Deep-Sea Fauna and Pollutants in Nansei Islands, edited by K. Hasegawa, G. Shinohara and M. Takeda, pp. 225–247, National Science Museum Monographs, No. 29, Tokyo, 2005

Three New Species of Deep-Sea Hyperbenthic Aetideid Copepods (Crustacea) Collected from Nansei Islands, Southwestern Japan

Susumu Ohtsuka[1], Geoffrey A. Boxshall[2] and Michitaka Shimomura[3]

[1]Takehara Marine Science Station, Graduate School of Biosphere Science, Hiroshima University, 5-8-1 Minato-machi, Takehara, Hiroshima 725-0024, Japan
e-mail: ohtsuka@hiroshima-u.ac.jp
[2]Department of Zoology, The Natural History Museum, Cromwell Road, London, SW7 5BD, U.K.
[3]Kitakyushu Museum of Natural History and Human History, 2-4-1 Higashida, Yahatahigashi-ku, Kitakyushu, Fukuoka 805-0071, Japan

Abstract: Three new species of deep-sea hyperbenthic calanoid copepods belonging to the family Actideidae are described from the Nansei Islands, southwestern Japan: *Bradyetes pacificus* n. sp., *Lutamator paradiseus* n. sp., and *Paracomantenna goi* n. sp. The genus *Bradyetes* is recorded from the Indo-Pacific region for the first time. The male of the genus *Lutamator* is described here for the first time and this record is also the first for the genus from the North Pacific. These results are further demonstration of the existence of a highly diverse copepod fauna in the deep hyperbenthic waters of Japan, similar to that already known from both the Atlantic and the southern Pacific.

Key words: Copepoda, Calanoida, Aetideidae, hyperbenthic, the Nansei Islands

Introduction

Intensive surveys of the deep-sea hyperbenthic copepods caught off the Nansei Islands, southwestern Japan, have revealed the presence of genera such as *Metacalanus* Cleve, 1901, *Paramisophiria* Scott, 1897, *Scutogerulus* Bradford, 1969 (Arietellidae), *Macandrewella* Scott, 1909, *Neoscolecithrix* Canu, 1896 and *Scolecocalanus* Farran, 1936 (Scolecitrichidae) (Ohtsuka *et al.*, 1994, 2002, 2003; Ohtsuka & Boxshall, 2004). The genera *Scutogerulus*, *Macandrewella*, *Neoscolecithrix* and *Scolecocalanus* were all recorded from Japanese waters for the first time, which suggests that the diversity of hyperbenthic calanoid copepods in these deep waters is high.

The hyperbenthic habitat has been identified as being of major significance in recent studies on the origin and evolution of calanoid copepods (Huys & Boxshall, 1991; Bradford-Grieve, 2002), and on the colonization of the pelagic realm and of anchialine caves by calanoid and other copepods (Jaume *et al.*, 2000; Bradford-Grieve, 2002). The family Aetideidae accommodates many hyperbenthic taxa (cf. Bradford & Jillett, 1980; Markhaseva, 1996), but has never been studied in detail in Japanese waters. According to Bradford-Grieve (2002), the deep-sea hyperbenthic zone has probably been colonized by calanoid copepods several times over geological time scales, and she regarded the family Aetideidae as a relatively late colonizer. Little is known of the detailed biology of hyperbenthic aetideids, except for the unique reproductive and developmental adaptations of *Bradydius* Giesbrecht, 1897 to life in hyperbenthic layers that were clarified by Matthews (1964).

The present paper deals with three new species of deep-sea hyperbenthic aetideids

collected from the Nansei Islands, southwestern Japan.

Materials and Methods

Copepods were captured using a NORPAC net (mesh size 0.3 mm) attached to the mouth of a beam trawl at two stations in the Nansei Islands, southwestern Japan: St. TY-04-X, off Amami-Oshima Island, Kagoshima, 28°22.37′N, 129°15.97′E～28°22.28′N, 129°15.43′E, 290 m depth, 21 May 2004 (local time 1110–1130); St. TY-03-11, off Kuroshima Island, Okinawa, 26°19.18′N, 127°25.56′E, 596–606 m depth, 24 May 2003 (local time 1220–1325). The gear was towed along the bottom at a speed of 2 knots for 20 minutes by the T/S *Toyoshio-Maru* of Hiroshima University. Samples were fixed with 10% neutralized formalin/sea water immediately after collection. Copepods were examined in lactophenol under a differential interference contrast microscope (Nikon Optiphoto) equipped with a camera lucida. Dissected parts of copepods were mounted on glass slides using the mounting medium CMC-10 (Masters Company Inc.).

Terminology follows Huys and Boxshall (1991). Type specimens are deposited at the National Science Museum, Tokyo (NSMT-CR).

Taxonomy

Family Aetideidae Giesbrecht, 1893
Genus ***Bradyetes*** Farran, 1905

Remarks. The deep-sea hyperbenthic genus *Bradyetes* currently accommodates only two species, both from the Atlantic (Grice, 1972; Johannessen, 1976; Markhaseva, 1996): *B. inermis* Farran, 1905 (Ireland, off Woods Hole, Madeira, ?300–1500 m depth) and *B. matthei* Johannessen, 1976 (off Norway, 548–580 m depth). These two species differ significantly in segmentation and setation of appendages of both sexes. The only possible synapomorphies in female serving to define the genus are the presence of an aesthetasc-like element on the distal endite of the maxillipedal syncoxa, and of a heavily sclerotized seta on the maxillary basis. However, the sensory element on the maxilliped is relatively long in *B. inermis* but short in *B. matthei*. This raises some doubt over their homology. These two character states are also shared with other aetideid genera, such as *Comantenna* Wilson, 1924 and *Mesocomantenna* Alvarez, 1986, and with two species of *Paracomantenna* Campaner, 1978. In *Comantenna*, *Mesocomantenna* and *Paracomantenna magalyae* Campaner, 1978, the sensory elements are short and thick, whereas in *Bradyetes* and *Paracomantenna gracilis* Alvarez, 1986 they are long and slender. As already pointed out by Markhaseva (1996), it is evident that the genus *Paracomantenna* is not monophyletic, since important characters such as the aesthetasc-like element on the maxillipedal syncoxa may be present or absent (see Remarks on *Paracomanntena*). Alvarez (1986) pointed out that the ornamentation of the setae on the second coxal and basal endites of the maxilla in the female is an important character distinguishing between *Comantenna*, *Mesocomantenna* and *Paracomentenna*. Spinules along the inner margin of the basal spiniform seta are relatively fine and dense in *Bradyetes* and *Comantenna*, but thick and sparse in *Mesocomantenna* and *Paracomantenna* s.l. In addition, the spinules at the base of the setae on the first and second praecoxal endites of the maxilla are relatively fine in the former, but heavily sclerotized in the latter. These differences are related to feeding strategies (Alvarez, 1986). Lack of knowledge on the males of

Mesocomantenna and *Paracomantenna* s.l. also makes it more difficult to define clear boundaries between these genera.

The present new species described below is similar to the type species *B. inermis* rather than the subsequently described species *B. matthei*, and can be reasonably assigned to the genus, pending revision of this group of genera.

Bradyetes pacificus sp. nov.
(Figs. 1–3)

Material examined (types). Holotype (NSMT-Cr 16099): 1 ♀, appendages dissected and mounted on glass slides, body stored in alcohol, collected at St. TY-04-X (off Amami-Oshima Island, Kagoshima, 28°22.37′N, 129°15.97′E～28°22.28′N, 129°15.43′E, 290 m depth), 21 May 2004. Paratype (NSMT-Cr 16100): 1 ♀, partly dissected and mounted on glass slides, body proper in vial, locality and collection date same as in holotype.

Body length. Female 2.96 mm (holotype); 2.98 mm (paratype).

Description. Female. Body (Fig. 1A, B) robust; prosome approximately 3.4 times as long as urosome; cephalosome partly fused to pediger 1; rostrum (Fig. 1C, D) produced ventrally into blunt point, not bifurcate at tip; posterolateral processes of prosome (Fig. 1E, F), in dorsal view, bifurcate terminally, reaching beyond level of genital operculum. Urosomites 1–3 with striated hyaline frill along posterior margin (Fig. 1E, F); genital double-somite expanded anterolaterally; genital operculum (Fig. 1G) relatively narrow; seminal receptacles (Fig. 1B, E, G) slender, reaching beyond mid-height in lateral view (see Fig. 1E); caudal rami symmetrical, slightly longer than wide; caudal seta I minute; seta VII originating from ventral midpoint.

Antennule (Fig. 1H, I) indistinctly 24-segmented with suture between segments I and II clearly visible; fusion pattern and setal formula as follows: I–IV=7+ae (1, 2, 2+ae, 2), V=2+ae, VI=2, VII=2+ae, VIII=2, IX=2, X–XI=4+ae (2, 2+ae), XII=2, XIII=2, XIV=2+ae, XV=2, XVI=2+ae, XVII=2, XVIII=2, XIX=2, XX=2, XXI=2+ae, XXII=1, XXIII=1, XXIV=1+1, XXV=1+1, XXVI=1+1, XXVII–XXVIII=4+ae.

Antenna (Fig. 2A) with basis and endopod incompletely fused to form allobasis; coxa and basis bearing 1 and 2 setae at inner distal corners, respectively; exopod indistinctly 9-segmented, setal formula 1, 1, 1, 1, 1, 1, 1, 1, 3; subterminal and terminal lobes of distal endopodal segment with 8 and 7 setae, respectively.

Mandibular gnathobase (Fig. 2B) with 1 simple and 5 multicusped teeth, plus spinulose seta fused to gnathobase. Mandibular palp (Fig. 2C) with endopod smaller than exopod, 2-segmented; first endopodal segment reduced, unarmed, second segment with 4 setae of unequal length terminally; exopod indistinctly 5-segmented, setal formula 1, 1, 1, 1, 2.

Maxillule (Fig. 2D, E) with praecoxal arthrite bearing 4 surface and 9 terminal elements; short, stout spinules present at base of 3 surface setae; coxal endites with 4 setae, distalmost of which with stout spinules around base; coxal epipod with 6 setae, gradually increasing in thickness distally; first basal endite with 2 heavily sclerotized setae plus fine seta; second basal endite represented by inner knob with 4 stout setae; endopod almost incorporated into basis, but trace of segmentation recognizable, with setal formula 4, 2, 6; exopod swollen distally, with 11 marginal setae.

Maxilla (Fig. 2F) with 1 short and 2 long spinulose setae on each of praecoxal and coxal endites, with dense patches of long spinules near base of setae on each endite; basis

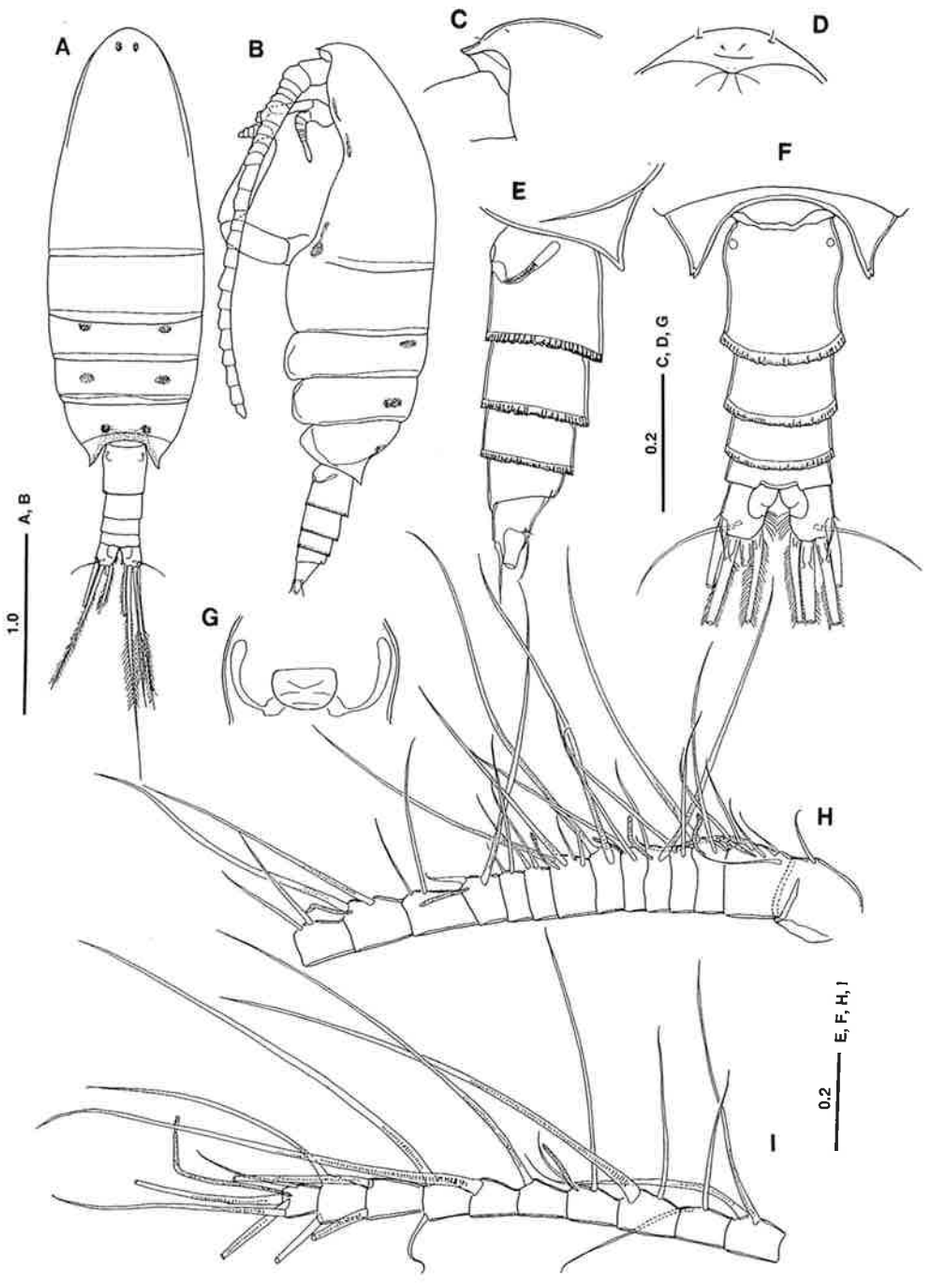

Fig. 1. *Bradyetes pacificus* n. sp., female (holotype). A, Habitus, dorsal view; B, Habitus, lateral view; C, Rostrum, lateral view; D, Rostrum, ventral view; E, Pediger 5 and urosome, lateral view; F, Pediger 5 and urosome, dorsal view; G, Genital operculum and seminal receptacles; H, Antennulary segments I (first) to XVII (14th); I, Antennulary segments XVIII (15th) to XXVII–XXVIII (24th). Scales in mm.

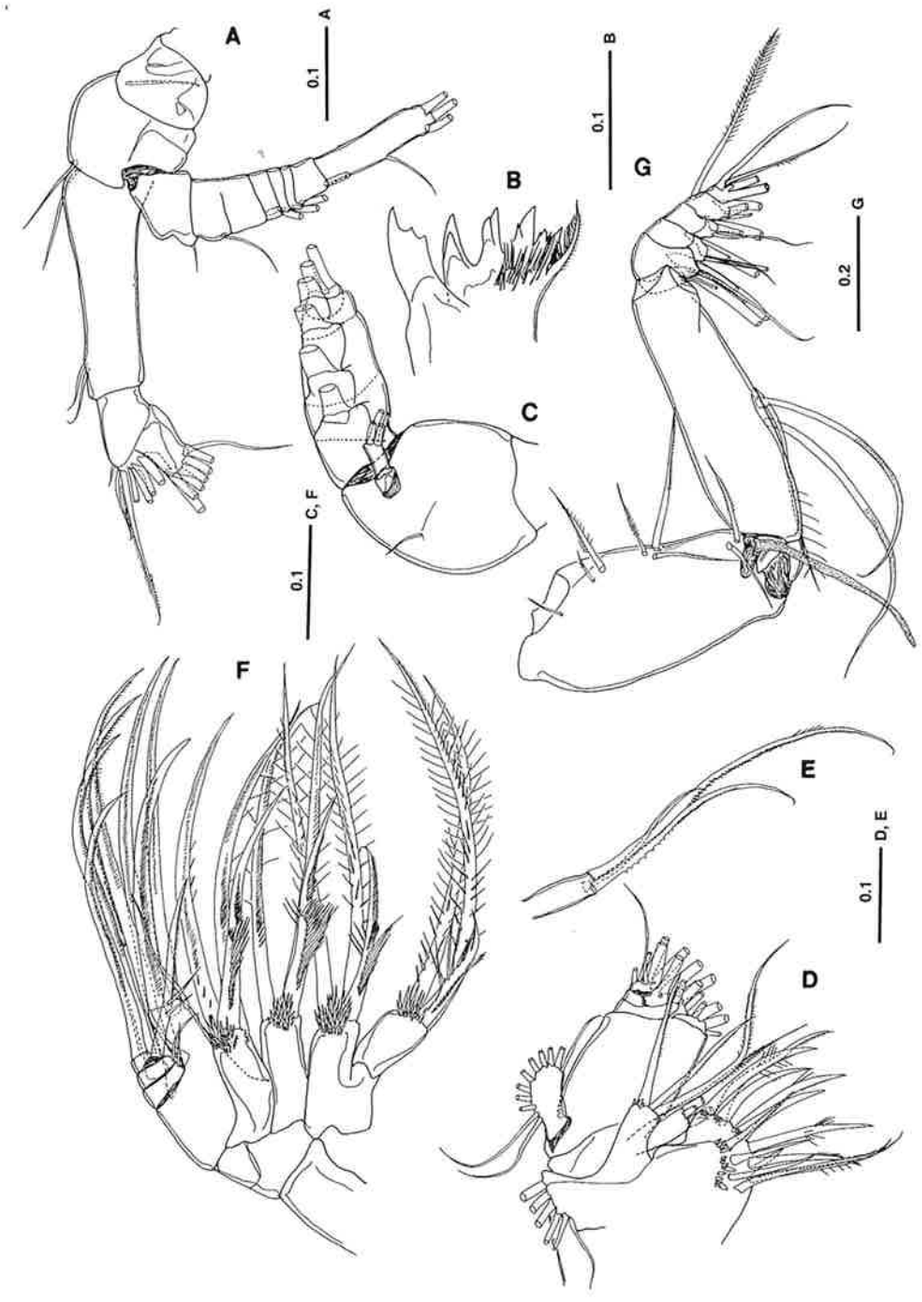

Fig. 2. *Bradyetes pacificus* n. sp., female (holotype). A, Antenna; B, Mandibular gnathobase; C, Mandibular palp; D, Maxillule; E, First basal endite of maxillule; F, Maxilla; G, Maxilliped. Scales in mm.

Table 1. Seta and spine formula of legs 1 to 4 of *Bradyetes pacificus* n. sp.

	coxa	basis	exopod			endopod		
			1	2	3	1	2	3
Leg 1	0-0	1-1	I-0;	I-1;	I, 1, 3	0,	2,	3
Leg 2	0-1	0-0	I-1;	I-1;	III, I, 4	0-1;	1,	2, 2
Leg 3	0-1	0-0	I-1;	I-1;	III, I, 4	0-1;	0-1;	1, 2, 2
Leg 4	0-1	0-0	I-1;	I-1;	III, I, 4	0-1;	0-1;	1, 2, 2

with 3 setae, 1 heavily sclerotized, 1 slender and 1 long; endopod indistinctly 4-segmented, second segment bearing 2 fine setae in addition to developed seta; endopodal setal formula 1, 3, 2, 2.

Maxilliped (Fig. 2G) well chitinized; syncoxa bearing 1, 2, and 3 setae on first to third endites; patch of minute prominences anteriorly at base of third endite; fourth endite with 1 naked and 2 spinulose setae and aesthetasc-like element; basis with 3 long setae midway; endopod 6-segmented, setal formula 2, 4, 4, 3, 3+1, 4; proximal setae on fifth and sixth endopodal segments fused to segment; outer spinulose seta on fifth segment well developed.

Seta and spine formula of legs 1–4 (Table 1). Leg 1 (Fig. 3A, B) with coxa unarmed; basis with minute outer seta subterminally; outer spines on first and second exopodal segments slender, ornamented with row of fine setules along inner margin; outer expansion of endopod swollen, with fine setules terminally. Leg 2 (Fig. 3C) with terminal spine on third exopodal segment coarsely serrate, serrations connected by lamella; distal outer corner of first endopodal segment not pointed. Legs 3 (Fig. 3D) and 4 (Fig. 3E) similar, but intercoxal sclerite narrower in leg 4; serrations on terminal spine of third exopodal segment connected by lamella; outer distal corner of first and second endopodal segments pointed.

Male unknown.

Coloration. In some specimens fixed with formalin/sea water, paired light brown spots are present anterodorsally and laterally on the cephalosome, and dorsally on pedigers 2 to 4 (Fig. 1A, B).

Remarks. This is the first record of the genus *Bradyetes* from the Indo-Pacific region. The new species is similar to *Bradyetes inermis* in having a long, aesthetasc-like element on the distal endite of the maxillipedal syncoxa and a reduced mandibular endopod. However it is easily distinguished from the latter by (states in parentheses for *B. inermis*): (1) the presence of a ventrally produced rostrum (rostrum absent); (2) the posterolateral angles of the prosome produced posteriorly into pointed processes (processes rounded); (3) the antennary basis with 2 setae (single seta); and (4) setal formula of mandibular endopod 0, 4 (1, 3).

Etymology. The new specific name "*pacificus* (Latin, meaning Pacific)" refers to this first report of the genus in the Pacific.

Genus ***Lutamator*** Bradford, 1969

Diagnosis (emended and supplemented from Markhaseva (1996)). Female. Cephalosome partly or totally fused to pediger 1. Rostrum forming bluntly rounded plate, not bifurcate at tip. Pedigers 4 and 5 completely or incompletely coalescent. Antenna with

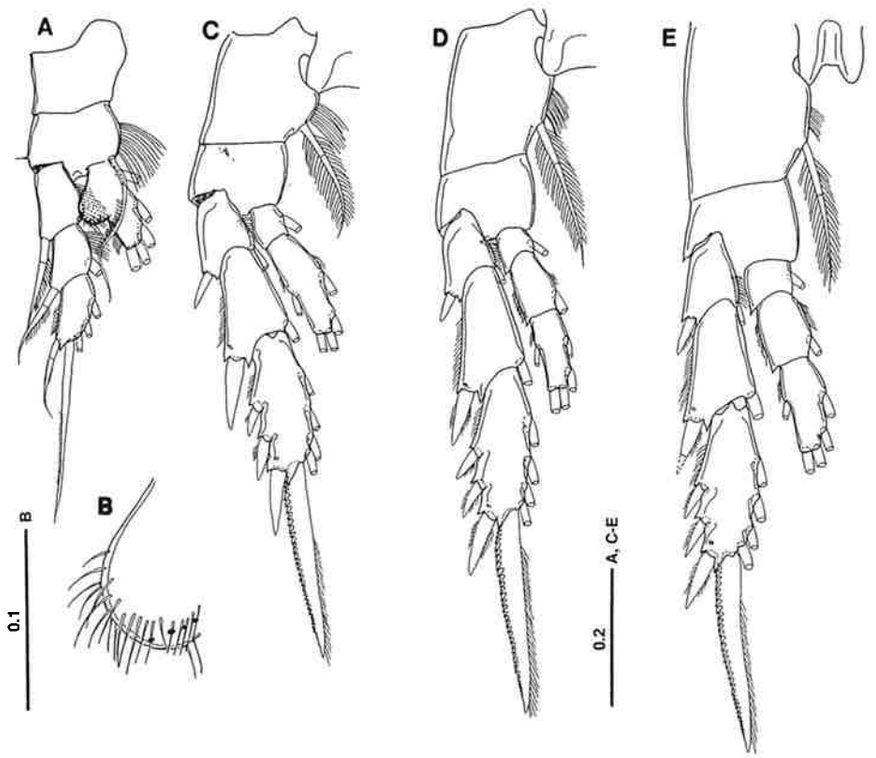

Fig. 3. *Bradyetes pacificus* n. sp., female (A–D: holotype; E: paratype). A, Leg 1, anterior surface; B, Outer expansion of endopod of leg 1; C, Leg 2, anterior surface; D, Leg 3, anterior surface; E, Leg 4, anterior surface. Scales in mm.

1 coxal and 1 or 2 basal setae; exopod as long as or longer than endopod, and as wide as or narrower than endopod; first exopodal segment with or without seta; compound distal endopodal segment with 8 or 9 setae on subterminal lobe. Mandibular basis with 0 or 1 seta; first endopodal segment with 0 or 1 seta. Coxal epipod of maxillule with 7 or 8 setae. Maxilla with patch of spinules at base of setae on each of praecoxal and coxal endites; one spiniform seta on basis heavily sclerotized; endopod 4-segmented, setal formula 1, 2, 2, 2. First syncoxal (praecoxal) endite of maxilliped with or without seta; fourth syncoxal endite with 2–4 setae, one of which longer than or as long as other setae.

Male. Cephalosome totally fused to pediger 1; rostrum forming blunt, rounded process; pedigers 4 and 5 incompletely coalescent. Antennule asymmetrical: segments XXII and XXIII separate on left but fused on right. Antenna with coxa and basis bearing 1 and 2 setae, respectively. Mandibular gnathobase reduced; palp with single basal seta; first endopodal segment bearing seta. Maxillule reduced except for exopod with 10 long setae. Maxilla wholly reduced, with vestigial elements. Maxilliped with only vestigial elements on distal lobe of syncoxa. Leg 1 as in female. Leg 5 uniramous; right leg shorter than left, 4-segmented; left 5-segmented, distal segment of which furnished with row of setules terminally.

Remarks. The genus was defined by monotypy by Bradford (1969), and redefined by Alvarez (1984). Subsequently Markhaseva (1996) emended the diagnosis in her thorough