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## Two species of copepods (*Crustacea*) parasitic on marine fish, *Konosirus punctatus*, from Kamak Bay in Korea

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Two species of the parasitic copepods, *Nothobomolochus thambus* (Poecilostomatoida, Bomolochidae) and *Mitrapus heteropodus* (Siphonostomatoida, Lernanthropidae), were recovered on the gills of a marine fish, *Konosirus punctatus* (Temminck and Schlegel) taken from Kamak Bay in Korea. *N. thambus* is very distinguishable in the armature of maxilliped from all other species of *Nothobomolochus*: one of the two strong, hairy setae has become naked. *M. heteropodus* is very distinguishable in the armature of leg 4; the inner process (endopod) is only about one-fifth the length of the outer process (exopod). Both parasitic copepod species are new to the Korean fauna.

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Key Words : Parasites, *Nothobomolochus thambus*, *Mitrapus heteropodus*, on fish

Copepod parasites have been considered as enemies of marine fishes (Kabata, 1979; Suh *et al.*, 1992; Suh *et al.*, 1993; Choi *et al.*, 1994a, 1994b), of marine shell fishes (Wilson, 1938; Davey *et al.*, 1978; Paul, 1983; Pregonzer, 1983; Suh and Choi, 1990; Choi and Suh, 1991; Suh and Choi, 1991) and ascidians (Choi and Hong, 1994c) capable of causing serious economic damages. In order to add our knowledge of the parasitic copepod

fauna of Korean marine animals, this survey has been carried out since 1990. In the course of the study we had an opportunity to examine specimens of marine fish, *Konosirus punctatus* taken from Kamak Bay in Korea. Having studied this material, we recovered two species of the copepod parasites: *Nothobomolochus thambus* (Bomolochidae) and *Mitrapus heteropodus* (Lernanthropidae). Both species are described for the first time in Korea.

## Materials and methods

The fishes examined for this study were taken from in Kamak Bay, Korea (34° 42'N, 127° 43'E) on 23 August, 1993. The copepod parasites were removed from the gills of fishes, 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 ramus. In the description of armature, Roman and Arabic numerals were used as indications of spines and setae, respectively. Drawings were made with the aid of a drawing tube. Body structures were described according to the terminology of Vervoort (1962) and Kabata (1979).

## Results and Discussion

The taxonomic status of these two species of copepods is listed as follows

Order Copepoda Edwards, 1840

Suborder Poecilostomatoida Thorell, 1859

Family Bomolochidae Claus, 1875

*Nothobomolochus thambus* Ho *et al.*, 1983

Suborder Siphonostomatoida Latreille, 1829

Family Lernanthropidae Kabata, 1979

*Mitrapus heteropodus* (Yu), 1933

1. *Nothobomolochus thambus* Ho *et al.*, 1983

Figs. 1 ~ 3.

**Material examined** : Seven females from the gills of 3 individuals of *Konosirus punctatus*

(Temminck and Schlegel) taken from Kamak Bay, 23 August 1993.

**Description** : Female: The body (Fig. 1A) is 1.70~1.96 mm (mean=1.82, n=5) long, more or less cyclopid, with a large transversally produced cephalothorax. The remaining thoracic somites gradually diminishing in width. Cephalothorax (Fig. 1A) is wider than long and measuring 0.54 mm (0.48~0.59 mm) × 0.98 mm (0.88~1.08 mm). Urosome (Figs. 1A, 2A) is gradually narrowing and distinctly five-segmented, 0.60 mm (0.59~0.61 mm). Genital complex (Figs. 2A) is laterally swelling rounded, wider than long, 0.22 mm (0.21~0.22 mm) × 0.29 mm (0.27~0.32 mm). Egg sac attachment area (Figs. 2C) is located dorso-laterally in genital complex, bordered by a strongly chitinized margin. From the opening protrude three fine setae. Caudal ramus (Figs. 2A) is slightly conical, longer than wide, 0.06 mm (0.05~0.07 mm) × 0.04 mm (0.04~0.05 mm), with 6 setae; one of the setae is lengthened on each side.

Antennule (Fig. 1B, 1C) consists of three fused basal segments and a three segmented flagellum. The basal segments are armed with 12 plumose setae on the basal portion of anterior margin, 6 short setae and 7 long setae on the rest margin; the dorsal chitinized plate is divided into 3 fairly broad and bluntly pointed finger-shaped processes with the same length; the median spine is particularly strongly chitinized and dagger-shaped. The formula for the three-segmented flagellum is 4, 2+1 aesthete, and 7+1 aesthete respectively. Antenna (Fig. 1D) is two-segmented sympod;

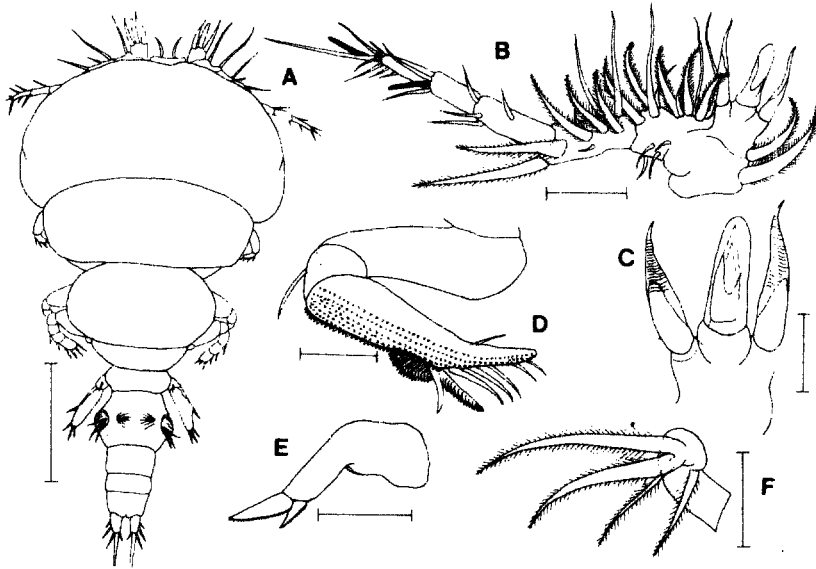


Fig. 1. *Nothobomolochus thambus* Ho *et al.*, female : A, habitus, dorsal; B, first antenna; C, proximal part of first antenna, dorsal; D, second antenna; E, mandible; F, first maxilla. Scale bar:  $\Lambda=0.4$  mm; B=0.1 mm; C-F=0.05 mm.

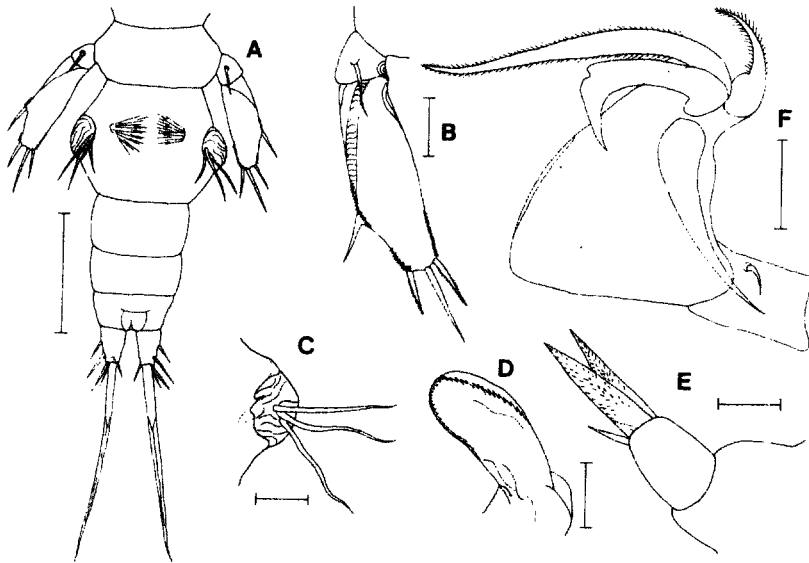


Fig. 2. *Nothobomolochus thambus* Ho *et al.*, female : A, urosome; B, fifth leg; C, egg sac attachment; D, paragnath; E, second maxilla; F, maxilliped. Scale bar : A=0.2 mm; B-C, F=0.05 mm; D-E=0.025 mm.

first segment is long, subcylindrical, with long slender seta near distal end; second segment is short. The first segment of endopod long is armed with several rows of fine spinules; the tubercle and the lamellar process are armed with a pectinate row of bigger spinules, in addition with 4 hooked spines and 3 setae. The second segment is robust, with several rows of fine spinules continuing over its surface from the first segment.

Mandible (Fig. 1E) is flat, with rounded base and cylindrical shaft; large subtriangular process is sharp ventral edge and smaller but similar process. Paragnaths (Fig. 2D) are rounded, apparently with a small spiniform membrane.

Maxillule (Fig. 1F) is small, rounded, with 2 long and 2 shorter setae, all plumose. Maxilla (Fig. 2E) consists of 2 haired teeth at the apex. Maxilliped (Fig. 2F) has rather unusual features; one of the two strong, hairy setae has become naked; the distal inner corner is protruded to support the much smaller, hairy seta; the terminal claw is relatively small, curved with auxiliary small falling at the median region. The setal and spinal formulae of the legs (Fig. 3A-D) are as follows (Roman numerals indicating spines; Arabic numerals representing setae) :

	Endopod	Exopod
Leg 1	0-1; 0-1; 5	I-0; III, 6
Leg 2	0-1; 0-2; II, 3	I-0; I-1; III, I, 5
Leg 3	0-1; 0-2; II, 2	I-0; I-1; II, I, 5
Leg 4	0-1; 0-1; I, 1, I	I-0; I-1; II, I, 4

The endopod and exopod of the first leg are strongly flattened; the segments of the exopod

almost fused. Both rami of the second to the fourth legs are three-segmented. All setae of four legs are strongly plumose. The external and internal margin spines of the exopodes of the second to the third legs consist of a fine flagellum and a spur. The external marginal spines of the exopodes of the fourth legs consist of a fine flagellum and a spur, but the internal margin of these spines is smooth.

The fifth leg (Fig. 2B) has a short intermediate segment, bearing a fine seta, and a spatulate distal segment, bearing a external spiniform seta and 3 apical spiniform setae, of which the median seta is lengthened, naked.

**Remarks;** The species of the Bomolochidae are parasitic copepods of marine teleosts. They live on the head of their hosts occurring mainly in the branchial cavities. When Vervoort (1962) erected *Nothobomolochus*, Yamaguti's subgenus *Pseudobomolochus* (1939) were transferred into the former. In describing *Nothobomolochus* he has not mentioned this latter characteristic as the presence of the tripartite dorsal plate and a caudal production of some of the thoracic somites are met with in the various genera of Bomolochidae without any definite order.

This is the second report of *Nothobomolochus thambus* in the world. This species was first described by Ho *et al.* (1983) from Kojima Bay, Japan, but now, we also found *N. thambus* from the same host, *Konosirus punctatus* from Kamak Bay, Korea. *N. thambus* is easily characterized by body shape, antennule, and maxilliped; for instance, the present species is very distinguishable in the

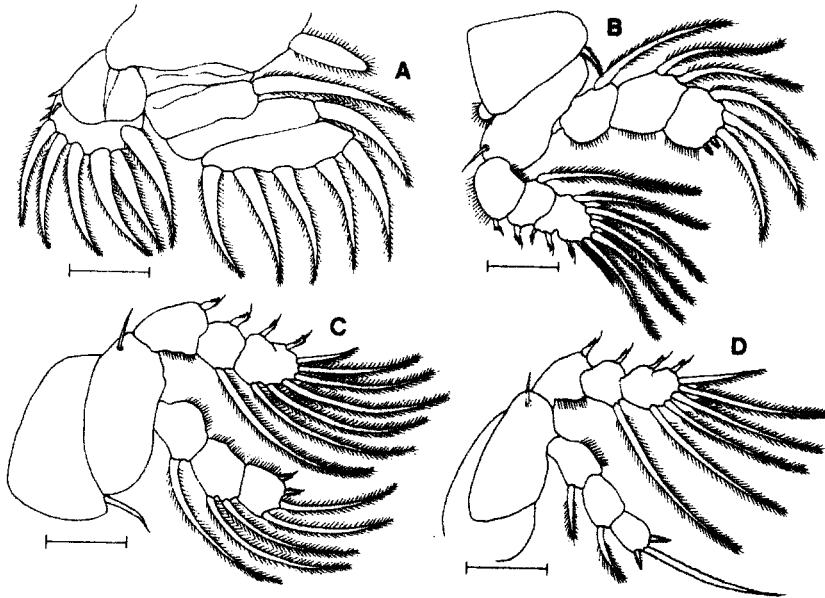


Fig. 3. *Nothobomolochus thambus* Ho *et al.*, female : A, first leg; B, second leg; C, third leg; D, fourth leg. Scale bar : A - D = 0.1mm.

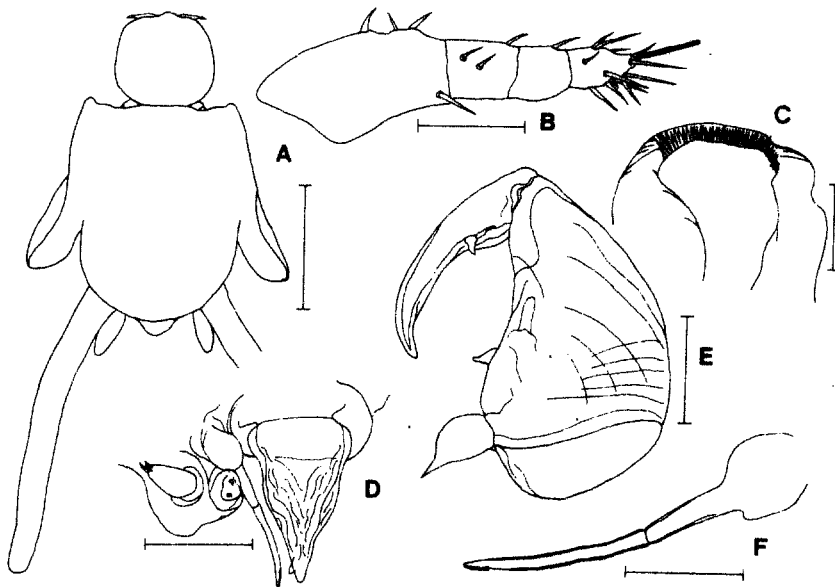


Fig. 4. *Mitrapus heteropodus* (Yu), female : A, habitus, dorsal; B, first antenna; C, cephalic fold at the base of second antenna; D, oral appendages; E, second antenna; F, mandible. Scale bar : A = 1 mm ; B, F = 0.05 mm; C - E = 0.1 mm.

armature of maxilliped from all other species of *Nothobomolochus*; one of the two strong, hairy setae has become naked. Unlike the description of Ho *et al.* (1983), the first segment of the leg 4 with inner plume was observed in the present study.

Male has not yet been found in Korean and Japanese waters.

## 2. *Mitrapus heteropodus* (Yu), 1933

Figs. 4 ~ 6

*Lernanthropus heteropodus* Yu, 1933, 123-126, pl. 4, figs. 1-7, pl. 5, fig. 1; Yamaguti, 1936, 17-18; Yamaguti, 1939, 454-455; Yamaguti, 1963, 149, pl. 155, figs. 3a-b.

*Mitrapus heteropodus* Song and Chen, 1976, 412-413, figs. 4A-H; Song and Kuang, 1980, 61, figs. 1-4; Ho and Do, 1985, 47-51.

**Material examined:** One adult female from the gills of 3 individuals of *Konosirus punctatus* (Temminck and Schlegel) taken from Kamak Bay, 23 August 1993.

**Description:** Female; The body (Fig. 4A) is short and broad. The anterior surface of the head is armed with a semicircle spinules (Fig. 4C). The anterior corners of the trunk are protruded forward to form a prominent knob-like protrusion. Urosome (Figs. 5A, 6A) is gradually narrowing and indistinctly four-segmented. The abdomen (Fig. 6A) has the caudal rami on its ventral surface. The caudal ramus (Fig. 5A, B) is armed with 5 unequal setae.

Antennule (Fig. 4B) consists of four segments. The setal formula of those segments are 4, 3,

1, and 13+1 aesthete. Antenna (Fig. 4E) is the most powerful appendage in the cephalothorax. It consists of a robust corpus (the first segment) and a hook-like subchela. The base of subchela has a papilliform process. The oral cone (Fig. 4C, D) is long, with the shorter labium bearing subterminally two blades.

Mandible (Fig. 4D, F) consists of two segments. There are 8 teeth on the shaft. Maxillule (Fig. 4D, 5D) is tipped with 2 elements in the exopod (outer lobe) and 3 unequal setae in the endopod (inner lobe). Maxilla (Fig. 5E) is two segmented, the proximal segment (lacertus) is the larger of the segments and unarmed as in the typical lernanthropid: the second segment (brachium) is equipped with 2 distal elements of which one is a forked spiniform process. Maxilliped (Fig. 5F) is a strong prehensile appendage, sparsely covered with denticles on its corpus, which bears a seta on a swelling in the myxal area. The subchela is divisible into a shaft and a claw at the level where the distal element is situated; there is an inner seta in the subterminal region of the shaft.

Leg 1 (Fig. 6B) has a large two-segmented protopod carrying unimerous rami. The basis is armed with a slender outer seta and a stout inner seta. The exopod is broad and armed with 5 spines on the distal surface. The endopod is conical and tipped with a longer spine, like a seta. Leg 2 (Fig. 6C) is different from leg 1 in lacking the median seta on the protopod and having 4 spines (instead of 5) on the exopod. The endopod is conical and tipped

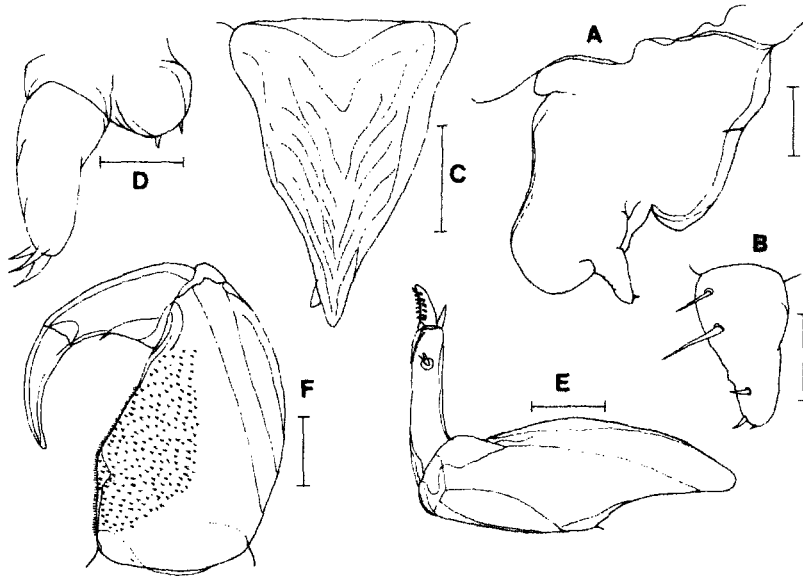


Fig. 5. *Mitrapus heteropodus* (Yu), female : A, urosome, lateral; B, caudal ramus; C, mouth tube ; D, first maxilla ; E, second maxilla ; F, maxilliped. Scale bar : A=0.1 mm; B - C, E - F=0.05 mm ; D=0.03 mm.

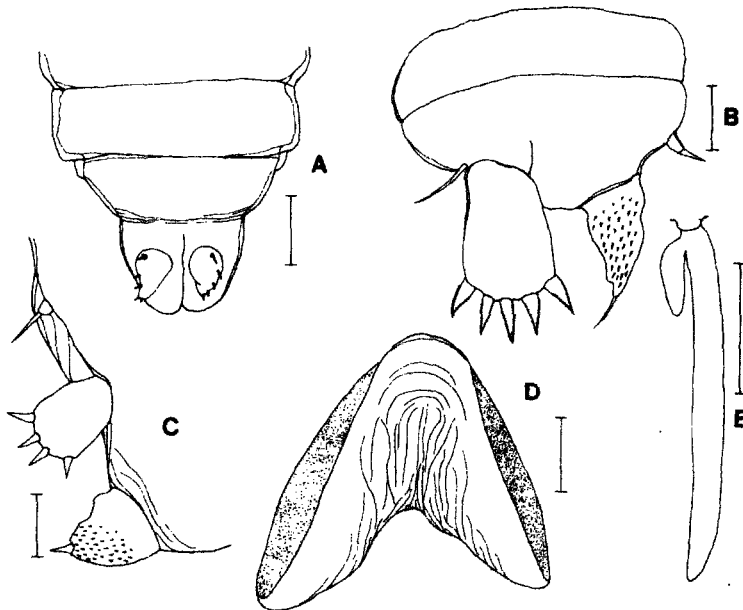


Fig. 6. *Mitrapus heteropodus* (Yu), female : A, urosome, ventral; B, first leg; C, second leg; D, third leg; E, fourth leg. Scale bar : A=1 mm; B - C=0.025 mm; D=0.03 mm; E=1 mm.



with a spine. Leg 3 (Fig. 6D) is a large fleshy lamella expanded downward from the ventral surface of the third pedigerous somite and then extended backward to form a horseshoe-shaped fold. Leg 4 (Fig. 6E) is a pair of extremely unequal bilobate process; the inner process (endopod) is only about one-fifth the length of the outer process (exopod).

**Remarks:** *Lernanthropus* de Blainville, 1822 is the third largest genus of Copepoda that parasitize marine fish. There are 119 nominated species in this genus which was removed not long ago by Kabata (1979) from the family Anthosomatidae and formed, together with four other anthosomatid genera, a separate taxon called Lernanthropidae.

Song and Chen (1976) erected *Mitrapus*, and transferred four species of *Lernanthropus* into the former: *engraulis* Tripathi, 1959; *heteropodus* Yu, 1933; *oblongus* Pillai, 1964; and *rubiginisus* Redkar *et al.*, 1949.

They proposed *Mitrapus*, the following features in female were enumerated to be distinctly different from *Lernanthropus*: (1) small head, (2) trunk with a forward protruberance at each anterolateral conner, (3) caudal ramus attached to the ventral surface of abdomen, and (4) leg 4 with much longer exopod.

*Mitrapus heteropodus* (Yu, 1933) is easily identified by body shape, trunk, leg 4, maxilliped. This species has been excellently redescribed by Ho and Do (1985) from Japan. The Korean specimens show no significant difference from their redescription.

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## 한국산 어류 (전어) 에 기생하는 요각류 2 종 (*Nothobomolochus thambus*, *Mitrapus heteropodus*)

최상덕 · 홍성운\* · 노용길

국립수산진흥원 남해수산연구소 \*부산수산대학교 해양생물학과

한국산 어류 (전어) 아가미에서 기생성 요각류 2 종, *Nothobomolochus thambus* (Poecilostomatoida, Bomolochidae) 와 *Mitrapus heteropodus* (Siphonostomatoida, Lernanthropidae) 이 채집되었다. *N. thambus* 은 특이한 턱다리의 구조를 가지므로 *Nothobomolochus* 속 다른 종과 쉽게 구별된다. ; 턱다리의 큰 강모 2 개중 1 개는 잔털을 갖지 않는다. ; *M. heteropodus* 의 주요 특징은 4 번째 다리의 구조이다 ; 4 번째 다리의 안다리는 바깥다리의 1/5 크기이다. 이들은 모두 한국 미기록종이다.

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Key Words : Parasites, *Nothobomolochus thambus*, *Mitrapus heteropodus*, on fish