” (KT) of the Ocean Research Institute (ORI), at that time in the University of Tokyo. In addition, a few materials were obtained by the first author (YH).

The samples were basically fixed with 5–10% formalin sea water immediately after samplings, and then mysids were subsequently sorted out and preserved until laboratory examinations. The studied specimens were finally transferred into 70% ethanol: hence, they are not suitable for DNA analyses. Moreover, most specimens were more or less damaged during samplings.

Carapace length (cl in mm) is given to indicate the standard size of specimens by measuring the length between the orbital margin and the postero-median margin.

The materials used in this paper are deposited in the National Museum of Nature and Science at Tsukuba, Japan (NSMT-Cr).

Other abbreviations used in the article are; IKMT, Isaacs-Kidd Midwater Trawl; ind(s), individual(s); juv(s), juvenile(s); ovig, ovigerous.

Taxonomic Accounts

Family Lophogastridae G. O. Sars, 1870

Genus *Lophogaster* M. Sars, 1857

Lophogaster intermedius Hansen, 1910

(Fig. 1)

Lophogaster intermedius Hansen, 1910: 14, pl. 1, fig. 1; W.M. Tattersall, 1922: 448; Fage, 1942: 31, fig. 20; O. S. Tattersall, 1960: 534, fig. 2; Băcescu, 1985: 357, fig. 1; Casanova, 1996: 138, fig. 6a–d; — 1997: 96, fig. 2f; Fukuoka & Murano, 2002: 55; Yolanda *et al.*, 2023a: 203; —, 2023b: 418.

Lophogaster hawaiiensis: Wang and Liu, 1994: 62; — 1997: 195; Liu and Wang, 2000: 59, fig. 1.

?*Lophogaster typicus*: Ortmann, 1905: 967.

?*Lophogaster hawaiiensis* Fage, 1940: 325: — 1942: 30, figs. 19, 24a, 25b; O. S. Tattersall, 1960: 537, fig. 4.

Not *Lophogaster intermedius*: W. M. Tattersall, 1951: 20, fig. 1c (= *L. japonicus* W. M. Tattersall, 1951).

Material examined. **Central Pacific.** 2 males (cl. 3.5, 3.6 mm), 1 juv. (cl. 2.2 mm), 1 female (cl. 8.8 mm), KH-74-2, St. 20, 28°07.3'N 178°25.0'W–28°10.2'N 178°35.0'W, 10 June 1974, IKMT, ca. 1200–0 m, coll. M. Murano

(NSMT-Cr 32872); —1 male (cl. 4.5 mm), KH-74-2, St. 21-1, 28°15.0'N 178°38.8'W–28°20.2'N 179°28.7'W, 11 June 1974, IKMT, ca. 1200–0 m, coll. M. Murano (NSMT-Cr 32873).

Sahul Shelf. 2 juvs (cl. 1.3, 1.4 mm) (id tentative), KH-72-1, St. 30, 12°24.8'S 128°00.1'E–12°24.8'S 128°00.2'E, June 25 1972, inner net of 3 m Beam Trawl, 115–115 m, coll. M. Murano (NSMT-Cr 32874).

Diagnosis. Body integument somewhat weakly calcified.

Carapace (Fig. 1a, b) feebly granulated on dorsal and dorso-lateral surfaces; rostral plate developed, covering basal 2 segments of antennular peduncle and eye-stalk, anterior part slightly narrower than basal part, and anterior margin distinctly concave; antero-lateral tooth well developed, gently curving inwards; rostral process rather long, slightly curving upwards, apex falling just short of anterior tooth of antennal scale; post-ocular process absent; dorsal median carina on posterior part indistinct or bluntly ridged; postero-lateral tooth (= alar spine) moderately long, directed slightly upwards.

Abdomen (Fig. 1c) with ventral median tooth on first 5 somites, decreasing its height posteriorly; sixth somite sub-equal in length to fifth, with very short postero-lateral tooth; pleura on fourth and fifth somites ending in small spine but those on first 3 somites rounded, without tooth or spine.

Telson (Fig. 1c, d) about 2.5 times as long as sixth abdominal somite, with obtuse dorsal median tubercle in basal part, armed laterally with single, or rarely 2 setal-spines on either side, in addition to ordinary 2 distal pairs, penultimate pair of which close to terminal pair, less than half length of longest terminal pair; posterior plate weakly produced, bearing 4–6 short spinules and possible 1 pair of plumose setae.

Uropod (Fig. 1c, d) with both rami sub-equal in length, exopod ending laterally in distinct tooth.

Antennular lamina (Fig. 1e) with distal margin almost rounded or weakly advanced lobe, and disto-median part with short triangular process,

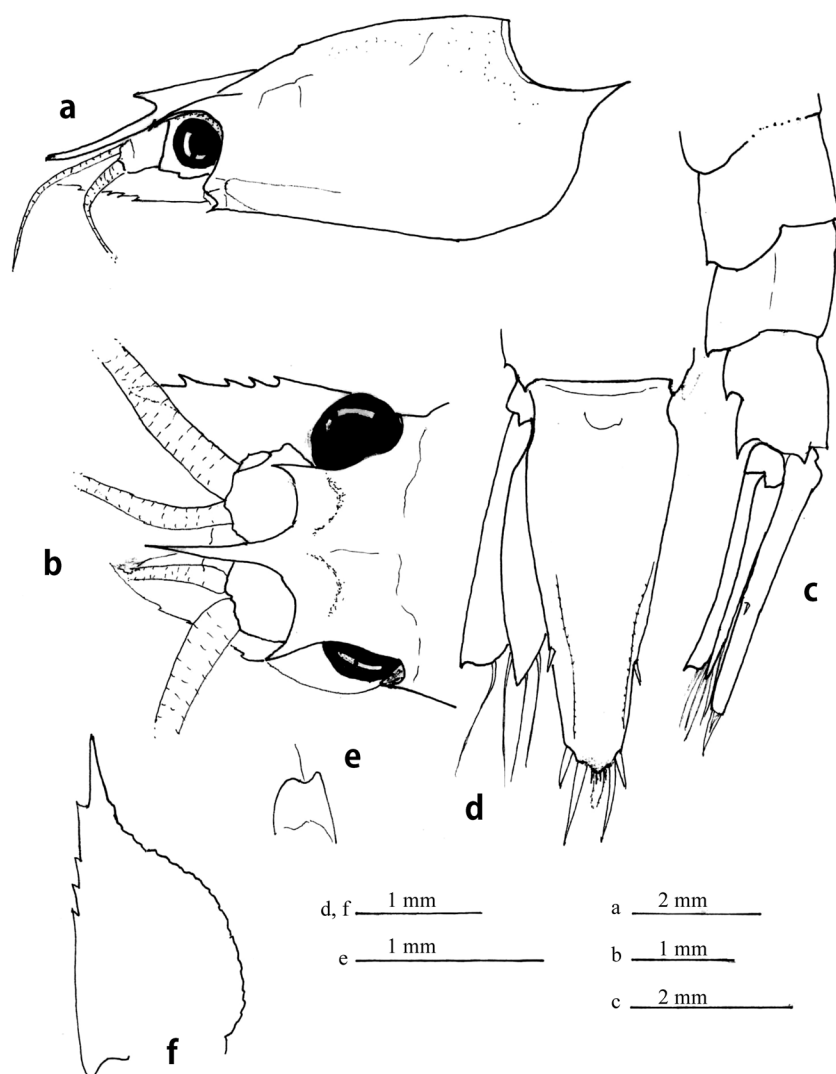


Fig. 1. *Lophogaster intermedius* Hansen, 1910. a–f, male, cl 4.5 mm from Central Pacific (NSMT-Cr 32873): — a, carapace and cephalic appendages, lateral view; b, anterior part of carapace and cephalic appendages, dorsal view; c, posterior part of body, lateral view; d, telson and uropod, dorsal view; e, right antennular lamina, dorsal view; f, right antennal scale, ventral view.

with long seta arising from concaved part.

Antennal scale (Fig. 1f) sub-triangular, broadest in basal part, twice or slightly longer than broad, apical tooth rather long, directed straightly forward or very gently curving inwards, outer margin weakly convex, bearing 4 or 5 teeth increasing in length towards apex on its anterior half.

Remarks. This species was well-documented by Băcescu (1985) and Casanova (1996) (see

also Hansen, 1910; O. S. Tattersall, 1960).

Casanova (1996) mentioned that *L. hawaiiensis* Fage, 1940 could be a junior synonym of *L. intermedius* on the basis of the published data. To date, this might be a common taxonomic concept among the mysid researchers (e.g., WoRMS, accessed in March 2024), although O. S. Tattersall (1960) noted that these two species can be distinguished by several features such as tubercles on the carapace, the rostral length, as well as

the shapes in the anterior margin of the antennular lamina.

So far documented, the form of the antennular lamina referred to *L. intermedius* appears to show some variations in its form, from well produced wide to short triangular or denticular or even undeveloped plain lobe (Hansen, 1910; Băcescu, 1985; Casanova, 1996; this study). However, it deserves future studies in details to verify the taxonomic status for a little-known Hawaiian species based on further specimens by incorporating molecular data.

Distribution. This species is currently believed to be distributed in the western Pacific and its neighbouring regions, under a synonymy over *L. hawaiiensis*, from Hawaii to New Caledonia, and eastern part of the Indian Ocean, through South-east Asian waters.

***Lophogaster japonicus* W. M. Tattersall, 1951**

(Figs. 2, 3)

Lophogaster typicus: Ortmann, 1906: 23 (in part, not M. Sars, 1857).

Lophogaster japonicus W. M. Tattersall, 1951: 19, figs. 1b, 2a; Murano, 1970: 3, fig. 1a–d; Saitoh and Kajihara, 2002, figs. 2a, 3; Fukuoka, 2009: 406.

Lophogaster pacificus: O. S. Tattersall, 1960: 534, fig. 3; Băcescu, 1981: 265, figs. 1c–i, 2a–i; — 1991: 88 (at least in part, not Fage, 1942).

Material examined. **West Pacific. North-east-**

ern Japan: off Kesen-numa; 2 males (cl 7.0, 7.0 mm), 1 ovig. female (cl 7.7 mm), 38°29.8'N 141°41.0'E, 144–0 m, 25 Apr 1964, coll. M. Murano (NSMT-Cr 32875). **Central Japan: off Kashima;** 5 ovig. females (cl 7.2–8.0 mm), 37°40'N, 141°05'E, 28–27 m, trawl, 24 Nov 1991, coll. M. Tanno (NSMT-Cr 32876): **Suruga Bay;** 1 juv. (cl 2.6 mm), KT-65-9, St. 111-1, 34°30.1'N 138°30.5'E–34°31.2'N 138°33.7'E, 1000–0 m, ORI net, 24 Apr 1965, coll. M. Murano (NSMT-Cr 32877); —1 juv. (cl 3.2 mm), KT-69-6, St. 391-1, 34°54.3'N 138°27.8'E–34°54.2'N 138°27.1'E, 66–42 m, bottom-net, 13 May 1969, coll. M. Murano (NSMT-Cr 32878); —1 male (cl 3.2 mm), 12 juvs (cl 1.7–2.8 mm), KT-69-6, St. 392-1, 34°54.0'N 138°27.0'E–34°54.1'N 138°26.3'E, 72 m, bottom-net, 13 May 1969, coll. M. Murano (NSMT-Cr 32879): **Suruga Bay, off Toi;** 2 males (3.5, 4.2 mm), KT-78-18, St. OT-7, 160–145 m, 2 m Beam Trawl, 20 Nov 1978, coll. M. Murano (NSMT-Cr 32880): — **Sagami Bay;** 1 ovig. female (cl 7.0 mm), “Shinyo-Marui”, St. 2, 34°31.35'N 139°25.39'E, 126–121 m, dredge, 17 Oct 1991, coll. M. Murano (NSMT-Cr 32881).

Diagnosis. Integument of body (Fig. 2) somewhat calcified.

Carapace (Figs. 2, 3a–c) with small tubercles or processes of different sizes and shapes scattered on dorsal and dorso-lateral surfaces; stout

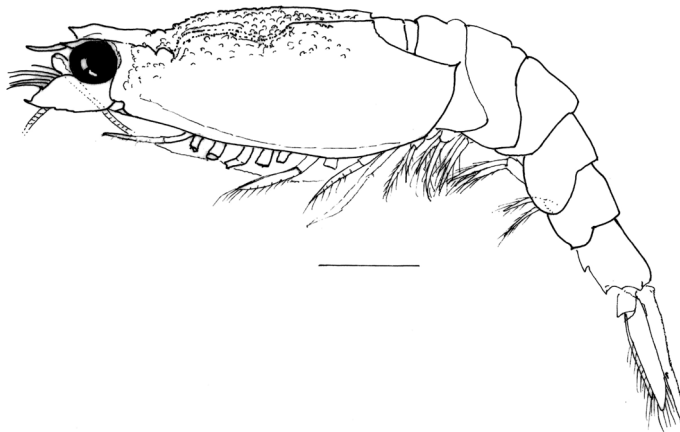


Fig. 2. *Lophogaster japonicus* W. M. Tattersall, 1951, male, cl 8.0 mm from north-western Pacific off Japan (NSMT-Cr 32876). Scale = 3 mm.

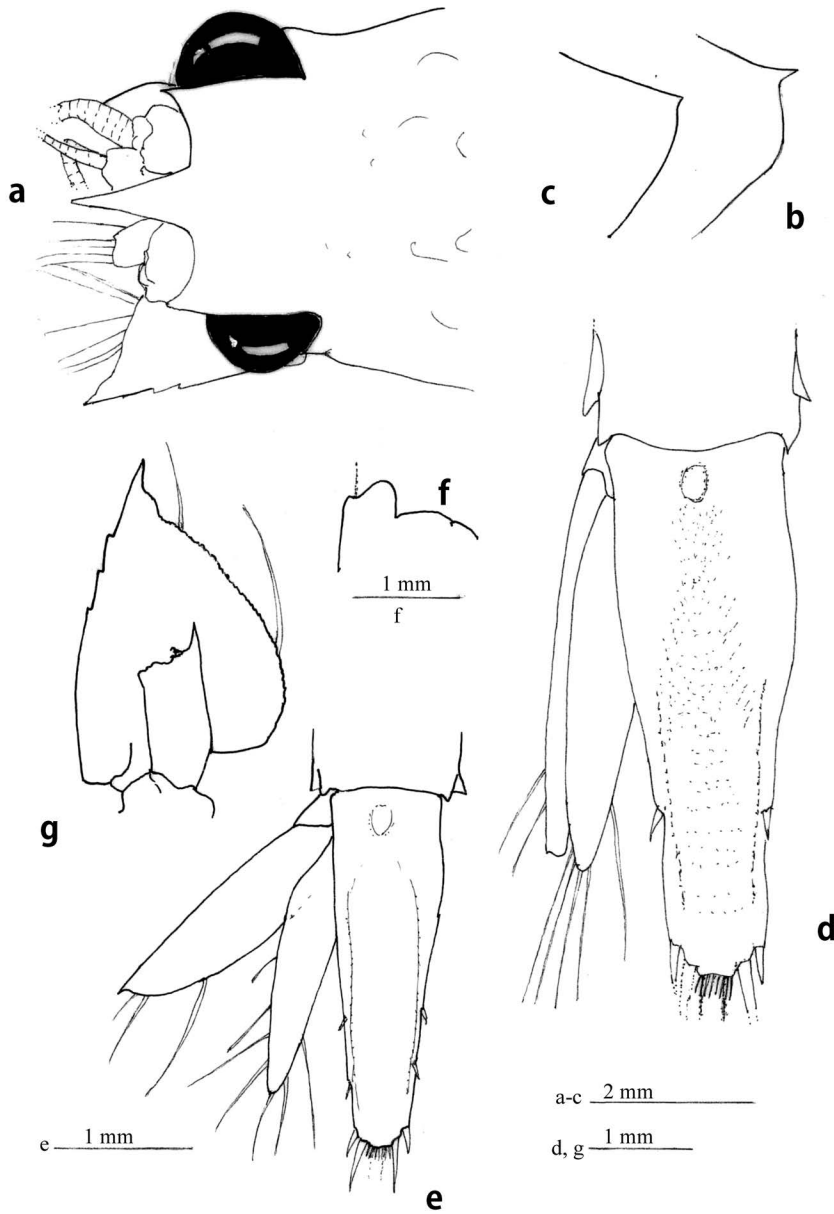


Fig. 3. *Lophogaster japonicus* W. M. Tattersall, 1951. a, b, d, f, g, male, cl 8.0mm from north-western Pacific off Japan (NSMT-Cr 32876), c, male, cl 3.2 mm from Suruga Bay, Central Japan (NSMT-Cr 32879), and e, male, cl 7.0mm from north-western Pacific off Japan ((NSMT-Cr 32875): — a, anterior part of carapace and cephalic appendages, dorsal view; b, c, postero-lateral part of carapace (alar spine), lateral view; d, e, telson and uropod, dorsal view; f, right antennular lamina, dorsal view; g, right antennal scale, ventral view.

post-orbital processes present and median dorsal carina marked on posterior part; rostral plate wide, completely covering eye-stalks as well as basal 2 segments of antennular peduncle, antero-lateral part with short but distinct tooth; rostral

process rather long with slightly upturned apex extending beyond antennular lamina and/or barely reaching tip of antennal scale; postero-lateral part with short tooth (alar spine) directed obliquely upwards, sometimes very feebly

toothed or rarely indistinct.

Abdomen (Fig. 2) in both sexes with sharp ventral median tooth on anterior 5 somites, among which second one is strongest, then decreasing its height posteriorly; pleuron of fifth somite ending in small postero-ventral tooth; sixth somite about 1.5 times as long as fifth, its ventral margin with strong tooth at mid-length as in postero-ventral part.

Telson (Figs. 2, 3d, e) about twice length of sixth abdominal somite, marked median dorsal tubercle present on basal part, dorsal surface slightly sulcate; lateral margin commonly with 2, rarely single, pairs of setal-spines; posterior margin with original 2 pairs of strong setal-spines; distal lamina between strong terminal setal-spines less produced but broad, bearing 8 small setal-spines and 1 pair of long plumose setae.

Exopod of uropod (Figs. 2, 3d, e) slightly shorter than endopod, outer margin smooth and naked, ending in tiny process; endopod extending well beyond posterior lateral setal-spines of telson.

Antennular lamina (Fig. 3f) with anterior margin providing short projection in median part together with widely rounded major projection, thus forming convexity and 1 long seta arising from concaved part between small and large projections.

Antennal scale (Fig. 3g) sub-triangular in general shape, about 1.5 times as long as broad, with strong distal tooth slightly curving inwards, and weakly convex outer margin bearing 2 or 3 obtuse denticles on anterior half.

Remarks. Tattersall (1960) considered that *Lophogaster japonicus* could be a junior synonym of *L. pacificus*. Contrary to this, Murano (1970) pointed out that *L. japonicus* is a good species, and it can be distinguishable from *L. pacificus* in the shapes of the antennular lamina, antennal scale, and rostral length.

In addition to these points, as briefly noted by Murano (1970), *L. japonicus* has a relatively short uropod and the carapace is armed with slightly low and obtuse tubercles when compared with those of *L. pacificus*. Unfortunately,

Băcescu (1981, 1985, 1991) was unaware about the paper by Murano (1970), while Casanova (1996) regarded *L. japonicus* to be a valid species.

Although *L. japonicus* is little-known for its morphological features, this species is remarkable among the members within the genus in having a sub-triangular antennal scale with two or three obtuse denticles on its outer margin. In addition, this species is characterised by having a combination of following features: antennular lamina with anterior margin with widely rounded major protrusion together with inner short projection; carapace with post-ocular process and numerous tubercles on dorsal surface as well as somewhat short postero-lateral spine; telson with one or two pairs of setal-spines on its lateral margin.

One ovigerous female (NSMT-Cr 32881) and small specimens (NSMT-Cr 32877, -32878) devoid of a marked postero-lateral carapace tooth (alar spine); nevertheless other features agreed well with those of this species.

Distribution. This species is recorded with certainty from the western North Pacific, and commonly captured off the Pacific coasts of Japan, and in depths from 50–300 m (W. M. Tattersall, 1951; Murano, 1970; Saitoh and Kajihara, 2002; Fukuoka, 2009).

Lophogaster manilae Băcescu, 1985

(Fig. 4)

Lophogaster sp.? sensu W. M. Tattersall, 1951: 20, fig. 1d.

Lophogaster sp. A sensu O. S. Tattersall, 1960: 542, fig. 6.

Lophogaster sp. sensu Murano, 1970: 3, fig. 2.

Lophogaster sp. sensu Wang and Liu, 1997: 195; Liu and Wang, 2000: 63: fig. 3.

Lophogaster manilae Băcescu, 1985: 360, fig. 2a–n; Casanova, 1993: 37, fig. 2; — 1996: 140, fig. 6e–h; Yolanda *et al.*, 2023b, 418.

Material examined. **West Pacific. Central Japan: Suruga Bay;** 1 juv. (cl 1.2 mm), KT-69-6, St. 363-5, 34°50.0'N, 138°37.9'E–34°49.4'N 138°37.7'E, 380–300 m, ORI net, horizontal tow, 10 May 1969, coll. M. Murano (NSMT-Cr 32882); —1 male (cl 4.8 mm), damaged slightly,

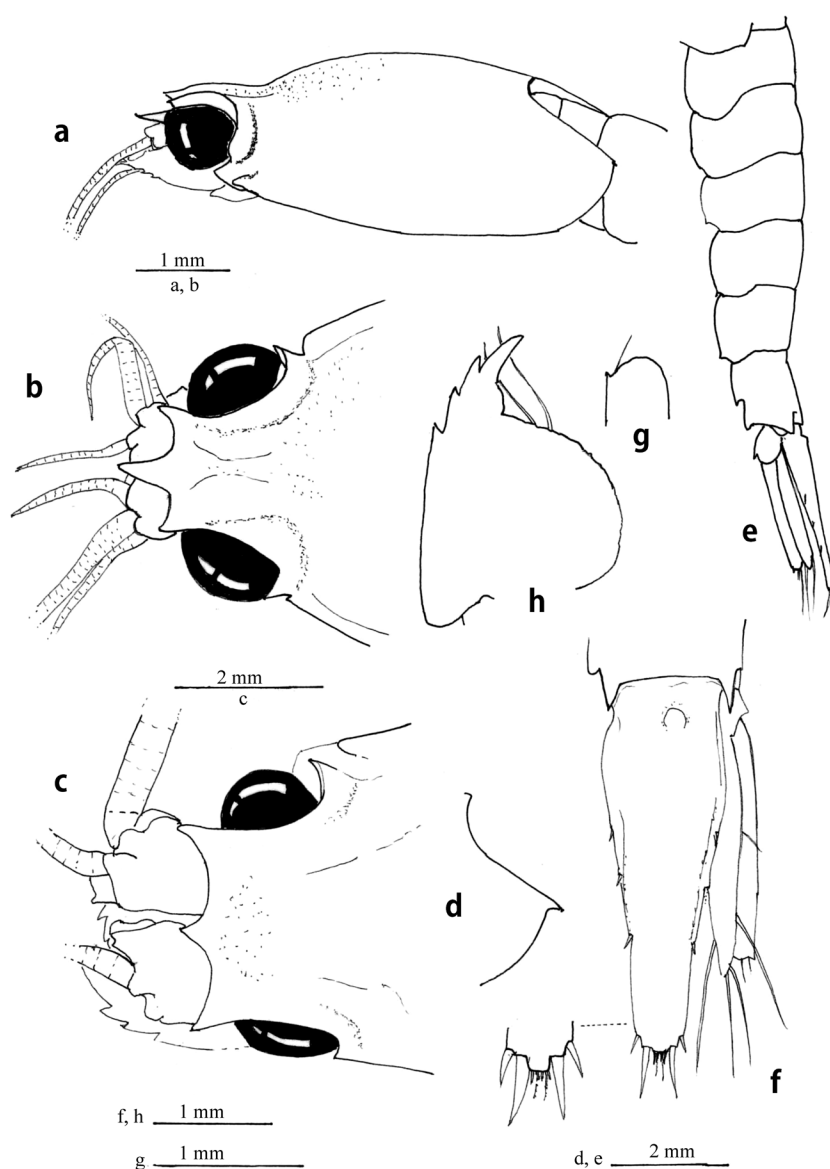


Fig. 4. *Lophogaster manilae* Băcescu, 1985. a, b, e–h, female, cl 4.8 mm from Sulu Sea (NSMT-Cr 32886), c, d, male, cl 4.8 mm from Suruga Bay, Japan (NSMT-Cr 32883): — a, carapace and cephalic appendages, lateral view; b, anterior part of carapace and cephalic appendages, dorsal view; c, same; d, postero-lateral part (= alar spine) of carapace, lateral view; e, posterior part of body, lateral view; f, telson and uropod, dorsal view; g, left antennular lamina, dorsal view; h, right antennal scale, ventral view.

KT-69-6, St. 389-6, 80–0m, IKMT, 12 May 1969, coll. M. Murano (NSMT-Cr 32883): — **Suruga Bay, off Toi**; 1 female (cl 5.5 mm) damaged slightly, KT-76-16, St. T2, 300–294m, 2 m Beam Trawl, 23 Sept 1976, coll. M. Murano (NSMT-Cr 32884). **East China Sea**. 5 males (cl

4.0–5.8 mm), 7 females (cl 4.2–5.6 mm), 51 juvs (cl 2.7–3.0 mm), KH-74-3, St. B11-1, 31°15.7'N 128°20.6'E–31°17.5'N 128°22.1'E, 369–364m, 3 m Beam Trawl, 5 Aug 1974, coll. M. Murano (NSMT-Cr 32885). **Sulu Sea**, 1 female (cl 4.8 mm), KH-72-1, St. 12, 08°19.0'N

118°09.1'E–08°18.7'N 118°08.5'E, 500–495 m, inner net of 3 m Beam Trawl, 27 May 1972, coll. M. Murano (NSMT-Cr 32886).

Diagnosis. Body integument somewhat calcified.

Carapace (Fig. 4a–d) with several to numerous fine tubercles or processes on anterior part, but smooth on posterior part; rostral plate well developed, covering entire basal 2 segments of antennular peduncle and part of cornea of eye; lateral margin ending in marked disto-lateral process, directed slightly outwards, or sometimes slightly curving inwards, posterior margin evenly concave; male rostral process (Fig. 4c) short, as long as antero-lateral processes, while female rostral process (Fig. 4a, b) much longer than in male, its upturned apex reaching as far as end of antennular lamina; post-ocular process/spine absent; posterior median part rounded or weakly ridged; postero-lateral part with short process (alar spine), directed slightly downwards.

Abdomen (Fig. 4e) with ventral median spine or tooth on first 5 somites decreasing its height posteriorly; sixth somite 1.0–1.3 times as long as fifth, with moderately long postero-lateral process; pleura on anterior 5 somites angulated or toothed at postero-ventral part, and generally becoming sharper posteriorly.

Telson (Fig. 4e, f) 1.8–2.2 times as long as sixth abdominal somite, with obtusely rounded ridge in basal part of dorsal surface; armed laterally with 2 or 3 setal-spines in addition to possible ordinary 2 distal pairs, penultimate one moderately long, reaching mid-length of terminal one, terminal plate well noticeable, bearing 4 small spinules and pair of plumose setae.

Exopod of uropod (Fig. 4e, f) slightly shorter than endopod, outer margin smooth and naked, ending distally in process.

Antennular lamina (Fig. 4g) with anteriorly produced rounded lobe and small process in antero-median part and single long seta arising from concaved part between 2 projections.

Antennal scale (Fig. 4h) bell-shaped or nearly rounded, 1.3–1.6 times as long as broad, outer margin weakly convex, armed on anterior 2/5

with 3 or 4 teeth, becoming stouter anteriorly, terminal tooth strongly curving inwards.

Remarks. This species shows marked sexual dimorphisms in the rostral plate and rostral process as females have a much longer rostral plate as well as longer rostral process than those of males (see also Casanova, 1993). In addition, the postero-lateral tooth on the carapace (= alar spine) shows variations at some extent, and one female in this study showed an angulation in the identical part instead of an ordinal toothed process.

Distribution. This species has been collected in the western Pacific, from Japan to New Caledonia and the Wallis and Futuna Islands.

Lophogaster pacificus Fage, 1940

(Fig. 5)

Lophogaster typicus: Ortmann, 1906: 967 (in part, not M. Sars, 1857)

Lophogaster pacificus Fage, 1940: 324; — 1942: 29, figs. 18a–d, 24b, 25a, 26, 27; Murano, 1970: 3, fig. 1e–i; Băcescu, 1985: 363, fig. 1a–f; — 1991: 88 (part); Wang and Liu, 1994: 64, fig. 2; — 1997: 195; Liu and Wang, 2000: 61, fig. 2.

Not *Lophogaster pacificus*: O. S. Tattersall, 1960: 534, fig. 3; Băcescu, 1981: 265, figs. 1c–i, 2a–i; — 1991: 88 (at least in part) (= *L. japonicus* W. M. Tattersall, 1951)

Material examined. **East China Sea.** 1 male (cl 4.2 mm), 2 females (cl 6.0, 6.2 mm), 1 juv. (cl 2.8 mm), KH-74-3, St. B13, 31°36.9'N 127°06.5'E–31°38.5'N 127°08.8'E, 110–110 m, inner net of 3 m Beam Trawl, 6 Aug 1974, coll. M. Murano (NSMT-Cr 32887). **Sahul Shelf.** 1 juv. (cl 1.2 mm) (id tentative), KH-72-1, St. 29, 12°17.3'S 129°40.9'E–12°17.2'S 129°41.8'E, 52–49 m, inner net of 3 m Beam Trawl, 24 June 1972, coll. M. Murano (NSMT-Cr 32888).

Diagnosis. Body somewhat calcified.

Carapace (Fig. 5a, b) with distinct post-ocular processes as well as numerous tubercles of different sizes and shapes scattered on dorsal surface; rostral plate slightly narrowing anteriorly, small part of eye-stalk exposed but completely covering basal 2 segments of antennular pedun-

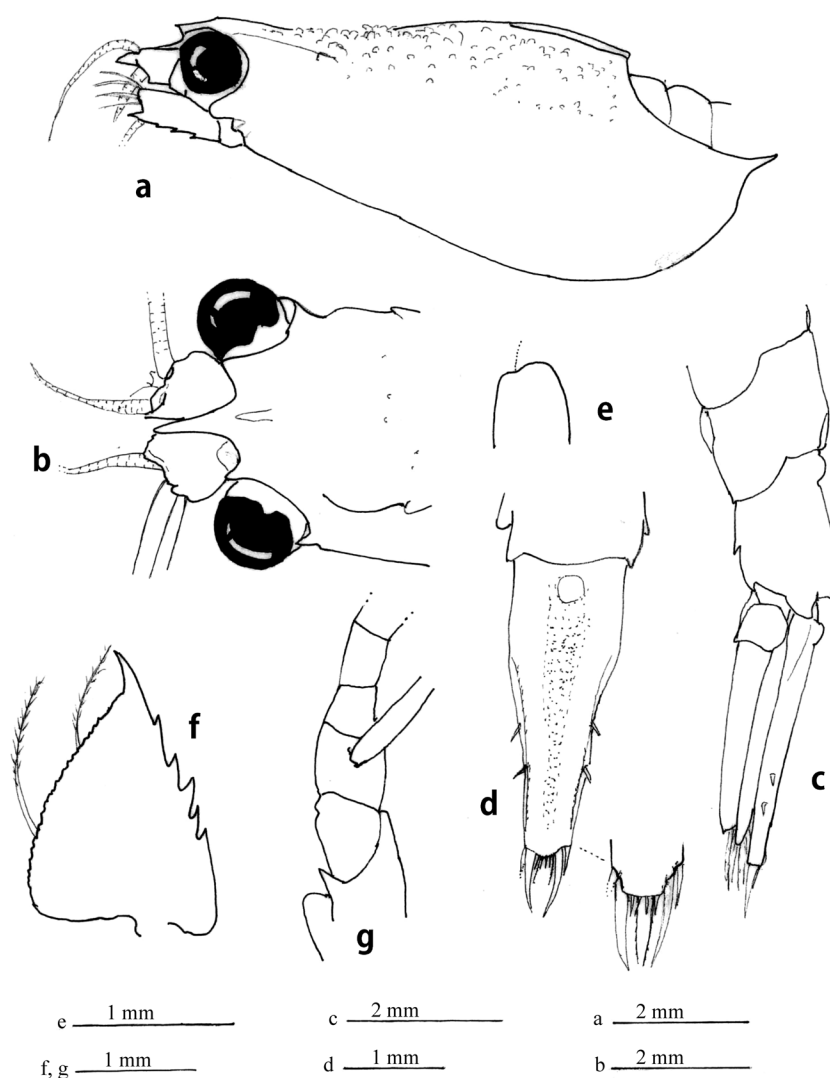


Fig. 5. *Lophogaster pacificus* Fage, 1940. Female, cl 6.2 mm from East China Sea (NSMT-Cr 32887): — a, carapace and cephalic appendages, lateral view; b, anterior part of carapace and cephalic appendages, dorsal view; c, posterior part of body, lateral view; d, telson, dorsal view; e, left antennular lamina, dorsal view; f, left antennal scale, ventral view; g, basal part of left seventh thoracopod.

cle in dorsal view, with sharp tooth at antero-lateral corner; rostral process weakly curving upwards, barely reaching anterior end of antennular peduncle; low carina running on branchial region of carapace; postero-lateral tooth (alar spine) moderately long, directed obliquely upwards.

Abdomen (Fig. 5c) in both sexes with sharp ventral process on anterior 5 somites, decreasing its height posteriorly; postero-ventral corner of

fifth pleuron angulate or with minute process; sixth somite about 1.3 times as long as fifth.

Telson (Fig. 5c, d) about 1.8 times as long as sixth abdominal somite, with somewhat low median tubercle in basal part, dorsal surface slightly sulcate posteriorly; lateral margin armed commonly with 2 pairs of setal-spines in addition to ordinary 2 distal pairs; median part of posterior margin weakly produced, bearing 4 short setal-spines and 2 plumose setae.

Exopod of uropod (Fig. 5c) slightly shorter than endopod, outer margin smooth, ending in triangular process; endopod reaching near mid-length between distal end and posterior pair of lateral setal-spines of telson.

Antennular lamina (Fig. 5e) with widely rounded major lobe but no projection at inner distal corner forming obtuse shoulder, with single seta near inner base of major lobe.

Antennal scale (Fig. 5f) sub-triangular in general form, apical tooth slightly curving inwards; outer margin weakly convex, bearing 5, occasionally 4, denticles on distal two-thirds.

Endopod of seventh thoracopod (Fig. 5g) with short tooth on pre-coxa.

Remarks. As aforementioned, several early researchers considered *Lophogaster pacificus* to be a senior synonym over *L. japonicus*, but the difference between these two species was explicitly discussed by Murano (1970) (see "Remarks" under *L. japonicus*).

In addition to the previous observations, it appears that this species has a relatively longer postero-lateral carapace tooth (= alar spine) as compared with that of *L. japonicus*.

Distribution. This species has been collected from the tropical to temperate regions of the western Pacific, including its marginal seas.

Lophogaster schmidtii Fage, 1940

(Fig. 6)

Lophogaster schmidtii Fage, 1940: 326; — 1942: 34, figs. 23, 24d, 25e; O. S. Tattersall, 1955: 45, fig. 3a–f; — 1960: 539, fig. 5; Yolanda *et al.*, 2023b: 419.

Material examined. **Central Pacific.** 1 male (cl 4.2 mm), KH-74-2, St. 20, 28°07.3'N 178°25.0'W–28°10.2'N 178°35.0'W, ca. 1200–0 m, IKMT, 10 June 1974, coll. M. Murano (NSMT-Cr 32889). **Western Pacific.** 3 juvs (cl 3.1–3.3 mm), KH-67-5, St. H14-2, 00°03.9'N 148°39.1'E–00°02.7'N 148°37.3'E, 110 m, ORI net, horizontal tow, 25 Dec 1967, coll. M. Murano (NSMT-Cr 32890); —1 male (cl 3.8 mm), 1 juv. (cl. 2.8 mm), KH-67-5, St. H14-16, 00°17.9'S 148°48.0'E–00°17.2'S 148°50.3'E,

800–0 m, ORI net, oblique tow, 26 Dec 1967, coll. M. Murano (NSMT-Cr 32891); —1 female (cl 5.4 mm), "*Kaiyo-Maru*", T-2, off Okinotorishima Is., 20°23.9'N, 136°16.5'E, 120–0 m, attached on mantle of squid, 22 Sept 1988, coll. M. Murano (NSMT-Cr 32936). **Celebes Sea.** 1 female (cl 5.3 mm), KH-72-1, St. 23-4, 04°41.4'N 122°43.3'E–04°46.2'N 122°45.2'E, 1330–0 m, IKMT, 14 June 1972, coll. M. Murano (NSMT-Cr 32892). **South Pacific.** 1 male (cl. 5.7 mm), KH-69-4, St. H123-1, 10°00.6'S 154°58.6'W–09°59.5'S 154°58.6'W, 270–190 m, ORI net, horizontal tow, 5 Oct 1969, coll. M. Murano (NSMT-Cr 32893); —1 juv. (cl. 1.4 mm) KH-69-4, St. H122-4, 14°48.5'S 155°04.3'W–14°47.5'S 155°04.8'W, 720–590 m, ORI net, horizontal tow, 15 Oct 1969, coll. M. Murano (NSMT-Cr 32894); —1 juv. (cl. 3.0 mm), KH-69-4, St. H123-1, 14°30.0'S 155°18.7'W–14°30.6'S 155°18.1'W, 1580–0 m, ORI net, oblique tow, 16 Oct 1969, coll. M. Murano (NSMT-Cr 32895); —2 juvs (cl 1.1, 1.2 mm), KH-69-4, St. H123-2, 14°30.7'S 155°18.0'W–14°31.2'S 155°17.5'W, 155–105 m, ORI net, horizontal tow, 16 Oct 1969, coll. M. Murano (NSMT-Cr 32896). **Indian Ocean.** 1 male (cl 5.2 mm), KH-72-1, St. 35-3, 11°58.0'S 119°59.0'E–11°51.3'S 119°55.2'E, 1480–0 m, IKMT, 27 June 1972, coll. M. Murano (NSMT-Cr 32897); —1 male (cl 5.3 mm), KH-72-1, St. 37-3, 11°52.5'S 109°59.5'E–11°53.0'S 110°05.0'E, 3000–0 m, IKMT, 30 June 1972, coll. M. Murano (NSMT-Cr 32898); —1 female (cl 7.0 mm), KH-76-5, St. 11, 4°57.3'S, 87°08.1'E–4°59.2'S 87°01.1'E, 870–0 m, ORI net, oblique tow, 23 Jan 1976, coll. M. Murano (NSMT-Cr 32899).

Diagnosis. Body integument somewhat less-calcified, surface rather smooth and basically without distinct tubercles.

Carapace (Fig. 6a, b) with rostral plate well developed, grooved on dorsal part, completely covering basal 2 segments of antennular peduncle and eyes, exposing narrow distal part of cornea, stout tooth in antero-lateral part directed slightly outwards; rostral process moderately long, barely reaching end of antennular peduncle

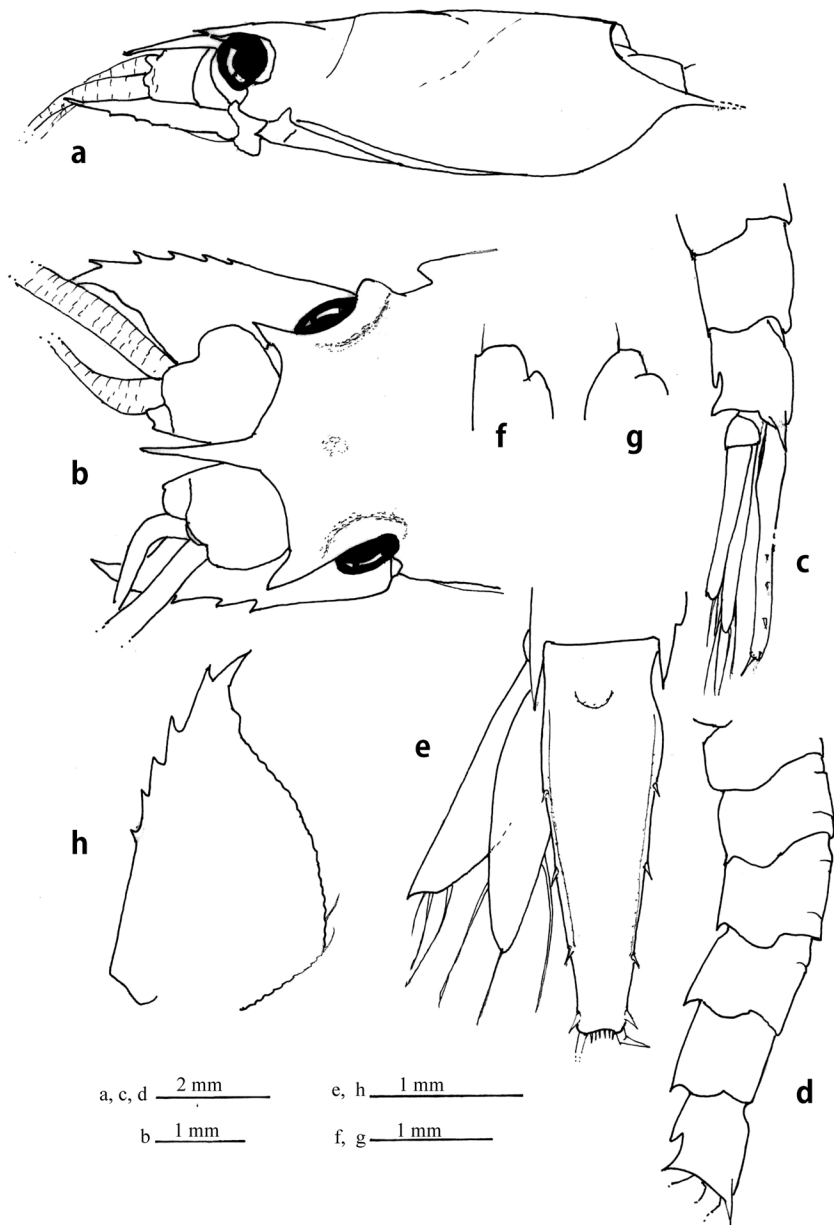


Fig. 6. *Lophogaster schmidtii* Fage, 1940. a–c, e, f, h, male, cl 5.7 mm from South Pacific (NSMT-Cr 32893), d, female, cl 7.0 mm from eastern Indian Ocean (NSMT-Cr 32899), g, female, cl 5.3 mm from Central Pacific (NSMT-Cr 32892): — a, carapace and cephalic appendages, lateral view; b, anterior part of carapace and cephalic appendages, dorsal view; c, posterior part of body, lateral view; d, second to sixth abdominal somites, lateral view; e, telson and uropod, dorsal view; f, g, left antennular lamina, dorsal view; h, right antennal scale, ventral view.

in male, while in females extending well beyond antennular lamina, occasionally extending beyond antennal scale; post-ocular process absent; posterior dorsal median carina noticeably

ridged or sometimes obscure; postero-lateral tooth (alar spine) rather long, directed almost straightly backwards.

Eyes (Fig. 6a, b) rather small, cornea slightly

wider than eye-stalk.

Abdomen (Fig. 6c, d) with median ventral process on anterior 5 somites, decreasing its height posteriorly; sixth somite sub-equal to or slightly longer than fifth, with sharp and long tooth on posterior dorso-lateral part; pleura normally ending in distinct tooth at postero-ventral part except first somite, of which that on second pleuron rarely obtuse.

Telson (Fig. 6c, e) 2.2–2.4 times as long as sixth abdominal somite, dorsal surface slightly sulcate, with feeble dorsal median process in basal part, commonly with 3, rarely 2, small setal-spines on lateral margin in addition to ordinary distal 2 pairs, among latter penultimate pair much smaller than distal pair and arising somewhat apart from terminal pair and barely reaching or falling just short of terminal margin; distal plate very indistinct and posterior margin truncate or weakly sinuous, bearing 9–11 small spines and 1 pair of plumose setae.

Endopod of uropod (Fig. 6c, e) extending slightly beyond last posterior pair of lateral setal-spines of telson; exopod sub-equal in length to endopod, outer margin ending in distinct tooth.

Antennular lamina (Fig. 6f, g) with anterior margin widely rounded and small projection at distal inner part, forming shallow groove, from which part single seta arising, but occasionally distal inner projection absent, merely forming rounded distal corner.

Antennal scale (Fig. 6h) ring-bell shaped, 1.4–1.6 times as long as broad, widest near base owing to marked swollen; outer margin weakly convex or nearly straight in posterior half while slightly convex in anterior half bearing 4 or 5 teeth increasing its size anteriorly; apical tooth distinctly curving inwards.

Remarks. This species is diagnosed by having a combination of several remarkable characters: the carapace shows a rather smooth surfaces, with a well-developed rostral plate possessing a relatively long rostral spine reaching or extending far beyond the antennular peduncle, together with a long postero-lateral tooth (= alar spine); the second to fifth pleura of the abdomen armed with

postero-ventral teeth; and the sixth abdominal somite with a long tooth at the postero-lateral end.

Distribution. *Lophogaster schmidtii* is one of the most abundantly captured species in the present sampling series and probably distributed in common in the tropical waters of the West Pacific and Indian Oceans (see also O. S. Tattersall, 1960; Fage, 1942; Yalanda *et al.*, 2023b).

Genus *Paralophogaster* Hansen, 1910

Paralophogaster glaber Hansen, 1910

(Fig. 7)

Paralophogaster glaber Hansen, 1910: 16, pl. 1, fig. 2a–n; W. M. Tattersall, 1923: 279; — 1951: 22; Băcescu, 1981: 270, fig. 3a–k; — 1991: 92, fig. 2f–h; Casanova, 1993: 44, fig. 7a, b; — 1996: 141; — 1997: 99; Yolanda *et al.*, 2023b: 419; Hernández-Payán *et al.*, 2023: 5.

? *Paralophogaster glaber pacificus* Vereshchaka, 1990: 119, fig. 1.

Material examined. **Western Pacific. Central Japan: Suruga Bay;** 1 female (cl 3.0 mm), KT-65-9, St. 111-1, 34°30.1'N 138°30.5'E–34°31.2'N 138°33.7'E, 1000–0m, ORI net, 24 Apr 1965, coll. M. Murano (NSMT-Cr 32900). **East China Sea.** 2 females (cl 3.0, 3.5 mm), 4 ovig. females (cl 3.0–3.6 mm), KH-74-3, St. B11-1, 31°15.7'N 128°20.6'E–31°17.5'N 128°22.1'E, 364–369m, 3m Beam Trawl, 5 Aug 1974, coll. M. Murano (NSMT-Cr 32901).

Diagnosis. Integument rather fragile.

Carapace (Fig. 7a) with rostral plate of onion-shaped structure in dorsal view, antero-lateral margin slightly convex, leading to short median rostral tooth; pair of short teeth at antero-lateral corner; lateral parts of rostral plate curving upwards, forming weakly elevated rims in lateral aspect; median dorsal tubercle placed just posterior to rostral plate.

Eye (Fig. 7a) large, cornea 1.45–1.55 times as broad as rostral plate.

Antennal scale (Fig. 7a) rather long, extending beyond antennular peduncle by slightly more than 1/3 length of blade, and about 4 times as long as wide; lateral margin nearly straight, bear-

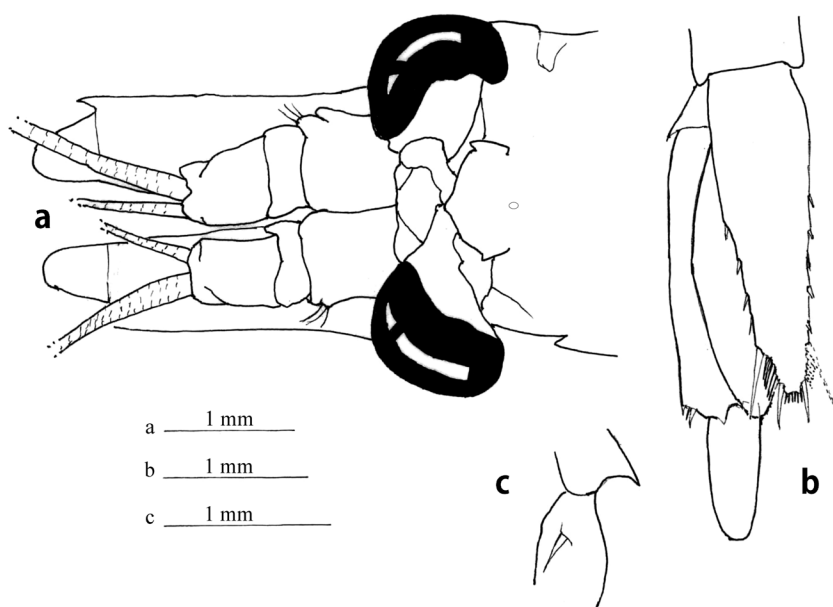


Fig. 7. *Paralophogaster graber* Hansen, 1910. a, b, female, cl 3.0 mm from Suruga Bay, Central Japan (NSMT-Cr 32900), c, ovigerous female, cl 3.6 mm from East China Sea (NSMT-Cr 32901): — a, anterior part of carapace and cephalic appendages, dorsal view; b, telson and uropod, dorsal view; c, basal part of endopod of uropod, ventral view.

ing short tooth falling far short of anterior end of blade; sub-terminal suture present.

Telson (Fig. 7b) as long as or slightly shorter than sixth abdominal somite, noticeably narrowing posteriorly beyond sub-terminal stout setal-spines, bearing 5 or 6 feeble setal-spinules on lateral margin and pair of long sub-terminal spines extending far beyond posterior end of telson, bearing 4 or 5 moderate spines increasing in length posteriorly between these 2 stout spine pairs; postero-median plate noticeable, possessing most probably 5 short spinules and 4 plumose setae.

Uropod (Fig. 7c) with endopod bearing stout ventral setal-spine in basal part.

Remarks. Although Băcescu (1981) (see also Hansen, 1910, Pl. 1, fig. 2b) showed the presence of two stout inner basal spines on the antennal flagellum, only a single spine can be seen in our specimens. In addition, the ventral spine on the endopod of the uropod appears to be less developed as compared with that shown by Băcescu.

Müller (1993) regarded that *Paralophogaster*

glaber pacificus reported by Vereshchaka (1990) from the waters around the Nazka and Sala y Gómez ridges could be a synonym of *P. glaber*. However, as noted by Hernández-Payán (2023), the structure of the telson of the south-eastern Pacific specimens differs from that of the western Pacific population (e.g., Hansen, 1910; W. M. Tattersall, 1951; Băcescu 1981, 1991; Casanova, 1996).

Contrary to this, Hernández-Payán (2023) mentioned that their specimens collected off Chile showed the typical form of the western Pacific population in the identical part.

Thus, the identity of the south-eastern Pacific subspecies of *P. glaber* should be re-assessed in the future studies. Furthermore, a taxonomic review for such eurychoric species is strongly recommended over its geographical scale in order to verify the origin and/or diversification of the local populations.

Distribution. According to the published literature, this species is known to distribute in the Atlantic and Indo-Pacific Oceans (see W.M. Tattersall, 1951; Müller, 1993; Hernández-Payán *et*

al., 2023).

Paralophogaster philippinensis Băcescu, 1981

(Figs. 8, 9)

Paralophogaster philippinensis Băcescu, 1981: 267, figs. 3 m, n, 4a–j: — 1985: 356; Casanova, 1993, 45: figs. 4c–e, 7e, f; — 1996: 143; Saitoh and Kajihara, 2002: 22, fig. 4; Yolanda *et al.*, 2023b: 419.

Material examined. West Pacific. Central Japan: Sagami Bay; 1 juv. (cl 1.5 mm), KT-64-1, St. 3-8, 35°11.5'N 139°15.9'E–35°11.6'N 139°15.6'E, 260–0 m, Larva Net, 22 Jan 1964, coll. M. Murano (NSMT-Cr 32902); — **Suruga Bay, off Matsu-zaki;** 3 males (cl 2.2–3.3 mm), 4 females (cl 3.4–4.0 mm), 2 ovig. females (cl 4.8, 5.0 mm), KT-74-14, St. B3, 144–135 m, 2 m Beam Trawl, 21 Sept 1974, coll. M. Murano (NSMT-Cr 32903); — **Suruga Bay, off Kuno-san;** 2 males (cl 3.0, 3.2 mm), KT-77-7, St. K, 123–81 m, 2 m Beam Trawl, 12 June 1977, coll. M. Murano (NSMT-Cr 32904); — **Suruga Bay, Uchiura-wan;** 1 female (cl 5.5 mm), KT-78-11, St. OT-6(II), 115–108 m, 2 m Beam Trawl, 14 July 1978, coll. M. Murano (NSMT-Cr 32905); — **Suruga Bay, off Toi;** 4 females (cl 3.0–4.0 mm), KT-78-18, St. OT-6, 105–98 m, 2 m Beam Trawl, 20 Nov 1978, coll. M. Murano (NSMT-Cr 32906); — 42 males (cl 2.5–4.0 mm),

40 females (cl 2.7–4.2 mm), 2 ovig. females (cl 4.2, 4.5 mm), 25 juvs & damaged inds (cl 2.4–3.5 mm), KT-78-18, St. OT-7, 160–145 m, 2 m Beam Trawl, 20 Nov 1978, coll. M. Murano (NSMT-Cr 32907); — **Western Japan: off Kochi;** 1 male (cl 3.7 mm), 1 female (cl 4.5 mm), 170 m, 2 June 1983, other details unknown (NSMT-Cr 32908). **Sea of Japan.** 1 female (cl ca 4.0 mm), KH-70-4, St. 137-1, 37°50.7'N 136°41.6'E–37°52.2'N 136°38.8'E, 140–0 m, IKMT, 9 Aug 1970, coll. M. Murano (NSMT-Cr 32909). **East China Sea.** 6 males (cl 2.0–4.0 mm), 4 females (cl 2.5–3.7 mm), 1 ind. (damaged), KH-74-3, St. B13, 31°36.9'N 127°06.5'E–31°38.5'N 127°08.8'E, 110–110 m, 3 m Beam Trawl, 6 Aug 1974, coll. M. Murano (NSMT-Cr 32910).

Diagnosis. Integument of body (Fig. 8) rather fragile.

Carapace (Fig. 9a, b) with rostral plate somewhat pentagonal in dorsal view, not converging posteriorly but running almost parallel to each other; anterior margin feebly convex or nearly straight, leading to short median rostral tooth; pair of short teeth placed antero-lateral corner; lateral parts of rostral plate curving upwards, forming well marked elevated rims in lateral aspect; small median dorsal tubercle present just posterior to rostral plate.

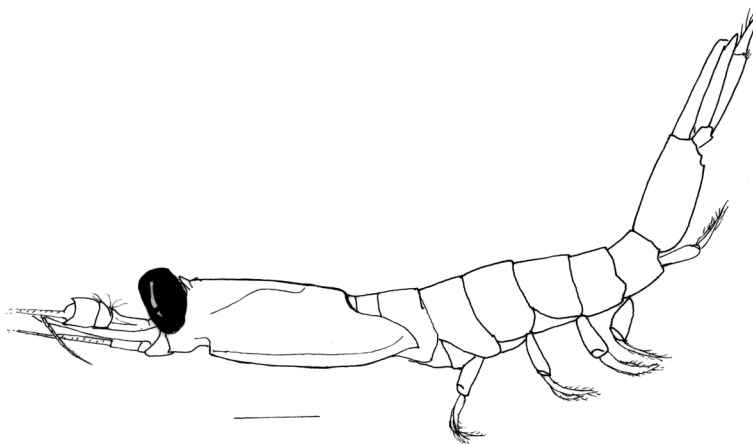


Fig. 8. *Paralophogaster philippinensis* Băcescu, 1981, female, cl 5.5 mm from central Japan (NSMT-Cr 32902), lateral view, thoracic legs not illustrated due to poor condition. Scale = 3 mm.

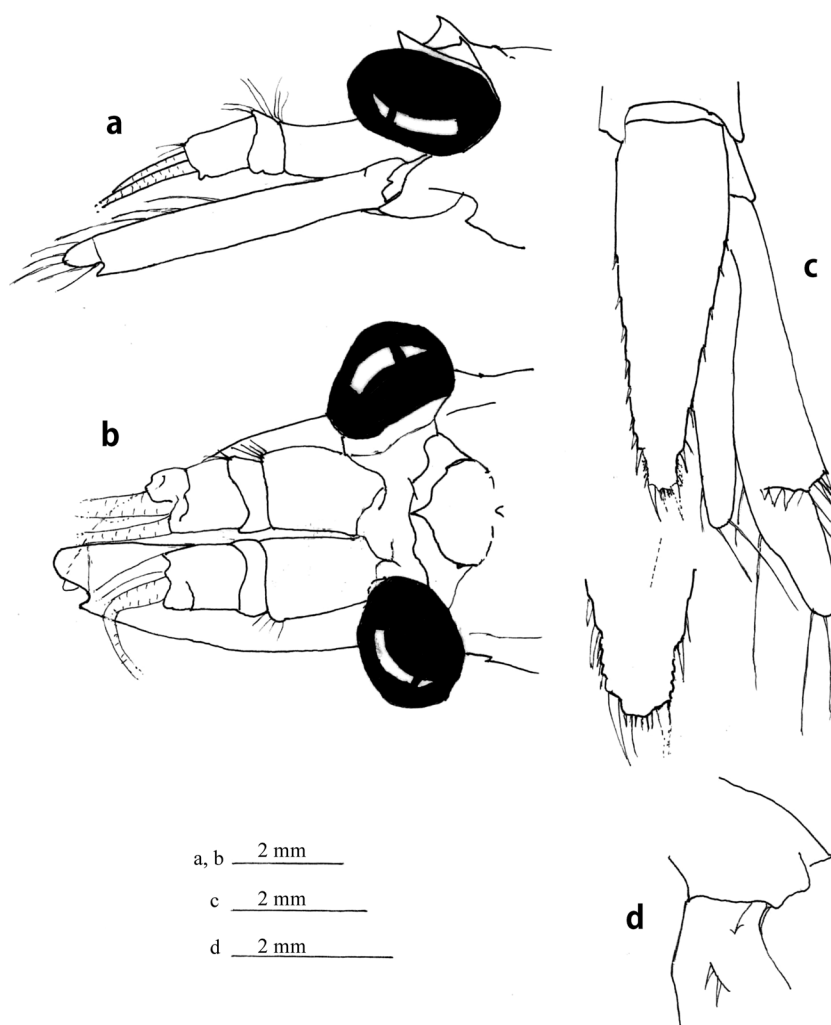


Fig. 9. *Paralophogaster philippinensis* Băcescu, 1981. a, female, cl 4.5 mm from Japan ((NSMT-Cr 32908), b–d, female, cl 5.5 mm from Japan (NSMT-Cr 32905): — a, anterior part of carapace and cephalic appendages, lateral view; b, same, dorsal view; c, telson and uropod, dorsal view; d, basal part of endopod of uropod, ventral view.

Telson (Fig. 9c) as long as or slightly longer than sixth abdominal somite, gradually narrowing posteriorly, with 5–7 short setal-spinules along lateral margin; moderately large sub-terminal setal-spine falling far short of posterior end of telson and much shorter than terminal setal-spines, bearing 4 or 5 moderate setal-spines increasing in length posteriorly between terminal and sub-terminal stout spines; postero-median plate noticeable, most probably with 5 denticles and 4 plumose setae.

Uropod (Fig. 9d) with endopod commonly with 2, infrequently 3, moderate setal-spines in basal part of ventral side.

Eye (Fig. 9a, b) with cornea 1.60–1.75 times as broad as rostral plate.

Antennal scale (Fig. 9a, b) rather long, extending beyond antennular peduncle by about 1/3 length of blade, about 4 times as long as wide; lateral margin nearly straight, bearing short tooth falling far short of anterior end of blade; sub-terminal suture present.

Distribution. This species is known from Japan, Philippines, Indonesia, and New Caledonia, and captured in abundance around the Japanese coastal waters. According to our survey, this species appears to commonly inhabit in depths shallower than 200 m.

Key to the Indo-West Pacific species of *Lophogaster*

- 1 Carapace with postero-lateral corner evenly rounded, lacking spine (alar spine)2
- Carapace with postero-lateral corner produced into spine (alar spine), if not toothed, more or less having angulation or trace of tooth3
- 2 Rostral plate completely lacking rostral process as well as sharp teeth in antero-lateral part *L. anoplos* Casanova, 1997
- Rostral plate typical of genus, having median process and anterolateral teeth *L. rotundatus* Illig, 1930
- 3 Carapace with marked post-ocular teeth or tubercles or carinate swelling.....4
- Carapace without post-ocular teeth or tubercles or carinate swelling.....9
- 4 Carapace with 2 pairs of post-ocular teeth or tubercles5
- Carapace with single pair of post-ocular teeth or tubercles6
- 5 Telson without spiniform setae on lateral margin, except for usual 2 distal pairs; sixth abdominal somite ending into short postero-lateral projection.....*L. inermis* Casanova, 1996
- Telson with 4 or 5 setal-spines on lateral margin in addition to usual 2 distal pairs, sub-distal spine as small as lateral spine series and arising far from distalmost one; sixth abdominal somite with rather long postero-lateral projection*L. multispinosus* Fage, 1940
- 6 Antennular lamina with evenly rounded anterior margin*L. schmidtii* Fage, 1940
- Antennular lamina with sub-distal inner corner markedly grooved and forming rounded or sub-acute shoulder.....7
- 7 Antennular lamina with sub-distal inner part forming sub-acute projection; antennal scale bearing obtuse 2 or 3 denticles on outer margin*L. japonicus* W. M. Tattersall, 1951
- Antennular lamina with sub-distal inner part forming rounded shoulder, without projection; antennal scale bearing marked 5 or 6 denticles on outer margin8
- 8 Antennular lamina bearing 1 short and 1 long setae distally; last pereopod with basis smooth *L. pacificus* Fage, 1940
- Antennular lamina bearing 2 long sub-equal setae distally; last pereopod with basis with marked projection near mid-length *L. musorstomi* Băcescu, 1991
- 9 Telson with single setal-spine on lateral margin in addition to ordinary 2 terminal pairs10
- Telson with 2 or 3 setal-spines on lateral margin in addition to ordinary 2 terminal pairs.....11
- 10 Antennular lamina with anterior inner margin forming angulate shoulder, having more or less

prominent denticle or process; rostrum reaching or over-reaching antennular peduncle; antennal scale broadest around basal part, anterior half of its inner margin gently concave, with terminal tooth gently to strongly curving inwards

-*L. intermedius* Hansen, 1910 (= *L. hawaiiensis* Fage, 1940^{*1})
- Antennular lamina with anterior inner part forming rounded shoulder, without prominent process
.....*L. affinis* Colosi, 1930
- 11 Male rostrum not extending beyond antennular peduncle; antennal scale of “*rotundatus*” type, bearing 3–5 denticles on outer margin12
- Male rostrum extending beyond antennular peduncle; antennal scale of “*sub-triangular*” type, bearing 5–7 denticles on outer margin *L. neocaledonensis* Casanova, 1993
- 12 Three to 5 denticles on antennal scale situated almost on its anterior half of outer margin, with robust terminal process*L. manilae* Băcescu, 1985
- Four or 5 denticles on antennal scale situated almost over entire length of outer margin, with moderately robust terminal process..... *L. erythraeus* Colosi, 1930^{*2}

^{*1} Casanova (1996) considered that *Lophogaster intermedius* Hansen, 1910 could be a senior synonym of *L. hawaiiensis* Fage, 1940, although O. S. Tattersall (1960) noted that the latter differs from the former (see also the “Remarks” section under *L. intermedius*).

^{*2} If this species has prominent ocular spines or protuberances as in species of the couplets 5–8 in this key, it can be distinguished from these species in having a short median rostral process and a “*rotundatus*” type antennal scale.

Key to the known species of *Paralophogaster*

- 1 Telson gently narrowing posteriorly, without marked constriction posterior to sub-terminal lateral long setal-spines falling far short of posterior margin of telson (“*sanzoi*” group) 2
- Telson abruptly narrowing posterior to sub-terminal lateral long setal-spines extending beyond posterior margin of telson (“*glaber*” group) 5
- 2 Rostral plate with anterior margin well produced anteriorly, noticeably narrowing towards basal part in dorsal aspect.....3
- Rostral plate with anterior margins nearly straight or slightly convex, not distinctly narrowing towards basal part in dorsal aspect.....4
- 3 Eyes with long ocular papilla..... *P. foresti* Băcescu, 1981
- Eyes without ocular papilla..... *P. boucheti* Casanova, 1993
- 4 Rostral plate with anterior margins convex; eyes with large cornea more than one and half times as broad as rostral plate*P. philippinensis* Băcescu, 1981
- Rostral plate with anterior margins straight; eyes with moderately large cornea as broad as rostral plate*P. sanzoi* Colosi, 1930
- 5 Eyes noticeably small, cornea narrower than eye-stalk6

- Eyes moderate or large, cornea broader than eye-stalk.....7
- 6 Rostral plate with obtuse median tooth; telson with posterior plate bearing 5 marginal denticles
..... *P. microps* Colosi, 1930
- Rostral plate without median tooth; telson with posterior plate bearing 4 marginal denticles
.....*P. intermedius* Coifmann, 1937
- 7 Rostral plate without evenly rounded median tooth*P. macrops* Colosi, 1934
- Rostral plate with median tooth8
- 8 Rostral plate less produced anteriorly, with nearly straight anterior margins....*P. indicus* Pillai, 1973
- Rostral plate well produced anteriorly, with appreciably convex anterior margins9
- 9 Telson with postero-lateral margin armed with 3 graded setal-spines between long setal-spines,
anterior pair of which shorter than terminal pairs..... *P. atlanticus* W. M. Tattersall, 1937
- Telson with postero-lateral margin armed with 5 or 6 graded setal-spines between long setal-spines,
anterior pair of which longer than posterior pairs.....*P. glaber* Hansen, 1910^{*3}
- ^{*3} The identity of *Paralophogaster glaber pacificus* Vereshchaka, 1990 reported from the south-eastern Pacific, which is currently regarded to be a synonym of this species, should be re-assessed due to a notable difference in the form of the telson.

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