

SPECIES OF THE GENERA *TEMORA* AND *TORTANUS* FROM INDONESIAN COASTAL WATERS

Mulyadi

Division of Zoology, Research Center for Biology, Indonesian Institute of Sciences
Jl. Raya Bogor Km. 46 Cibinong 16911, Indonesia
E-mail: mulyadi-08@yahoo.com

ABSTRACT

During taxonomic studies on the pelagic copepods of Indonesian waters, three species of *Temora*, *T. discaudata* Giesbrecht, 1882, *T. discaudata* n. var. and *T. turbinata* (Dana, 1849), and three species of *Tortanus*, *T. (Tortanus) barbatus*, *T. (Tortanus) forcipatus* and *T. (Tortanus) gracilis* were described and figured on specimens collected from 8 sites along Indonesian coastal waters. Descriptions, measurements and figures are given for those species, along with a review of their distribution over the world oceans, and with taxonomic remarks, ecological notes, and restricted synonymies.

Key words: taxonomy, *Temora*, *Tortanus*, Indonesian waters

INTRODUCTION

Family Temoridae Giesbrecht, 1893 comprises of 35 species from four genera, *Epischura* Forbes, 1882; *Eurytemora* Giesbrecht, 1881; *Hetercope* Sars, 1863; and *Temora* Baird, 1850. The genus *Temora* presently comprises of five species (Boxshall & Halsey, 2004). Among them two species, *T. discaudata* Giesbrecht, 1882 and *T. turbinata* (Dana, 1849) have been reported from Indonesian waters (Scott, 1909).

Copepods of the genus *Tortanus* Giesbrecht & Schmeil, 1898 mainly inhabit tropical or subtropical coastal waters. At present, about 32 species of the genus *Tortanus* Giesbrecht, 1892 have been documented from the Indo-Pacific region and the Atlantic Ocean (Ohtsuka *et al.*, 1987; Ohtsuka & Kimoto, 1989; Ohtsuka, 1992; Chen & Hwang, 1999). The species of this genus are divided into four subgenera based on various morphological characters. These subgenera are: *Tortanus (Tortanus)* Giesbrecht, 1892, *Tortanus (Atortus)* Ohtsuka, 1992, *Tortanus (Eutortanus)* Smirnov, 1935, and *Tortanus (Acutanus)* Ohtsuka, 1992.

In Indonesian waters, four species from two subgenera have hitherto been reported. These are: *T. (Tortanus) barbatus* (Brady, 1883), *T. (Tortanus) gracilis* (Brady, 1883), *T. (Atortus) brevipes* Scott, 1909; and *T. (Atortus) murrayi* Scott, 1909.

Two species of *Temora* and a new variety of *T. discaudata* and three species of *Tortanus*, *T. (Tortanus) barbatus*, *T. (Tortanus) forcipatus* and *T. (Tortanus) gracilis* were collected from shallow waters in 8 sites of Indonesia.

MATERIALS AND METHODS

The present plankton samples were obtained from 8 sites during 1994–2007 (Figure 1). Sampling was done by surface and vertical hauls (10 m and 20 m depth to the surface) with plankton net (0.33 mm mesh size, 0.45 m mouth diameter). The samples were fixed and preserved in 5% buffered formaldehyde/sea water solution. As far as possible, the specimens were identified to species level. Habitus and appendages were examined and measured using a compound microscope and detailed drawings were made with a camera lucida. Reference slides of appendages were prepared using glycerin jelly and methyl blue and deposited at the Museum Zoologicum Bogoriense, Research Center for Biologi – LIPI, Cibinong, Indonesia.

Abbreviations used in the text to described morphological features are: A1, antennule; A2, antenna; Ms1–Ms5, metasomal somites 1–5; P1–P5, swimming legs 1–5; Ur1–Ur5, urosomal somites 1–5; CR, caudal rami; Re, exopod; Ri, endopod.

DESCRIPTIONS

Temora turbinata (Dana, 1849)

Calanus turbinatus Dana, 1849:12

Temora turbinata, Giesbrecht, 1892: 329, pl. 17; Scott, 1909: 119; Mori, 1937: 64, pl. 32; Tanaka, 1963: 13; Gonzales & Bowman, 1965: 249; Bradford, 1977: 135, figs. 3–4; Greenwood, 1978: 4–5.

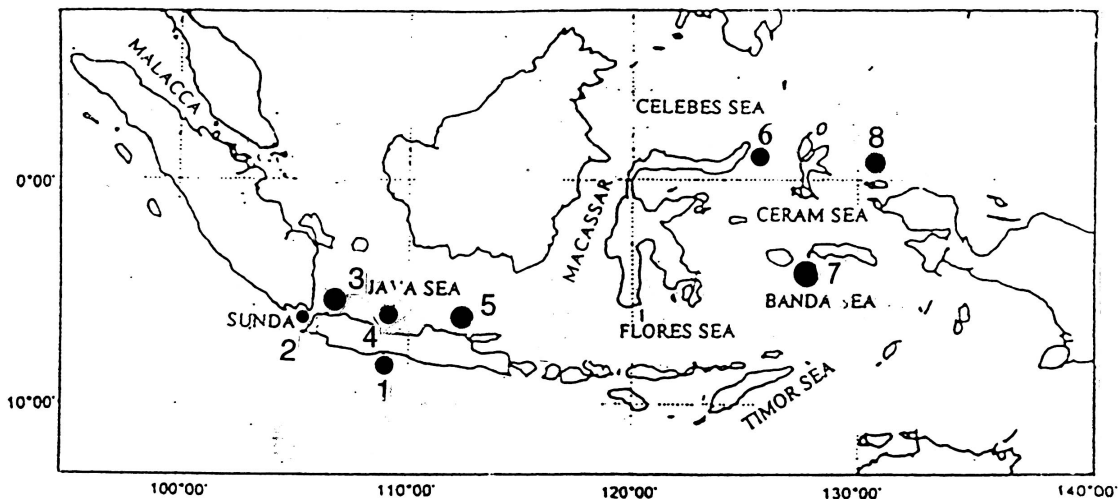


Figure 1. Map of Indonesian waters showing study sites 1–8.

Table 1. Sampling sites, dates and number of samples in Indonesian coastal waters

Sites	Position	Date	Depth of hauls	Number of samples
1. Cilacap Bay	07°40'S 109°00'E	24 March 2006	15 m	10
2. Off Labuan	06°10'S 106°00'E	18 March 1998	15 m	10
3. Jakarta Bay	06°00'S 106°45'E	2 Nov. 2007	15 m	10
4. Off Tegal	06°40'S 109°10'E	23 March 2007	10 m	10
5. Off Surabaya	07°40'S 109°10'E	20 Sept. 1999	10 m	10
6. Bitung Bay	01°23'N 125°06'E	14 May 2004	20 m	10
7. Ambon Bay	03°40'S 128°10'E	21 April 2004	20 m	10
8. Waigeo, Papua	00°17'S 130°52'E	20 June 2007	15 m	10

Table 2. Species list of *Temora* and *Tortanus* recorded in the present study, their sampling sites and their previous record in the major oceans. 1-8, study sites; I, P, At, Indian, Pacific and Atlantic Oceans; O, Oceanic; N-O, Neritic Oceanic; N, Neritic; E-N, Estuarine-Neritic; ○, present records; ●, previous records.

No.	Species	Sites								Oceans			Remarks
		1	2	3	4	5	6	7	8	I	P	At	
1.	<i>Temora turbinata</i>	○	○	○	○	○	○	○	○	●	●	●	N
2.	<i>T. discaudata</i>	○	○	○	○	○	○	○	○	●	●	●	N
3.	<i>T. discaudata</i> n. var							○	○				N
4.	<i>T. (Tortanus) barbatus</i>	○	○	○	○					●	●		N
5.	<i>T. (Tortanus) forcipatus</i>	○	○	○	○					●	●		N
6.	<i>T. (Tortanus) gracilis</i>		○				○			●	●		N

1, Cilacap Bay; 2, Off Labuan; 3, Jakarta Bay; 4, Off Tegal; 5, Off Surabaya; 6, Bitung Bay; 7, Ambon Bay; 8, Waigeo Island, Papua.

Material examined. Ten females (1.10–1.25 mm), 10 males (1.0–1.20 mm) collected off Labuan, west Java by surface tow of 0.33 mm mesh plankton net at daytime on 18 April 1998.

Female. - Body short and compact. Cephalon much higher than posterior prosome, with 2 delicate rostral filaments, fused with Ms1; Ms4 and Ms5 fused, posterolateral ends

produced into smoothly rounded lobes, without spines. A1 24-segmented. Urosome consists of 3 somites, genital complex flattened ventrally; anal somite shorter than Ur2 and somewhat asymmetrical; CR longer and narrow, asymmetrical, right rami slightly longer than left, 7 times as long as wide, 2nd inner seta enlarged at the base. P1-P4 with 3-segmented Re, Ri 2 segmented in P1 and 3 segmented in P2-P4. P5 uniramous, symmetrical, with 1 coxa, 1 basis and

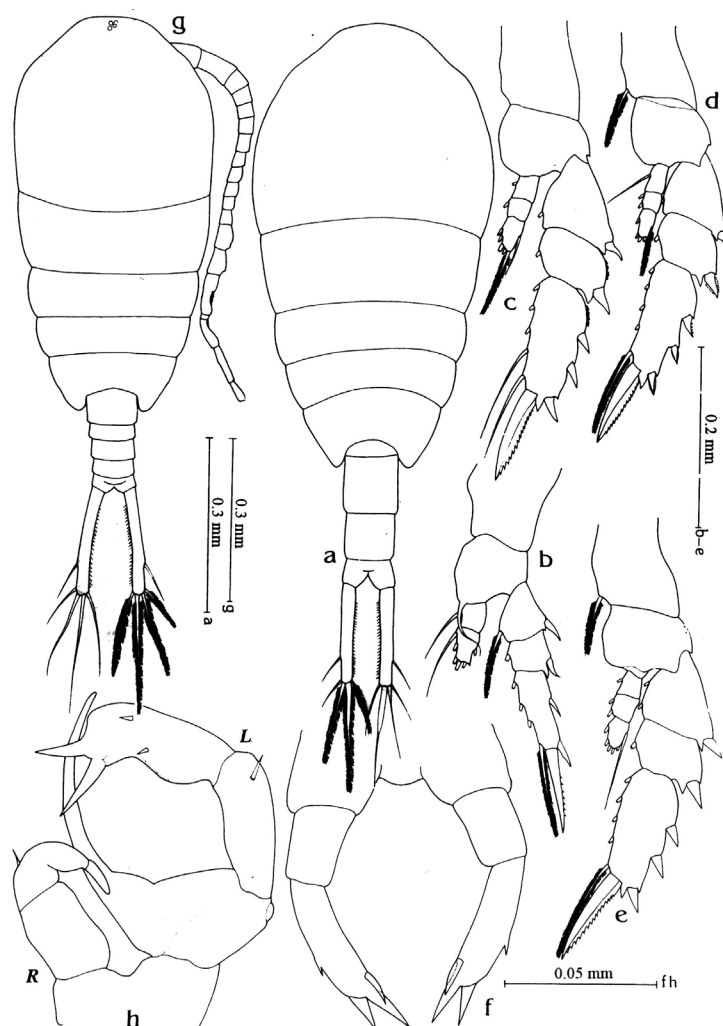


Figure 2. *Temora turbinata* (Dana, 1849). Female. a, whole animal, dorsal view; b-e, 1st-4th legs; f, 5th legs. Male. g, whole animal, dorsal view; h, 5th legs.

1 exopodal segments, Re with 1 outer spine and 3 subequal spines at apex, 2nd inner spine the longest.

Male.- Posterolateral ends of Ms5 narrowly rounded. Urosome consists of 5 somites; anal somite symmetrical; CR almost symmetrical, 2nd inner seta not swollen. P5 uniramous, left leg 4 segmented, inner side of 2nd segment with 1 slender thumb-like process, slightly curved and extending about $\frac{3}{4}$ distal end of 4th segment; 3rd segment with 1 distolateral spine; 4th segment bluntly rounded distally, with 2 stout apical spines, and 2 outer spines, inner margin swollen. Right leg short, 3 segmented, 3rd segment with 1 outer spine-like seta, gradually curved and hook-like, terminal spine short and curved inward.

Remarks.- This species resembles *T. longicornis*, but is distinguished from the latter by the anal somite form and the symmetrical CR. *T. turbinata* is widespread and tolerant of wide range of environmental variation means it should be able to transported considerable distances in the open ocean. It has been reported as common in the tropical and subtropical region of Pacific and Indian Oceans. Well recorded from Burma to the Arafura Sea and northwards the South China Sea (Dana, 1849; Sewell, 1912), and Australian region from New Zealand, southern New South Wales to Barrier Reef waters (Dakin & Colefax, 1940; Bradford, 1977; Greenwood, 1978).

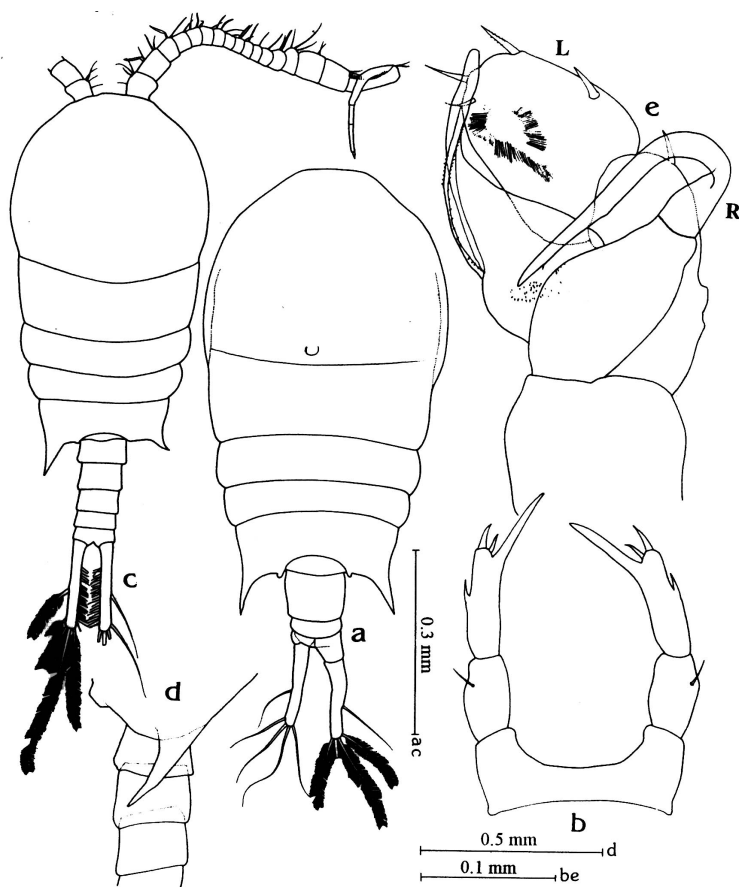


Figure 3. *Temora discaudata* Giesbrecht, 1892. Female. a, whole animal, dorsal view; b, 5th legs. Male. c, whole animal, dorsal view; d, Ms5 and Ur1-Ur3, lateral view; e, 5th legs.

***Temora discaudata* Giesbrecht, 1889**

Temora discaudata Giesbrecht, 1889: 328, pl. 17; Scott, 1909: 118; Sewell, 1912: 365; Mori, 1937: 65, pl. 32; Tanaka, 1963: 13; Greenwood, 1978: 2, fig. 1a-h.

Material examined. Ten females (1.68–2.05 mm), 10 males (1.65–1.85 mm) collected from Waigeo Island, Papua by surface tow of 0.33 mm mesh plankton net at daytime on 12 June 2007.

Female.- Cephalon widened anteriorly, separated from Ms1; Ms4 and Ms5 fused, posterolateral ends of Ms5 produced into asymmetrical acute lobes, right side apparently longer than left. A1 24-segmented, reaching distal end of Ur3 when folded backwards. Urosome consists of 3 somites, genital complex wide, almost symmetrical; Ur2 short; anal somite asymmetrical, left side much longer than right; CR asymmetrical, right side longer and bigger than left, about 6 times as long as wide. P5 uniramous, symmetrical, with 1 coxa, 1 basis, and 1 exopodal segments; basis with 1 distolateral spine-like seta; Re with 1 outer spine at middle,

and 3 unequal spines at apex, innermost much longer and stout.

Male.- General appearance as in female. Posterolateral ends of Ms5 produced into asymmetrical pointed lobes, left side longer than right, tip of right side curved outwards. Left A1 24-segmented reaching distal end of Ms5 when folded backwards. Right A1 geniculate, fused segments 19–21 with a row of devoid denticles. Urosome consists of 5 somites, almost symmetrical; CR long, 8 times as long as wide. P5 uniramous, left leg 3 segmented, 2nd segment with a wide thumb-like process on inner margin, and 1 distolateral spine; terminal segment lamelliform, and furnished with 4 outer spines, inner margin hirsute. Right leg, 3rd segment hook-like, sharply bent back against the outside of leg.

***Temora discaudata* immature**

Temora styliifera, Mori, 1937: 6, pl. 33, figs. 1-2; Dakin & Colefax, 1940: 92, figs. 116a-c; Wilson, 1950: 343; Chiba, 1953b: 722, fig. 1a-h; Tanaka, 1963: 14; Chen & Zhang, 1965, pl. 21, figs. 1-4.

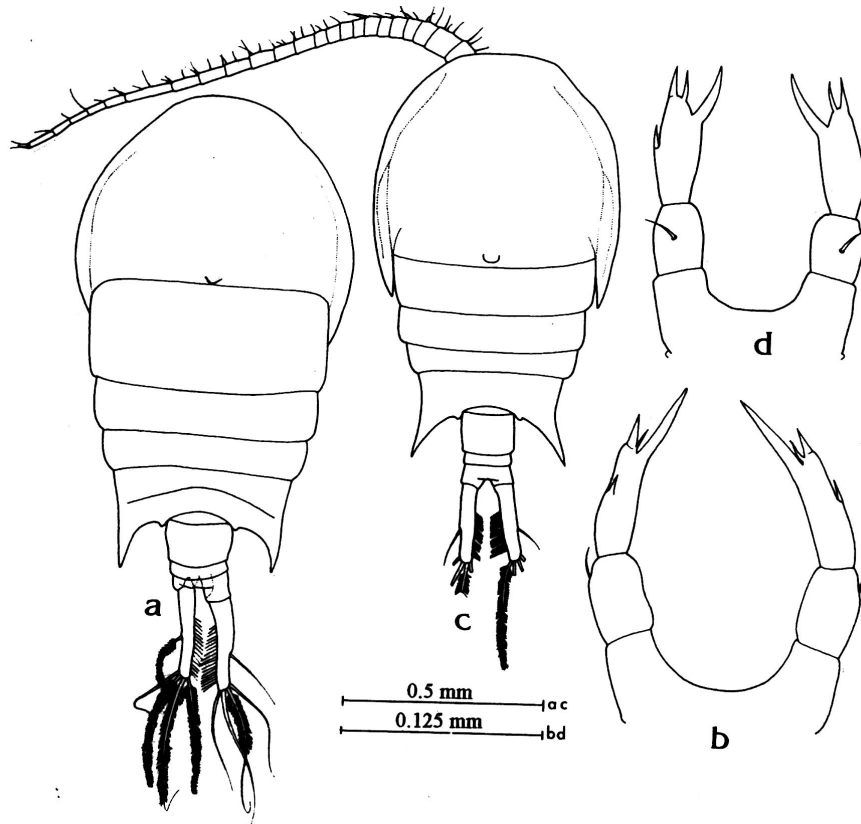


Figure 4. *Temora discaudata* Giesbrecht, 1892. Female. a, copepodite stage V, dorsal view; b, 5th legs; c, copepodite stage IV, dorsal view; d, 5th legs.

Material examined. Five immature females (1.27–1.30 mm) collected from Waigeo Island, Papua by surface tow od 0.33 mm mesh plankton net at daytime 12 June 2007.

Female (fig. 4c).- Cephalon rounded anteriorly, shorter than wide (3 : 4), posterior corners pointed, posteromedially with a knob-like process. Posterolateral ends of Ms5 produced into symmetrical long spines. A1 24-segmented reaching distal end of CR when folded backwards. Urosome consists of 3 somites, almost symmetrical, anal somite symmetrical and separated from CR; CR symmetrical, about 6.5 times as long as wide. P5 symmetrical with 1 coxa, 1 basis, and 1 exopodal segment; basis with 1 short seta; Re with 1 outer spine at middle, and 3 unequal spines at apex, innermost much longer and stout.

Remarks.- Copepodite V stages of *T. discaudata* have symmetrical posterolateral ends of Ms5 and caudal rami, and posterolateral process on cephalon in both sexes can be superficially mistaken for *T. stylifera* by (Mori, 1937; Tanaka, 1963; Chen & Zhang, 1965). It is probable the juveniles recorded and figured off New South Wales by Dakin & Colefax (1940) as *T. stylifera* were in fact *T. discaudata*.

***Temora discaudata* n. var.**

Material examined. Ten females (1.65–1.95 mm), 10 males (1.60–1.85 mm) collected from Ambon Bay by surface tow of 0.33 mm mesh plankton net at daytime on 13 March 1995.

Female.- In general appearance resembles *T. discaudata*, except for P1 and P5. P1, Ri1 with 1 long spine-like seta arising from distal end of segment extend beyond Ri2. P5 symmetrical with 1 coxa, 1 basis and 1 exopodal segments; basis with 1 distolateral spine-like seta; Re with 1 outer seta at middle and 4 spines at apex, innermost one much longer and stouter.

Male.- In general appearance resembles *T. discaudata*, but differs in posterolateral ends of Ms5, right side produced into short spine, curved outward in dorsal view.

Remarks.- Only two species of *Temora* have pointed Ms5, *T. stylifera* and *T. discaudata*, and the latter species is distinguished readily by its asymmetrical CR. Moreover, the 2 spines were probably allopatric, with *T. stylifera* limited to the Atlantic and *T. discaudata* to the Indo-Pacific.

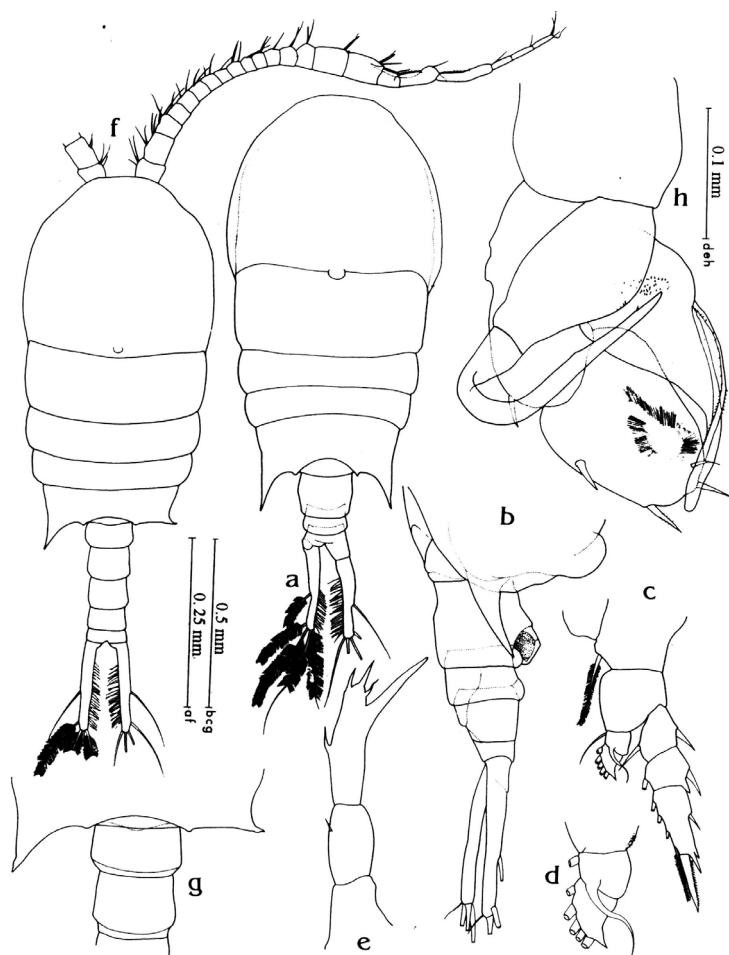


Figure 5. *Temora discaudata* n. var. Female. a, whole animal, dorsal view; b, Ms5 and urosome, lateral view; c, 1st leg; d, Ri of P1; e, 5th leg. Male. f, whole animal, dorsal view; g, Ms5 and Ur1-Ur2, dorsal view; h, 5th legs.

The Pacific Ocean (Wilson, 1950) and China Sea (Chen & Zhang, 1965) records of *T. stylifera* were misidentification, actually *T. discaudata*. Mori (1937) and Tanaka (1963) illustrations of *T. stylifera* were of an immature female, because the posterior corners of the cephalon are produced into points, the anal somite and CR are symmetrical, and the distal segment of P5 is shorter than in the adult. Chiba (1953a) described the male of *T. stylifera* from Japan Sea, but his drawing of P5 clearly places this specimens in *T. discaudata*. Later Chiba (1953b) again described the male of *T. stylifera* with short CR and incompletely developed P5, it was doubtless a young *T. discaudata*.

***Tortanus (Tortanus) barbatus* (Brady, 1883)**

Corynura barbata Brady, 1883: 71, pl. 31.

Corynura denticulata Giesbrecht, 1889: 26; 1893: 525, pls. 31, 42.

Tortanus barbatus, Giesbrecht & Schmeil, 1898: 158; A. Scott, 1909: 189; Sewell, 1912: 377; Früchtl, 1924: 37, 83; Greenwood, 1978: 18, fig. 9a-j.

Tortanus sp. Dakin & Colefax, 1940: 106, figs. 161a-c.

Material examined. Five females (1.59–1.65 mm), 5 males (1.40–1.45 mm) collected off Labuan, west Java by surface tow of 0.33 mm mesh plankton net at daytime on 18 June 1994.

Female.—Cephalon rounded anteriorly, separate from Ms1. Rostrum absent. Eye large without lenses. Ms4 and Ms5 separate, posterolateral ends produced into small rounded lobes. A1 17-segmented. Urosome consists of 3 somites, anal somite long and narrow, fused with CR; CR much elongated, asymmetrical, right side longer than left. P1-P4 with 3 Re and 2 Ri in P1 and 3 Ri in P2-P4. P5 asymmetrical, right leg, Re short and naked, less than half

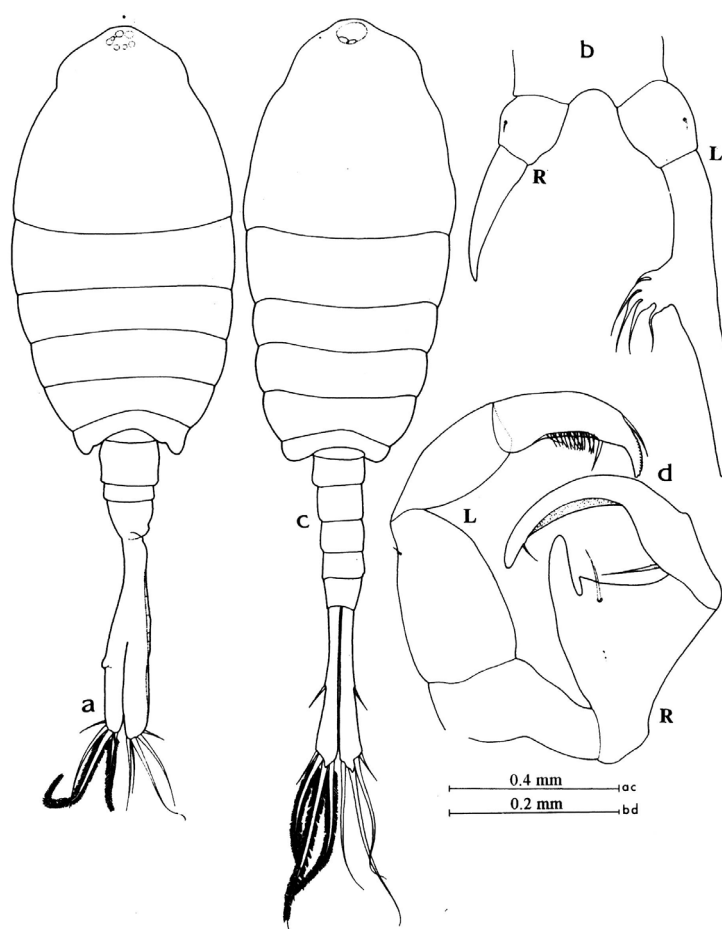


Figure 6. *Tortanus (Tortanus) barbatus* (Brady, 1883). Female. a, whole animal, dorsal view; b, 5th legs. Male. c, whole animal, dorsal view; d, 5th legs.

length of left one. Left leg long and comparatively stout, middle inner margin of Re furnished with a tuft of 5 curved lamelliform teeth.

Male.- Prosome as in female. Urosome consists of 5 somites; CR symmetrical, separate from anal somite. P1-P4 as in female. P5 asymmetrical, right leg 3-segmented, basis widened basally, Re1 widened posteriorly with 1 thumb, 1 triangular process and 1 seta. Re2 curved inwards with 1 basal and 1 posterior seta, inner margin smooth. Left leg 3-segmented, basis widened basally with 1 small outer seta, Re1 shorter than Re2; Re2 with 1 outer seta and 1 inner seta, $\frac{1}{4}$ distal part denticulated, inner margin hirsute.

Remarks.- Considerable confusion has occurred in this species in the past because of the variability in the nature of the comb of denticles on inner margin of female left P5, and the lateral setae of CR. In Brady's (1883) figures the denticles terminated in long "whips" and the outer seta on CR was long, reaching distal end of CR, in contrast to that

of *T. denticulatus*. Scott (1909) first suggested synonymy of *T. denticulatus* and *T. barbatus* when he found intermediate forms in "Siboga" specimens, however Sewell (1912) in examining specimens from Bengal Bay still considered that distinct species, suggesting that Scott had mistaken *T. denticulatus* for *T. barbatus* in the Siboga specimens. Früchtl (1924) analysed large numbers of individuals and fully supported Scott's case for synonymy. This was accepted by Steuer (1926), and subsequently by Sewell (1932) recognising that the denticles could vary from obtuse to elongate and whip-like, and a long seta may or may not be present on the midlateral margin of the right CR.

In both these respects the Moreton Bay material (Greenwood, 1978) is very uniform and agrees with the previous *denticulatus* end of the spectrum. All specimens examined had 5 distinct obtuse denticles with no evidence of whip-like extensions, and there were no setae arising from the lateral margin of the right CR. Dakin & Colefax (1940) *Tortanus* sp. is clearly the male of *T. barbatus*.

Mainly tropical Indo-Malaysian. Recorded from the bay of Bengal (Sewell, 1912), Aru Island (Früchtl, 1924), Sulu Sea and Verde Island passage (Wilson, 1950), Manipa Strait (Scott, 1909), Zebu Harbour (Brady, 1883), and Australian waters (Greenwood, 1978). Giesbrecht's *C. denticulata* came from the Red Sea.

***Tortanus (Tortanus) forcipatus* (Giesbrecht, 1889)**

Corynura forcipata Giesbrecht, 1889: 525, pl. 31.

Tortanus forcipatus, Giesbrecht & Schmeil, 1898: 158; Sato, 1913: 2; Rechman, 1973: 113–118, pl. 1.

Material examined. Ten females (1.25–1.27 mm) collected from Bone Bay, South Celebes by surface tow of 0.33 mm mesh plankton net at night on 16 June 1999.

Female.- Cephalon and Ms1 separate and also Ms4 and Ms5, posterolateral ends produced into symmetrical knob-like lobes. A1 18-segmented, not reaching distal end of CR when folded backwards. Urosome consists of 3 somites, asymmetrical, anal somite and CR fused. CR asymmetrical, left ramus slightly narrow and smaller than right. P5 uniramous, consists of 3 segments (1 coxa, 1 basis, and 1 exopodal), asymmetrical, right leg longer than left, Re with 2 outer spinules; Re of left leg small, with 2 outer spinules.

Male was not found in the present study.

Remarks.- *T. forcipatus* was first established upon female specimens from the Formosa Strait. For a long time *T. forcipatus* was confused with *T. gracilis* (Brady, 1883),

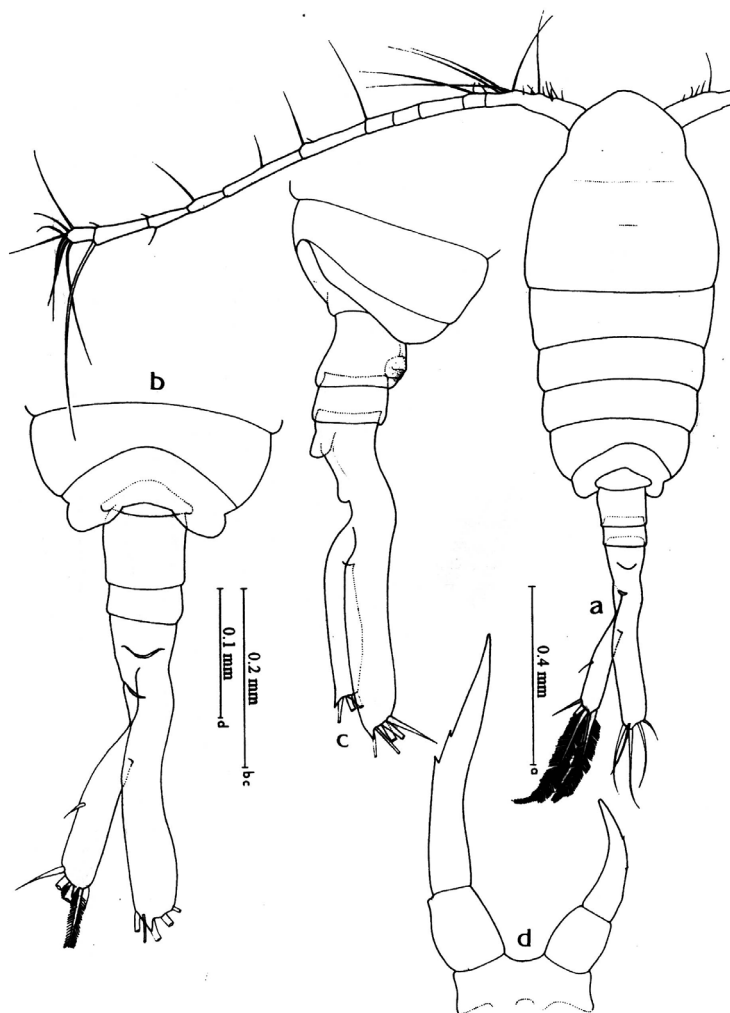


Figure 7. *Tortanus (Tortanus) forcipatus* (Giesbrecht, 1889). Female. a, whole animal, dorsal view; b, Ms5 and urosome, dorsal view; c, Ms5 and urosome, lateral view; d, 5th legs.

but latter on Scott (1909) distinguished between the female of both species, on the basis of the form of 5th leg. The male of this species was first reported by Sewell (1914), but he's account was devoid of any structural details other than those of the 5th leg.

***Tortanus (Tortanus) gracilis* (Brady, 1883)**

Corynura gracilis Brady, 1883: 71, pl. 33.

Tortanus gracilis, Giesbrecht & Schmeil, 1898: 258; Thompson & Scott, 1903: 254; A. Scott, 1909: 190.

Material examined. Two females (1.55 mm) collected from Jakarta Bay by surface tow of 0.33 mesh plankton net at daytime on 2 June 1994.

Female.- Ms4 and Ms5 separate, posterolateral ends produced into symmetrical knob-like lobes. Urosome consists of 3 somites, asymmetrical, anal somite and CR fused. CR asymmetrical, right ramus larger and longer than left. Nodulated protuberance absent. P5 asymmetrical, 3 segmented, basis with 1 seta, Re of left leg slightly larger and longer than right.

Male was not found in the present study.

Remarks.- The female of this species resembles *T. forcipatus*, but is distinguishable from the latter by the absence of nodulated protuberances and the form of the P5, and the larger size. Brady (1883) showed that in

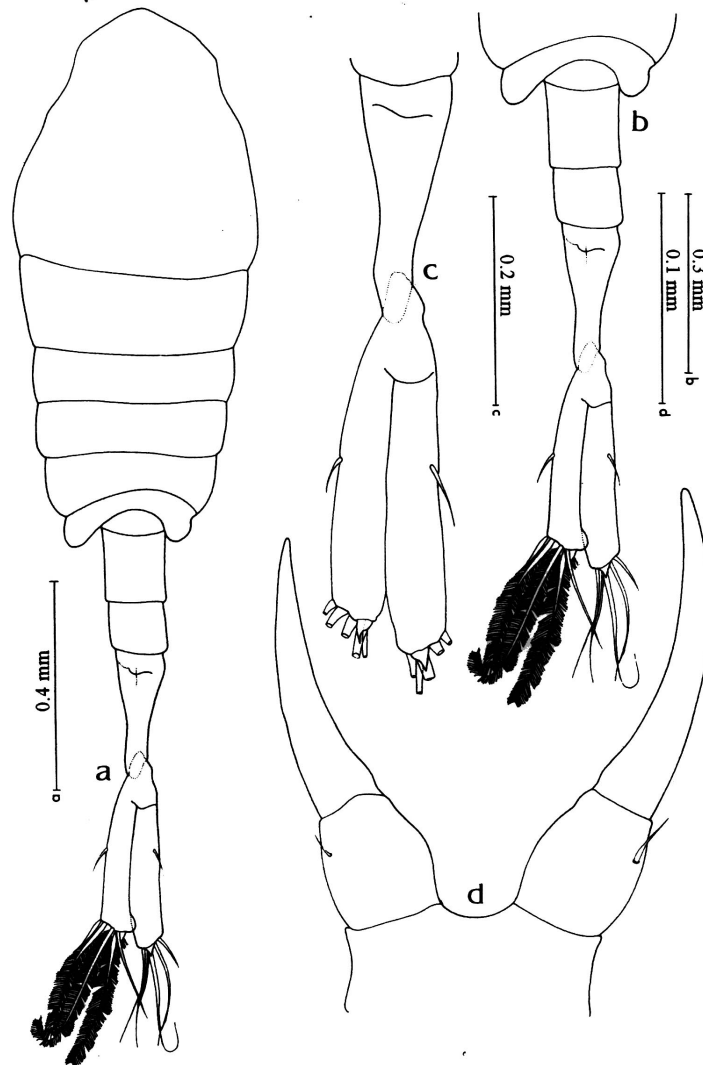


Figure 8. *Tortanus (Tortanus) gracilis* (Brady, 1883). Female. a, whole animal, dorsal view; b, Ms5 and urosome, dorsal view; c, Urosome, dorsal view; d, 5th legs.

T. gracilis the 5 the legs are symmetrical. Scott (1909) found two forms (small and large forms) of this species from Indonesian waters. In the small form (1.52 mm) the 5th legs quite symmetrical, but in the large form (1.68 mm) there is a very slight difference between the length of the left and the right side. Cleve (1901) reported than in some cases larger specimens of *T. gracilis* showed a tendency for the left 5 the legs to be slightly larger. According to (Cleve, 1901; Wolfenden, 1911; Steuer, 1927) *T. gracilis* is open sea form, but it also found in coastal waters in the present study.

General Remarks

Ohtsuka (1992) discussed the subgeneric divisions of *Tortanus*, recognising a total of four subgenera. *T. (Tortanus)* consists of three species, including *Corynura gracilis* Brady, 1883 which was designated the type-species by Ohtsuka (1992). *T. (Eutortanus)* Smirnov, 1935 consists of seven species, *T. (Acutanus)* Ohtsuka, 1992 which accomodates four species and *T. (Atortus)* Ohtsuka, 1992 which currently comprises 21 species (Ohtsuka & Kimoto, 1989; Chen & Hwang, 1999). *Atortus* Sewell, 1932 was unavailable, since Sewell (1932) did not designate a type-species. Ohtsuka & Reid (1998) established a new monotypic subgenus, *T. (Boreotortanus)*, based on the species *Tortanus discaudatus* (Thompson & Scott, 1903) and provided keys to species of *T. (Acutanus)*, *T. (Eutortanus)* and *T. (Tortanus)*.

The most characteristic feature of their distributions is that each species within the subgenus is endemic to a certain locality in the coastal waters in the Indo-Pacific region, while the species of the subgenus *Tortanus* are widely distributed on the Indo-Pacific and Atlantic coast. In Indo-Pacific region, *Tortanus (Tortanus) forcipatus* (Giesbrecht), *T. (Tortanus) gracilis* (Brady), and *T. (Tortanus) barbatus* (Brady) are widely distributed (Brady, 1883; Chen & Zhang, 1965; Madhupratap & Haridas, 1986). *T. (Tortanus) discaudatus* (Thompson & Scott, 1903) has a wide distribution on the North Pacific and the North Atlantic coast (Brodsky, 1950; Kim, 1985).

REFERENCES

- Brady GS, 1883. Report on the Copepoda collected by H.M.S. Challenger during the years 1873–1876. *Report Scien. Results of H.M.S. Challenger, Zool.*, 8: 142.
- Boxshall A and Halsey SH, 2004. *An introduction to copepod diversity*. The Ray Society, 966 pp.
- Bradford JM, 1977. Distribution of the pelagic copepod *Temora turbinata* in New Zealand coastal waters, and possible Trans-Tasman population continuity. *Jour. Marine and Freshwater Res.* 11(1): 131–44.
- Brodsky KA, 1950. Calanoida of Polar and Far Eastern Seas of the U.S.S.R. *Opred. Faune SSSR*, 35: 1–442.
- Chen QC and Hwang JS, 1999. A new species of *Tortanus* (Copepoda, Calanoida) from Taiwan. *Crustaceana*, 72: 265–71.
- Chen QC and Zhang SZ, 1965. The planktonic copepods of the Yellow Sea and the East China Sea. I. Calanoida. *Studia Marina Sinica*, 7: 20–131, 53 pls.
- Chiba T, 1953a. Studies on the pelagic Copepoda from the Japan Sea. III. On the genus of *Temora* Baird 1850. *Bull. Japan Soc. Scient. Fish.*, 18(12): 695–7.
- Chiba T, 1953b. On the distribution of the plankton in the East China Sea and Yellow Sea VIII. Description on the male of the pelagic Copepoda, *Temora stylifera* and *T. discaudata*. *Bull. Japan Soc. Scient. Fish.*, 19(6): 722–5.
- Cleve PT, 1901. Plankton from the Indian Ocean and the Malay Archipelago. *K. svenska Vetensk. Akad. Hadl.*, 36(8): 1–53.
- Dakin WJ and Colefax A, 1940. The plankton of the Australian coastal waters off New South wales. *Monogr. Dep. Zool. Univ. Sydney*, 1: 215 pp.
- Dana JD, 1849. Conpectus Crustaceorum quae in orbis terrarum circumnavigatione Carlo Wilkes e classe Reipublicae Foederatae Duce, lexit et descripsit J. D. Dana. *Proc. American Acad. Arts Sci.*, pars II, vol. 2: 9–61.
- Früchtl F, 1924. Die Cladoceren und Copepoden fauna des Aru-Archipels. Mit Beitragen zur Kenntnis der strukturellen Anomalien indo-pazifischer Plankton-Copepoden. *Arb. Zool. Inst. Univ. Innsbruck*, 2(2): 1–114.
- Giesbrecht W, 1889. Elenco dei Copepodi pelagici raccoti dal tenente di vascello Gaetano Chierchia durante il viaggio della R. Corvetta “Vettor Pisani” negli anni 1882–1885 e dal tenente di vascello Francesco Orsini nel mar Rosso, nel 1884. *Rend. Acc. Lincei*, 6(2): 24–9.
- Giesbrecht W, 1892. Systematik und Faunistik der Pelagischen Copepoden des Golfes von Neapel. *Fauna u. Flora Golf. Neapel, monogr.* 19, 831 pp., 54 pls.
- Giesbrecht W and Schmeil O, 1898. Copepoda I. Gymnoplea. *Das Tierreich*, 6: 1–69, 31 text-figs.
- Gonzales JG and Bowman TE, 1965. Planktonic copepods from Bahia Fosforescent, Puerto Rico, and adjacent waters. *Proc. U. S. Nat. Mus.*, 117(3513): 241–304.
- Greenwood JG, 1978. Calanoid copepods of Moreton Bay (Queensland) III. Families Temoridae to Tortanidae, excluding Pontellidae. *Proc. Roy. Soc. Queensland*, 89: 1–21.
- Kim DY, 1985. Taxonomical study on calanoid copepod (Crustacea: Copepoda) in Korean waters. PhD Thesis, Hanyang University, South Korea, 1–187, 50 pls.

- Madhupatap M and Haridas P, 1986. Epipelagic calanoid copepods of the northern Indian Ocean. *Oceanologia Acta*, 9(2): 105–17.
- Mori T, 1937. *The pelagic Copepoda from the neighbouring waters of Japan*. Tokyo, 150 pp, 80 pls.
- Ohtsuka S, Fukura AY, and Go A, 1987. Description of a new species of *Tortanus* (Copepoda: Calanoida) from Kuchinoerabu Island, Kyusu, with notes on its possible feeding mechanism and in-situ feeding habits. *Bull. Plankton Society of Japan*, 34: 53–63.
- Ohtsuka S and Kimoto K, 1989. *Tortanus* (*Atortus*) (Copepoda: Calanoida) of southern Japanese waters, with description of two new species and notes on distribution and swarming behavior of *Atortus*. *Journ. Crustacean Biol.*, 9: 92–408.
- Ohtsuka S, 1992. *Tortanus* (*Acutanus*) *angularis* new subgenus and new species (Copepoda: Calanoida) from Caribbean Sea, with remarks on the subgenera in the genus *Tortanus*. *Proc. Biol. Soc. Wash.*, 105(2): 255–67.
- Ohtsuka S and Reid JW, 1998. Phylogeny and zoogeography of the planktonic copepod genus *Tortanus* (Calanoida: Tortanidae), with establishment of a new subgenus and descriptions of two new species. *Journ. Crustacean Biol.*, 18: 774–807.
- Rechman FU, 1973. Observation on variation in planktonic copepod *Tortanus forcipatus* (Giesbrecht, 1889) from the inshore waters of the Karachi coast, Pakistan. *Crustaceana*, 25(2): 113–9.
- Scott A, 1909. *The Copepoda of the Siboga Expedition*. 1. Free-swimming, littoral and semiparasitic Copepoda. Siboga Exped., monogr. 29a, 323 pp. 69 pls.
- Sewell RBS, 1912. Notes on the surface-living Copepoda of the Bay of Bengal, I & II. *Rec. Indian Mus.*, 7(4): 313–82.
- Sewell RBS, 1914. Notes on the surface Copepoda of the Gulf of Manaar. *Spolia Zeylanica*, 9(25): 1–199.
- Sewell RBS, 1932. The Copepoda of Indian Seas. Calanoida. *Mem. Indian Mus.*, 10: 223–407.
- Shen CJ and Lee FS, 1963. The estuarine Copepoda of Chiekong and Zaikong rivers, Kwantung Province, China. *Acta zool. Sinica*, 15: 571–96.
- Smirnov SS, 1935. K faune Copepoda Amurskogo limana. Zur Copepoden fauna des Amur-Limans.]. *Issledovaniia Morei SSSR*, 22: 41–53. [in Russian].
- Steuer A, 1927. Revision der Copepodengattung *Tortanus* Giesbr. *Adriatica Sci. Nat., Triest*, 29: 50–69.
- Tanaka O, 1963. The pelagic copepods of the Izu region, middle Japan. Systematic account IX. Families Centropagidae, Pseudodiaptomidae, Temoridae, Metridiidae. *Publs. Seto mar. biol. Lab.*, 11(1): 7–55.
- Thompson IC and Scott A, 1903. Report on Copepoda collected by Prof. Herdman at Ceylon. *Ceylon Pearl Oyster Fisheries Suppl. Rept.*, 7: 227–307.
- Wilson CB, 1932. The copepods of the Woods Hole region, Massachusetts. *U.S. Nat. Mus. Bull.* 158, 635 pp, 41 pls.
- Wilson CB, 1950. Copepods gathered by the United States Fisheries “Albatross” from 1887-1889, chiefly in the Pacific Ocean. *Bull. U.S. Nat. Mus.*, 100, 14(4): 141–441, pls. 36.
- Wolfenden RN, 1911. Die marinen Copepoden der Deutschen Sudpolar Expedition 1901–1903. *Dt. Sudpolar Exped., (Zoologie)* 4: 181–380.

Reviewer: **Dr. Bambang Irawan**