EUPOLYMNIPHILUS ORIENTALIS N. SP. (COPEPODA, CYCLOPOIDA, SABELLIPHILIDAE) FROM INTERTIDAL BURROWS IN KOREA, WITH THE RECOGNITION OF FOUR SPECIES IN THE GENUS

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ABSTRACT

Eupolymniphilus orientalis is described as a new species discovered in intertidal invertebrate burrows in Korea. In addition to the type species, *E. finmarchicus* (T. Scott, 1903), also *Scambicornus armoricanus* (Bocquet, Stock & Kleeton, 1963) and *S. tenuicaudis* (G. O. Sars, 1918) are recognized as members of the genus *Eupolymniphilus*. The new species is distinguished from its three congeners by the presence of an outer scale on the mandible, short caudal rami, and a specialized proximal caudal seta. A key to distinguish the four species of the genus is provided.

RÉSUMÉ

Eupolymniphilus orientalis est décrite comme une nouvelle espèce découverte dans les terriers d'Invertébrés intertidaux en Corée. En supplément de l'espèce type *E. finmarchicus* (T. Scott, 1903), *Scambicornus armoricanus* (Bocquet, Stock & Kleeton, 1963) et *S. tenuicaudis* (G.O. Sars, 1918) sont aussi reconnues comme membres du genre *Eupolymniphilus*. La nouvelle espèce se distingue de ses trois congénères par la présence d'une écaille externe sur la mandibule, une courte rame caudale et une soie caudale proximale spécialisée. Une clé de détermination pour les quatre espèces est proposée.

INTRODUCTION

Many copepods are associated with tubicolous marine invertebrates or at least live in tubes made by other invertebrates. The copepods of the family Sabelliphilidae are associates of the tubicolous polychaetes belonging to the families Sabellidae, Serpulidae, and Terebellidae (cf. Boxshall & Halsey, 2004). In their revision of the lichomolgoid complex, Humes & Boxshall (1996) redefined the families belonging to that assemblage. They assigned eight genera to the family

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Sabelliphilidae, including the genus *Eupolymniphilus*, which they proposed as a new genus to incorporate *Scambicornus finmarchicus* (T. Scott, 1903). Therefore, until now this genus remained as a monotypic genus awaiting records of further possible members.

Recently, the author had a chance to visit Port Seogwipo located on Cheju Island, the southernmost island of Korea, where he collected several copepods from water stagnated after shovelling intertidal muds. This collecting activity yielded several species of copepods, including a new species of *Eupolymniphilus* that is described herein.

MATERIAL AND METHODS

Intertidal muds under rocks and gravel were shovelled up, and the resulting, stagnated water was filtered through a dip net. The muds were inhabited by various species of polychaetes and crustaceans. The filtrates were poured into a jar containing absolute ethanol and in the laboratory the copepod material was sorted out under a dissecting microscope. The copepod material consisted of several undescribed species of *Kelleria* and *Hemicyclops* that will be described elsewhere, in addition to *Eupolymniphilus orientalis* n. sp. described in the present paper.

Copepod specimens were measured and dissected after soaking in lactic acid. Dissection was done using the reversed slide method of Humes & Gooding (1964). In the following description, the body length does not include setae on the caudal rami. Roman and Arabic numerals in the armature formulae represent spines and setae, respectively. All figures were drawn with the aid of a camera lucida.

Family SABELLIPHILIDAE Gurney, 1927

Genus *Eupolymniphilus* Humes & Boxshall, 1996

Eupolymniphilus orientalis n. sp. (figs. 1-3)

Material examined. — Six ♀♀ and 1 ♂ from invertebrate burrows (mainly of polychaetes and decapods) in intertidal muds at Port Seogwipo (33°14′11″N 126°33′44″E) on Cheju Island, 19 August 2005, collected by I.-H. Kim. Holotype (♀, USNM 1081722) and paratypes (3 ♀♀, USNM 1081723) have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D. C., U. S. A. Dissected paratypes (2 ♀♀, 1 ♂) are kept in the collection of the author.

Female. — Body (fig. 1A) moderately slender. Body length of dissected specimen 1.01 mm, maximum width 413 μm. Mean body length of six specimens 0.97 mm (0.88-1.04 mm). Prosome 688 μm long. Cephalothorax divided by dorsal suture line into cephalosome and first pedigerous somite. Lateral margin of epimera of third pedigerous somite bordered by narrow membrane. Urosome (fig. 1B) 5-segmented, small, 317 μm long, less than half length of prosome. Fifth pedigerous somite 155 μm wide, with sleeve-like, large posterior extension on both sides near base of free segment of leg 5 (figs. 1B, 3B). Genital double-somite 155 $\times$ 125 μm, expanded near middle, 70 μm wide across narrowed posterior part. Genital areas located laterally. Three abdominal somites 25 $\times$ 65, 25 $\times$ 65, and 17 $\times$ 63 μm, from anterior to posterior. Posteroventral margin of anal somite ornamented with fine spinules. Caudal ramus (fig. 1C) nearly rectangular, 42 $\times$ 28 μm (ratio 1.50:1), slightly shorter than anal somite; posteroventral margin equipped with fine spinules. Two median terminal setae out of 6 caudal setae weakly plumose, other four setae naked; proximal caudal seta located dorsally at midlength of caudal ramus and characteristically swollen proximally (fig. 1C). Egg sac unknown.

Rostrum distinct and strongly tapering (fig. 1D). Antennule (fig. 1E) 293 μm long and 7-segmented, with armature formula 4, 13, 6, 3, 4 + 1 aesthetasc, 2 + 1 aesthetasc, and 4 + 1 aesthetasc; all setae naked. First and second segments distinctly wider than remaining ones. Two of 4 setae on first segment distinctly larger than other 2 setae on same segment. Terminal segment shorter than wide. Antenna (fig. 1F) 4-segmented. First segment (coxobasis) with 1 inner distal seta. Second segment with 1 inner seta and pointed outer distal corner. Third segment with 1 setiform claw and 3 setae. Fourth segment 50 $\times$ 20 μm, with 3 setiform claws and 4 setae.

Labrum (fig. 2A) posteriorly elongated, with deep and narrow posteromedian incision. Mandible (fig. 2B) curved at right angle near base of blade, with 1 scale on convex side, a row of spines, and 1 isolated subterminal spine on concave margin of blade. Blade moderately elongate and evenly tapering. Convex margin of lash with numerous minute denticles. Maxillule (fig. 2C) armed with 3 terminal naked setae and 1 lateral setiform element. Maxilla (fig. 2D) with unarmed first segment. Second segment with small proximal seta, naked anterior seta, elongate, spinulated inner setae, and spines along inner margin distal to inner seta. Distal lash slender and basally well demarcated from second segment. Maxilliped (fig. 2E) with unarmed first segment. Second segment with protruded outer margin in proximal half, with 1 small tubercle proximally near inner margin and 2 naked setae, one of these characteristically recurved. Third segment divided by incomplete proximal suture line into 2 parts, distally tapering, with 1 seta on distal part.

Legs 1-4 (figs. 2F-H, 3A) with 3-segmented exopod and endopod. Third exopodal segment of legs 1-3 with bifid terminal process. Third endopodal segment of legs 3 and 4 with dentiform process on distal part of inner margin. Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-0; exp. I-0; I-1; III,I,4; enp. 0-1; 0-1; I,5
Leg 2: coxa 0-1; basis 1-0; exp. I-0; I-1; III,I,5; enp. 0-1; 0-2; I,II,3

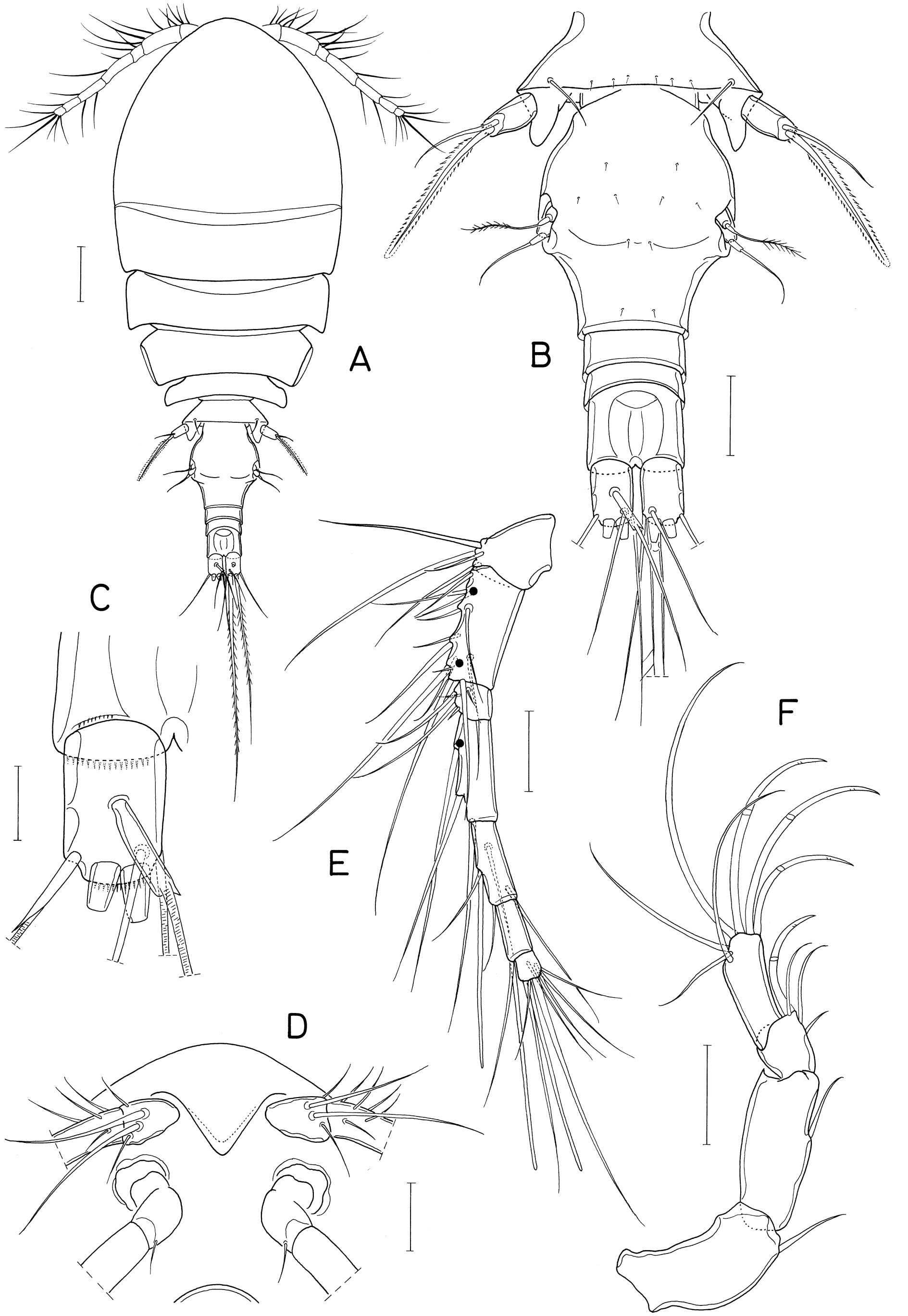

Fig. 1. *Eupolymniphilus orientalis* n. sp., female. A, habitus, dorsal; B, urosome, dorsal; C, caudal ramus, dorsal; D, rostral area, ventral; E, antennule (dots indicate insertions of additional aesthetascs in male); F, antenna. Scales: A, 0.1 mm; B, D-F, 0.05 mm; C, 0.02 mm.

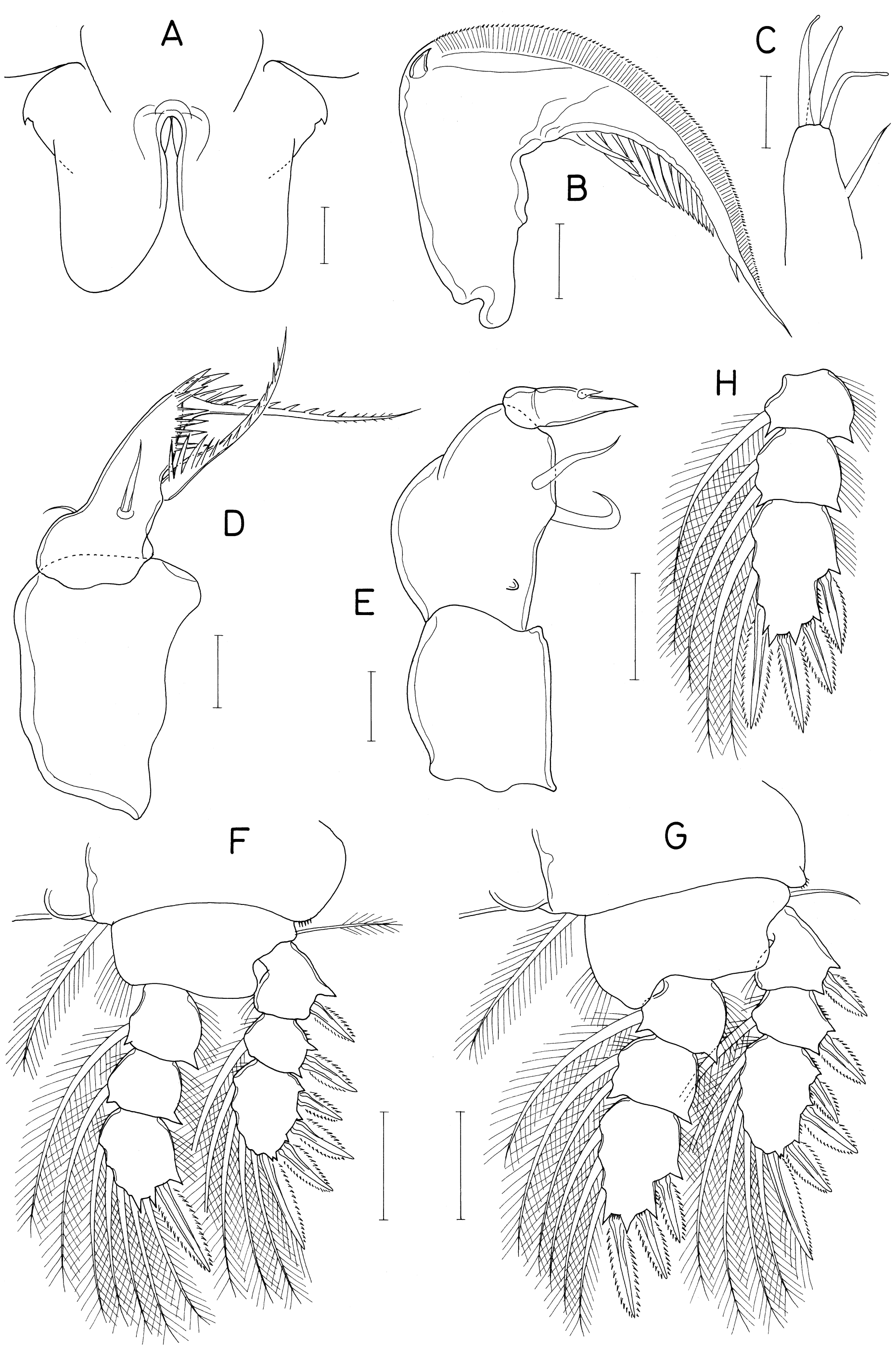

Fig. 2. *Eupolymniphilus orientalis* n. sp., female. A, labrum; B, mandible; D, maxillule; D, maxilla; E, maxilliped; F, leg 1; G, leg 2; H, endopod of leg 3. Scales: A-E, 0.02 mm; F-H, 0.05 mm.

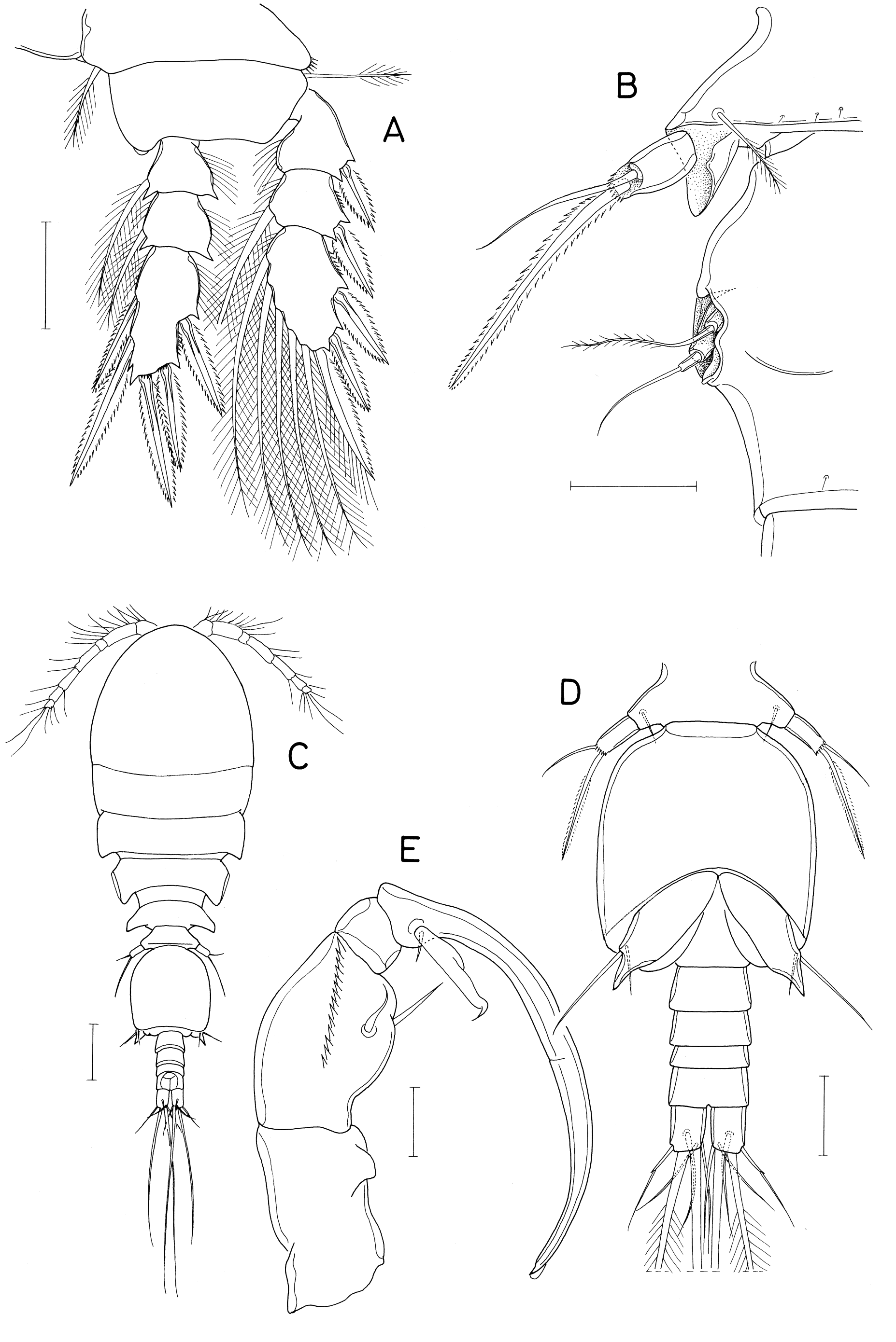

Fig. 3. *Eupolymniphilus orientalis* n. sp., A-B, female: A, leg 4; B, left leg 5 and genital area, dorsal; C-E, male: C, habitus, dorsal; D, urosome, ventral; E, maxilliped. Scales: A, B, D, 0.05 mm; C, 0.1 mm, E, 0.02 mm.

Leg 3: coxa 0-1; basis 1-0; exp. I-0; I-1; III,I,5; enp. 0-1; 0-2; I,II,I + 1
Leg 4: coxa 0-1; basis 1-0; exp. I-0; I-1; II,I,5; enp. 0-1; 0-1; I,II,II

Leg 5 consisting of a single free segment and 1 plumose dorsolateral seta on fifth pedigerous somite (fig. 3B). Free segment 36 × 18 μm, terminally serrated and armed with 1 long spine (112 μm) and 1 naked seta (74 μm). Leg 6 represented in genital area by plumose, proximally thickened anterior seta and naked posterior seta bearing rod-shaped base.

Male. — Body (fig. 3C) similar to that of female. Body length 858 μm. Greatest width 290 μm. Urosome (fig. 3D) 6-segmented. Fifth pedigerous somite 105 μm wide. Genital somite 150 × 137 μm. Four abdominal somites 28 × 52, 23 × 51, 13 × 50, and 25 × 50 μm, respectively. Caudal ramus 45 × 22 μm, ratio of length to width 2.05 : 1.

Rostrum as in female. Antennule with 3 additional aesthetascs: 2 on second and 1 on fourth segments as indicated by dots in fig. 1E. Antenna with a few additional spinules on proximal half of inner margin of second segment.

Mouthparts as in female except for maxilliped. Maxilliped (fig. 3E) 4-segmented including terminal claw. First segment unarmed. Second segment expanded in middle, with 1 longitudinal row of spinules and 2 inner setae. Third segment small and unarmed. Terminal claw arched, as long as 3 proximal segments combined, proximally with 1 large transformed seta and 1 small seta.

Legs 1-4 as in female. Third endopodal segment of leg 1 armed as in female. Free segment of leg 5 with parallel lateral margins. Leg 6 represented by 1 longer and 1 shorter seta on genital flap (fig. 3D).

Etymology. — The specific name *orientalis* refers to the origin of the new species from the oriental region. The name is an adjective agreeing in gender with the (masculine) generic name.

DISCUSSION

Eupolymniphilus is a genus proposed by Humes & Boxshall (1996) to incorporate *Herrmannella finmarchica* T. Scott, 1903. This species was redescribed by G. O. Sars (1918) under the same name. Later, Humes (1967) transferred this species to *Scambicornus*, a genus belonging to another lichomolgoid family, the Synapticolidae. *Herrmannella* is now classified as a genus of the Lichomolgidae. *Eupolymniphilus finmarchicus* (T. Scott, 1903) has the same leg setation as in the species of *Scambicornus*, but Humes & Boxshall (1996) explained that it differs from the members of *Scambicornus* and other synapticolids in the possession of one slender claw on the third antennary segment and of several slender, but claw-like elements on the well-developed fourth segment. *Eupolymniphilus finmarchicus* is known only by the female.

Bocquet et al. (1963) described *Preherrmannella armoricana* as a new species on the basis of two males discovered on the polychaete, *Polymnia nebulosa* (Montagu, 1818) from northern France. This species was then transferred to *Scambicornus* by Humes (1967), and Humes & Stock (1973) noted that the species might belong to a new genus. Later, Holmes & Gotto (1992) synonymized *S. armoricanus* with *S. finmarchicus* and explained that the specimens (males) of *S. armoricanus* were the male of *S. finmarchicus*, which had been known only by the female until that time. They collected several specimens of both sexes from the southwest coast of Ireland, mostly from unknown hosts except for a single male that was discovered on the nemertean, *Lineus longissimus* (Gunnerus, 1770). Gotto (1993) also noted the possibility of the conspecificity of the two species but recorded them separately.

Eupolymniphilus orientalis n. sp. is closely similar to *E. finmarchicus* in having an identical setation of the legs and an identical form of the antenna, but differs from the European species, because it has distinctly shorter caudal rami with a ratio of length to width of 1.50 : 1 (about 4 : 1 in *E. finmarchicus*, according to the illustration given by G. O. Sars, 1918). The form of the second segment of the maxilla also differs between the two species: the terminal lash of this appendage is clearly demarcated from the second segment in *E. orientalis*, but is not demarcated in *E. finmarchicus*.

Humes & Boxshall (1996) did not include *Scambicornus tenuicaudis* (G. O. Sars, 1918) in *Eupolymniphilus* in spite of the fact that this species agrees exactly with their definition of *Eupolymniphilus*. This species should hence be transferred to this genus and be called *E. tenuicaudis* (G. O. Sars, 1918).

A comparison of *E. finmarchicus*, *E. tenuicaudis*, and *E. orientalis* suggests that the members of *Eupolymniphilus* are very homogeneous in morphology. For example, in the descriptions of *E. finmarchicus* and *E. tenuicaudis* by G. O. Sars (1918), these two species can be differentiated only by the shape of the caudal rami. In this respect, I consider that *S. armoricanus* (= *E. armoricanus*) and *S. finmarchicus* (= *E. finmarchicus*) are different species. These species may be distinguished by the following dissimilarities: (1) the fourth segment of the antenna of *E. finmarchicus* is more slender than that of *E. armoricanus*, and (2) unlike *E. finmarchicus*, *E. armoricanus* has a pointed outer distal process on the second segment of the antenna as in *E. orientalis*; (3) the caudal ramus of *E. finmarchicus* is distinctly longer than that of *E. armoricanus* (about twice as long as wide according to the illustration given by Bocquet et al., 1963); (4) the terminal lash of the maxilla is clearly demarcated from the second segment in *E. armoricanus*, but is not demarcated in *E. finmarchicus*.

Therefore, *Eupolymniphilus* is here considered to consist of four known species: *E. finmarchicus* (T. Scott, 1903), *E. tenuicaudis* (G. O. Sars, 1918), *E. armoricanus*

(Bocquet, Stock & Kleeton, 1963), and *E. orientalis* n. sp. They can be differentiated using the following key:

1. Mandible with 1 distinct outer scale; proximal seta on caudal rami with broadened proximal part .... *E. orientalis*
– Mandible without such outer scale; proximal seta on caudal rami not specialized 2
2. Caudal rami more than 10 times as long as wide .... *E. tenuicaudis*
– Caudal rami about 4 times as long as wide or less 3
3. Outer distal corner of second antennal segment sharply pointed; its fourth segment at most twice as long as wide; lash of maxilla clearly demarcated from second segment .... *E. armoricanus*
– Outer distal corner of second antennal segment not pointed; its fourth segment more than twice as long as wide; lash of maxilla not demarcated from second segment .... *E. finmarchicus*

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