

Two species of Parasitic Copepods (*Clavellopsis hugu* and *Taeniacanthus yamagutii*) from the Cultured Marine Fish, *Takifugu obscurus*, from the Western Coast of Korea

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Two species of the parasitic copepods, *Clavellopsis hugu* (Lernaeopodidae; Siphonostomatoida) and *Taeniacanthus yamagutii* (Taeniacanthidae; Poecilostomatoida) from cultured Korean fish, *Takifugu obscurus*, is described and reported for the first time in Korea. The parasite was recovered from the buccal cavity, nose and skin. *Clavellopsis hugu* is easily identified by the body shape, 2nd antenna, mandible and 2nd maxillae. In female, cephalothorax flexed dorsally, second antenna biramose, mandible with serrate blade, second maxillae completely fused at base of cephalothorax. In male, cephalothorax and trunk fused into an ovoid, two pairs of maxillipeds chelate. The most distinctive features of *Taeniacanthus yamagutii* are terminal process of second maxilla stout, maxilliped claw with conspicuous digitiform process at base and a setiform element at the tip of each exopod spine of legs 2-4. Both parasitic copepod species are new to the Korean fauna. The Korean fish, *Takifugu obscurus* should be considered as an additional host of this species because these parasite were recovered from the western coast of Korea (Boryung Hatchery).

Key words: Parasitic copepoda, *Clavellopsis hugu*, *Taeniacanthus yamagutii*, Cultured Korean fish, *Takifugu obscurus*

Because of serious economic damage, copepod parasites have been considered as enemies of marine fishes (Kabata, 1979; Suh *et al.*, 1992, 1993; Choi *et al.*, 1994, 1995, 1996), marine shellfishes (Wilson, 1938; Davey *et al.*, 1978; Paul, 1983; Suh and Choi, 1990, 1991; Choi and Suh, 1991), and ascidians (Choi and Hong, 1994). Kabata (1981) reviewed the effects of copepod infections on their fish hosts and divided them into two categories: The first, local effects are those limited to the immediate vicinity of the copepod's attachment site and are mainly due to the mechanical influences of its attachment and feeding activities. The second, general effects are those which manifest themselves at sites remote

from the permanent habitat of the adult parasite. Choi *et al.* (1996) examined histologically fish gills invaded by the second antenna of *Acanthochondria sprigera* and found that copepod eat oesophageal mucous.

We had an opportunity to examine specimens of the mortalities of cultured marine fishes, *Takifugu obscurus* occurred on the Western Coast of Korea (Boryung Hatchery). Having studied this material, we recovered two species of copepod parasites: *Clavellopsis hugu* Yamaguti and *Taeniacanthus yamagutii* (Shiino). Those species were all different in their systematic position, belonging to the Taeniacanthidae (Poecilostomatoida) and Lernaeopodidae (Siphonostomatoida) respectively. Both species were described for the first time in Korea.

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Materials and Methods

The fishes examined for the copepod parasites were taken from the western coast of Korea (Boryung Hatchery) at September 1997. The copepod parasites were removed from the buccal, branchial cavities and skin of *Takifugu obscurus*, and where ulceration and bleeding were observed with a large amount of mucus. And all the parasites were fixed in 5% buffered formalin-seawater. For morphological observation the copepods were cleared in lactic acid and dissected on wooden slides as used by Humes and Gooding (1964). Body length was measured from anterior tip of prosome to posterior margin of caudal rami. In the description of armature, Roman and Arabic numerals indicate spines and setae, respectively. All figures were drawn with the aid of a camera lucida. Body structures are described according to the terminology of Shiino (1957) and Kabata (1979).

Results and Discussion

The classification of these species of copepods is listed as follows :

Suborder Siphonostomatoidea Latreille, 1829

Family Lernaeopodidae Edwards, 1840

Clavelloopsis hugu Yamaguti, 1939

Suborder Poecilostomatoidea Thorell, 1859

Family Taeniacanthidae Wilson, 1911

Taeniacanthus yamagutii (Shiino, 1957)

***Clavelloopsis hugu* Yamaguti, 1939**

Material examined

34 females and 29 males obtained from all 6 host individuals. A single host was infected by 19 females in the maxium.

Habitat

Adhering to the roof or floor of buccal cavity, nose and skin. The female buries, further, its anterior portion deep into the furrow of the host skin and thus strengthens the security of fixation. This parasite is unique in having evolved a method of attachment

involving modified second maxillae (first maxilliped) fused with an anchoring device, known as the bulla. Male attaches to the female at the caudal end. In one case, a female was associated with 2 males, but in other cases it had either a single male or none.

Description

Female : Body (Fig. 1A) consisting of a plump, cylindrical cephalothorax, second maxillae and trunk. Cephalothorax prolonged, but relatively broad, vermiform, strongly flexed dorsally as well as posteriorly, extending a trifle beyond caudal end of trunk, and with integument rugose. Length of cephalothorax 2.84 mm based on 5 specimens. Trunk longer than broad, well swollen both laterally and dorsiventrally, ovoidal in shape and carrying a pair of posterior processes, but small or rudimentary. Length, breadth and thickness of trunk $1.54 \times 1.51 \times 1.18$ mm, caudal process 0.56 mm long. Egg sac more than third as long as paired processes, and packed with eggs arranged in several rows. Egg sac 2.13 mm long, color white, egg sac containing yellowish eggs.

Antennule (Fig. 1B) 3-segmented, 1st joint broad and comparatively massive, but other segments slender and rod like. 2nd segment shorter than 3rd segment which is sparingly 3 spinous at the end. Antenna (Fig. 1C) turned inward at right angles, with their biramous apices meeting on midline and hanging over mouth tube. Exopod broader than and extending beyond endopod, round at the end, where it is covered by fine granules besides bearing a short spine. Endopod also blunt and with a short spine. Mouth tube (Fig. 1E, G) conical, opening forward, apex part of same covered by fine cilia. Mandibles (Fig. 1D) have blade reinforced by 9 sharp, recurved teeth, of which 2nd to 4th from the apex interpose a feeble tooth between consecutive 2. First maxilla (Fig. 1H) bipartite, each lobe ending in a sharp spine. Exoite larger than and surmounted with 2 long spines. Endite short, surmounted with 2 short spines. Second maxilla (Fig. 1F) displaced to the posterior end of cephalothorax, completely fused together into a conical structure and in line with trunk. Modified second

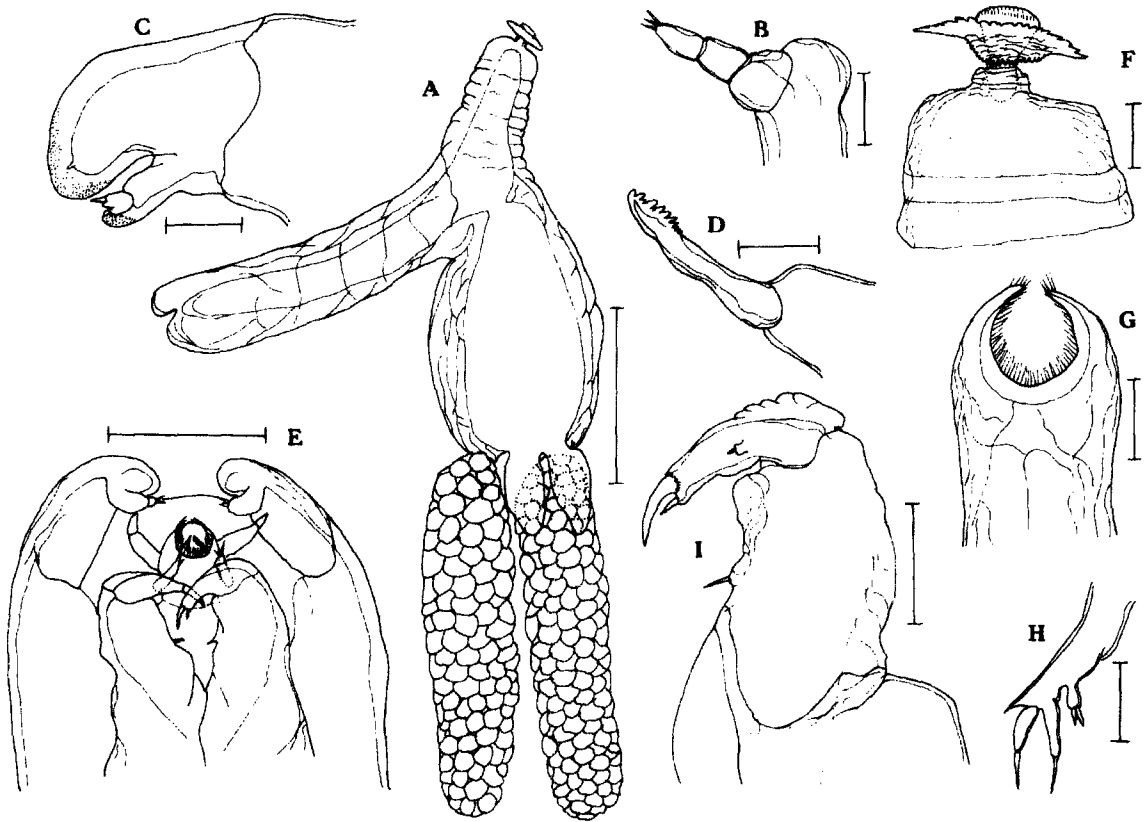


Fig. 1. *Clavellopsis hugu* Yamaguti, Female: A, habitus, lateral; B, first antenna; C, second antenna; D, mandible; E, mouth parts; F, second maxillae; G, mouth tube; H, first maxilla; I, second maxilliped. Scale bar: A = 1.0 mm; B-D = 0.05 mm; E = 0.3 mm; F = 0.1 mm; G-H = 0.05 mm.

maxillae (first maxilliped) fused with an anchoring device, known as the bulla. Bulla shaped like a nail head. Second maxillipeds (Fig. 1I) placed behind other mouth parts and close to the midline. Their palm fusiform, furnished at about the center of inner border with a conical papilla surmounted by a short spinule. Finger nearly straight, with a tiny basal spine and a sharply pointed, curved terminal claw which is associated at the origin with a short accessory spine.

Male : Body (Fig. 1A) is bent in a V-shape, consisting of cephalothorax and cylindrical trunk. Cephalothorax 0.58 mm long, 0.38 mm thick. Cephalothorax with carapace distinct and convex and making a triangle in lateral aspect. Trunk 0.65 mm long, 0.32 mm thick. Trunk well developed, larger than cephalothorax, from which it is well demarked and

with which it makes an obtuse angle. It is cylindrical, nearly straight, but round at caudal end and has no trace of segmentation. Cephalic appendages and oral tube large in size, projecting forward.

Antennule (Fig. 2B) styliform, 3-segmented. 1st and 2nd with a small spinous, respectively. 2nd segment shorter than 3rd segment which is sparingly 3 spines and a small spinous at the end. Antenna (Fig. 2C) bilobed, endopodite ovate and exopodite 2-jointed, extending beyond endopodite. Endopodite armed with marginal spinules on outer side besides with a small spinous. First jointed of exopodite elongate, distinctly bordered basally, 2nd jointed armed with marginal spinules on outer side besides with a stout apical claw. Mandibles (Fig. 2D) styliform have blade reinforced by 9 sharp. Maxillule (Fig. 2E) resembl-

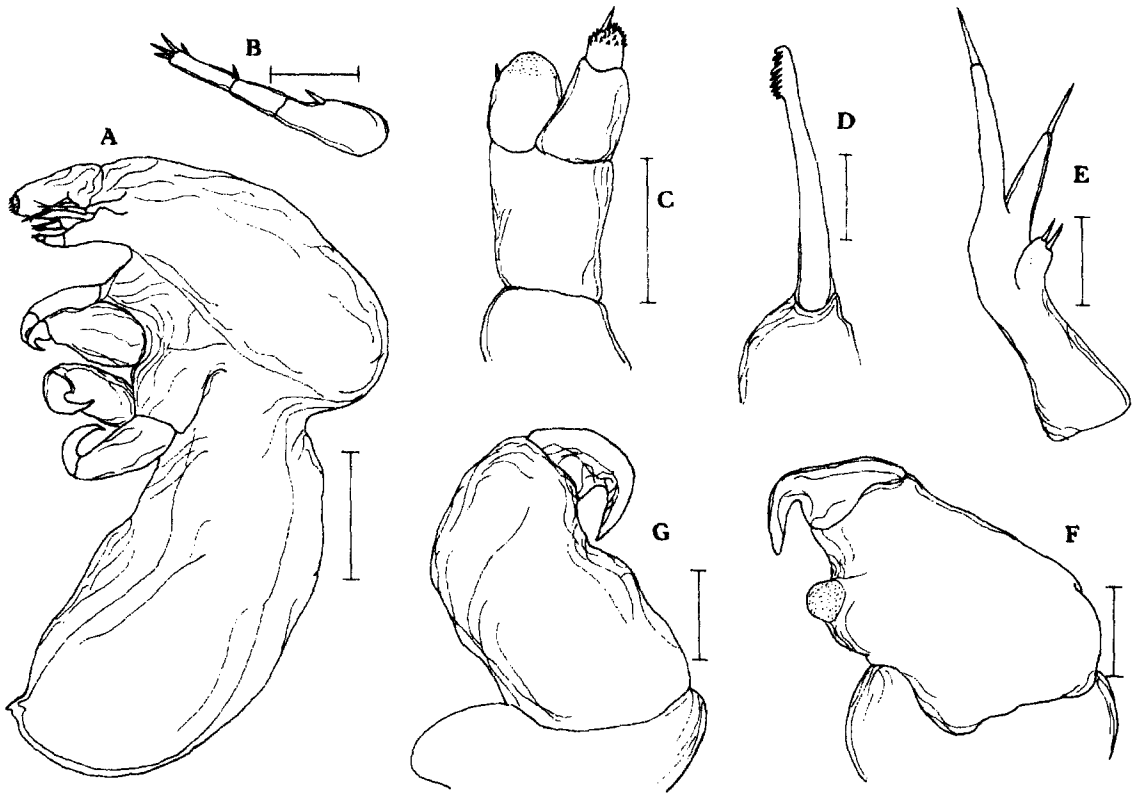


Fig. 2. *Clavellopsis hugu* Yamaguti, Male: A, habitus, lateral; B, first antenna; C, second antenna; D, mandible; E, maxilla; F, first maxilliped; G, second maxilliped. Scale bar: A = 0.2 mm; B-C = 0.05 mm; D-E = 0.025 mm; F-G = 0.05 mm.

ing those of female, forked into 2 spine-tipped, styliform lobes and bearing a short endite tipped by 2 tiny spines. First maxillipeds (Fig. 2F) palm oblong, produced on inner margin near distal end into a finely granulated, molar-like protuberance against which an acuminate, strongly curved terminal claw. Second maxillipeds (Fig. 2G) as stout as preceding limbs, resembling in structure and armed with similar inner distal protuberance on the palm.

Remarks

Clavellopsis hugu was first reported from *Spheroides rubripes* at sea of Japan (Yamaguti, 1939). It was found again from *S. alboplumbeus* at Wakayama Pref., Japan (Shiino, 1957). This is the third report of this species from *Takifugu obscurus* in the western coast of Korea (Boryung Hatchery). *C. hugu* is easily identified by the body shape, 2nd antenna, mandible

and 2nd maxillae (Table 1). In female, cephalothorax flexed dorsally, second antenna biramose, mandible with serrate blade, second maxillae completely fused at base of cephalothorax. In male, cephalothorax and trunk fused into an ovoid, two pairs of maxillipeds chelate.

Resembling in many respects of original species, the present species differs from it in having 9 sharp teeth of the mandible. The shape of body is also somewhat different from that figured by Shiino. This is subject to changes due to the conditions of fixation to some extent. And individual variations may occur also. Even among my specimens, whether the 2nd maxillae is reduced short conical structure or well developed. The Korean fish, *Takifugu obscurus* should be considered as an additional host of this species because *C. hugu* were recovered from

Table 1. Comparison of morphological features among *Clavellopsis hugu* which infected in the marine fish

Items	<i>Clavellopsis hugu</i>		
	Present	Shiino (1957)	Yamaguti (1939)
Host	<i>Takifugu obscurus</i>	<i>Spheroides alboplumbeus</i>	<i>Spheroides rubripes</i>
Cephalothorax	Flexed dorsally	Flexed dorsally	Flexed dorsally
Length of cephalothorax	2.84 mm	2.86 mm	--
Posterior process	Present	Present	Present
Trunk	1.54 × 1.51 × 1.18 mm	1.47 × 1.71 × 1.21 mm	--
Caudal ramus	0.56 mm	1.00 mm	--
Antennule	3 spinous	3 spinous	3 spinous
Endopo of antenna	1 spine	1 spine	1 spin
Mandible	9 teeth	8 teeth	? teet
Endite of maxillul	2 spine	2 spine	2 spin
Second maxillae	Bulla type	Bulla type	Bulla type
Second maxilliped	3 spinule, 1 claw	3 spinule, 1 claw	3 spinule, 1 claw

the western coast of Korea (Boryung Hatchery).

Taeniacanthus yamaguti (Shiino, 1957)

Material examined

18 females obtained from all 6 host individuals. A single host was infected by 19 females in the maxium.

Habitat

On inner surface of operculum and floor of gill cavity. The parasite swallows up the host skin in the ventral depression of carapace, bringing about a mammiform tumor on the skin, and thus hold the body securely together with the aid of mouth parts.

Description

Female : Body (Fig. 3A) cyclopid, oculate, head fused with first segment and enlarged, the rest of metasome gradually narrowed posteriorly, without fusion of segments. Total length 2.21 mm and greatest width 1.15 mm based on 5 specimens. Cephalothorax 0.39 × 1.15 mm, comprising less than 20% of total body length. Thoracic segment bearing legs 2, 3, and 4 relatively large and decreasing in width posteriorly. Genital complex (Fig. 3A, 4A) wider than long, 0.17 × 0.34 mm, with rows spinules on posteroventral margin. Abdomen a quarter as long as entire body, cylindrical and somewhat tapering caudad. It consists of 4 rectangular segments diminishing in size from before backward except the

last which is as long as the 1st. Last segment V-shaped posteriorly, traversed on ventral surface in anterior region by 4 parallel rows of tiny hairs, all interrupted on the midline, and fringed by similar row on caudal margin on each side. Caudal rami (Fig. 3A) shorter than last segment, cylindrical, with 6 setae; 2 large median terminal setae finely bristled; outermost terminal seta with short row of spinules at base.

Antennule (Fig. 3A) 6-segmented; amature formula: 5, 15, 8, 4, 2+1 aesthete, and 7+1 aesthete. Antenna (Fig. 3C) 4-segmented; first segment with attenuate distal seta; second segment with acuminate distal seta; third segment with 2 pectinate processes and a large curved spine; fourth segment with 2 large curved spines and 4 setae. Mandibles (Fig. 3D) bearing 2 unequal blades, each spinulated along a margin, and a large, finely bristled hyaline seta. First maxilla (Fig. 3E) with 5 setae (2 setae small). Second maxillae (Fig. 3F) 2-segmented; first segment an ill-defined sclerotized area; second segment with bilaterally denticulate terminal process bearing 2 finely bristled spines. Maxilliped (Fig. 3G) 3-segmented; first segment large, carrying a seta near articulation with second segment; second segment with 2 naked setae; terminal segment a claw bearing a sub-terminal spinulated seta on rounded digitiform process.

First 4 pairs of legs (Fig. 3H, 4B-D) biramous.

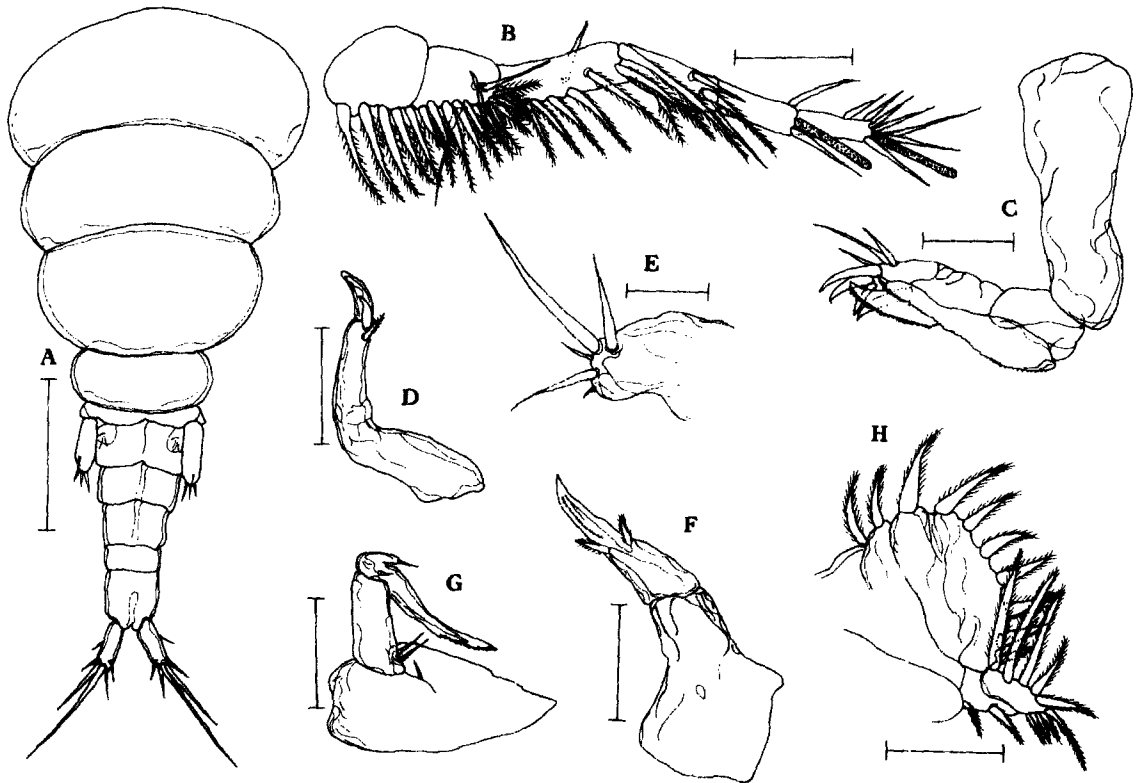


Fig. 3. *Taeniacanthus yamagutii* (Shiino), Female: A, habitus, dorsal; B, first antenna; C, second antenna; D, mandible; E, first maxilla; F, second maxillae; G, maxilliped; H, first leg. Scale bar: A = 0.5 mm; B = 0.1 mm; C = 0.05 mm; D = 0.1 mm; E = 0.05 mm; F-H = 0.1 mm.

Spinal and setal formula as follows:

	Endopod	Exopod
Leg 1	0-1; 7	1-0; 9
Leg 2	0-1; 0-1; II, I, 3	I-0; I-1; II, I, 4
Leg 3	0-1; 0-1; II, I, 2	I-0; I-1; II, I, 5
Leg 4	0-1; 0-1; II, I	I-0; I-1; II, I, 4

First pair directed forward unlike others and different in constitution, consisting of broad lamellar protopodite and much smaller, indistinctly 2-segmented rami. Endopodite broad but short, crescentic, exopodite much narrower and both with marginal plumose spines turned backward. Succeeding 3 pairs similar to one another and with rami narrower and longer than those of 1st pair. The rami subequal in size in all pairs and composed of 3 segments, each armed with simple and plumose spines, or with eith-

er of these. Fifth legs (Fig. 4E) very short, with 2 segments. First segment with 1 naked seta and spinules on posteroventral margin. Second segment bearing 3 spinulated spines and 1 naked seta with row of relatively large spinules at base; dorsomedial margin of segment with patches of spinules along entire length.

Remarks

Taeniacanthus yamagutii was originally described by Yamaguti (1936) as "*Irodes teraodontis* (Bassett-Smith, 1989)". Shiino (1957) proposed that Yamaguti's specimens were not conspecific with the species described by Bassett-Smith, and so established a new species, *Irodes yamagutii*. This species was later transferred to *Taeniacanthus* by Yamaguti and Yamasu (1959). *T. yamagutii* is most closely related to *T. fugu* and *T. kitamakura*. But the most distinctive fea-

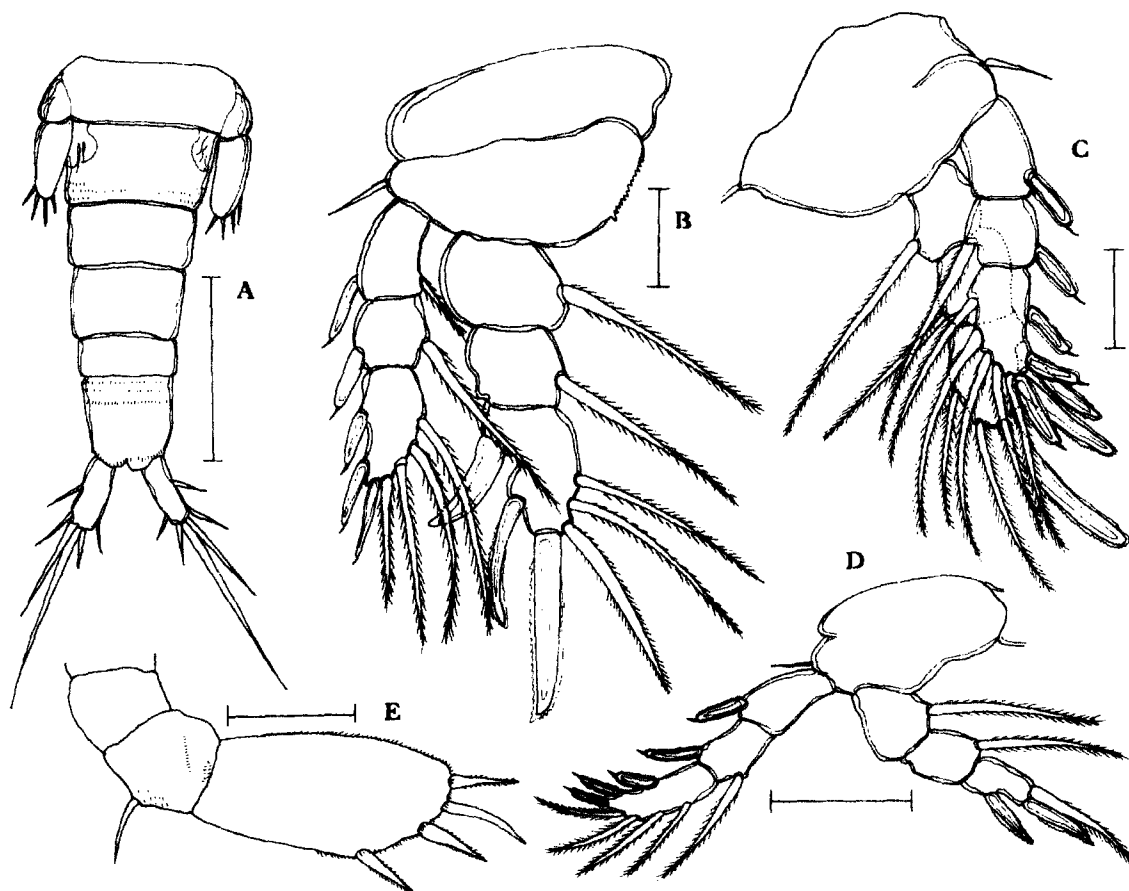


Fig. 4. *Taeniacanthus yamagutii* (Shiino), Female: A, urosome; B, second leg; C, third leg; D, fourth leg; E, fifth leg. Scale bar: A = 0.4 mm; B-C = 0.1 mm; D = 0.2 mm; E = 0.1 mm.

Table 2. Comparison of morphological features among *Taeniacanthus yamagutii* which infected in the marine fish

Items	<i>Taeniacanthus yamagutii</i>		
	Present	Shiino (1957)	Dojiri and Cressey (1987)
Host	<i>Takifugu obscurus</i>	<i>Spheroides alboplumbeus</i>	<i>Takifugu rubripes</i>
Total length	2.21 mm	2.15 mm	2.49 mm
Cephalothorax	0.39 × 1.15 mm	0.53 × 1.07 mm	0.42 × 1.13 mm
Genital complex	0.17 × 0.34 mm	0.15 × 0.37 mm	0.23 × 0.35 mm
Antennule	6-segmented	6-segmented	6-segmented
Antenna	4-segmented	4-segmented	3-segmented
First 4 pairs of legs	biramous	biramous	biramous
Fifth leg	uniramous	uniramous	uniramous
Caudal rami	6 setae	6 setae	6 setae

tures of *T. yamagutii* are terminal process of second maxilla stout, maxilliped claw with conspicuous digitiform process at base and a setiform element at the tip of each exopod spine of legs 2-4 (Table 2).

The Korean fish, *Takifugu obscurus* should be considered as an additional host of this species because *T. yamagutii* were recovered from the western coast of Korea (Boryung Hatchery).

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양식 황복에서의 요각류(*Clavellopsis hugu*, *Taeniacanthus yamagutii*) 기생에 관한 국내보고

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기생성 요각류 2종, *Clavellopsis hugu*(Lernaeopodidae; Siphonostomatoida)와 *Taeniacanthus yamagutii* (Taeniacanthidae; Poecilostomatoida)이 한국산 양식 황복의 구강, 코, 표피 등에 기생하고 있음을 국내에서 처음으로 보고하며, 아울러 이종의 형태학적 특징을 상세히 기술하였다. *Clavellopsis hugu*의 체형, 제2 촉각, 큰 턱 및 제2 소악 등은 다른 종과 쉽게 구별된다. 암컷의 두흉부는 등쪽으로 휘어져 있으며, 제2 촉각은 2분지, 큰 턱의 날은 톱니 모양, 제2 소악은 두흉부 기저에 완전히 융합된 bulla 형태이다. 수컷의 두흉부와 몸통은 완전히 융합된 난형이며, 두쌍의 악각은 집게형이다. *Taeniacanthus yamagutii*의 주요 특징은 제2 소악이 견고하고, 악각의 갈고리 기저에 돌기가 있으며, 제2-4 바깥 다리의 가시 끝에 촉각이 1개씩 있다. 이들은 모두 한국 미기록종이며, 양식산 복어(*Takifugu obscurus*)는 새로운 숙주이다.

Key words: Parasitic copepoda, *Clavellopsis hugu*, *Taeniacanthus yamagutii*, Cultured Korean fish, *Takifugu obscurus*