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Arctodiaptomus (*Rhabdodiaptomus*) *michaeli* n.sp. (Copepoda, Calanoida) from Kashmir, India

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Abstract

Arctodiaptomus (*Rhabdodiaptomus*) *michaeli* n.sp. is described from the material collected in Alapathar Lake and Marsar Lake of Kashmir, India.

Introduction

The genus *Arctodiaptomus* Kiefer with nearly 50 species is one of the largest genera in the family Diaptomidae. In India, only six valid species are so far known under this genus (see Dussart & Defaye, 1983). A perusal of the existing literature shows that there has been little follow-up work on the taxonomy of the Indian arctodiaptomids since Kiefer's (1939) account.

While studying the taxonomy of the copepod fauna of diverse freshwater habitats such as pools, ponds, lakes, springs, and drains of Jammu and Kashmir, India, we have come across several specimens belonging to a hitherto undescribed species of *Arctodiaptomus* in four plankton samples collected from two lakes of Kashmir. This paper deals with illustrated description of the new species under the name *Arctodiaptomus* (*Rhabdodiaptomus*) *michaeli* n.sp., along with its relationships with other species.

Arctodiaptomus (*Rhabdodiaptomus*) *michaeli* n.sp. (Figs. 1-50)

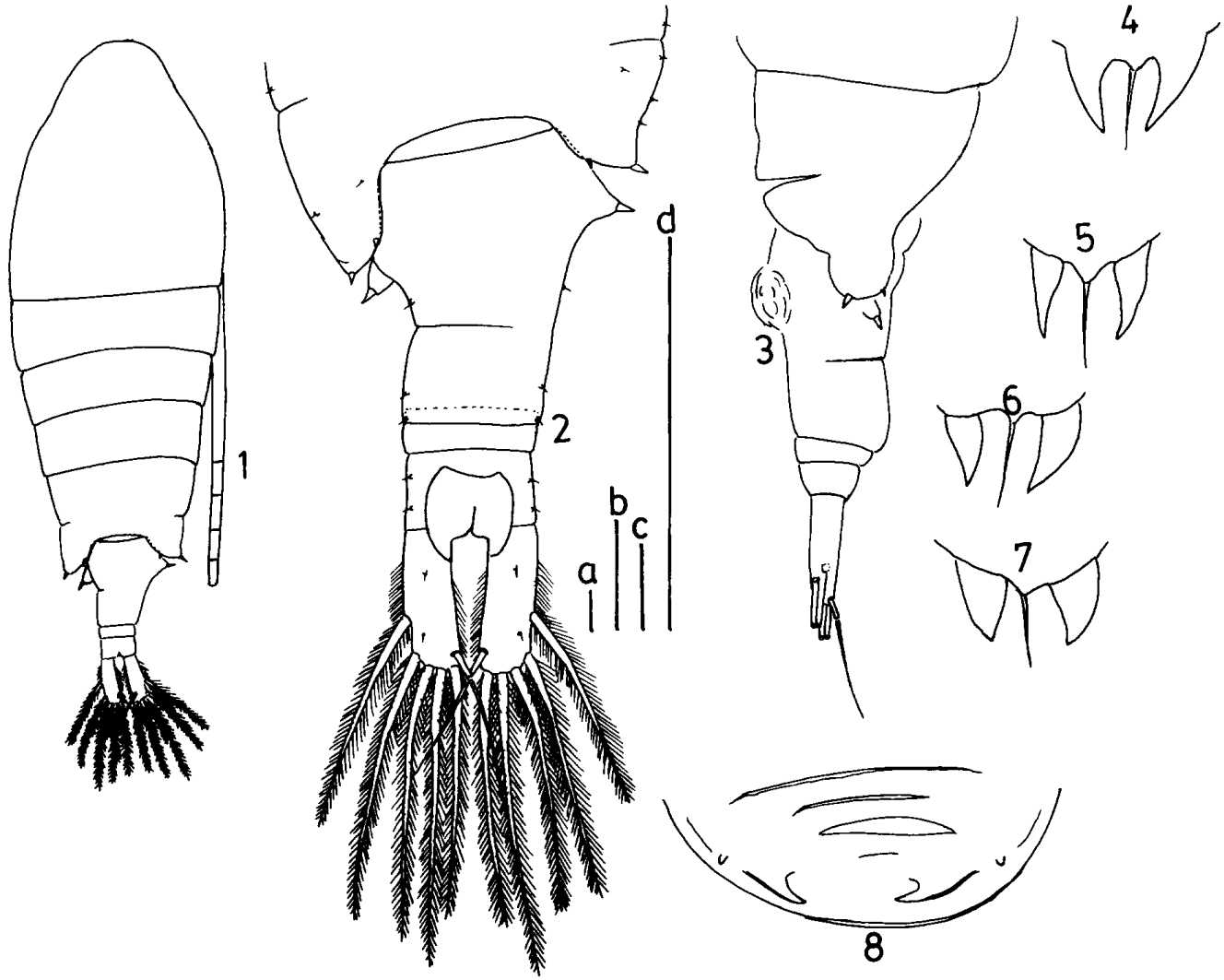
Locality data and material examined: Alapathar Lake, Kilanmarg, Kashmir, now designated the type-locality of the new species. 9 September 1984 at 2.20 p.m.; altitude 3200 m; temperature: air 8 °C, water 12 °C; pH 6.93; dissolved oxygen 6.8 mg l^{-1}; vegetationless; 24♀♀, 17♂♂ and 7 copepodids. Marsar Lake, upper Dachigam, Kashmir. 24 September 1984 at 12.14 p.m.; altitude 3600 m; temperature: air −2 °C, water 9 °C; pH 7.54; dissolved oxygen 7.2 mg l^{-1}; no visible vegetation; 1♀ and 1 copepodid.

The holotype and paratypes are deposited in the British Museum (Natural History), London; their registration numbers – holotype ♂: 1987: 268; paratypes, 6♀♀: 1987: 269-274, 4♂♂: 1987: 275-278.

Adult female (Figs. 1-25)

Total length exclusive of caudal setae 1.41-1.66 mm, mean 1.56 mm, (n = 17). Rostral spines (Figs. 4-7) strongly developed, pointed and showing intrapopulation variation. Body (Fig. 1) somewhat slender with maximum width (*c.* 0.38 mm) near posterior border of cephalosome; anterior end narrow and broadly rounded. Fourth and fifth pedigers fused, fusion being indicated by indentation on each side. Fifth pediger with moderately-developed, asymmetrical wings; left wing distinctly larger than right wing, posteriorly directed, attenuating apically and extending almost up to left genital spine; right wing roughly triangular with its tip directed posterolaterally; each wing with 2 unequal spines, apical spine being larger than inner spine; apical spine of right wing larger than that of left wing. Prosome about 3 times as long as urosome.

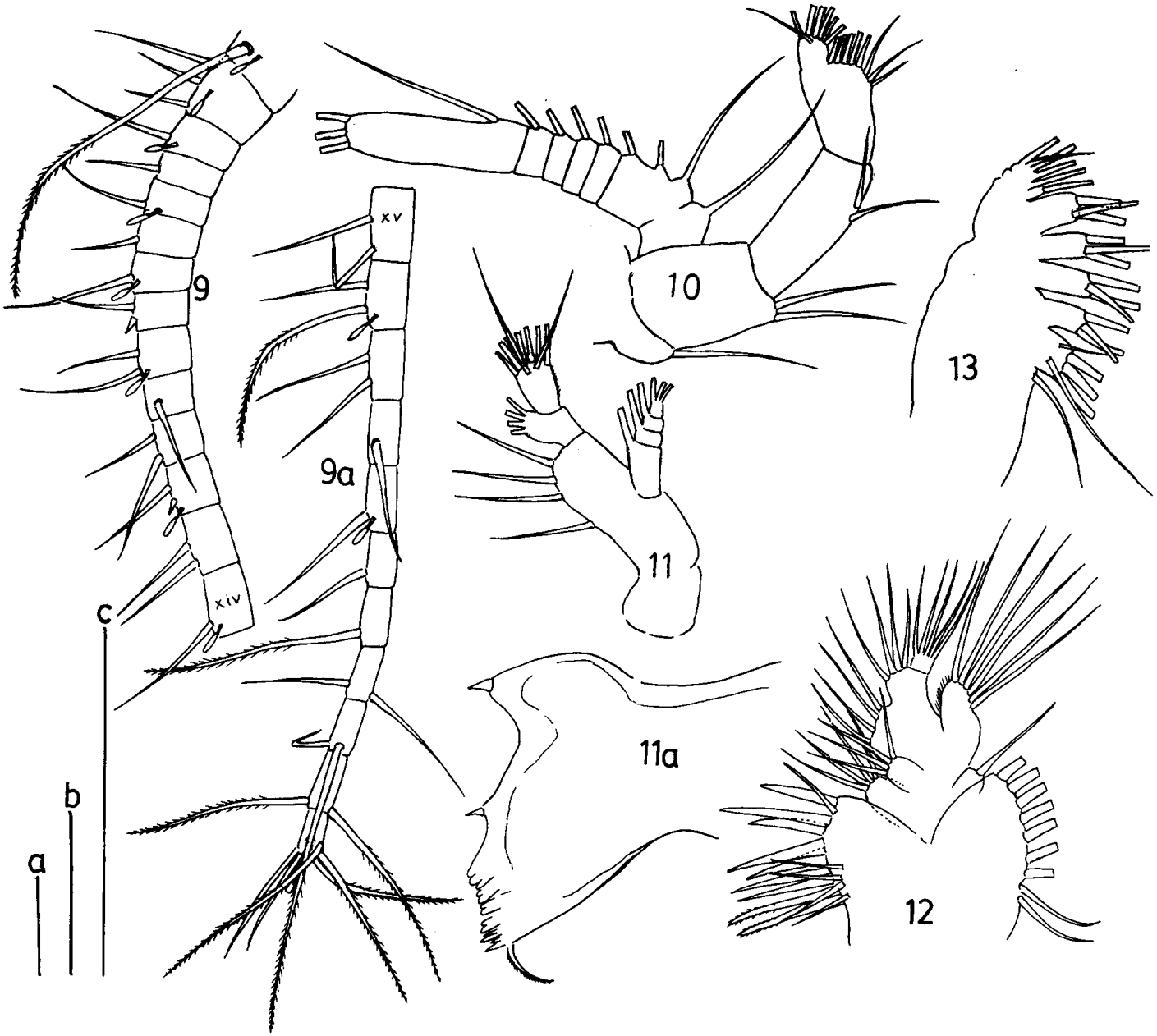
Urosome of 3 somites; genital somite longer than succeeding 2 somites plus caudal rami; proximal lateral part asymmetrically expanded and armed with small spine on each side; right spine arising from short chitinous lateral projection and directed laterally; left spine arising from small but distinct chitinous lobe, located distal to right spine and directed posterolaterally; somite



Figs. 1-8. Arctodiaptomus (Rhabdodiaptomus) michaeli n.sp. Female. 1, habitus, dorsal; 2, pedigers 4,5 and urosome, dorsal; 3, same, lateral; 4-7, rostral spines, frontal view; 8, genital field. Scale a, Fig. 1; scale b, Fig. 2; scale c, Fig. 3; scale d, Figs. 4-8; scale bars = 100 μm.

incompletely divided dorsally at about midlength (Figs. 2, 3); genital field with 2 incurved spines near posterior border as in Fig. 8. Second urosomite smallest with about proximal 1/3 telescoped into genital somite. Caudal rami nearly parallel to each other, symmetrical, about 2.7 times as long as wide and with fine hairs along both margins; setae slightly dilated proximally. Arrangement of sensilla on fourth and fifth pedigers and urosomites as in Fig. 2.

Antennule 25-segmented, extending nearly up to midlength of genital somite and armed with 2 setae each on segments 9, 11, 13, 15-17, 22-24, 3 setae on segment 2, 5 setae on segment 25, and 1 seta each on all other segments; seta on segment 1 longest (300-360 μm), reaching 10th segment; other details as in Figs. 9, 9a.



Figs. 9-13. Arctodiaptomus (Rhabdodiaptomus) michaeli n.sp. Female. 9,9a, antennule; 10, antenna; 11, mandibular palp; 11a, gnathal lobe of mandible; 12, maxillula; 13, maxilla. Scale a, Figs. 9, 9a; scale b, Figs. 10-13; scale c, Fig. 11a; scale bars = 100 μm.

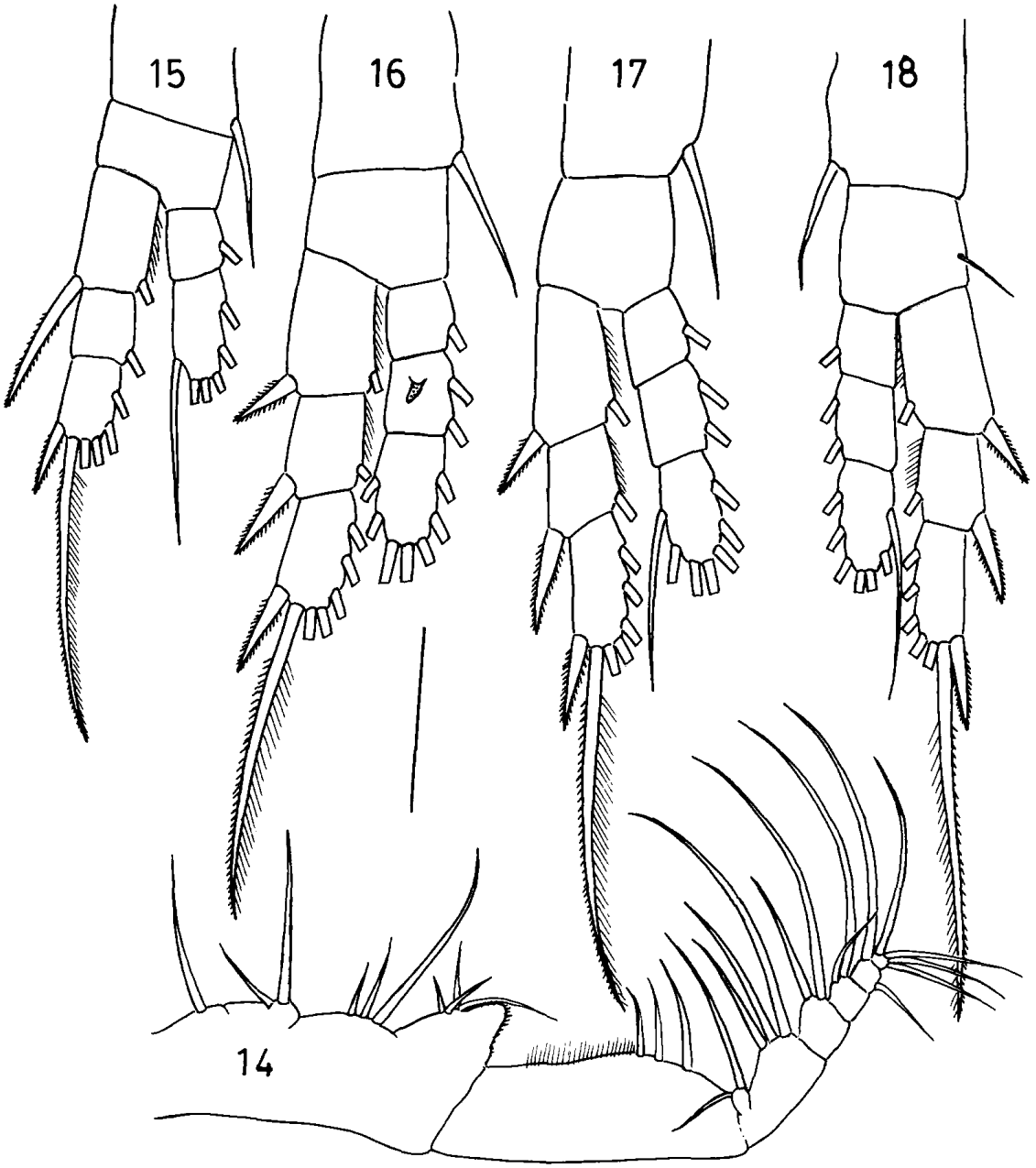
Antenna (Fig. 10) with 2 setae and no spines on first exopodite-segment, and 7 terminal and 8 subterminal setae on second segment.

Mandible (Figs. 11, 11a). Sympodite with 4 setae. Exopodite 4-segmented with 1, 1, 1 and 3 setae. Endopodite 2-segmented with 4 and 9 setae; distal segment with spinulose outer margin, and its third apical seta (counted from outerside) with somewhat bulged base; dentition of gnathal lobe as illustrated.

Maxillula (Fig. 12). Exo- and endopodites with 6 and 8 setae; other details as illustrated.

Maxilla as in Fig. 13.

Maxilliped (Fig. 14) with 4 medium-sized coxal endites with 1, 2, 3 and 4 setae; distalmost seta of third endite sturdy and over twice as long as middle seta; distalmost seta of fourth endite longer than other 3 setae; proximal seta of proximal lobe of first endopodite-segment much small and sharply bent forward; proximal seta of third

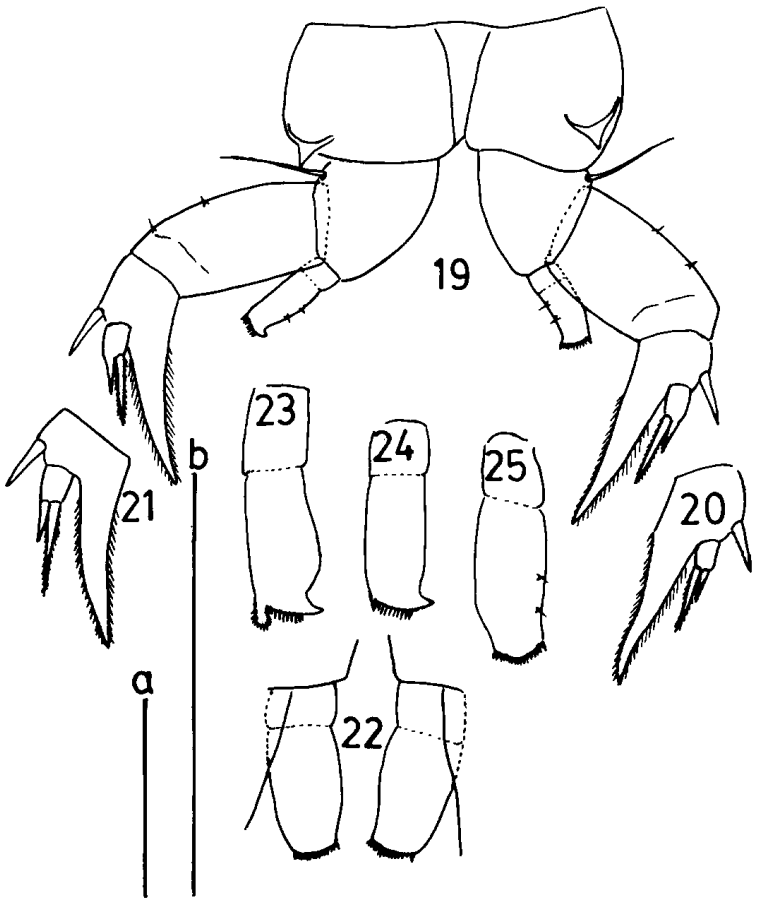


Figs. 14-18. Arctodiaptomus (Rhabdodiaptomus) michaeli n.sp. Female. 14, maxilliped; 15, leg 1; 16, leg 2; 17, leg 3; 18, leg 4. Scale bar = 100 μm.

endopodite-segment also small but bent backward as illustrated.

Natatory legs (Figs. 15-18). All exopodite spines generally elongate with serrate margins; spine on first exopodite-segment of leg 1 setiform and equaling combined length of second and third segments of same ramus; in leg 2, second endopodite-segment with Schmeil's organ on posterior surface; in leg 4, coxal seta same as in other legs, and basis carrying short sensory seta.

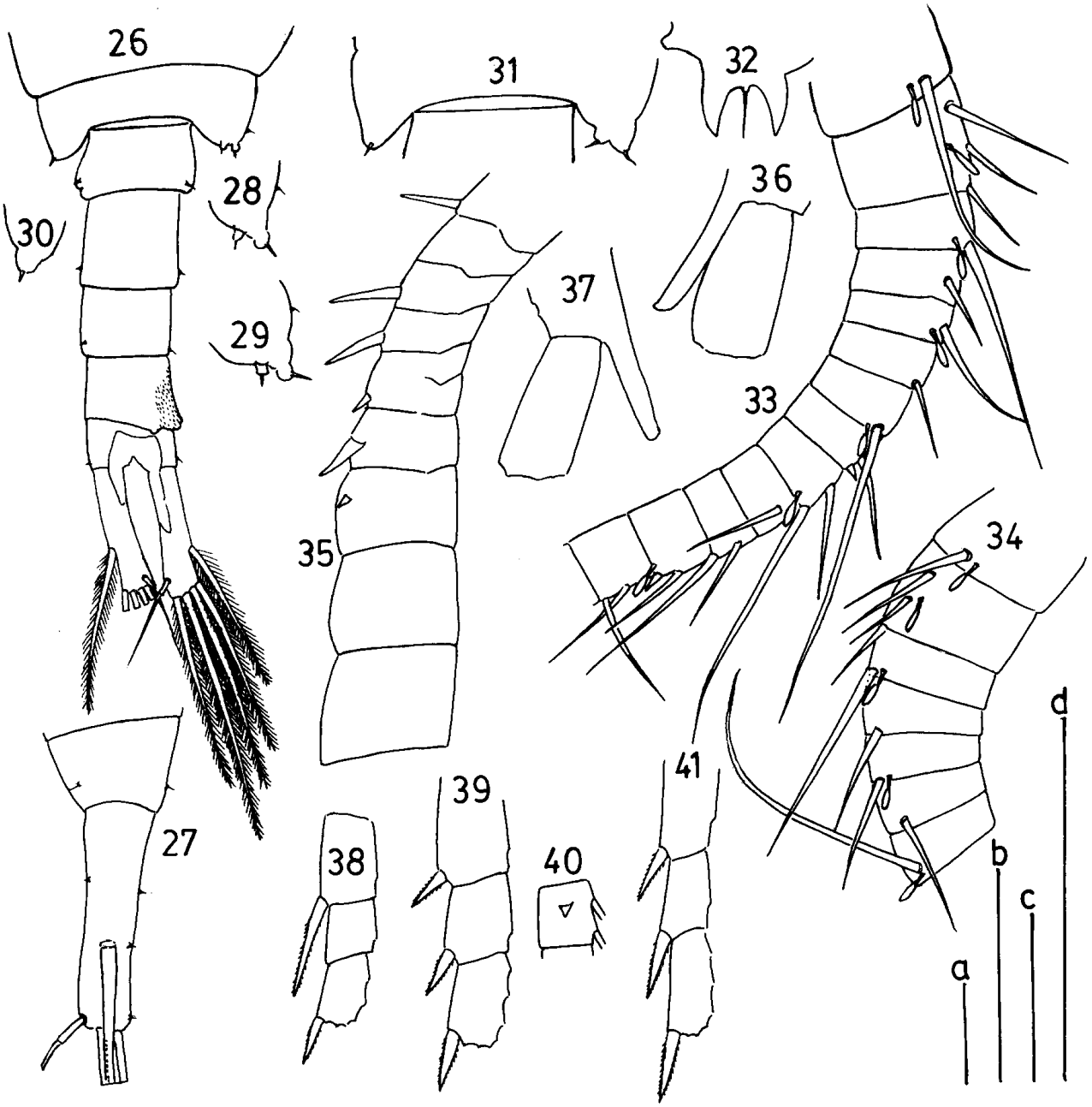
Fifth legs (Figs. 19-25) almost symmetrical. Coxa roughly rectangular and armed with small but broad-based hyaline spine at disto-outer corner on posterior surface. Basis smaller than coxa and with short, delicate, lateral seta. First exopodite-segment of right leg stouter than its counterpart of left leg and 1.5 times as long as wide; 2 sensilla occurring on outer margin. Second segment (end claw) slender and with coarse hairs on lateral margins, and with elongate spine near base of third segment; lateral margins generally almost straight (Fig. 19), but curved in some specimens (Figs. 20, 21). Third segment longer than wide and with 2 dissimilar spines, outer spine being bare and about half as long as inner serrate spine. Endopodite weakly divided into 2 unequal segments, 2/3 as long as inner margin of first exopodite-segment and with 2 sensilla on inner margin; apex rounded with transverse row of short, coarse hairs, and small spine on each side; disto-inner region slightly bent, and left endopodite, in one specimen, showing hook-like spine at disto-inner corner (Fig. 24). Abnormality: Apex of left endopodite in one specimen carrying hook-like spine on innerside, and short, club-shaped spinous process on outerside (Fig. 23).



Figs. 19-25. Arctodiaptomus (Rhabdodiaptomus) michaeli n.sp. Female. 19, fifth legs, posterior; 20, second and third exopodite-segments, right leg 5; 21, same, left leg 5; 22-25, endopodites of fifth legs. Scale a, Figs. 19-21; scale b, Figs. 22-25; scale bars = 100 μm.

Adult male (Figs. 26-50)

Total length excluding caudal setae 1.25-1.34 mm, mean 1.31 mm (n = 15). Rostral spines (Fig. 32) smaller than in female. Body widest at posterior border of cephalosome. Suture separating fourth and fifth pedigers complete (Fig. 26). Fifth pediger produced into small, posterolaterally-directed wings on each side; right wing slightly larger than left wing and ending in button-like lobe with hyaline spine; right wing also bearing similar but smaller lobe on inner margin and 1 sensillum on



Figs. 26-41. Arctodiaptomus (Rhabdodiaptomus) michaeli n.sp. Male. 26, pedigers 4,5 and urosome, dorsal; 27, anal somite and caudal ramus, lateral; 28, 29, right metasomal wing; 30, left metasomal wing; 31, metasomal wings, dorsal; 32, rostral spines, frontal view; 33, left antennule, segments 1-13; 34, right antennule, segments 1-7; 35, same, segments 8-16; 36,37, same, spinous process on antepenultimate segment; 38, exopodite, leg 1; 39, same, leg 2; 40, second endopodite-segment, leg 2; 41, exopodite, leg 4. Scale a, Fig. 26; scale b, Fig. 27; scale c, Figs. 28-31, 33-35, 38-41; scale d, Figs. 32, 36, 37; scale bars = 100 μm.

outer margin; left wing almost rounded with apical hyaline spine (Fig. 26); in one specimen, apical region of left wing differentiated into lobe-like structure (Fig. 30); sometimes both wings as in Fig. 31.

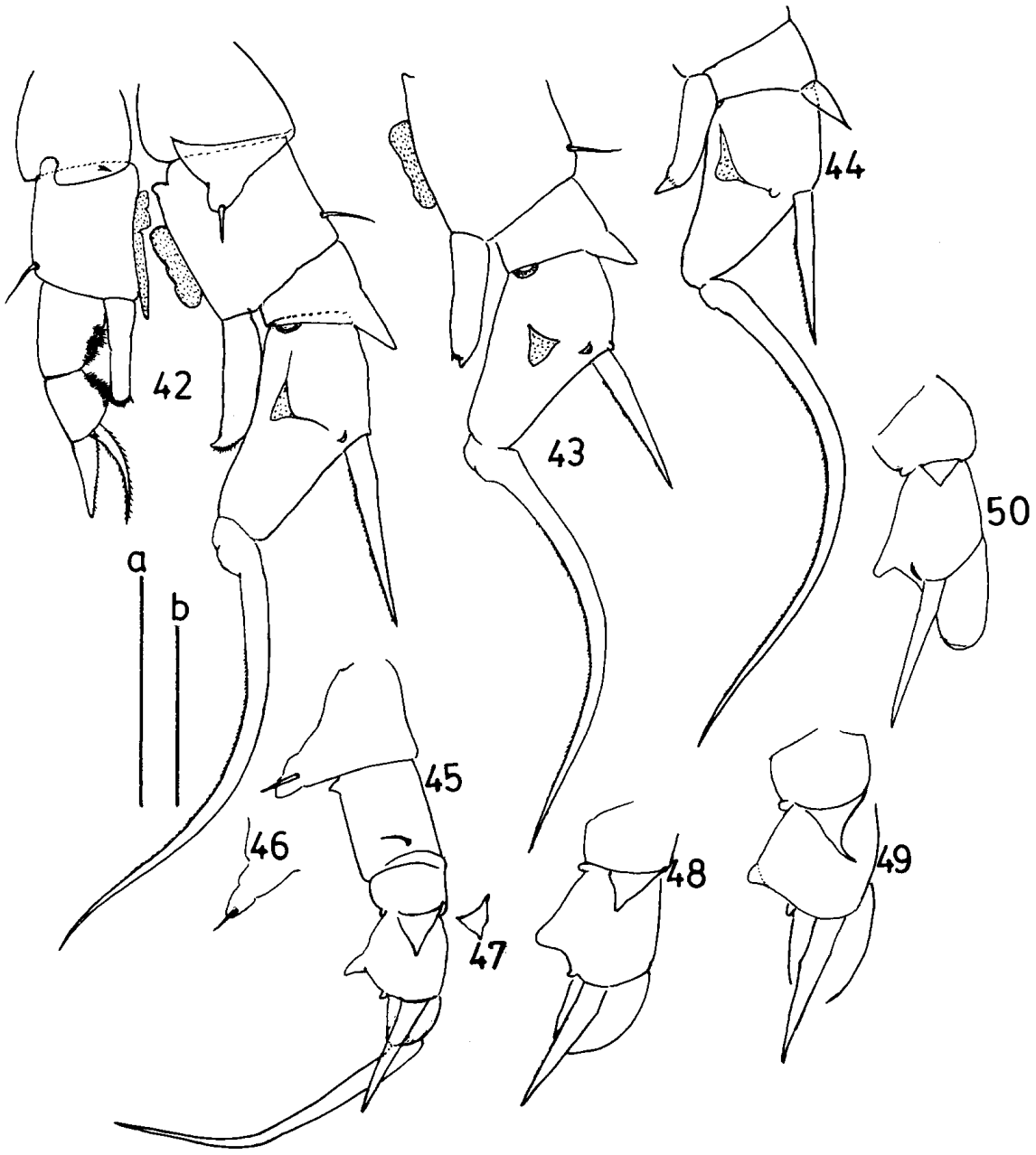
Urosome of 5 somites, almost straight and attenuating but little behind. Genital somite with 1 short, sensory spine on each side; second, third and fifth somites with 1 sensillum on each side; fourth somite asymmetrical with right distal part being somewhat produced and ornamented with minute spinules near right lateral margin as shown in Fig. 26. Caudal rami nearly symmetrical, somewhat dilated apically, 4 times as long as median width and hairless; sensilla arranged as in Fig. 27; setae slender and unmodified.

Left antennule as in female except for seta on segment 1 being shorter whereas setae on segments 3, 7 and 8 being longer as in Fig. 33. In right antennule (Fig. 34), seta on segment 1 even shorter; segments 8, 10-13 with spine each; segment 14 with very small chitinous tooth instead of typical spine; spine on segment 13 short and thick; relative lengths of spines in decreasing order as follows: 10 > 11 > 8 > 13 > 12 (Fig. 35); spinous process on antepenultimate segment nearly straight, staff-like and shorter than succeeding segment; apex generally rounded (Fig. 37), or sometimes slightly produced (Fig. 36), but never claw-like.

Structure and armature of antenna and oral parts as in female; spines on exopodite-segments of natatory legs (Figs. 38, 39, 41) generally elongate; spine on first exopodite-segment of leg 1 remarkably long as in female, and second endopodite-segment of leg 2 with relatively small Schmeil's organ (Fig. 40).

Right fifth leg (Figs. 42-50). Coxa wider than long and carrying, on posterior face, large, roughly triangular lobe tipped with small hyaline spine. Basis only slightly longer than wide, produced into short thumb-like process at proximal inner corner, and armed with large hyaline lobe on inner margin and sensory seta at disto-outer corner. First exopodite-segment twice as wide as median length, drawn into generally strong, triangular spinous process at disto-outer angle and bearing crescentic hyaline lobe near disto-inner corner; spinous process variable in form as shown in Figs. 42-45, 47-50. Second exopodite-segment slightly exceeding combined length of basis and first exopodite-segment, 2.3 times as long as wide at base, proximal part gradually expanding up to origin of lateral spine and then attenuating distally; inner margin almost straight or moderately concave and outer margin convex; same segment showing 2 chitinous outgrowths on posterior surface: (i) relatively large, triangular lobe at a level corresponding to origin of lateral spine and close to inner margin (Figs. 42, 44), or at about middle (Fig. 43) of segment, and (ii) tiny crescentic lobe just below lateral spine. Lateral spine moderately strong, straight, only slightly shorter than second exopodite-segment, finely serrate on inner margin and located at about mid-outer margin of the above segment. End claw roughly as long as rest of right leg, gently curved inwards with recurved terminal part ending in sharp point, and armed with fine spinules along distal 3/4 inner margin. Endopodite 1-segmented, somewhat cylindrical, terminal part narrow and ending in short, oblique, spinous process on innerside; apex with transverse row of short, coarse hairs.

Left fifth leg (Fig. 42) reaching posterior border of second expodite-segment of right leg. Coxa as long as wide and with small hyaline spine toward disto-inner corner. Basis almost rectangular in outline and having long, narrow hyaline lamella along inner margin and sensory seta at disto-outer corner; hyaline lamella wider over proximal 1/3 and projecting slightly beyond posterior border of basis. Exopodite 2-segmented; proximal segment 0.7 as long as basis and having 2 hairy lobes; distal segment almost oval in outline and with 1 hairy lobe at proximal inner margin and 2 terminal processes: (i) long, sturdy, blunt, finger-like spinous process with finely serrate inner margin, on outerside, and (ii) outcurved setiform process, slightly longer than spinous process, on innerside. Endopodite more or less cylindrical, reaching midlength of second exopodite-segment; apex rounded with transverse row of short, coarse hairs, and minute spine on innerside.



Figs. 42-50. Arctodiaptomus (Rhabdodiaptomus) michaeli n.sp. Male. 42, fifth legs, posterior; 43,44, right leg 5, posterior; 45, same, lateral; 46, same, coxal process, lateral; 47, same, spinous process of first exopodite-segment, lateral; 48-50, right leg 5 (part), lateral. Scale a, Figs. 42-44, scale b, Figs. 45-47; scale bars = 100 μm.

Etymology

This species is named in honor of Prof. Dr. R.G. Michael, North Eastern Hill University, India, who has made valuable contributions to the understanding of the Indian freshwater zooplankton, particularly Cladocera and Rotifera.

Remarks

The genus *Arctodiaptomus* Kiefer has been divided into four subgenera, viz. *Arctodiaptomus* s.str. Kiefer, *Rhabdodiaptomus* Kiefer, *Stenodiaptomus* Kiefer and *Haplodiaptomus* Kiefer. The new species can be assigned to the subgenus *Rhabdo-*

diaptomus based on the following characters: In grasping antennule, segment 14 is devoid of typical spine, but only has a small chitinous tooth, and the spinous process on the antepenultimate segment is almost straight, thick, long and staff-like. In right fifth leg of male, the endopodite is long, terminating in an oblique spinous process on the innerside. Kiefer (1971) extensively dealt with the species and subspecies of *Rhabdodiaptomus* as *bacillifer*-group, and recognized as valid 16 species with 4 subspecies.

Morphologically, the new species on the whole is quite unique in the entire genus *Arctodiaptomus*. The presence of 2 setae on segment 16 just like on segments 11, 13, 15, 22-24 of the female antennules seems to be one of its outstanding features (cf. Kiefer, 1978, p. 123). Similarly, the exceptionally long, setiform spine on the first exopodite-segment of leg 1 in both sexes is its another highly remarkable character, which has not yet been reported for any arctodiaptomid. It must be pointed out here that, unfortunately, morphological details of the natatory legs, barring the Schmeil's organ of leg 2, are not known for most of the arctodiaptomids or for diaptomids in general. Hence it cannot now be said for certain whether the setiform spine of leg 1 is really unique for the new species. All the same the two characters mentioned above are strongly indicative of the primitive nature of the new species. The anomalous nature of the new species is apparent in another respect also. Unlike most of *Rhabdodiaptomus* species, the new species possesses a small chitinous tooth on segment 14 of the grasping antennule. To our knowledge, only four other species of this subgenus show this character. They are: *A. (Rh.) alpinus* (Imhof), *A. (Rh.) stephanidesi* Pesta, *A. (Rh.) centetes* (Brehm) and *A. (Rh.) burduricus* Kiefer.

Within the subgenus *Rhabdodiaptomus*, the new species is conspicuous, inter alia, by its asymmetrical wings and nature of genital somite in female, relatively long caudal rami in both sexes, and several characters of fifth legs in male. Its closest affinity to *A. (Rh.) bacillifer* (Koelbel) is revealed mainly by the structural features of fifth legs in male, particularly the form of second exopodite-segment and the position of the lateral spine in right fifth leg. However, the two species are distinct from each other in the metasomal wings and genital somite in female, caudal rami in both sexes, spinous process on the antepenultimate segment of the grasping antennule, etc. The new species greatly differs from the sole Indian species of *Rhabdodiaptomus*, i.e. *A. (Rh.) salinus* (Daday, 1885), in several details of metasomal wings, genital somite, caudal rami, relative length of the seta on first antennular segment in female, armature of grasping antennule and structure of fifth legs in male.

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