

New records of *Colobomatus mylionus* Fukui, 1965 and *Clavellisa chinensis* (Yü, 1933) (Crustacea: Copepoda) parasitic on marine fish of Korea

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Two parasitic copepods, poecilostomatoid *Colobomatus mylionus* Fukui, 1965 and siphonostomatoid *Clavellisa chinensis* (Yü, 1933), were reported for the first time from Korea and redescribed based on the females collected from the marine fish of Korean waters. The *C. mylionus* was collected from the blackhead seabream, *Acanthopagrus schelegelii* (Bleeker). *Colobomatus mylionus* had been frequently reorded from marine teleost fishes from of Eden, Newcastle, Brisbane, Yelloon, and Point Sampson. The second record was *C. chinensis* redescribed based on the speciemens collected from the gills of a Japanese grenadier anchovy, *Coilia nasus* Temminck and Schlegel. Some differences were observed between the original description of known specimens examined in this study, these differences do not warrant a change in the taxonomic staus of the two species. The attachment site of all two copepods reported from Korea were the cephalic sensory canals and gills.

Keywords: first records, fish parasites, Lernaeopodidae, Philichthyidae, Poecilostomatoida, Sihponostomatoida

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INTRODUCTION

Most members of the cyclopoid and siphonostomatoid copepods are a common component of the ectoparasite assemblages of all kinds of fish, from all environments and ecosystems (Kim, 1998; 2014; Boxshall and Halsey, 2004). The cyclopoids comprise 29 families and are the most common parasites of marine fish (Boxshall and Halsey, 2004; Kim, 2014; WoRMS, 2019). The fish-parasitic cyclopoids fauna of Korean marine fish was reviewed by Kim (1998; 2014), who has recorded a total of 64 species. Of these, the family Philichthyidae Vogt, 1877 comprises highly modified and internal parasitic species, which are generally endoparasitic in occupying spaces associated with the sensory canals of the lateral line and skull bones of marine actinopterygians (Boxshall and Halsey, 2004; Madinabeitia *et al.*, 2013; Kim, 2014). This family comprises nine genera and the largest genus, *Colobomatus* Hesse, 1873 currently contains 72 species (Boxshall and Halsey, 2004; Castro Romeo and Muñoz, 2011; Pereira *et al.*, 2012; Madinabeitia *et al.*, 2013; Kim and Moon, 2013; Pombo *et al.*, 2015; Paschoal *et al.*,

2016). However, only five species have been reported from Korean waters, *i.e.*, *Colobomatus similis* Kim, 1995, *C. orientalis* Kim and Moon, 2013, *C. recticaudatus* Kim and Moon, 2013, and *C. unimanus* Kim and Moon, 2013 (Kim, 1995; 1998; 2014; Kim and Moon, 2013).

The siphonostomatoids comprise 41 families the most common parasites of marine fish (WoRMS, 2019). The Lernaeopodidae Mile Edwards, 1840 is a large family that comprises ca. 380 species of 48 genera and are ectoparasites of marine fish (Kabata, 1979; Kim, 1998; Boxshall and Halsey, 2004). They are most widely adjusted to parasitism and are highly host-specific (Kabata 1979; 1986). The genus *Clavellisa* Wilson, 1915 is currently 12 valid species with almost all of their members occurring as the gill parasites of teleosts of the order Clupeiformes (Kabata, 1979; WoRMS, 2019).

We need to improve our knowledge of the biodiversity of parasitic copepods in Korea (Kim, 1998; 2014; Moon and Kim, 2012; Kim and Moon, 2013; Venmathi Maran *et al.*, 2015; Moon *et al.*, 2015). Recently, we were able to examine various marine fish caught mainly from Korean coasts to collect parasitic copepods. Among the

collected fish-parasitic copepods, *Colobomatus mylionus* Fukui, 1965 from the blackhead seabream, *Acanthopagrus schelegelii* (Bleeker, 1854), and the rediscovery of *C. chinensis* recovered from the gills of Japanese grenadier anchovy, *Coilia nasus* Temminck and Schlegel, 1846 from Korean waters.

METHODS

Parasitic copepods were collected from the cephalic sensory canals and gills of marine fish caught in the Korean coastal waters (Fig. 1). Parasitic copepods were carefully removed from the cephalic sensory and gills of the hosts by using fine forceps and were observed under a dissecting microscope. Copepods specimens were preserved in 70% ethanol and subsequently cleared in a drop of 80% lactic acid before examination using an Olympus BX51 differential phase-contrast microscope. Examination was carried out using the wooden slide method (Humes and Gooding, 1964). Drawings were made with the aid of a drawing tube mounted on a Nikon Eclipse 80i microscope. After the microscopic examination, the dissected appendages were mounted on a slide in lactophenol mounting medium. Preparations were sealed with transparent nail varnish. The morphological terminology follows Kabata (1979) and fish names follow FishBase (2019). The total body length of each examined specimen was measured from the frontal tip of the cephalosome and/or trunk to the posterior margin of the caudal rami excluding the caudal setae, using a micrometer. Specimens are deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea. Here, are the first records of two species in Korean waters.

SYSTEMATIC ACCOUNTS

Order Cyclopoida Burmeister, 1834 검물벼룩목
Family Philichthyidae Vogt, 1877 괴벌레과
Genus *Colobomatus* Hesse, 1873 괴벌레속

Colobomatus mylionus Fukui, 1965

Korea name: Gam-seong-dom-goe-beol-rae
감성돔괴벌레 (신칭) (Fig. 2)

Colobomatus mylionus Fukui, 1965: p. 60, fig. 1; Bynes and Cressey 1986, p. 388, figs. 1–15; West, 1992, p. 125, figs. 190–207.

Material examined. Korea: Two females (NIBRIV00002 93066, one vial), coast of Shinji-do (34°19'27"N, 126°53'08"E), Jeollanam-do province, southern Korea, 12 September, 2012, Seong Yong Moon.

Description. Female. Total body length (Fig. 2A) 3.19 to 4.16 mm long ($n=2$) and unsegmented, without divisions between cephalosome and trunk or between trunk and urosome. Maximum width of cephalic region, 398 μ m, measured in the oral region. Cephalic region with three frontal processes: paired anterolateral processes (Fig. 2A) tapering, 356 μ m long, with blunt tip and rosette-like papillae in distal region; small mid-frontal process (Fig. 2B) about 164 μ m long, with rosette-like papillae apically. All processes have pointed tips and bearing spinose ornamentation. Trunk with two pairs of lateral processes: anterolateral processes located midway level between legs 1 and 2, about 420 μ m long, with tip covered with rosetted papillae; posterolateral process positioned at level of leg 3, about 490 μ m larger than the anterolateral one, confusing with trunk at base, with distal end bifurcated and covered with rosette papillae. Posterior part of body strongly nar-

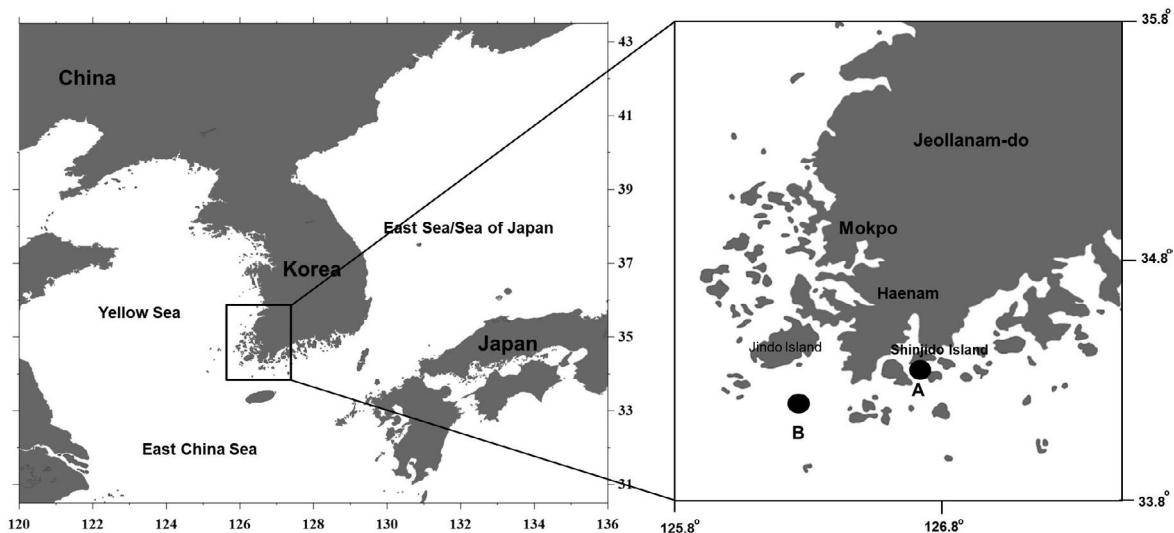


Fig. 1. Distribution of records of parasitic copepods in Korea. A. *Colobomatus mylionus* Fukui, 1965. B. *Clavellisa chinensis* (Yü, 1933).

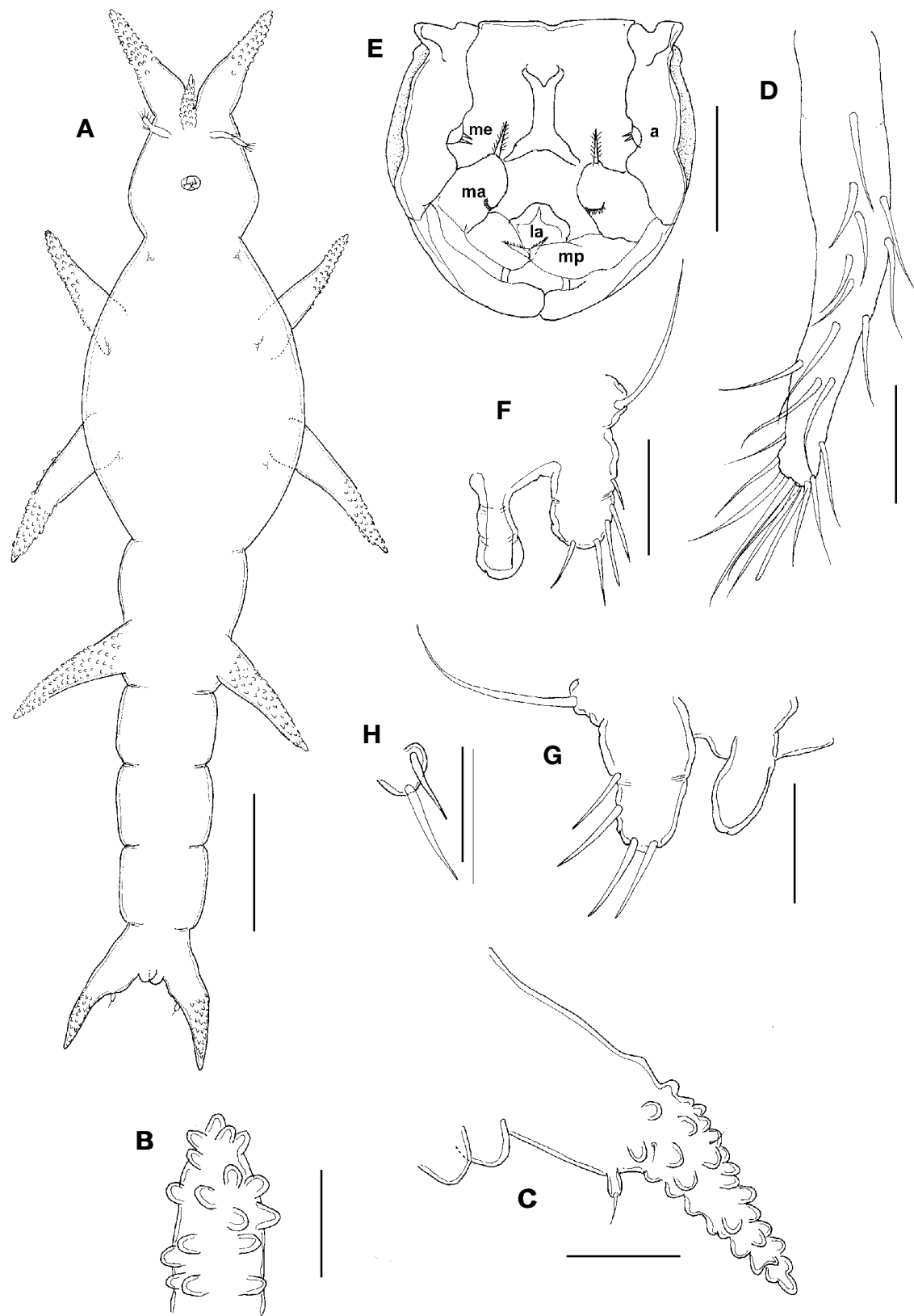


Fig. 2. *Colobomatus mylionus* Fukui, 1965, adult female from Shinji-do Island, Korea. A. habitus, ventral view. B. small mid-frontal process of cephalosome. C. caudal ramus, proximalateral seta of caudal rami. D. antennule. E. buccal area, showing position of antenna (a), maxillule (me), maxilla (ma), maxilliped (mp), and labium (la). F. leg 1. G. leg 2. H. leg 3. Scale bars: A = 500 μ m; B–H = 100 μ m.

rowing behind posterolateral processes. Urosome with paired ventrolateral processes in the genital area; these processes weakly tapering, about 440 μm long, directed posterolaterally, with granule-like ornaments near the tip. Genital aperture located dorsolaterally, without any armature element. Abdominal region recurved dorsally. Caudal ramus (Fig. 2C) directed anterodorsally, 332 μm long, about 3.1 times as long as wide, with several scattered setules.

Antennule (Fig. 2D) unsegmented, about 113 μm long, with narrower distal two-fifths, and armed with 21 naked setae and one aesthetasc. Antenna forming anterior margin of buccal capsule, with posteromedial margin indented (Fig. 2E, a). Buccal capsule as small ventral projection; mouth organs invisible. Labrum and mandibles not seen. Maxillule small, bearing a single apical spine (Fig. 2E, me). Maxilla with basal segment bearing ventral spine-cluster in semi-circular formation, denticulate auxiliary spine and denticulate claw (Fig. 2E, ma). Labium undivided (Fig. 2E, la). Maxilliped finger-like with an apical spine (Fig. 2E, mp).

Leg 1 (Fig. 2F) biramous, located at anterior region trunk, consisting of weakly defined protopod and unsegmented rami; protopod with one outer seta; exopod with five setae; small endopod lobate and unarmed. Leg 2 (Fig. 2G) biramous, located at level of anterior processes of trunk and consisting of separated outer seta, exopod bearing four setae, endopod lobated and unarmed. Leg 3 (Fig. 2H) small, reduced to turbicula bearing two setae. Legs 4 to 6 absent.

Male. Not collected.

Host. *Acanthopagrus schelegelii* (Bleeker, 1854)

Distribution. *Colobomatus mylionus* has been recorded in Japanese waters (Fukui, 1965), and from Eden, Newcastle, Brisbane, Yellon, and Point Sampson (Byrnes and Cressey, 1986) in Australian waters (West, 1992). This is the first record of this species in Korean waters.

Remarks. *Colobomatus* has the following major features which provide a key for females: (1) the body is highly modified and elongated, comprising cephalosome, fused thoracic somites, abdomen, and caudal rami; (2) the presence of at least two pairs of divergent lateral processes in the thoracic region, arranged in the shape of an “x”; and (3) leg 4 being reduced to a single seta and/or absent (Fukui, 1965; West, 1992; Boxshall and Halsey, 2004; Pereira *et al.*, 2012; Paschoal *et al.*, 2016). To date, the presence of a single midventral simple cephalic process, two lateral cephalic processes, and processes on the trunk in *C. mylionus* are shared by another 19 species (Paschoal *et al.*, 2016, see Table 2). *Colobomatus mylionus* was originally described and illustrated from a single damaged adult female from the *A. schlegelii* (Fukui, 1965). After that, 51 females and two males were collected from the cephalic canal system adjacent to the nasal cavity of *A. australis*

(Günther, 1859), *A. berda* (Forsskål, 1775), and *A. latus* (Houttuyn, 1782) from off Eden, Newcastle, Brisbane, Yellon, and Point Sampson (Byrnes and Cressey, 1986). Three female specimens of *C. chinensis* were found infected from gill rakers of the Japanese grenadier anchovy, *Coilia nasus*. Korean specimens of *C. chinensis* can be distinguished from other species of the genus by the following characters: the subcylindrical head is nearly rectangular, the neck cylindrical and the trunk bunkler.

Careful comparison between our material and the complete description and illustration provided by West (1992) revealed some differences: (1) shorter thoracic lobes and caudal rami; (2) the protopod of legs 1 and 2 has one lateral seta; (3) the exopod of leg 1 has five setae; (3) the exopod of leg 2 has four setae; and (4) the leg 3 has two setae. However, our material to be identified with *C. mylionus* because of the presence of rosette-like papillae on the surface of the lateral processes of the female. The new Korean name of “Gam-seong-dom-goe-beol-rae” proposed for *C. mylionus*.

Order Siphonostomatoida Thorell, 1859 대롱입요각목
Family Lernaeopodidae Mile Edwards, 1840 턱벌레과
Genus *Clavellisa* Wilson, 1915 긴목털벌레속

Clavellisa chinensis (Yü, 1933)

Korea name: Ung-eo-gin-mok-teol-beol-rae
웅어긴목털벌레 (신칭) (Fig. 3)

Epiclavella chinensis Yü, 1933, p. 134, pl. 8, figs. 1–7.

Material examined. Three females (NIBRIV0000293 065, one vial), off Haenam-gun (34°19'24"N, 126°28'07"E), Jeollanam-do Province, southern Korea, 27 June, 2013, Seong Yong Moon.

Description. Female. Total body length 2.78 mm. Cephalothorax (Fig. 3A, B) is extremely elongated, about 1.46 times as long as the trunk. Head subcylindrical, nearly rectangular, with slightly expanded anterior end. Trunk (Fig. 3A, B) buckler-shaped in dorsal view, 1.34 times (1.252 × 0.932 mm) longer than wide with nearly parallel lateral margin and rounded posterior corners. Antennule (Fig. 3C) incompletely three-segmented; proximal and second segments armed with a seta (whip) on medioventral margin; distal segment with slightly tapering tip with prominent gibbous and apical armature consisting of five setae and three tubercles. Antenna (Fig. 3D) biramous, elongate; exopod prominent and longer than endopod, armed with one seta and four prominent claws; endopod one-segmented, armed apically with three spiniform setae. Mandible small, with subapical marginal teeth as Fig. 3E. Maxillule (Fig. 3F) biramous, with small endopod and prominent tripartite exopod; endopod composed of short digitiform process surmounted with patch of spinules me-

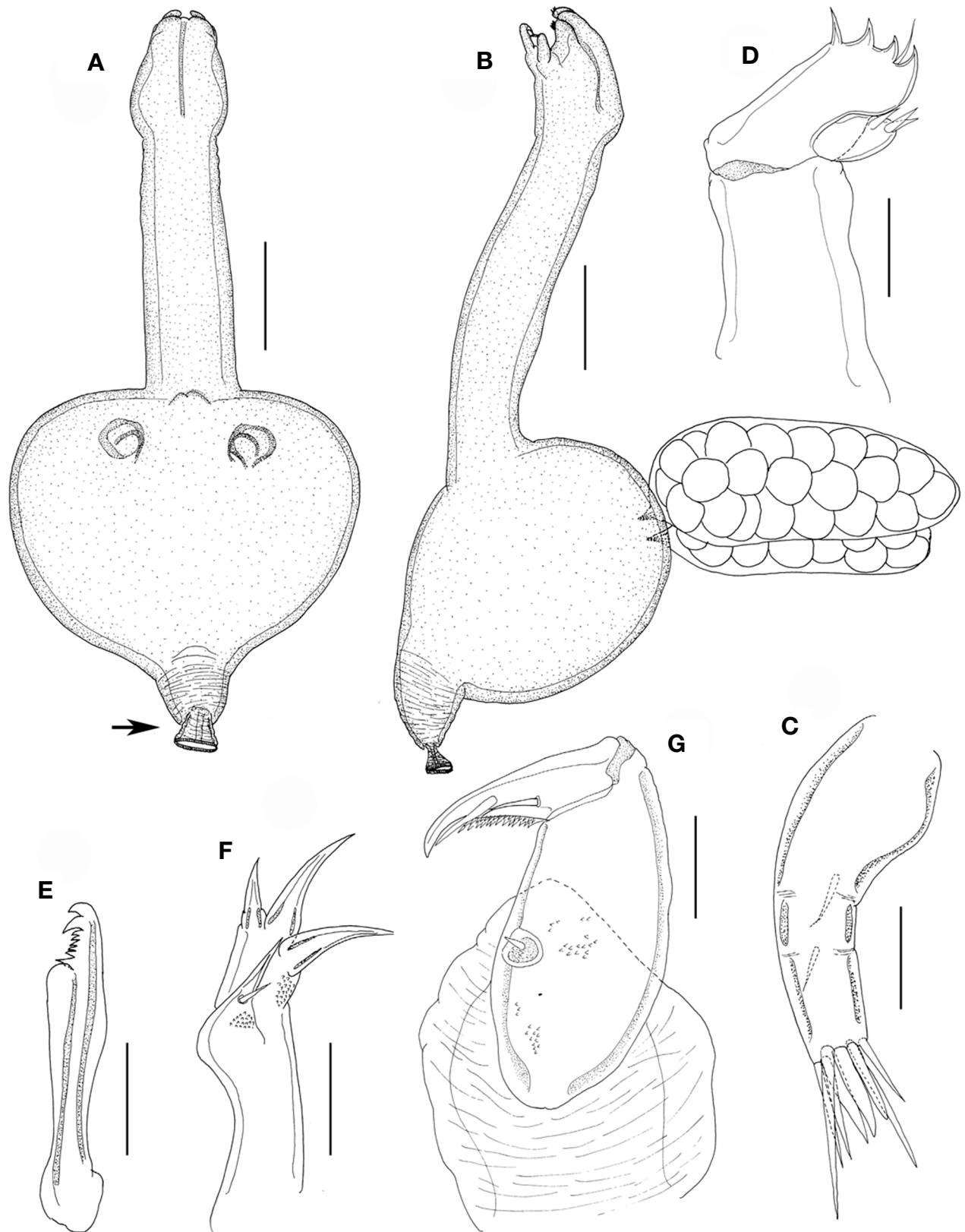


Fig. 3. *Clavellisa chinensis* (Yü, 1933), adult female. A. habitus, dorsal view. B. habitus, lateral view. C. antennule. D. antenna. E. mandible. F. maxillule. G. maxilliped. Scale bars: A, B = 500 μ m; C, D, G = 200 μ m; E, F = 100 μ m.

diolaterally and a single seta; exopod tripartite with patch of spinules mediolaterally, two large digitiform processes, and a short third one ending with conical elongate setiferous processes. Maxilla (arrowed in Fig. 3A) forming arms serving as primary attachment organ; each maxillary arm short, tapering and closely opposed to opposite member, but apparently not fused; bulla ovoid. Maxilliped (Fig. 3G) subchelate with robust corpus, covered by thick, wrinkled cuticle and a single seta on medial side; long slender subchela with a single seta on ventral margin and a row of teeth at base; large claw (constituting almost one-third of subchela), large auxiliary seta at base of claw medially. Thoracic appendages not observed.

Male. Not found.

Host. *Coilia nasus* Temminck and Schlegel, 1846

Distribution. *Clavellisa chinensis* has been found only off Xiamen, China (Yü, 1933). This is the first record of this species in Korean waters.

Remarks. Genus *Clavellisa* consists of 12 valid species (WoRMS, 2019), which are associated with clupeiform fish, particularly those from Indian waters (Kabata, 1979). *Clavellisa chinensis* was originally reported from off Xiamen, China, and the parasites were reported as *Epiclavella chinensis* from Gray's grenadier anchovy, *Coilia grayii* Richardson, 1845 (Yü, 1933). This species was previously placed in the genus *Clavellisa* and like its congeners was parasitic on a clupeiform fish, *Co. grayii* (Kabata, 1979). In this study, after more than 80 years since *Cl. chinensis* was reported, we successfully rediscovered this species from the *Co. nasus*. The female is of the usual *Clavellisa* form. The subcylindrical head is nearly rectangular, the neck cylindrical, and the trunk buckler-shaped, which allowed the Korean specimens to be identified with *Cl. chinensis*. *Clavellisa chinensis* was characterized based on the following adult female features: the cephalothorax elongated, the head subcylindrical is nearly rectangular, the trunk buckler-shaped in dorsal view, the antennule is incompletely three-segmented, the exopod of antenna armed with one seta and four prominent claws, the mandible has eight setae, the maxilla with scattered denticles, and the subchelate of maxilliped with robust corpus, covered by thick, wrinkled cuticle and a medial seta. *Coilia nasus* is distributed in the Northwest Pacific (Yellow Sea, South China Sea, and southwestern Japan) (FishBase, 2019). That is, this species of *Clavellisa* occurs the Indo-Pacific region mainly (Kabata, 1979; WoRMS, 2019). However, the testing of this hypothesis awaits more detailed knowledge of the host-specificity and zoogeography of species of *Clavellisa*. Two species, *C. dorosomatis* Yamaguti, 1939 and *C. chinensis*, of this genus have been recorded from Korean waters (Kim, 1998; this study). In this study, I confirmed a new host of *C. chinensis*, the Japanese grenadier anchovy, *Coilia nasus*. The new Korean name of "Ung-eo-gin-mok-teol-beol-rae" is proposed for

C. chinensis.

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