

Description of a New Species of *Tortanus* (Copepoda: Calanoida) from Kuchinoerabu Island, Kyushu, with Notes on Its Possible Feeding Mechanism and In-situ Feeding Habits^{1), 2)}

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Abstract

A new species of *Tortanus* (Copepoda: Calanoida) collected from Kuchinoerabu Island, Kyushu, Japan, by SCUBA diving is described. This species belongs to the subgenus *Atortus* Sewell, 1932 which was revised by BOWMAN (1971). The diagnosis of the subgenus emended by BOWMAN (1971) should be further revised with the finding of the present new species: the female of *Atortus* have 2- or 3-segmented urosome. The mouthparts examination and the gut contents analysis of this new species revealed that the species was carnivorous feeding mainly on *Oithona* copepodids.

The genus *Tortanus* inhabits the coastal waters (BOWMAN 1971) and most species of this genus occur in tropical regions (KIM 1985). In the neighbouring seas of Japan, Korea and China, 13 species of *Tortanus* have so far been recorded (Table 1). We found a new species of *Tortanus* at a shallow station of Kuchinoerabu Island, Kyushu, Japan, by SCUBA diving. The new species apparently belongs to the subgenus *Atortus* established by SEWELL (1932) and revised by BOWMAN (1971). However, the definition of *Atortus* by BOWMAN (1971) does not coincide partly with the new species and needs to be emended.

The family Tortanidae is thought to be a typical carnivorous calanoid (ANRAKU & OMORI 1963, ITOH 1970, AMBLER & FROST 1974). We examined the mouthpart structures and the gut contents of both sexes of the present new species, and report here its possible feeding mechanisms and in-situ feeding ecology.

Materials and Methods

The sampling station (30°27'N, 130°10'E) is located in Honmura Bay, a shallow small bay of Kuchinoerabu Island, Kyushu, Japan. Specimens were collected by SCUBA diving at a depth of less than 6 m just above the flat sandy bottom on 12 September, 1986. The original purpose was to collect near-bottom calanoid copepods (OHTSUKA 1984, 1985), but none of them

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²⁾ 口永良部島(九州)から発見されたカラヌス目橈脚類 *Tortanus* の 1 新種の記載とその摂食様式及び天然における食性の知見

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TABLE 1. *Tortanus* OCCURRING IN THE NEIGHBOURING SEAS OF JAPAN, KOREA AND CHINA.

Species	Locality	Source
<i>Tortanus denticulatus</i> Shen & Lee	mouth of Chiekong River	SHEN & LEE (1963)
<i>T. derjugini</i> Smirnov	Ariake Sea, East China Sea, Taiwan Strait, South China Sea, Sea of Japan, Sea of Okhotsk	TANAKA (1965), CHEN (1983), CHEN & ZHANG (1965)
<i>T. dextrilobatus</i> Chen & Zhang	South China Sea, Taiwan Strait	CHEN (1983), CHEN & ZHANG (1965)
<i>T. discaudatus</i> (Thompson & Scott)	Sea of Japan, North Pacific, Yellow Sea	MORI (1937), SATO (1913), KIM (1985)
<i>T. forcipatus</i> (Giesbrecht)	Inland Sea of Japan, Ariake Sea, Sagami Bay, Sea of Japan, Yellow Sea, East China Sea, South China Sea	HIROTA (1968a, b), MORI (1937), SATO (1913), TANAKA (1965), KIM (1985), CHEN (1983)
<i>T. gracilis</i> (Brady)	South China Sea	CHEN (1983)
<i>T. longipes</i> Brodsky	Sea of Japan, Sagami Bay, Tanabe Bay, Shijiki Bay, Sea of Okhotsk	KIMOTO (unpubl.), TANAKA (1965), OHTSUKA (1985)
<i>T. murrayi</i> Scott	South China Sea	CHEN (1983)
<i>T. rubidus</i> Tanaka	Sagami Bay, Shijiki Bay	KIMOTO (unpubl.), TANAKA (1965)
<i>T. scaphus</i> Bowman	South China Sea	BOWMAN (1971), CHEN (1983)
<i>T. sinicus</i> Chen	South China Sea	CHEN (1983)
<i>T. spinicaudatus</i> Shen & Bai	Yellow Sea, Pohai, East China Sea, South China Sea	KIM (1985), CHEN (1983), CHEN & ZHANG (1965)
<i>T. vermiculus</i> Shen	East China Sea, South China Sea	CHEN (1983), SHEN (1955), CHEN & ZHANG (1965)

had been collected and, instead, 14 females and 21 males of a new species of *Tortanus* and numerous *Oithona oculata* were collected. A hand-net with a diameter of 30 cm and mesh size of 0.1 mm was pushed forwards along the bottom. At the same station a night surface towing was also carried out, but no specimens of this new species were collected. Samples were fixed immediately after collection with 10% neutralized formalin/seawater.

For the examination of the food in the guts, 10 intact specimens of each sex were dissected, and the frequency of occurrence of each food item was recorded. The detailed procedure for making preparations for gut content examination was described in OHTSUKA et al (in press).

Description

Tortanus (Atortus) erabuensis n. sp.

Materials examined. An adult female dissected was designated as the holotype and a dissected adult male as the allotype. Two dissected and an intact individuals of each sex were designated as paratypes. The type specimens of this new species are deposited in the National Science Museum, Tokyo, Japan (holotype: NSMT-Cr 9358; allotype: NSMT-Cr 9359; paratypes: NSMT-Cr 9360).

Female (holotype). Body (Fig. 1A) robust, 2.44 mm in length; cephalosome separated from 1st metasomal segment with a transverse groove dorsally, produced anteriorly into rounded eye protuberance; 4th and 5th metasomal segments fused, the end of prosome asymmetrical,

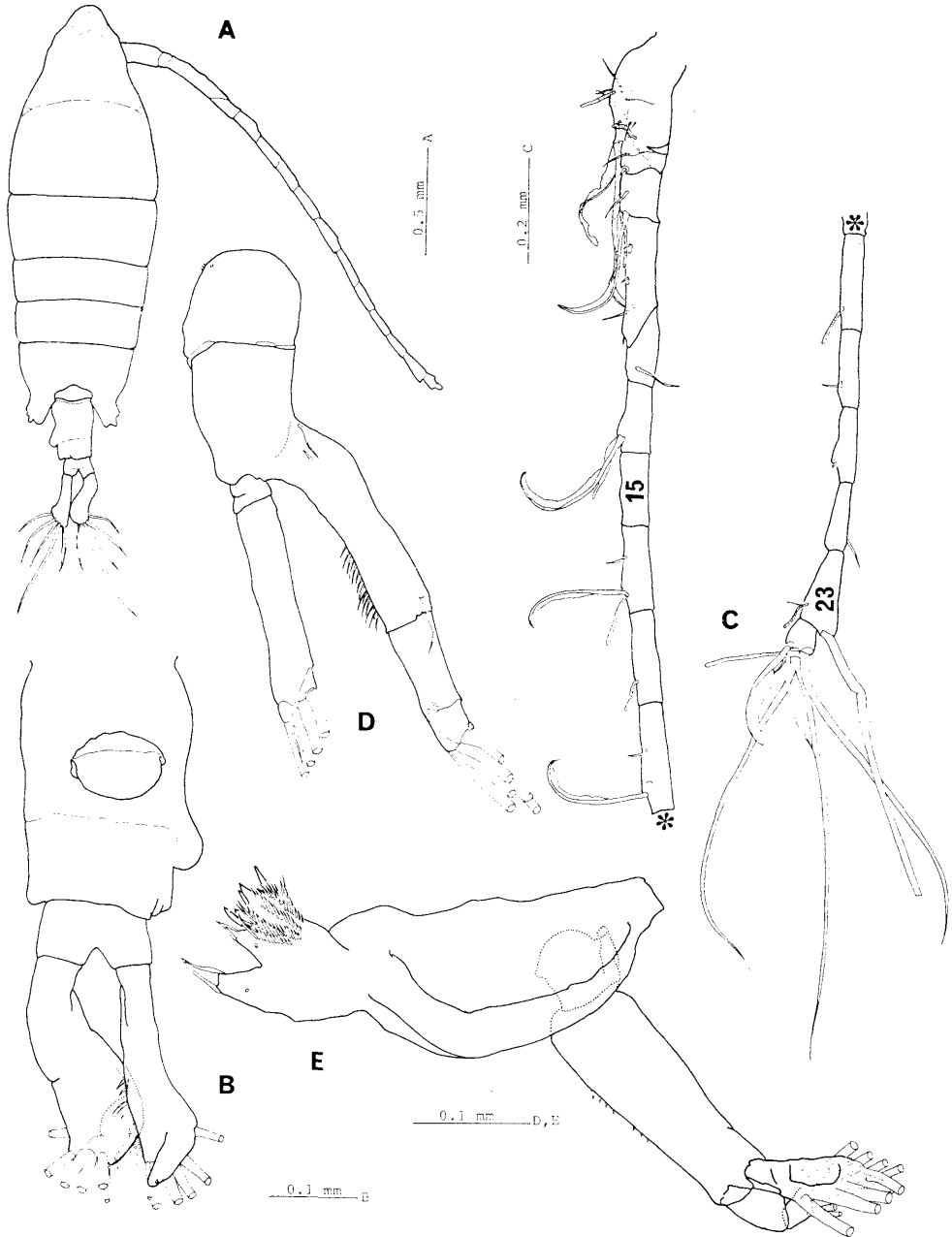


Fig. 1. *Tortanus erabuensis* n. sp. Female (holotype).
 A. Habitus, dorsal view; B. Urosome, ventral view; C. Antennule;
 D. Antenna; E. Mandible.

produced backwards, reaching more than half the genital segment. Urosome (Fig. 1B) 3-segmented; genital operculum semi-circular; 2nd urosomal segment symmetrical, suture between genital and 2nd segments being very weak; caudal rami asymmetrical, the right ramus larger than the left, terminal part expanded and inner dorsal side produced, the left ramus with knob-like process near the end of the ventral surface. Antennule (Fig. 1C) symmetrical, reaching near the end of caudal ramus; the segmentation and armature are the same as those of *T. scaphus*: segments 1-7, 9-12 and 24-25 fused. Antenna (Fig. 1D): basipod 1 bearing very minute spinules on the base; basipod 2 imperfectly fused with the proximal segment of endopod; endopod consisting of 2 segments, proximal segment bearing a subterminal setule and numerous spinules along the distal half of the posterior margin, distal segment bearing 6 distal setae and a patch of short thick spinules at a point about two-thirds of the segment; exopod composed of 3 segments, proximal segment with no setule, middle segment with 2 setae and 1 setule, and distal segment with 2 setae. Mandible (Fig. 1E): cutting edge bearing 5 cuspidate teeth and 4 rows of spinules; mandibular palp with elongate basipod 2 whose inner margin bears small spinules; endopod composed of 2 segments, proximal segment with no seta and distal one with 6 setae; exopod with 5 setae and 3 rows of minute spinules. Maxillule (Fig. 2A): gnathobase (1st inner lobe) with 13 stout setae, bearing 5 short thick spines and a patch of spinules basally; 2nd inner lobe elongated, furnished with 7 short thick setae and three spinulose setae, tips of which are serrated. Maxilla (Fig. 2B) stout, with 5 basipodal lobes along the anterior margin, and 3-

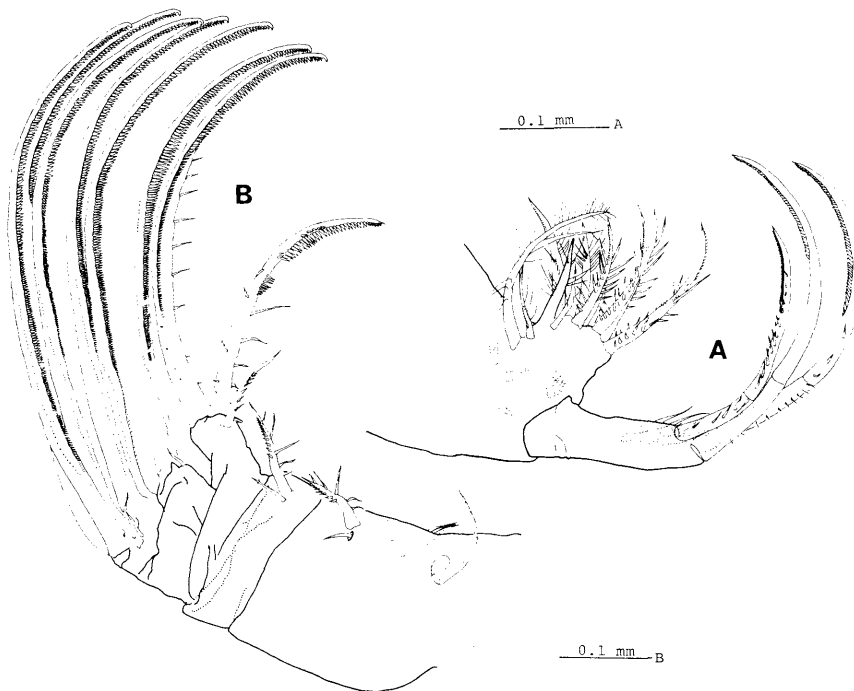


Fig. 2. *Tortanus erabuensis* n. sp. Female (holotype).
A. Maxillule; B. Maxilla.

segmented endopod; 1st basipodal lobe with 1 seta and aesthetasc-like setae; 2nd and 3rd lobes each with a spinulose seta; 4th lobe produced anteriorly and bearing 2 large serrate setae and a spinulose seta; 5th lobe with a strong serrate seta and a minute setule. Maxilliped (Fig. 3A) reduced; basipod 1 produced anteriorly into 2 lobes each bearing a long spinulose seta; basipod 2 with a few spinules subterminally; endopod with 3 thick plumose setae and a small naked

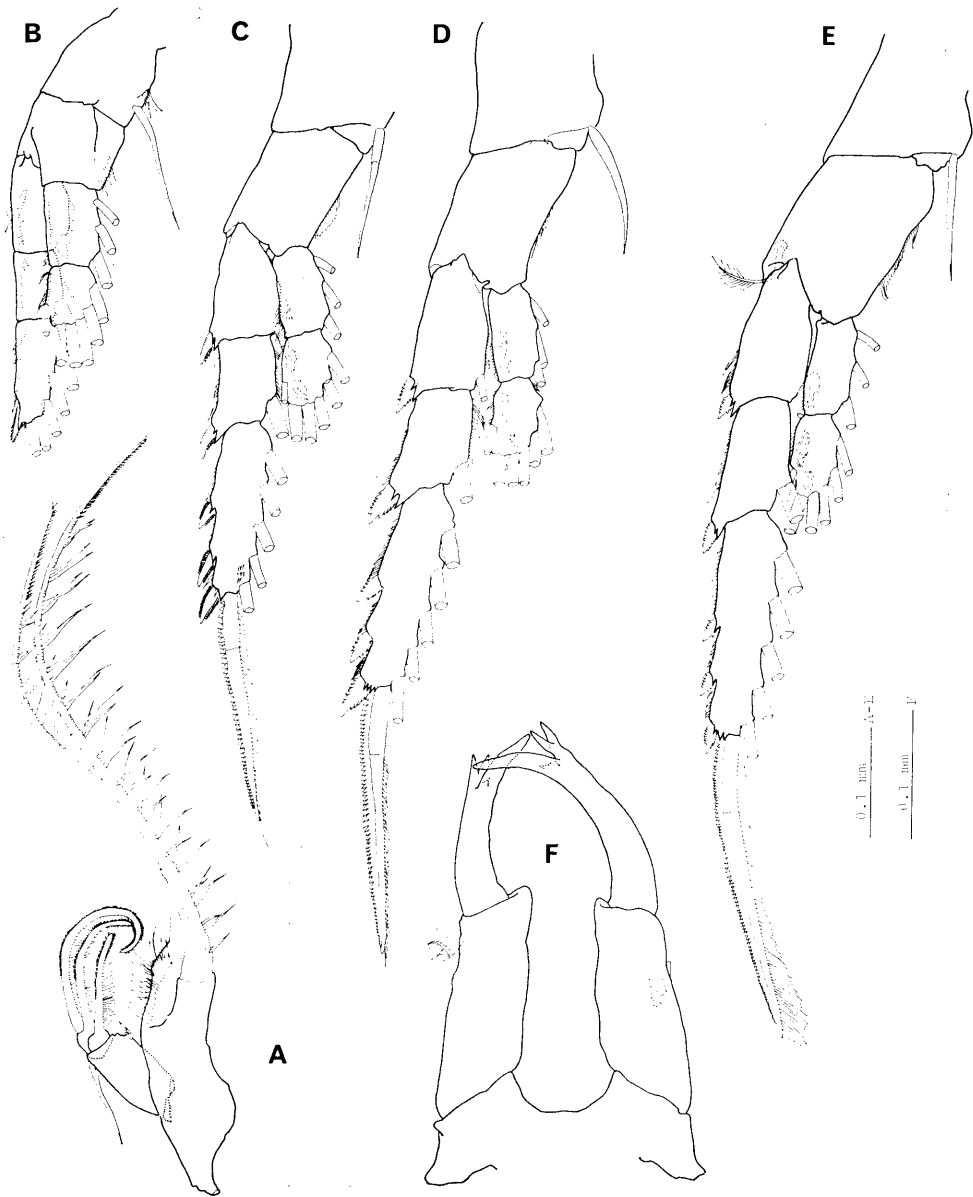


Fig. 3. *Tortanus erabuensis* n. sp. Female (holotype).
A. Maxilliped; B. Leg 1; C. Leg 2; D. Leg 3; E. Leg 4; F. Leg 5.

seta. Legs 1-4 each with 2-segmented endopod and 3-segmented exopod; leg 1 (Fig. 3B) different from following legs in setation and spinulation, 1st and 2nd exopod segments each without outer terminal spine, and 3rd exopod segment bearing 4 inner setae, 1 terminal seta and 1 outer spine; legs 2 and 3 (Fig. 3C, D) very similar to each other; leg 4 (Fig. 3E) with basipod 2 bearing 1 seta near the base of exopod on the posterior surface. Leg 5 (Fig. 3F) slightly asymmetrical, right leg longer than the left; both legs 3-segmented including a common basipod 1; 2nd segment elongated, bearing a plumose seta at a point five-sevenths of the outer margin; terminal segment curved inwards, produced into a process with blunt tip, near the base of which 1 minute low process and bifurcated process present.

Male (allotype). Body (Fig. 4A) 2.04 mm in length; cephalosome separated from 1st metasomal segment with a transverse groove dorsally; suture between 4th and 5th metasome segments visible from lateral view; 5th metasome segment symmetrical, produced into rounded tips on both sides; urosome 5-segmented; genital segment slightly asymmetrical, produced postero-laterally on the left side; caudal rami slightly asymmetrical, the right ramus larger than the left. Antennule: right antennule (Fig. 4B) with geniculation between 18th and 19th segments. Mouthparts and legs 1-4 similar to those of the female. Leg 5: right leg (Fig. 4C) with short swollen basipod 2 and 2-segmented exopod; 1st segment of exopod expanded, its inner margin produced medially into a rounded process bearing a stout short setule at the tip, and the posterior surface of the segment with 2 short setules of unequal lengths; inner margin of 2nd exopod segment lamellar and bearing 2 stout short setules and a small leaf-like setule; left leg (Fig. 4D) with elongated basipod 2 and 2-segmented exopod, curved smoothly inwards; 1st exopod segment with papilla located at a point about one-seventh of its inner margin; 2nd exopod segment with 2 serrated setae at the tip and 2 hairy rows on the anterior surface.

Remarks. *T. erabuensis* is closely similar to *T. lophus*, *T. murrayi* and *T. sinicus*, but differs from these three species in the shape of the posterior margin of female prosome, the segment number of the female urosome, the shape of the grasping organ of the male right antennule, and the shape of the legs 5 of both sexes. Except for the number of the female urosome segments, the diagnosis of the subgenus *Atortus* (SEWELL 1932, BOWMAN 1971) is applicable to the present new species. The female of this new species has 3-segmented urosome, while those of other members within the subgenus have 2-segmented ones and their anal segments often fuse with the caudal rami. Because the suture between the genital and 2nd segments is very weak, we conclude to assign the present new species to *Atortus*. In *T. sinicus* which apparently belongs to the subgenus, the situation is similar; although CHEN (1983) has not pointed in the description, a suture between the genital and 2nd segments is present viewed from the right lateral side (see CHEN 1983, p. 134, fig. 1C). So a part of the description in BOWMAN's (1971) diagnosis should be revised as follows: female urosome 2 or 3-merous.

BOWMAN (1971) subdivided the members of *Atortus* into two groups by the morphological differences of the male antennule, the lateral process of the male 2nd urosome segment and the female leg 5. The present new species belongs to the 2nd group defined by BOWMAN (1971), which is characterized by the male 2nd urosome segment without the lateral process, 18th

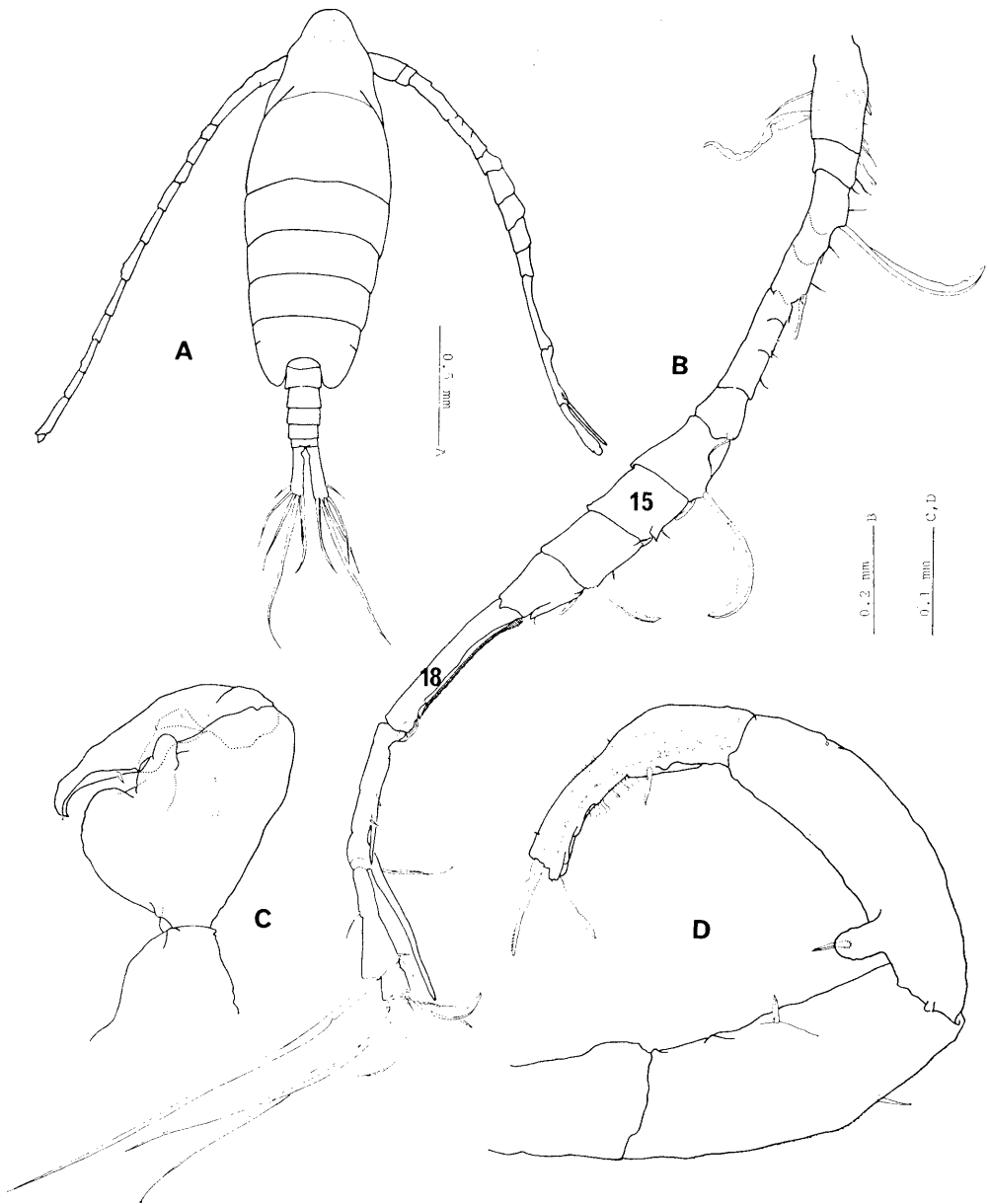


Fig. 4. *Tortanus erabuensis* n. sp. Male (allotype).

A. Habitus, dorsal view; B. Right antennule; C. Right leg 5; D. Left leg 5.

segment of the male right antennule not produced, and the female leg 5 ending in three prongs. The 2nd group has originally consisted of *T. recticauda* from the Red Sea, and *T. lophus*, *T. murrayi* and *T. scaphus* from the western Pacific (GIESBRECHT 1892, BOWMAN 1971). Considering the morphological and zoogeographical differences of *T. recticauda* from other members, as BOWMAN (1971) has already suggested, it might be removed from the 2nd group

and form another group with *T. capensis* Grindley from South Africa which is most similar to *T. recticauda* in legs 5 of both sexes. *T. sinicus* from the South China Sea should also be placed in the 2nd group, although the female leg 5 does not end in three but two prongs. The members of the 2nd group including the present new species and *T. sinicus* inhabit subtropical or tropical waters in the western Pacific and seem to prefer off-shore waters around the coral reefs to estuarine and coastal waters as suggested for *T. murrayi*, *T. sinicus* and *T. scaphus* in the South China Sea by CHEN (1983).

Notes on the Possible Feeding Mechanisms and the In-situ Feeding Habits of *T. erabuensis*

Tortanus appears to employ two feeding methods for capturing preys varying in size: maxillary fling for smaller preys and direct grasp with the tips of the maxillary setae for larger preys (cf. AMBLER & FROST 1974, BOXSHALL 1985). According to AMBLER & FROST (1974) *Tortanus* uses its maxillae as a scoop net to capture nauplii of *Calanus* by the former method, and grasps the copepodids and small adult copepods with maxillae and holds them by the maxillae and maxillipeds by the latter method. However, the role of the maxillules seems to be overlooked, because the three setae on the 2nd maxillular inner lobes are stout and serrated as the stout setae on the maxillary endopods, reaching as far as the tips of the maxillae (see Fig. 2A, B, Pl. I, A). Such morphological characteristics of the setae on the 2nd maxillar inner lobes suggest that they might function as the supplement of the maxillae for capturing, handling and holding the prey. The maxillae of the present new species are stout in structure, whose serrated setae on the 4th and 5th inner lobes and endopods (see Pl. I, B, C) seem to be well adapted to clasp the prey zooplankter. Especially the tips of these setae (Pl. I, C) are modified into claws to be suited for clasping the prey. The gut contents of both sexes of *T. erabuensis* are shown in Table 2. *T. erabuensis* fed mainly on *Oithona* copepodids. Copepodids other than *Oithona* were rarely found. It is obscure whether the unidentified remains and diatom fragments in the guts were derived from the gut contents of the preys or directly fed.

In a sample, *Oithona oculata* was dominant, but *T. erabuensis* was few. Other copepod species were collected only in small numbers. *O. oculata* is known to form a continuous flat swarm over flat sandy bottom at a depth of 6 to 14 m (UEDA et al. 1983). Although we

TABLE 2. THE FREQUENCY OF OCCURRENCE OF FOODS IN THE GUTS OF BOTH SEXES OF *T. erabuensis*.

Foods	Female (%)	Male (%)
<i>Oithona</i> copepodids	80	20
Other copepodids	0	20
Crustacean fragments	10	0
Diatom fragments	10	10
Unidentified remains	80	50
Empty guts	10	50

could not observe swarming of *Oithona* due to turbid water, the possibility that *O. oculata* formed a swarm just above the bottom at the station is very high. UEDA et al. (1983) suggested that the copepod swarms are important as foods for fishes, in particular, for juvenile fishes. Similarly, copepod swarms may also be very convenient food sources for invertebrate predators such as *Tortanus*.

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Explanation of Plate I.

SEM photomicrographs of the mouthparts of a female *Tortanus erabuensis* n. sp. A. Mouthparts, ventral view (mxu: maxillule; mxa: maxilla; mxp: maxilliped); B. Maxilla; C. Tips of the setae of maxillary 5th inner lobe and endopod, same maxilla (B), magnified. Scale bars: A & B=100 μ m, C=50 μ m.

PLATE I

