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Cirracanthus longus sp. nov. (Taeniacanthidae), a Copepod Parasitic on Seabats (Ogcocephalidae: *Halieutaea*) from Taiwan, with a Key to 23 Taeniacanthid Species Known from Taiwan

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Ju-shey Ho and Ching-Long Lin (2012) *Cirracanthus longus* sp. nov. (Taeniacanthidae), a copepod parasitic on seabats (Ogcocephalidae: *Halieutaea*) from Taiwan, with a key to 23 taeniacanthid species known from Taiwan. *Zoological Studies* **51**(4): 548-555. A new species of copepod, *Cirracanthus longus* sp. nov. (Poecilostomatoida: Taeniacanthidae), is described from the gills of the circular seabat, *Halieutaea fitzsimonsi* (Gilchrist and Thompson) and batfish, *H. stellata* (Vahl), collected off the northeastern and southwestern coasts of Taiwan. The new species is distinguished from its congeners by a combination of the following characters: (1) terminal segment of antenna armed with 2 curved claws and 4 setae; (2) 3rd exopodal segment of leg 2 with armature of III, I, 4; (3) 3rd exopodal segment of legs 3 and 4 with armature of II, I, 5; (4) distal segment of leg 5 armed with 4 setae; and (5) moderately long caudal ramus with a length/width ratio of 2.11. With the discovery of *C. longus* sp. nov., *Parataeniacanthus inimici* Yamaguti and Yamasu, 1959, also known as *Taeniacanthus inimici* (Yamaguti and Yamasu, 1959), is reconsidered to be a species of *Cirracanthus* Dojiri and Cressey, 1987. A key is provided for the 23 species (in 7 genera) of the Taeniacanthidae so far reported from Taiwan.
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Key words: Taeniacanthidae, *Cirracanthus*, Parasitic copepods, Marine fish, Taiwan.

The Taeniacanthidae is an unusual family of copepods parasitic on both invertebrates and vertebrates of the ocean. Although most of them live as parasites of marine fishes (including both elasmobranchs and teleosts) throughout the world's oceans, 14 species in 3 genera (*Clavisodalis* Humes, 1970; *Echinirus* Humes and Cressey, 1961; and *Echinosocius* Humes and Cressey, 1961) live exclusively in the esophagus of sea urchins in the Indo-West Pacific.

Twenty-two species of taeniacanthid copepods belonging to 6 genera (*Irodes* Wilson, 1911; *Makrostrotos* Ho and Lin, 2006; *Metataeniacanthus* Pillai, 1963; *Pseudotaeniacanthus* Yamaguti and Yamasu, 1959; *Taeniacanthus* Sumpf, 1871; and *Taeniastrotos* Cressey, 1969) have been reported from the marine fishes of Taiwan (Cressey and Cressey 1979, Dojiri and Cressey 1987, Ho and Lin 2006 2007a b, Lin and Ho 2006 2008, Ho et al. 2007). Recently, a new species of a taeniacanthid genus previously unrecorded from Taiwan, *Cirracanthus* Dojiri and Cressey, 1987, was discovered. It was found in the branchial cavities of the circular seabat, *Halieutaea fitzsimonsi* (Gilchrist and Thompson) and batfish, *H. stellata* (Vahl). Although these demersal fishes are widely distributed in the Indo-West Pacific (Froese and Pauly 2011), this is the 1st record of a copepod parasitic on them. In this report, we provide a key for identification of the taeniacanthids hitherto reported from Taiwan.

Three species of *Cirracanthus* are currently

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known (Walter 2010). Nevertheless, Tang (2005) believed that "*C. inimici* should be transferred back to *Taeniacanthus*." However, with the discovery of *C. longus* sp. nov., we believe that *C. inimici* should be retained in the genus *Cirracanthus* as Dojiri and Ho (1987) proposed. A discussion of this issue is also provided in this report.

MATERIALS AND METHODS

Fishes landed at fishing ports in Taiwan were purchased and transferred in an icebox to the Laboratory of Fish Disease located on the campus of National Chiayi Univ. (Chiayi, Taiwan). The fishes were examined under a dissection microscope, and the copepod parasites were removed, cleaned in saltwater, and preserved in 70% ethanol. The preserved specimens were soaked in 85% lactic acid overnight prior to dissection in a drop of lactic acid. The hanging-drop method, devised by Humes and Gooding (1964), was employed to examine the isolated body parts and appendages under a compound microscope with a series of magnifications of up to 1500×. All drawings were made with the aid of a drawing tube mounted on the compound microscope, and measurements were taken after soaking the specimens in lactic acid.

RESULTS

Order Poecilostomatoida Thorell, 1859
Family Taeniacanthidae Wilson, 1911
Cirracanthus Dojiri and Cressey, 1987
Cirracanthus longus sp. nov.
(Figs. 1, 2)

Material examined: 1 ♀ recovered from gill cavity of a circular seabat, *H. fitzsimonsi*, landed at Dahsi Fishing Port, Ilan County, NE Taiwan on 21 Aug. 2002; 1 ♀ collected from same species of host landed at same fishing port on 3 July 2009; 1 ♀ found on same species of host landed at Geh-Tze-Riau Fishing Port, Kaohsiung County, SW Taiwan on 20 Jan. 2010; and 2 ♀♀ recovered from a batfish, *H. stellata*, landed at Geh-Tze-Riau Fishing Port on 23 Dec. 2010. Holotype (USNM 1156952) and 2 paratypes (USNM 1156953) deposited in the National Museum of Natural History, Smithsonian Institution, Washington DC. Remaining, dissected specimens kept in collection of junior author.

Female: Body (Fig. 1A) 4.09 (3.80-4.38) mm long, excluding setae of caudal rami. Cephalothorax slightly wider than long, 0.97 (0.90-1.00) × 1.05 (1.02-1.06) mm. Pedigers 2, 3, and 4 well separated and distinctly wider than long. Urosome long, nearly 1/2 body length, 2.03 (1.84-2.10) mm long. Genital double somite distinctly wider than long, 0.25 (0.18-0.30) × 0.45 (0.44-0.46) mm, with area of egg sac attachment located on dorsolateral surface (Fig. 1B). Abdomen 4-segmented, without ornamentation. Caudal ramus (Fig. 1C) about 2x as long as wide, 0.19 (0.18-0.20) × 0.09 (0.08-0.10) mm, and armed with 4 short, 1 moderately long, and 1 extremely long setae in distal and subterminal regions. Egg sac (Fig. 1D) as long as body, multiseriate.

Rostral area broadly protruded anteriorly (Fig. 1A) and with slightly triangular sclerite on its ventral surface (Fig. 1E). Antennule (Fig. 1F) 6-segmented; armature formula: 5, 15, 8, 4, 2+ae, and 7+ae. Antenna (Fig. 1G) tripartite; proximal segment (coxobasis) largest, bearing single basal seta; 1st endopodal segment bearing small outer seta; 2nd and 3rd endopodal segments fused, with 2 pectinate distal processes (longer one with 4 rows of spinules plus distal seta, shorter one with 3 rows of spinules and hyaline seta at midlength) and tipped with 2 curved claws and 4 naked setae. Postantennal process (Fig. 1H) slightly curved at tip. Labrum (Fig. 1I) broad, fringed with spinules on posterior margin. Mandible (Fig. 1J) tipped with 2 unequal blades each fringed with denticles on posterior margin; accessory element absent. Paragnath (Fig. 1K) a protruded lobe bearing patches of spinules in basal region. Maxillule (Fig. 1L) a small lobe tipped with 3 short and 2 long setae. Maxilla (Fig. 1M) 2-segmented; proximal segment large, bent, and unarmed; distal segment tipped with 3 unequal, pinnate spines. Maxilliped (Fig. 1N) 3-segmented; proximal segment (syncoxa) bearing naked, small seta; 2nd segment (corpus) with 2 long, striated setae near proximal end; and distal (endopodal) segment a pointed, bipectinate process bearing 2 small setae in proximal region.

Armature on rami of legs 1-4 (Fig. 2) as follows (Roman and Arabic numerals indicate spines and setae, respectively; ss, setiform spine):

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

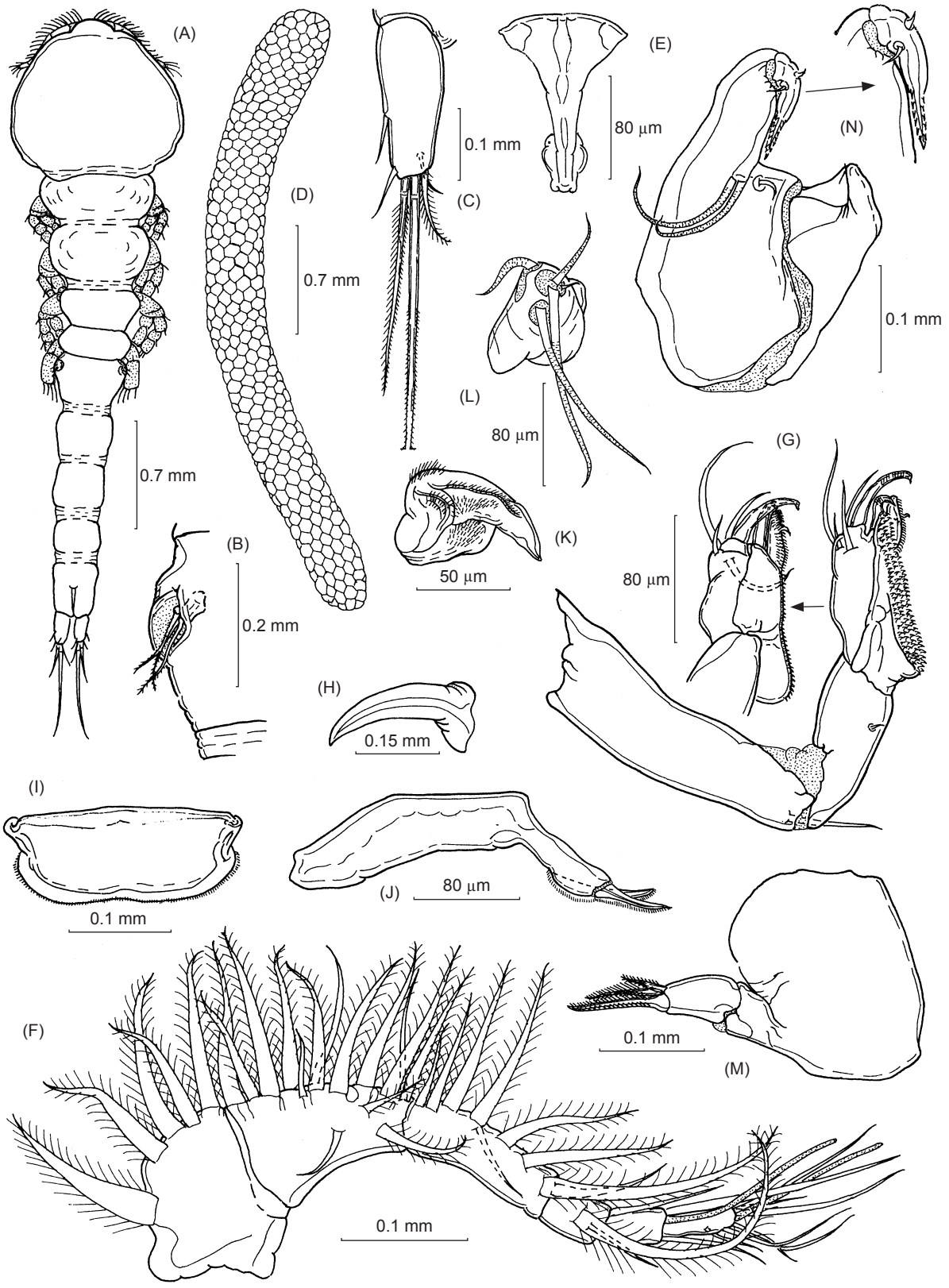

Fig. 1. *Cirracanthus longus* sp. nov., female. (A) Habitus, dorsal view; (B) genital somite, left, dorsal view; (C) caudal ramus, ventral view; (D) egg sac; (E) rostral sclerite, ventral view; (F) antennules; (G) antenna; (H) postantennal process; (I) labrum, ventral view; (J) mandible; (K) paragnath; (L) maxillule; (M) maxilla; (N) maxilliped.

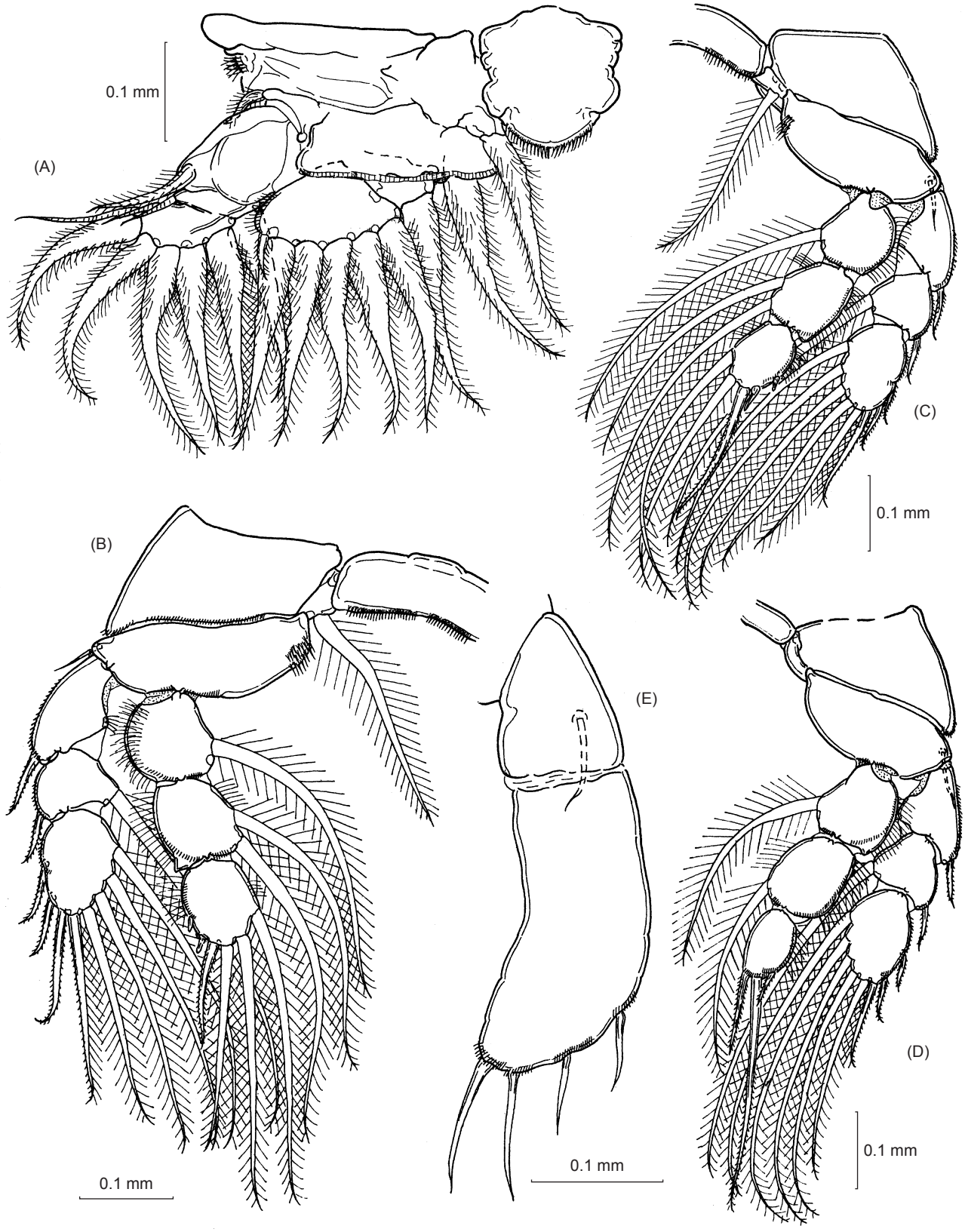

Fig. 2. *Cirracanthus longus* sp. nov., female. (A) Leg 1 and intercoxal plate, anterior view; (B) leg 2 and intercoxal bar, anterior view; (C) leg 3 and intercoxal bar, anterior view; (D) leg 4 and intercoxal bar; (E) leg 5, ventral view.

Intercoxal plate of leg 1 (Fig. 2A) with rows of spinules on mid-posterior protuberance. Intercoxal plate of legs 2 (Fig. 2B) and 3 (Fig. 2C) with interrupted row of spinules on posterior margin, but that of leg 4 (Fig. 2D) naked. Leg 5 (Fig. 2E) 2-segmented; proximal segment small, unornamented, armed with 1 outer seta; distal segment long, bent inward, carrying 4 simple setae with row of spinules at base of each setae. Leg 6 represented by 3 long, pinnate setae on genital operculum, located in pit for attachment of egg sac (Fig. 1B).

Male: Unknown.

Etymology: The species name *longus* means "long" in Latin. It alludes to the fact that *C. longus* is the longest taeniacanthid reported so far.

DISCUSSION

In 1939, Satyu Yamaguti reported from Tarumi, Japan an unusual species of *Taeniacanthus* taken from the gills of *Monacanthus cirrhifer* Temminck and Schlegel (the current valid name of this fish is *Stephanolepis cirrhifer* (Temminck and Schlegel)) (Froese and Pauly 2011). The terminal segment (or the claw) of the maxilliped, the curved tip of which is directed toward the corpus maxillipedis, of this species, *T. monacanthi* Yamaguti, 1939, is unusual. Since such subchelate formation of the maxilliped is unknown in female *Taeniacanthus*, the most speciose genus of the Taeniacanthidae with over 90 species, Dojiri and Cressey (1987) proposed a new genus, *Cirracanthus*, to accommodate *T. monacanthi*.

In 1959, Satyu Yamaguti and Teruhumi Yamasu reported another unusual taeniacanhid from the gills of *Inimicus japonicus* Cuvier and Valenciennes from the Inland Sea of Japan. Although the maxilliped claw of this species, *Parataeniacanthus inimici* Yamaguti and Yamasu, 1959, curves toward the corpus maxillipedis, just like the subchelate one found in *C. monacanthi* (Yamaguti, 1939), this important apomorphic feature was overlooked by Yamaguti and Yamasu (1959), and the species was placed in the genus *Parataeiniacanthus* created by Yamaguti back in 1939. According to Yamaguti (1939), *Parataeiniacanthus* chiefly differs from *Taeniacanthus* in possessing an incomplete fusion of the 1st pedigerous somite with the cephalosome and the presence of a long, slender, 4-jointed abdomen. Nevertheless, Dojiri and Cressey (1987) rejected Yamaguti's (1939) establishment of *Parataeniacanthus* and transferred its 8 species to either *Taeniacanthus* or *Cirracanthus*. *Parataeniacanthus inimici* Yamaguti and Yamasu, 1959 is an unusual taeniacanthid with a broad terminal claw on the maxilliped. Although Dojiri and Cressey (1987) transferred *P. inimici* to *Taeniacanthus*, it was correctly transferred to *Cirracanthus* by Dojiri and Ho (1987) due to the fact that the maxilliped claw is directed toward the corpus maxillipedis.

However, recently, Tang (2005) stated that "*C. inimici* should be transferred back to *Taeniacanthus* because it shares more characteristics (i.e. similar morphology and armature of legs 2-4) with *Taeniacanthus* species parasitic on other scorpaeniform fishes, such as *T. miles* (Pillai, 1963) and *T. rotundiceps* (Shiino, 1957), than with *C. monacanthi* and *C. spinosus*." Once again, the subchelate nature of the maxilliped seen in *C. inimici* was not considered a synapomorphy between *C. inimici* and the other 2 species of *Cirracanthus*.

With a long body and slender urosome, the general morphology of *C. inimici* is closer to *C. longus* than to either *T. miles* or *T. rotundiceps*. As far as the armature of legs 3 and 4 are concerned, *C. longus* displays an intermediate condition between *C. inimici* and *C. monacanthi*; while the endopods of these 2 legs are equipped with pointed spines as in *C. monacanthi*, the armature of their exopods are as in *C. inimici* in having a formula of II, I, 5 (Table 1). Moreover, leg 5 of *C. inimici* differs from that of *C. monacanthi* by carrying 3 spines and 1 seta, but *C. longus* resembles *C. monacanthi* in bearing 4 setae (Table 1). In other words, with the discovery of *C. longus*, the morphological gaps between *C. inimici* and *C. monacanthi* are not as great as Tang (2005) postulated. Therefore, we consider it more logical to retain *C. inimici* in the genus *Cirracanthus* as Dojiri and Ho (1987) proposed. Thus, 4 species of *Cirracanthus* are known, and their morphological differences are listed in table 1.

Key to species of female Taeniacanthidae reported from Taiwan

In their revision of the family Taeniacanthidae, Dojiri and Cressey (1987) provided a set of keys to the genera of the family and to the species of each genus containing more than 2 species. The following key is mainly patterned after those keys with the addition of new forms reported after the

publication of that taeniacanthid monograph.

1a. Rostral area with T-shaped sclerotized structure bearing transverse rows of hooklets on horizontal ridge; terminal segment of maxilliped a long, whip-like process 2
1b. Rostral area otherwise; terminal segment of maxilliped a claw or absent 3
2a. Terminal exopod segment of leg 4 with armature of II, I, 4 ..... *Makrostrotos hamus*
2b. Terminal exopod segment of leg 4 with armature of II, I, 5 ..... *Makrostrotos acuminatus*
3a. Rostral area with corrugated shield-like structure on ventromedial surface ..... *Taeniastrotos tragus*
3b. Rostral area without corrugated shield-like structure on ventromedial surface 4
4a. Rostral area with Y-shaped sclerotized structure bearing transverse rows of hooklets on ridges 5
4b. Rostral area otherwise 7
5a. Proximal segment of antennule without tooth on ventral surface ..... *Pseudotaeniacanthus conspicuus*
5b. Proximal segment of antennule with tooth on ventral surface 6
6a. Terminal endopod segment of leg 4 with armature of III .... *Pseudotaeniacanthus dentiferus*
6b. Terminal endopod segment of leg 4 with armature of 1, II . ..... *Pseudotaeniacanthus similis*
7a. Cephalothorax with ventrally directed lateral margins 8
7b. Cephalothorax without ventrally directed lateral margins 9
8a. Terminal exopod segment of legs 2 and 4 with armature of II, I, 4 ..... *Metataeniacanthus aquilonius*
8b. Terminal exopod segment of legs 2 and 4 with armature of II, I, 5 ..... *Metataeniacanthus synodi*
9a. Terminal segment (claw) of maxilliped absent or fused to corpus 10
9b. Terminal segment (claw) of maxilliped distinct 11
10a. Terminal exopod segment of leg 2 with armature of II, I, 5 ..... *Irodes upenei*
10b. Terminal exopod segment of leg 2 with armature of III, I, 5 ..... *Irodes parupenei*
11a. Maxilliped with terminal claw curved toward corpus .... *Cirracanthus longus*
11b. Maxilliped with terminal claw curving away from corpus 12
12a. Rostral area with a pair of tines on ventromedial surface .. .. *Taeniacanthus spiniferus*
12b. Rostral area without a pair of tines on ventromedial surface 13
13a. Mid-endopodal segment of leg 2 with 2 inner setae 14
13b. Mid-endopodal segment of leg 2 with 1 inner seta 19
14a. Mid-endopodal segment of leg 3 with 1 inner seta 15
14b. Mid-endopodal segment of leg 3 with 2 inner setae 16
15a. Terminal process and spinulated spine of maxilla broad, lamelliform; small spine absent .... *Taeniacanthus williamsi*
15b. Terminal process and spinulated spine of maxilla lanceolate; small spine present .... *Taeniacanthus glomerosus*
16a. Exopod of leg 1 incompletely or completely 3-segmented . ..... *Taeniacanthus miles*
16b. Exopod of leg 1 distinctly 2-segmented 17
17a. Second segment of leg 5 with 4 setae .... *Taeniacanthus pollicaris*
17b. Second segment of leg 5 with 1 or more spines 18
18a. Accessory process on mandible present; spines on terminal segment of leg 5 blunt .... *Taeniacanthus neopercis*
18b. Accessory process on mandible absent; spines on terminal segment of leg 5 pointed *Taeniacanthus pteroisi*
19a. Terminal exopod segments of legs 2 and 3 with armature formula of II, I, 4 ..... *Taeniacanthus acanthocepolae*
19b. Terminal exopod segment of legs 2 and 3 with armature formula otherwise 20
20a. Terminal exopod segment of leg 2 with armature formula of II, I, 5 ..... *Taeniacanthus anguillaris*
20b. Terminal exopod segment of leg 2 with armature formula of II, I, 4 21
21a Short pectinate process of antenna with several rows of spinules ..... *Taeniacanthus aluteri*
21b. Short pectinate process of antenna with single row of spinules 22
22a. Terminal exopod segment of leg 4 more than 3x longer than wide, and curved outwardly .... *Taeniacanthus balistae*
22b. Terminal exopod segment of leg 4 much less than 3x longer than wide, and not curved .... *Taeniacanthus lagocephali*

Up to the present 23 species of taeniacanthids have been reported from Taiwan (Table 2).

Table 1. Morphological differences among the 4 species of *Cirracanthus*

	C. inimici	*C. longus*	*C. monacanthi*	*C. spinosus*
Armature on terminal segment of antenna	IV, 3	II, 4	III, 4	II, 4
Spines on endopod of legs 2-4	rounded tip	pointed tip	rounded tip	pointed tip
Armature on distal segment of leg 2 exopod	II, I, 5	III, I, 4	II, I, 4	II, I, 4
Armature on distal segment of leg 3 exopod	II, I, 5	II, I, 5	II, I, 4	II, I, 5
Armature on distal segment of leg 4 exopod	II, I, 5	II, I, 5	II, I, 4	II, I, 4
Armature on distal segment of leg 5 exopod	II, 1, I	4	4	4
Anal somites	longer than wide	longer than wide	wider than long	wider than long
Caudal ramus (Length/width ratio)	> 2	> 2	< 2	< 2

Table 2. Species of Taeniacanthidae reported from marine fishes of Taiwan

Species	Host	Reported by
Cirracanthus Dojiri and Cressey, 1987		
C. longus sp. nov.	*Halieutaea fitzsimonsi*	present paper
	Halieutaea stellata	present paper
Irodes Wilson, 1911		
I. parupenei Ho and Lin, 2007	*Parupeneus spilurus*	Ho and Lin (2007a)
	Parupeneus multifasciatus	Ho and Lin (2007a)
I. upenei (Yamaguti, 1954)	*Parupeneus chrysopleuron*	Ho and Lin (2007b)
	Parupeneus pleurostigma	Ho and Lin (2007b)
	Parupeneus spilurus	Ho and Lin (2007b)
Makrostrotos Ho and Lin, 2006		
M. acuminatus Ho and Lin, 2006	*Gymnothorax favagineus*	Ho and Lin (2006)
M. hamus Ho and Lin, 2006	*Gymnothorax favagineus*	Ho and Lin (2006)
Metataeniacanthus Pillai, 1963		
M. aquilonius Cressey and Cressey, 1979	*Synodus macrops*	Cressey and Cressey (1979)
M. synodi Pillai, 1963	*Trachinocephalus myops*	Cressey and Cressey (1979)
	Saurida elongata	Ho and Lin (2007b)
Pseudotaeniacanthus Yamaguti and Yamasu, 1959		
P. conspicuus Lin and Ho, 2008	*Gymnothorax favagineus*	Lin and Ho (2008)
P. dentiferus Lin and Ho, 2008	*Gymnothorax favagineus*	Lin and Ho (2008)
P. similis Lin and Ho, 2008	*Gymnothorax favagineus*	Lin and Ho (2008)
Taeniacanthus Sumpf, 1871		
T. acanthocepolae Yamaguti, 1939	*Acanthocepola limbata*	Lin and Ho (2006)
T. aluteri (Avdeev, 1977)	*Abalistes stellatus*	Ho and Lin (2007b)
T. anguillaris (Devi and Shyamasundari, 1980)	*Plotosus lineatus*	Lin and Ho (2006)
T. balistae (Claus, 1864)	*Aluterus monoceros*	Lin and Ho (2006)
T. glomerosus Dojiri and Cressey, 1987	*Cirripectes filamentosus*	Dojiri and Cressey (1987)
	Cirripectes imitator	Dojiri and Cressey (1987)
T. lagocephali Pearse, 1952	*Lagocephalus gloveri*	Lin and Ho (2006)
	Lagocephalus wheeleri	Lin and Ho (2006)
T. miles (Pillai, 1963)	*Scorpaenopsis diabolus*	Ho et al. (2007)
T. neopercis Yamaguti, 1939	*Parapercis sexfasciata*	Lin and Ho (2006)
T. pollicaris Dojiri and Cressey, 1987	*Cirripectes fuscoguttatus*	Dojiri and Cressey (1987)
	Cirripectes polyzona	Dojiri and Cressey (1987)
T. pteroisi Shen, 1957	*Pterois antennata*	Ho and Lin (2007b)
T. spiniferus Ho and Lin, 2007	*Acanthocepola limbata*	Ho and Lin (2007a)
T. williamsi Dojiri and Cressey, 1987	*Cirripectes castaneus*	Dojiri and Cressey (1987)
	Cirripectes polyzona	Dojiri and Cressey (1987)
Taeniastrotos Cressey, 1969		
T. tragus Dojiri and Cressey, 1987	*Nemipterus bipunctatus*[a]	Dojiri and Cressey (1987)
	Lagocephalus gloveri	Ho and Lin (2007b)
	Trachinocephalus myops	Ho and Lin (2007b)

[a]Valid host name (originally *Nemipterus mulloides*).

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