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A new species of *Clausia* (Copepoda, Poecilostomatoida, Clausiidae) associated with the polychaete *Arenicola brasilliensis* Nonata in Korea

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Abstract

A new species of the genus *Clausia* associated with the polychaete *Arenicola brasilliensis* Nonata is described from intertidal sands in Korea. The new species, as a primitive member of the genus, has a large, non-transformed body and fully segmented rami on legs 1–4. This is the second record of Clausiidae in the Far Eastern seas. The genus *Doviella* Rocha, originally placed in the Clausidiidae, is synonymized with the genus *Clausia* in the Clausiidae.

Introduction

Only three species of Copepoda associated with polychaetes have been reported from Korean waters. Ho & Kim (1990) were the first to report a copepod associated with the polychaetes in this area, when they described *Hemicyclops ctenidis* as new species from *Neanthes japonica* (Izuka). Kim (1998) recorded *Nasomolgus firmus* (Humes & Ho, 1967) from a *Sabellastarte* sp., and recently Kim (2000) added to the Korean copepod fauna *Clausia minuta* as new species discovered from *Marphysa sanguinea* (Montagu).

Copepods of the family Clausiidae have been known as one of the so called 'nereicoliform families' (Gooding, 1963; Ho, 1984). When Wilson & Illg (1955) reviewed this family, they recognized only six species in the family. Since then, more species had been added with O'Reilly (1955) recognizing 15 species as valid, excluding the unpublished '*Clausia wilsoni*' (Gooding, 1963).

Although some member of the Clausiidae have been reported without reliable host data or found in the plankton, they are presumed to be mainly associates of polychaetes. In addition, most species of this family have been incompletely described or are based on very few specimens from western Europe. Therefore, as indicated by Wilson & Illg (1955), it is desirable that more species are accurately described, through careful examination of specimens from areas outside Europe.

In 1999, during a survey of northern shore of Jeju Island, the largest island in Korea, a copepod moving among live individuals of the polychaete *Arenicola brasilliensis* Nonata contained in a jar was observed by the naked eye. Immediately, several dozens of this polychaete were dug out from the intertidal sands at the same location and searched for copepods. More than 10 specimens were caught and are described here as a new species of *Clausia*.

Materials and methods

The polychaete hosts were dug out with a shovel, collected in a plastic bag, and fixed with 80% ethanol. In the laboratory, the fixed polychaetes were agitated and removed from the plastic bag. The remaining sediment was poured into a wide jar, and the copepods were sorted from the sediment.

Before measuring and dissection, the copepods were soaked in lactic acid for about an hour. The dissection was done using the reversed slide method of Humes & Gooding (1964). Body length does not include the setae on the caudal rami. In the armature formula of legs 1–4, Roman numerals represent spines

and Arabic numerals setae. All figures were drawn with the aid of a camera lucida.

Family Clausiidae Giesbrecht, 1895
Clausia antiqua n. sp. (Figs 1–3)

Material examined

7 ♀♀, 4 ♂♂ collected from washings of the polychaete *Arenicola brasilliensis* Nonata, in the intertidal sands at Sinhung-ri (33° 33′ N, 126° 39′ E), northern shore of Jeju Island, Korea, on 29 September 1999. Collector I.-H. Kim. Holotype (♀), allotype and paratypes (4 ♀♀, 2 ♂) will be deposited in the U.S. National Museum of Natural History, Smithsonian Institution. Dissected paratypes (2 ♀♀, 1 ♂) are retained in the collections of the author.

Other material examined

One ♂ from *Arenicola brasilliensis* in the intertidal mud flat at Sapsi-do Island (36° 20′ N, 126° 21′ E) in the Yellow Sea, on 26 October 1999.

Female

Body (Fig. 1A) 3.20 mm, greatest width 1.51 mm, measured across second pedigerous somite. Prosome broad and flat. Prosomal somites with well developed, rigid tergites. Prosome of young adult with less developed tergites and faint suture lines between somites. Cephalosome and first pedigerous somite completely fused to form cephalothorax. Mid-posterior margin of fourth pedigerous somite conspicuously protruded posteriorly. Urosome (Fig. 1B) 6-segmented. Fifth pedigerous somite about 618 μm wide. Genital somite 265×538 μm, anterior portion expanded laterally, with steeply oblique lateral margins. Paired genital fields located dorsolaterally. Abdomen gradually narrowing. Four abdominal somites 235×305, 229×265, 164×229 and 212×206 μm, respectively. Genital and first 3 abdominal somites ornamented with minute spinules on ventral surface. Anal somite with minute spinules near posteroventral border (Fig. 1C). Caudal ramus weakly tapering, 173×72 μm (2.37:1), with minute spinules near distal border of ventral surface. Caudal setae 7 in number, including proximal lateral seta (seta I); all setae naked, largest one 741 μm long.

Rostrum (Fig. 1D) nearly quadrangular, constricted laterally, and wider than long. Antennule (Fig. 1E) 6-segmented, gradually tapering, 490 μm long, with armature formula: 4, 12, 8, 4+1 aesthetasc, 2+1 aesthetasc and 7+1 aesthetasc. All aesthetascs setiform, hardly distinguishable from setae. All setae naked. Antenna (Fig. 1F) 3-segmented. All segments with minute spinules on inner surface. First and second segments each armed with 1 distal seta. Third segment subdivided by an incomplete suture line into proximal and distal portions (original third and fourth segments). Proximal portion with 2 small and 1 large, lanceolate setae; the latter rimmed with membrane along inner margin. Distal portion reduced, with 3 plain and 4 spiniform setae; the latter 4 setae each tipped with small spinulated pad.

Labrum (Fig. 2A) reduced, tapering posteriorly, and not covering mouthparts (Fig. 1G). Mandible (Fig. 2B) with 2 extremely unequal, terminal and subterminal spines; terminal spine large, rod-shaped, directed posteriorly, crenate on tip and along outer (posterior) margin; subterminal spine distinctly smaller than terminal, claw-like, with spinules on both sides. Paragnath (Fig. 2C) a naked lobe. Maxillule (Fig. 2D) lobate bearing anterior protrusion, armed with 6 distal setae; posteriormost seta bent basally; next posteriormost seta thick but shorter. Maxilla (Fig. 2E) largest mouthpart, 2-segmented: first segment broad and unarmed; second segment blunt, wider than long, terminally sclerotized, forming cutting edge, with 1 small seta at subterminal part of posterior margin. Maxilliped (Fig. 2F) rudimentary (Fig. 1G), 3-segmented and unarmed: terminal segment very small, with pointed tip.

Legs 1–4 (Figs 2G–I and 3A) with 3-segmented rami. Inner spine on basis of leg 1 shorter than first endopodal segment, with bilateral marginal membrane. Most spines on rami of legs setiform. Leg 4 without inner coxal seta. Armature formula of legs 1–4 as follows (Roman numerals representing spines, and Arabic ones for setae):

Leg 1: coxa 0-1; basis 1-I;	exp I-0; I-1; III,I,3
	enp 0-1; 0-1; I,4
Leg 2: coxa 0-1; basis 1-0;	exp I-0; I-1; III,I,4
	enp 0-1; 0-2; III,3
Leg 3: coxa 0-1; basis 1-0;	exp I-0; I-1; II,I,4
	enp 0-1; 0-1; III,3
Leg 4: coxa 0-0; basis 1-0;	exp I-0; I-1; II,I,4
	enp 0-1; 0-1; III,2

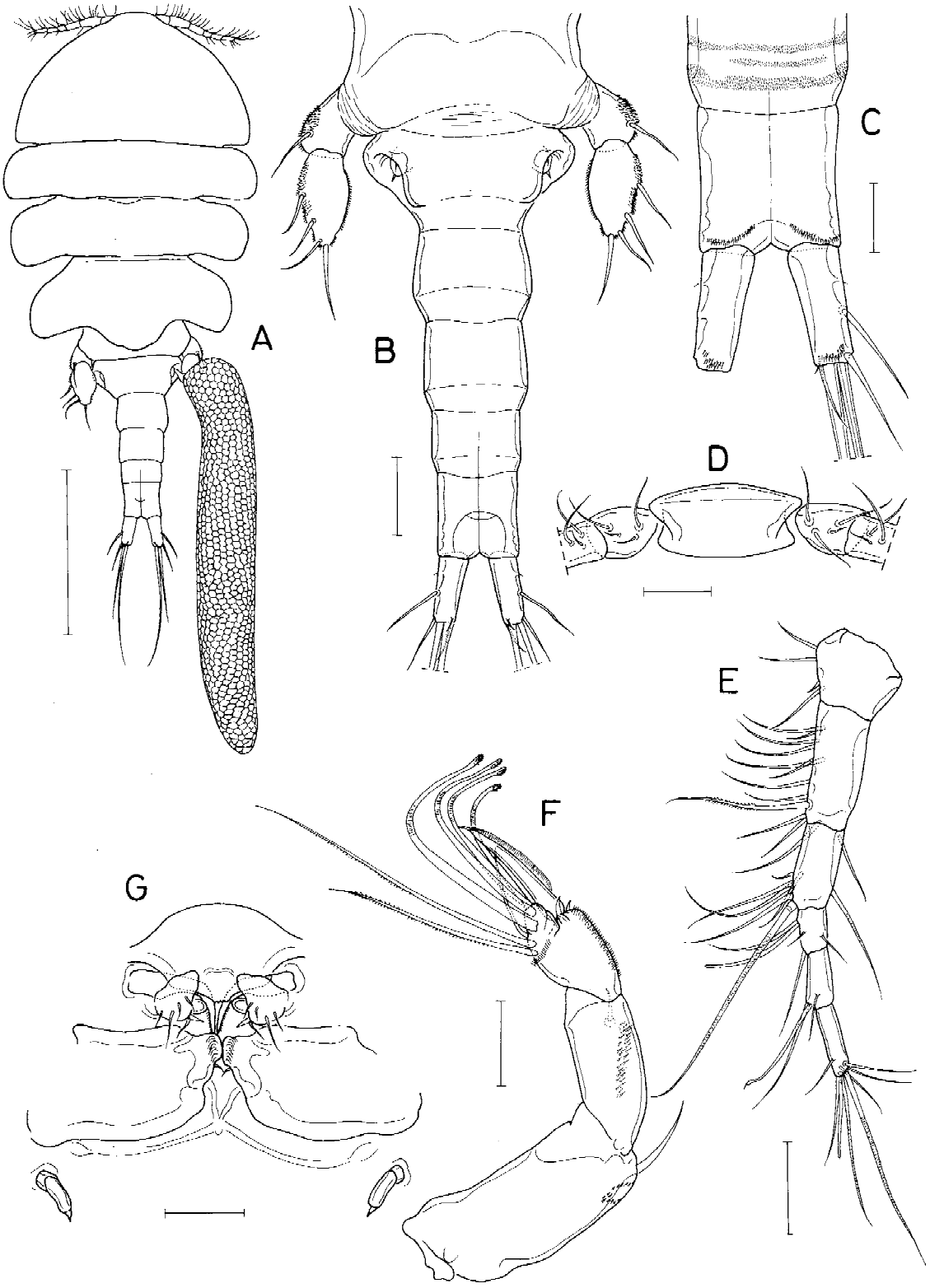

Figure 1. Clausia antiqua n. sp. Female: (A) habitus, dorsal; (B) urosome, dorsal; (C) posterior part of urosome, ventral; (D) rostral area, ventral; (E) antennule; (F) antenna; (G) mouthparts. Scales: A= 1 mm; B= 0.2 mm; C–E, G= 0.1 mm; F= 0.05 mm.

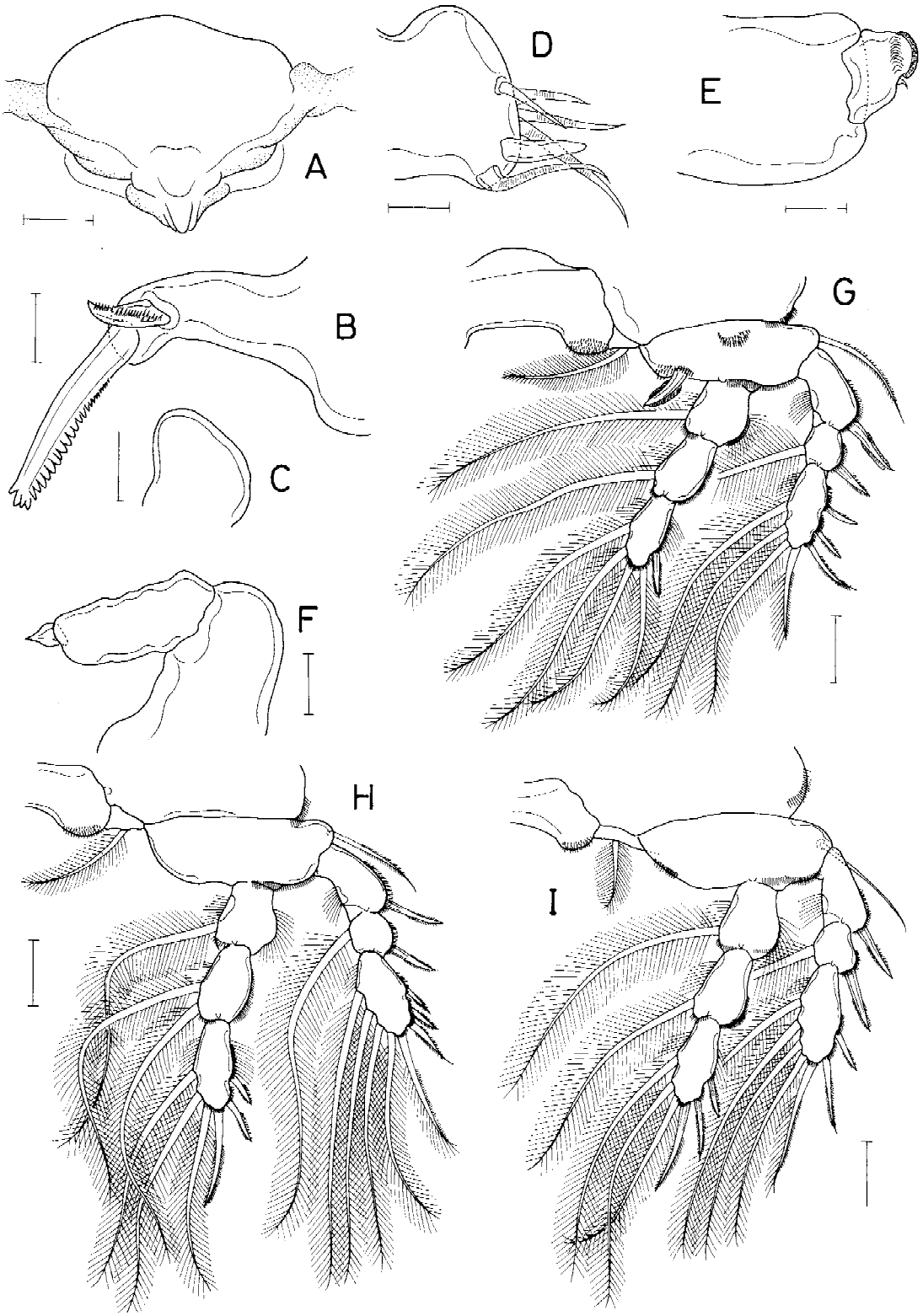

Figure 2. Clausia antiqua n. sp. Female: (A) labrum; (B) mandible; (C) paragnath; (D) maxillule; (E) maxilla; (F) maxilliped; (G), leg 1; H, leg 2; I, leg 3. Scales: A, D, E= 0.05 mm; B, D, F= 0.02 mm; G–I= 0.1 mm.

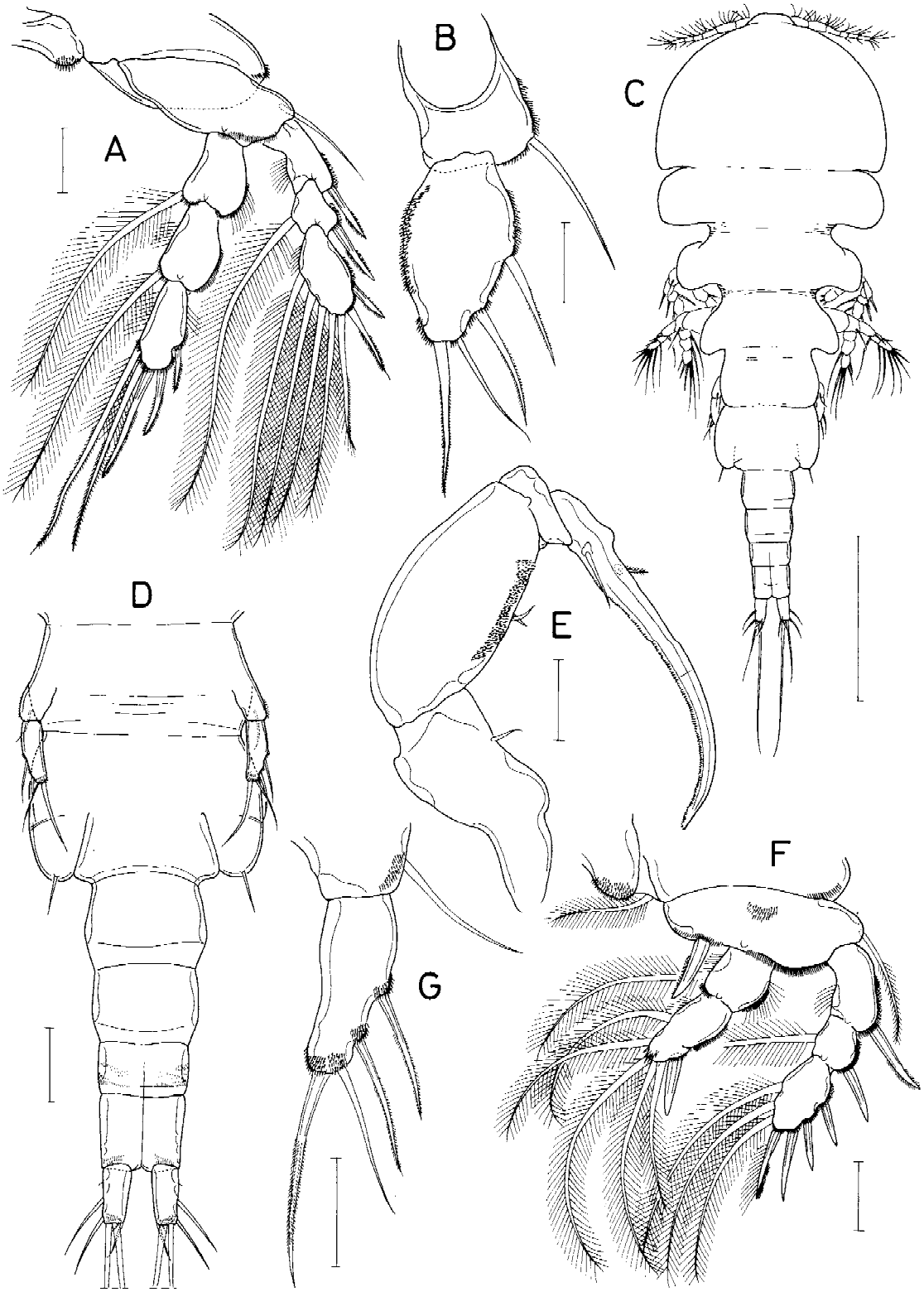

Figure 3. Clausia antiqua n. sp. Female: (A) leg 4; (B) leg 5. Male: (C) habitus, dorsal; (D) urosome, ventral; (E) maxilliped; (F) leg 1; (G), leg 5. Scales: A, B, E–G= 0.1 mm; C= 1 mm; D= 0.2 mm.

Leg 5 (Fig. 3B) 2-segmented. Basal segment with 1 outer seta and spinules on outer margin. Free segment roughly oval, 233×140 μm (1.66:1) with 2 outer and 2 terminal setae. Both outer and inner margins ornamented with spinules. All setae shorter than free segment. Leg 6 represented by 2 minute spinules in genital field (Fig. 1B).

Male

Body (Fig. 3C) 3.61 mm long. Prosomal somites with faint suture lines between somites. Second pedigerous somite as wide as cephalothorax. Third pedigerous somite narrower than second, with epimera well separated from those of second and fourth pedigerous somites. Fourth pedigerous somite almost fused with fifth pedigerous somite, much narrower than third, its epimera directed posterolaterally. Urosome (Fig. 3D) 6-segmented. Genital somite nearly quadrangular, 606×629 μm, slightly wider than fifth pedigerous somite. Four abdominal somites 235×329, 200×288, 135×247 and 200×232 μm, respectively. Caudal ramus 147×75 μm (1.96:1).

Antennule with additional seta on third segment (9 setae) than in female. Antenna with more conspicuous spinules on inner margins of segments, otherwise as in female.

Labrum, mandible and maxillule as in female. Maxilla with large patch of spinules on ventral surface of first segment. Maxilliped (Fig. 3E) well-developed, 4-segmented. First segment gradually broadening distally, with 1 small seta on inner margin. Second segment with minute spinules on inner surface and pair of small setae in middle of inner margin. Third segment short and unarmed. Fourth segment forming long, slender, distally curved claw, basally with 2 setae on opposite sides.

Leg 1 (Fig. 3F) sexually dimorphic: endopod 2-segmented with armature formula 0-1; I,5. Inner spine on basis longer than first endopodal segment. Legs 2–4 as in female. Free segment of leg 5 with narrower distal half (Fig. 3G), 173×73 μm (2.37:1). Distalmost seta longest, 210 μm, longer than free segment. Leg 6 represented by 1 seta on posterior corner of genital flap (Fig. 3D).

Etymology

The specific name *antiqua* (= primitive) refers to the primitive state of the new species in relation to its congeners.

Remarks

Clausia antiqua n sp. displays some similarities to genera currently placed in the family Clausidiidae, in particular to the genus *Leptinogaster* Pelseneer, 1928. The new species and the member of *Leptinogaster* show the similar body form, antennules and legs, and carry in common a rudimentary female maxilliped. The close relationship between Clausiidae and Clausidiidae has already been pointed out by previous workers (Wilson & Illg, 1955; Humes & Ho, 1969). Although it is possible that species will be discovered which present overlapping character states for both families, it is still possible to distinguish them, because the members of the Clausiidae have variously simplified appendages. *Clausia antiqua* also distinguishable from species of *Leptinogaster* by the retention of a 4-segmented female abdomen, by the fusion of third and fourth antennal segments, by the reduced labrum, and by the presence of only two elements on the mandible, and the blunt, simplified distal segment of the maxilla.

It is noticeable that there is a trend in the Clausiidae toward the reduction of endopod segments in male leg 1. Six of 17 known species in this family carry a 3-segmented endopod on female leg 1 (O'Reilly, 1995). In all these species, the male has a 2-segmented endopod on the same leg. Such a trend is not observable in the Clausidiidae.

O'Reilly (1995) recognized eight genera as valid in the Clausiidae, including *Megaclausia* that he proposed as a new genus to accommodate *M. mirabilis*. However, these genera are not easy to distinguish from one another. The degree of leg simplification, a traditional diagnostic character for distinguishing genera, is not clear-cut among genera but reveals a morphocline (Kim, 2000). The diagnostic features of *Megaclausia* that O'Reilly suggested are the large body size of female, the fusion of last two abdominal somites, and the retention of the endopod (instead of the exopod) in uniramous legs 3 and 4. But body size seems not to be a reliable taxonomic trait in copepods. The fusion of some abdominal somites has a weak taxonomic significance as well at the generic level, because the reduction of abdominal segmentation can be observable in a same genus of the Clausiidae, as exhibited by *Rhodinicola elongata* Levinsen which has a four-segmented abdomen and *R. gibbosa* Bresciani which has a non-segmented urosome, both illustrated by Bresciani (1964). The nature of the ramus on legs 3 and 4 of *Megaclausia mirabilis* is uncertain, although

it looks like the endopods of legs 1 and 2, because they are also similar in form to leg 5, the other uniramous leg, in which the single ramus is apparently the exopod. It seems certain in the Clausiidae and related families that whenever only a single ramus remains in legs 1–5 it is always the exopod. Therefore, in this report all the known genera of the family are tentatively included within a single genus,*Clausia*.

Clausia antiqua displays the fewest simplifications of appendages among existing species of the Clausiidae. Based on the structure of its legs 1–4 whose all rami are completely segmented, this species is a member of '*Pontoclausia*' group. At present, this group is consisted of *C. tomis* Bacescu & Por, 1959 and the unpublished '*C. wilsoni*' Gooding, 1963. It should be noted here that the genus *Doviella* Rocha, 1986 found to accommodate *D. prima* Rocha, 1986 was erroneously assigned to the family Clausidiidae. *D. prima* is undoubtedly a member of the '*Pontoclausia*' group within the genus *Clausia*. Moreover, close comparison of available descriptions of *D. prima* and '*C. wilsoni*' leads to the conclusion that they may be conspecific. The body form, antenna, maxillule, maxilla, female maxilliped, armature formula of legs 1–3, and the male leg 1 are identical in both species. The male maxillipeds of these two species in particular are characteristic and identical. Although some differences are found between the original descriptions in body length, antennular segmentation and armature of leg 4, these differences are considered to be of minor or of artificial. It is proposed here that *Doviella prima* Rocha should be transferred to *Clausia* as *Clausia prima* (Rocha, 1986).

Clausia antiqua has an unarmed, reduced famale maxilliped and more elements on the terminal segment of the antenna (3+7 in contrast to 2+4 in *C. tomis* or 6 in *C. prima*) and on the maxillule (6 in contrast to 4 in both *C. tomis* and *C. prima*) than the two related species.

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