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ORIGINAL ARTICLE

A new species of *Tortanus* (*Atortus*) Ohtsuka, 1992 (Copepoda, Calanoida, Tortanidae) from Great Nicobar Island, north-eastern Indian Ocean

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ABSTRACT

A new planktonic copepod assigned to the subgenus *Tortanus* (*Atortus*) Ohtsuka, 1992 is described from Great Nicobar Island, Andaman and Nicobar archipelago. The new species *Tortanus* (*Atortus*) *dhritiae* sp. nov. belongs to the *tropicus*-group. The new species can be distinguished from all other species of the *tropicus*-group by the presence of a notch on the left lateral joining of fourth and fifth pedigerous somites, asymmetrical caudal rami with a rounded process originating from the anterior portion of the left ramus produced over to the right, and an elliptical shaped exopodal lobe of leg 5 with distolateral curved seta in female. In male, serrated ridge on the anterior one-third surface of segment XX of the right antennule, obtuse trapezoid-shaped right leg 5 coxa with triangle-shaped medial process, semi-circular basis with slight curve near base and crocodilian head-shaped medial process with small process distally and bearing one distal and one medial setae.

KEYWORDS

Bay of Bengal, calanoid, copepods, coral reefs, taxonomy, *Tortanus dhritiae* sp. nov.

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Introduction

Species of the genus *Tortanus* Giesbrecht in Giesbrecht and Schmeil, 1898 (Calanoida, Tortanidae) are mainly observed in coastal waters of the Indo-West Pacific and the north-eastern Atlantic areas (Mulyadi *et al.*, 2017). Currently, the genus comprises 48 species assigned to five subgenera: *Tortanus* (*Tortanus*) Giesbrecht in Giesbrecht and Schmeil, 1898; *Tortanus* (*Eutortanus*) Smirnov, 1935; *Tortanus* (*Boreotortanus*) Ohtsuka and Reid, 1998; *Tortanus* (*Actanus*) Ohtsuka, 1992; and *Tortanus* (*Atortus*) Ohtsuka, 1992 (Walter and Boxshall, 2021). The subgenus *T.* (*Atortus*) currently accommodates 33 nominal species (Mulyadi *et al.*, 2017; Francis and Bijoy Nandan, 2019). They are exclusively distributed in the Indo-West Pacific region, and most of them are observed in oligotrophic, high-saline (34–40 PSU) clear waters of coral reefs and seagrass beds (Ohtsuka and Kimoto, 1989; Ohtsuka and Reid, 1998; Ohtsuka *et al.*, 2000; Nishida and Cho, 2005; Nishida *et al.*, 2015; Mulyadi *et al.*, 2017; Francis and Bijoy Nandan, 2019). During a taxonomic study of zooplankton diversity along the Andaman and Nicobar archipelago, a new calanoid copepod species of *Tortanus* (*Atortus*) has been collected from the Great Nicobar Island of Andaman and Nicobar. The present study describes the species with detailed illustrations and discusses the distinguishing morphological characteristics from its congeners.

Materials and Methods

The study was conducted off Lakshman beach of Great Nicobar Island (07°01'25.2"N 93°55' 23.0"E) (Fig. 1) on 7 February 2021. Zooplankton samples were collected during the morning hours from the intertidal and open waters using a Working Party (WP) net with mesh size 200 µm and mouth diameter of 60 cm, with a calibrated flow meter attached. The WP net was towed horizontally just below the water surface at a speed of 1 knot (= 1.8 km/h) for 15 minutes by a boat. The zooplankton samples were fixed in 4 % buffered formalin. The copepod specimens were observed under a stereo zoom microscope (Leica M125C) and subsequently identified to species level using the available literature. *Tortanus* (*Atortus*) specimens were sorted from the original samples, and mouthparts and swimming legs were dissected in a 50:50 solution of glycerine and distilled water. Line drawings were made using a drawing tube attached to a compound microscope (Nikon Eclipse) with 40–1000× magnifications. Type specimens were deposited in the Zoological Survey of India (ZSI), Kolkata, and non-type specimens were deposited in the museum of the Department of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin University of Science and Technology. The morphological terminology follows Huys and Boxshall (1991) and Ohtsuka and Reid (1998). The total length of the specimens was measured from forehead margin to caudal rami.

Systematics

Order Calanoida Sars, 1903

Superfamily Diaptomoidea Baird, 1850

Family Tortanidae Sars, 1902

Genus *Tortanus* Giesbrecht in Giesbrecht and Schmeil, 1898

***Tortanus* (*Atortus*) *dhritiae* Francis and Jasmine sp. nov.**
(Figs. 2–4)

Zoobank: http://zoobank.org/urn:lsid:zoobank.org:act:DEA28079-A9EA-4373-8266-BEA553171E73

Type material. Holotype: adult female (TL: 2.28 mm) dissected parts were mounted on a glass slide (ZSI-C9205/2). Allotype: 1 adult male (TL: 1.96 mm) dissected and mounted on a glass slide (ZSI-C9210/2). Paratypes: 1 undissected female ZSI-C9206/2 (TL: 2.26 mm) and 1 undissected male ZSI-C9207/2 (TL: 1.87 mm).

Other material examined. 1 undissected female (MBM/16/21) and 1 undissected male (MBM/17/21) preserved in a vial were deposited as non-type material.

Type locality. India, Great Nicobar Island, off Lakshman beach, 07°01'25.2"N 93°55' 23.0"E.

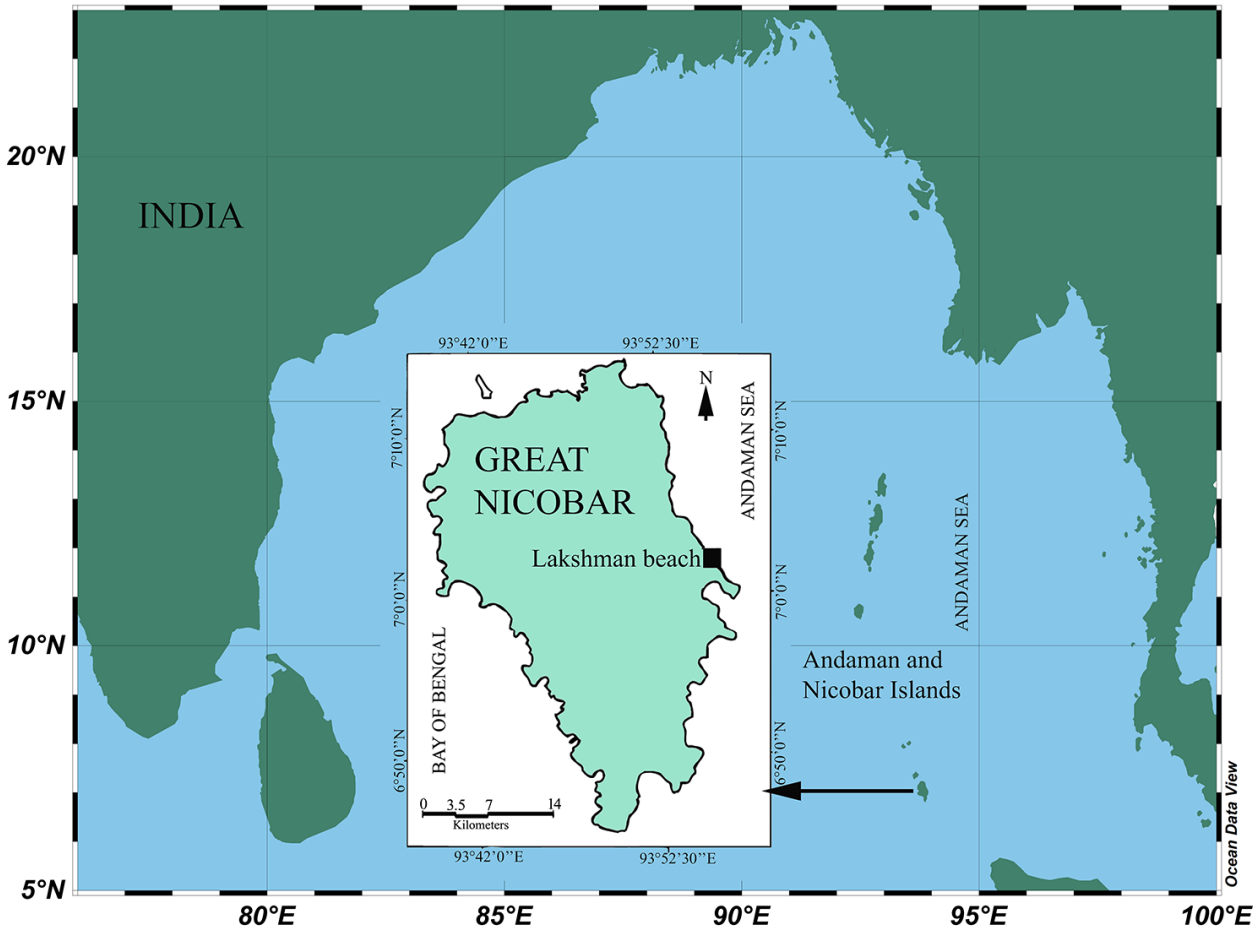

Figure 1. Map showing sampling location at Great Nicobar Island, Andaman and Nicobar archipelago.

Description. Female. Total body length: 2.21–2.28 mm (mean ± SD = 2.25 ± 0.04 mm, N = 3); prosome length: 1.79–1.81mm (1.8 ± 0.01 mm, holotype: 1.81 mm); width: 0.65–0.7 mm (0.68 ± 0.03 mm, holotype: 0.7 mm). Prosome (Fig. 2A) about 3.8 times long as urosome; cephalasome and first pedigerous somite separated; left joining side of fourth and fifth pedigerous somite with notch. Fifth pediger asymmetrical; left margin rounded, right margin with single downward directed triangular lobe. Urosome composed of 2 segments, genital compound somite symmetrical. Genital operculum semi-circular, ventrally located at anterior part of genital compound somite. Second urosomite (anal somite) completely fused with caudal rami. Caudal rami asymmetrical, left ramus broader than right. Anterior portion of left ramus produced into rounded process to the right. All specimens carry hyaline coupling device. Left process produced from notch between fourth and fifth pedigerous somites, covering left ventrolateral surface of fifth pedigerous somite and left lateral surface of genital compound somite. Right process produced from dorsolateral surface of genital compound somite, covering lateral surface of genital compound somite and reaching up to three-fourths of right caudal ramus. Antennule (Fig. 2C, D) 15 segmented, symmetrical, reaching posterior margin of caudal ramus. Ancestral segments I–IX (segment 1), XI–XIV (segment 3), and XXVI–XXVIII (segment 15) totally or partially fused. Armature as follows; I–IX, 6 (setae) + ae (aesthetascs); X, 3; XI–XIV, 5+ae; XV, 0; XVI, 1+ae; XVII, 0; XVIII, 2; XIX, 0; XX, 2; XXI, ae; XXII, 1; XXIII, 1; XXIV, 0+1; XXV, 1+1; XXVI–XXVIII, 6+ae. Antenna (Fig. 2E) coxa unarmed, basis and first endopodal segment incompletely fused with medial seta at proximal third, distomedial seta and distolateral row of spinules, second and distal segments incompletely fused, distal segment with proximolateral setules and 6 apical setae. Exopod 2-segmented, proximal segment short and naked, distal segment with

distomedial seta and 4 apical setae. Mandible palp (Fig. 2F) basis elongate, cylindrical and unarmed; endopod 2-segmented, proximal segment unarmed, distal segment with 6 setae. Exopod 1 non-segmented with 5 setae. Mandible gnathobase (Fig. 2G) with 5 cuspidate teeth, main tooth and second ventral-most tooth separated by wide diastema; both tips with articulation; dorsal-most tooth monocuspidate while remaining 2 teeth bicuspidate, 4 dorsal-most teeth with 4 longitudinal spinule rows proximally. Maxillule (Fig. 2H) basis absent, precoxal arthrite with 11 spinulose setae apically and 2 small setae; coxal endite with 3 stout, spinulose terminal setae. Maxilla (Fig. 2I) syncoxal endite with 1, 2, 2 and 3 setae from proximal to distal; basal endite with 6 stout setae with claw-like tip and 2 rudimentary setae. Maxilliped (Fig. 2J) syncoxa with 2 endites, each with a spinulose seta; basis unarmed; endopod with 3 medial spinulose setae and lateral seta. Legs 1–4 with 2-segmented endopods and 3-segmented exopods (Fig. 3A–D). Distal endopodal segment of legs 1–4 with setal tuft on anterior surface subdistally. Seta and spine formula as in Tab. 1. Outer setae on leg 1 basis minute. Leg 5 uniramous (Fig. 2K), 2-segmented, symmetrical with coxa, and intercoxal sclerite fused as a basal plate; exopodal lobe elliptical shaped with distolateral seta bearing fine setules along its margin.

Male. Total length: 1.87–1.96 mm (mean ± SD = 1.92 ± 0.05 mm, N = 3); prosome length: 1.38–1.51 mm (1.45 mm, allotype: 1.46 mm); width 0.49–0.52 mm (0.5 ± 0.02 mm, allotype: 0.52 mm). Prosome 3 times as long as urosome (Fig. 4A). Posterior corners of the pedigerous somite 5 symmetrical, rounded. Urosome composed of 5 somites. Second urosomite with posterolateral and posteroventral process on right side (Fig. 4E), one of which smaller, each with minute setae on tip. Caudal rami nearly symmetrical. Cephalic appendages similar to those of female except right antennule. Right antennule geniculate (Fig. 4B), 16-segmented; ancestral segment I–VII (segment 1), XXI–XXIII (segment 15), and XXIV–XXVIII (segment 16) totally or partially fused; segments XVI–XIX expanded. Armature as follows: I–VII, 7+2ae; VIII, 2; IX, 2; X, 2; XII, 1-ae; XIII, 0; XIV, 2; XV, 0, XVI, 2+ae; XVII, 1; XXVIII, 2+ae; XIX, 1+1P (process); XX, 1+1P; XXI–XXIII, 2+ae+2P; XXIV–XXVIII, 1+7+ae. The anterior one-third surface of segment XX furnished with serrated ridge that retro-flexes near base of segment XX, extending to triangular process of segment XIX (Fig. 4 B–D). Hinge joint formed between segment XX and fused segments XXI–XXIII. Legs 1–4 as in female. Right leg 5 coxa obtuse trapezoid (Fig. 4F) with triangle-shaped medial process; basis semi-circular with a slight curve near base and crocodilian head-shaped medial process with small process distally and bearing 2 setae, one distal and one medial. Exopod non-segmented, slightly curved medially, with medial seta and blunt tip bearing 1 minute seta on outer margin and 1 seta on inner margin. Left leg 5 (Fig. 4G) longer than right, coxa unarmed. Basis elongate, straight with lateral seta at distal third and medial seta halfway along inner margin of segment. Exopod 2-segmented, proximal segment with proximomedial, digitiform process bearing subdistal seta, distal segment with patches of setules on anterior surface, 2 lateral minute setae, 2 medial setae, and blunt subdistal seta slightly curved along hemispherical tip of segment with granular surface.

Etymology. The species is named in honor of Dr. Dhriti Banerjee, the first woman director of the Zoological Survey of India, one of the leading organizations involved in taxonomic studies of Indian fauna. This species is also dedicated to all women researchers in the field of taxonomy.

Remarks. The subgenus *T.* (*Atortus*) has been divided into the *tropicus*-group *sensu* Othman, 1987, and the *murrayi*-group *sensu* Othman, 1987 (Ohtsuka and Kimoto, 1989; Mulyadi *et al*., 2017). Ohtsuka and Kimoto (1989) have further subdivided the *tropicus*-group into *longipes*- and *rubidus*-groups (plus one unassigned group), and the *murrayi*-group into *murrayi*- and *recticauda*-groups, and renamed the *tropicus* and *murrayi* species groups as *brevipes* and *recticauda* species complexes, respectively (Ohtsuka and Kimoto, 1989; Mulyadi *et al*., 2017). Nishida and Cho (2005), Nishida *et al*. (2015), Francis and Bijoy Nandan (2019) (as in the present study) retain the group name *tropicus* proposed by Othman (1987) since the male of *Tortanus* (*Atortus*) *brevipes* A. Scott, 1909 has not yet been described.

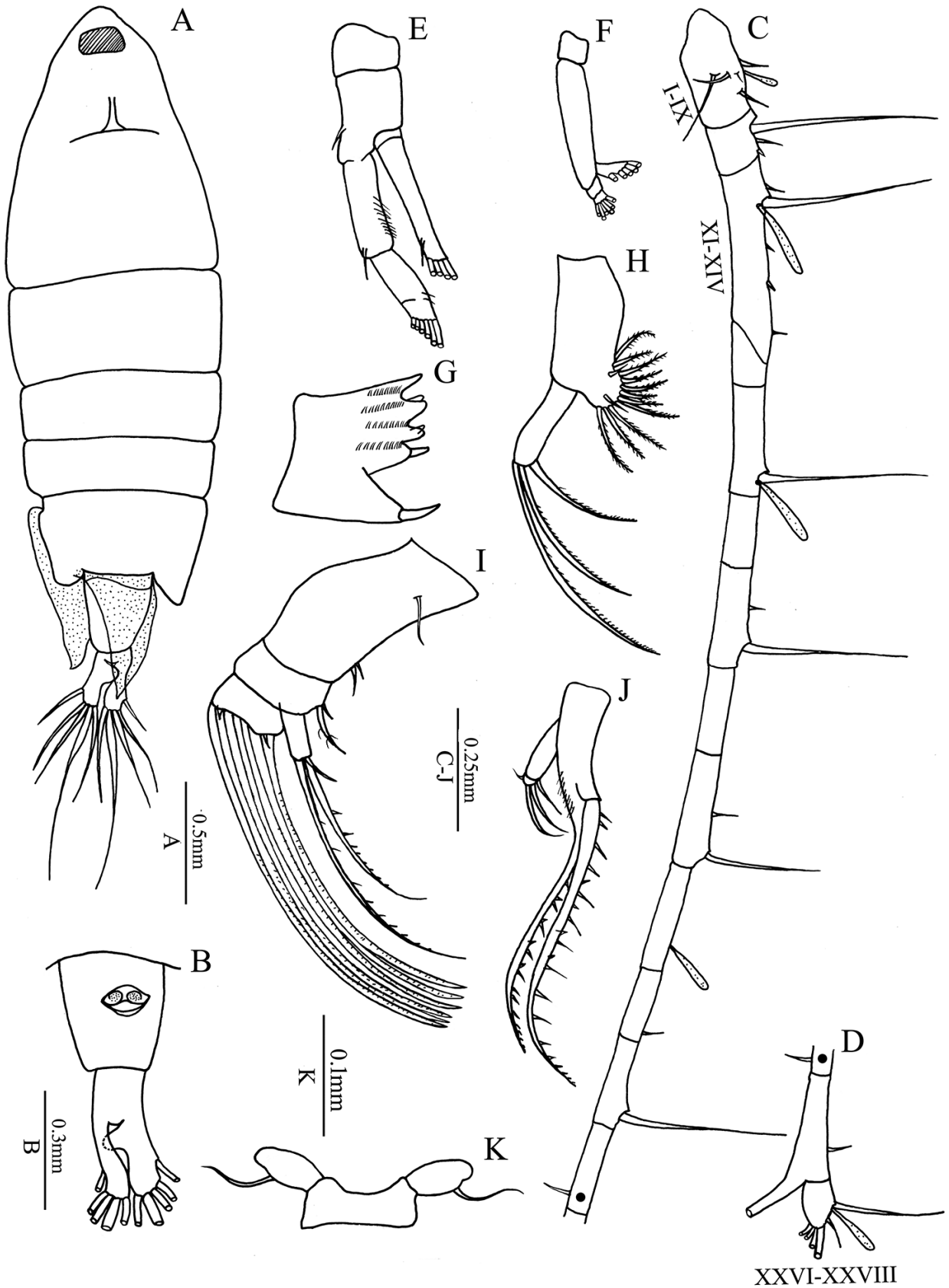

Figure 2. *Tortanus* (*Atortus*) *dhritiae* sp. nov., female (holotype): **A**) habitus dorsal view; coupling device is dotted; **B**) urosome ventral view; **C**, **D**) antennule; **E**) antenna; **F**) mandible palp; **G**) mandible gnathobase; **H**) maxillule; **I**) maxilla; **J**) maxilliped; **K**) leg 5.

Tortanus (*A.*) *dhritiae* sp. nov. is assigned to the *tropicus* species complex and closely resembles *Tortanus* (*Atortus*) *minicoyensis* Francis and Bijoy Nandan, 2019. The female of *T.* (*A.*) *dhritiae* sp. nov. can be distinguished from all other species of the *tropicus*-group [*T.* (*Atortus*) *brevipes*; *Tortanus* (*Atortus*) *tropicus* Sewell, 1932; *Tortanus* (*Atortus*) *longipes* Brodsky, 1950; *Tortanus* (*Atortus*) *rubidus* Tanaka, 1965; *Tortanus* (*Atortus*) *giesbrechti* Jones and Park, 1968; *Tortanus* (*Atortus*) *bowmani* Othman, 1987; *Tortanus* (*Atortus*) *ryukyuensis* Ohtsuka and Kimoto, 1989; *Tortanus* (*Atortus*) *digitalis* Ohtsuka and Kimoto, 1989; *Tortanus* (*Atortus*) *taiwanicus* Chen and Hwang, 1999; *Tortanus* (*Atortus*) *vietnamicus* Nishida and Cho, 2005; *Tortanus* (*Atortus*) *andamanensis* Nishida, Anandavelu and Padmavati, 2015, *Tortanus* (*Atortus*) *sigmoides* Nishida, Anandavelu and Padmavati, 2015; *Tortanus* (*Atortus*) *indonesiansis*, *Tortanus* (*Atortus*) *omorii* Mulyadi, Nishida and Ohtsuka, 2017, *Tortanus* (*Atortus*) *processus* Mulyadi, Nishida and Ohtsuka, 2017, *Tortanus* (*Atortus*) *lukmani* Mulyadi, Nishida and Ohtsuka, 2017, and *T.* (*Atortus*) *minicoyensis* Francis and Bijoy Nandan, 2019] by the following characteristics: (1) left lateral joining of fourth and fifth pedigerous somite with a notch; (2) asymmetrical caudal rami, left ramus broader than right; anterior portion of the left ramus produced with a rounded process to the right ramus; (3) leg 5 exopodal lobe elliptical shaped with distolateral curved seta. The male is distinguished from all other species of the *tropicus*-group by (1) the serrated ridge on the anterior one-third surface of segment XX of the right antennule, (2) obtuse trapezoid-shaped right leg 5 coxa with triangle-shaped medial process, (3) semi-circular basis with a slight curve near base and crocodilian head-shaped medial process with small process distally and bearing one distal and one medial seta.

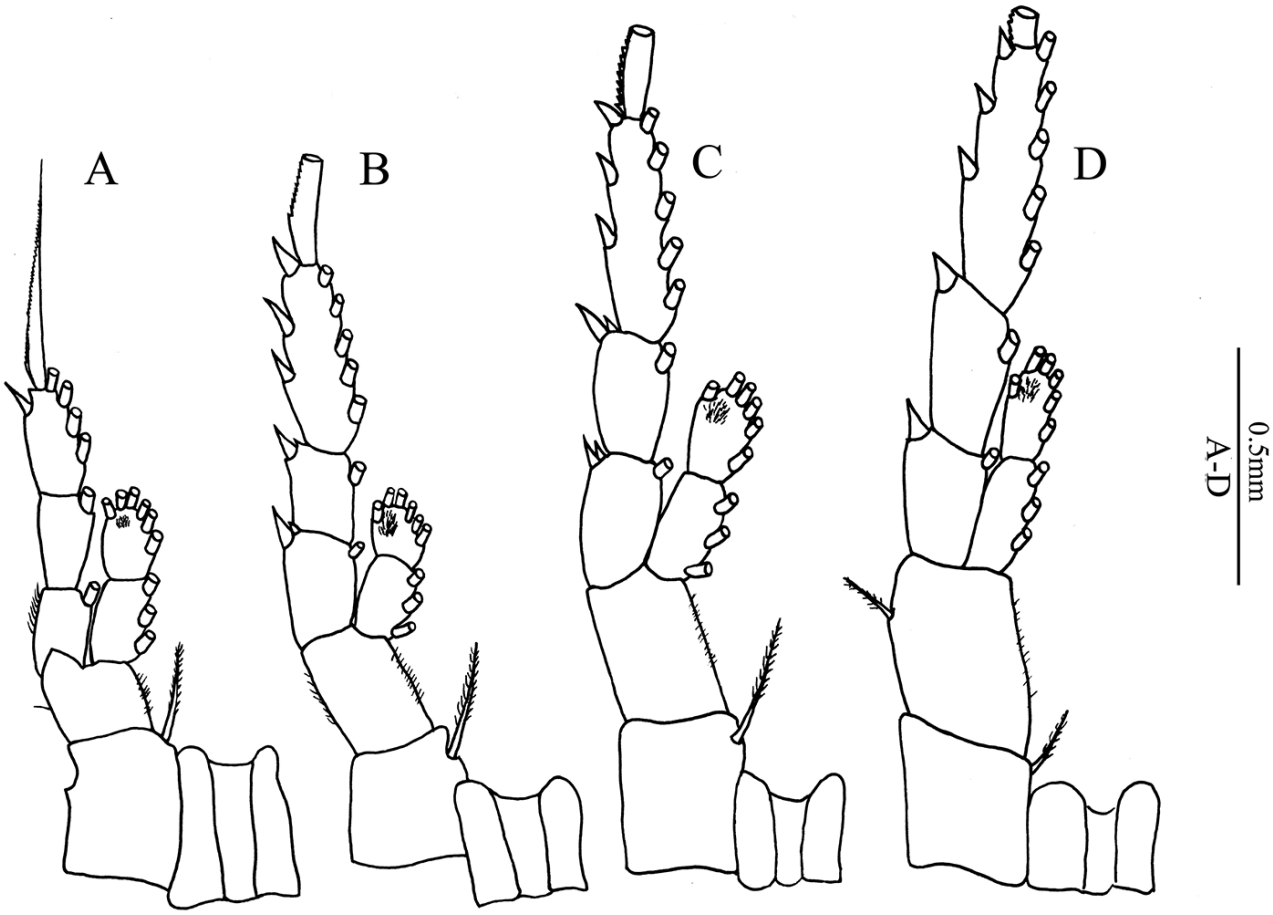

Figure 3. *Tortanus* (*Atortus*) *dhritiae* sp. nov., female (holotype), legs 1–4, anterior view: **A**) leg 1; **B**) leg 2; **C**) leg 3; **D**) leg 4.

Table 1. Seta (in Arabic numerals) and spine formula (in Roman numerals) of legs 1–4 of female *Tortanus* (*Atortus*) *dhritiae* sp. nov.

	Coxa	Basis	Exopod segment 1;2;3	Endopod segment 1;2
Leg1	0–1	1–0	0–1;0–1;I,I,4	0–3;1,2,3
Leg2	0–1	0–0	I–1;I–1;III,I,5	0–3;1,2,3
Leg3	0–1	0–0	I–1;I–1;III,I,5	0–3;1,2,3
Leg4	0–1	1–0	I–1;I–1;III,I,5	0–-3;1,2,3

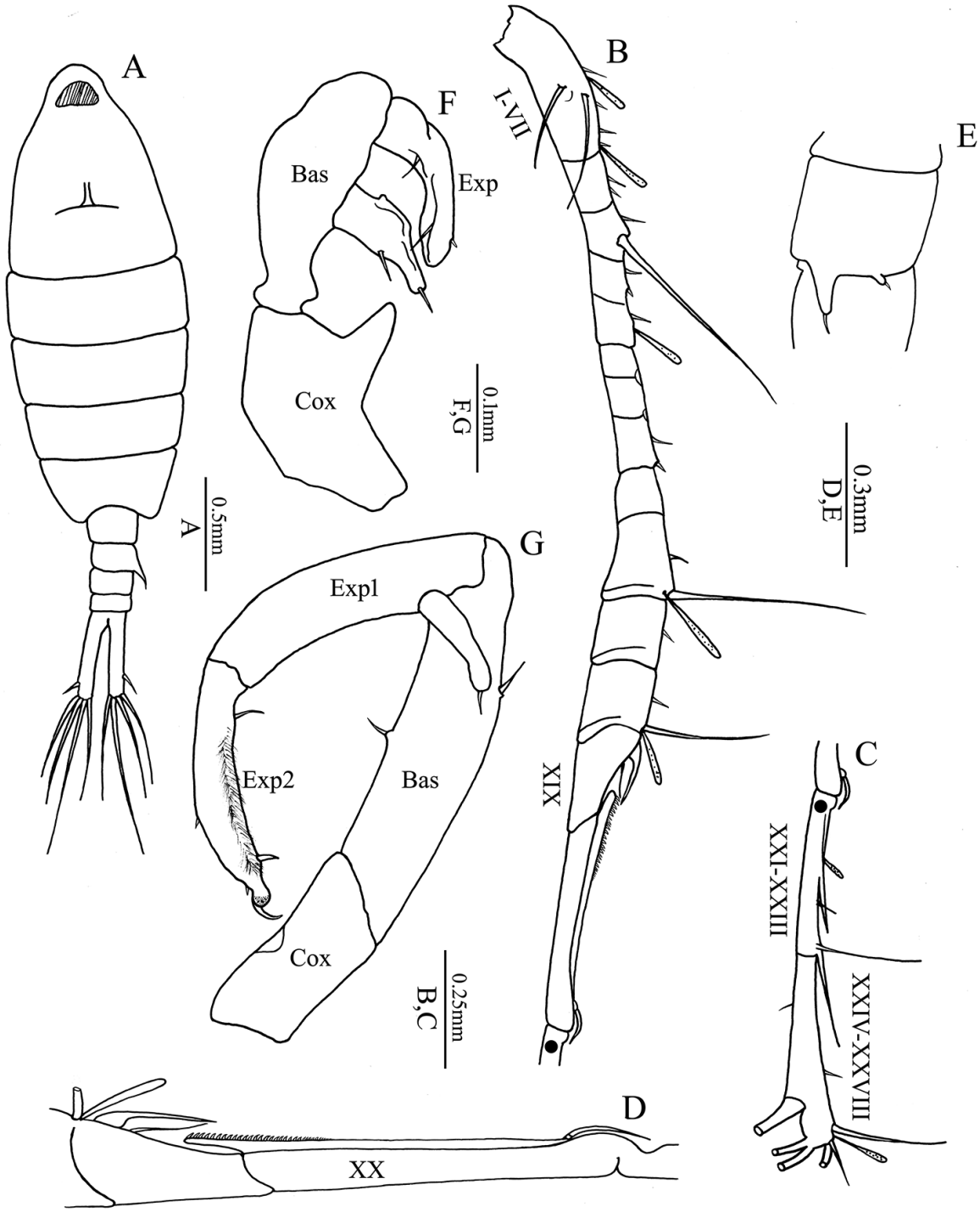

Figure 4. *Tortanus* (*Atortus*) *dhritiae* sp. nov. male (allotype): **A**) habitus dorsal view; **B**, **C**, **D**) antennule; **E**) urosome second segment right lateral view; **F**) right leg 5 posterior view; **G**) left leg posterior view.

Discussion

A total of seven species of the subgenus *Tortanus* (*Atortus*) have been discovered from the Indian Ocean (Francis and Bijoy Nandan, 2019). Three species of this subgenus are endemic to the Andaman Sea as reported by Sewell (1932) and Nishida *et al*. (2015). *Tortanus* (*A.*) *tropicus* from the Nicobar Islands and *T.* (*A.*) *andamanensis* and *T.* (*A.*) *sigmoides* were described from the South Andaman. The new species *T.* (*A.*) *dhritiae* sp. nov. has been collected from the Great Nicobar Island of Andaman and Nicobar archipelagos. The species is associated with the coral-sea grass (*Thalassia* sp.). Most of the occurrence records of *Tortanus* (*Atortus*) species come from the oligotrophic coral and seagrass beds of the Indo-West Pacific (Ohtsuka and Kimoto, 1989; Ohtsuka and Reid, 1998; Ohtsuka *et al.,* 2000; Nishida and Cho, 2005; Mulyadi *et al.,* 2017) and the *tropicus* species complex is restricted to the western-most rim of the Pacific Ocean. However, the occurrence of the species *T. (A.) giesbrechti* Jones and Park, 1968 from Central Pacific; *T.* (*A.*) *tropicus*, *T.* (*A.*) *andamanensis*; *T.* (*A.*) *sigmoides* from north-eastern Indian Ocean and *T.* (*A.*) *minicoyensis* from north-western Indian Ocean are exceptions. The present and previous records of the species of the genus *Tortanus* reveal that the Andaman and Nicobar Islands are a marine biodiversity hotspot, unique in terms of zooplankton biodiversity. The recent new species discoveries from the Andaman and Nicobar islands (Nishida *et al*., 2015) and Minicoy island of Lakshadweep archipelago (Francis and Bijoy Nandan, 2019) emphasized that the lagoon and adjacent oceanic waters of the island ecosystem and coastal environments of India remain unexplored in terms of species diversity, taxonomic descriptions, and distribution patterns of pelagic copepods. The co-occurrence of multiple, closely-related species of *Tortanus* (*Atortus*) observed by many authors (Nishida *et al*., 2015; Mulyadi *et al*., 2017) highlights the considerable difficulties inherent in associating males and females of species new to science which are collected together in the same net sample, based on morphology only (Francis and Nishida, 2018; Francis *et al*., 2018). The lack of integrated morphological and molecular approaches of these species results in unassigned species complexes and groups (Mulyadi *et al*., 2017) and a lack of descriptions of both sexes of all known species (Nishida and Cho, 2005; Nishida *et al*., 2015; Mulyadi *et al*., 2017). The presence of males and females of *T.* (*A.*) *dhritiae* sp. nov. in the same net sample made it possible to establish the female-male correspondence of the new species. The conventional net collection method is insufficient to observe species of the genus *Tortanus* because they are demersal during the day-time (Ohtsuka and Kimoto, 1989). Specific techniques like net towing by SCUBA diving (Ohtsuka and Kimoto, 1989) and night collections with or without light (Jones and Park, 1968; Bowman, 1971), will improve the collection of this group of copepods from different marine and coastal environments.

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