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Keraladiaptomus rangareddyi a new genus and new species of Diaptominae (Copepoda, Calanoida, Diaptomidae) from a temporary pond in Mattam, Kerala State, India

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Abstract

Calanoid copepods, belonging to the new genus and species *Keraladiaptomus rangareddyi*, were collected from temporary ponds in Kerala State, India. The new genus belongs to the family Diaptomidae, subfamily Diaptominae. It is described in detail and its affinity to the related genera, *Arctodiaptomus* Kiefer, 1932 and *Eodiaptomus* Kiefer, 1932, discussed.

Introduction

In two plankton samples from Kerala State, India, collected by one of us (F. K. Kakkassery) and studied during an international training course on lake zooplankton (1992–1993) at the University of Ghent, several specimens of a hitherto unknown calanoid genus and species were found. The aberrant structure of P5 in both the sexes, especially in the female, makes it impossible to allocate the specimens to any of the existing diaptomid genera.

The new monotypic genus is described and compared with *Arctodiaptomus* Kiefer, 1932 and *Eodiaptomus* Kiefer, 1932, which appear to be its closest relatives.

Material and methods

Before dissecting, the habitus of specimens in glycerol was drawn and measured. Each specimen was dissected on a separate glass slide and the preparations were sealed with glyceel.

Four male and four female paratypes (from the type locality) were examined by scanning electron microscopy (SEM) using a Jeol JSM-840 microscope. The specimens were put through a series of ethanol for dehydration, critical point dried, mounted on stubs and sputter coated with gold. All drawings were made with a Leitz Laborlux D compound microscope fitted with a camera lucida.

Type material was deposited in the Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (USNM), the British Museum, Natural History, London, Great Britain (BMNH), the Muséum National d'Histoire Naturelle, Paris, France (MNHN), the Indian Museum, Calcutta, India (IM) and the Ecological Institute of the University of Ghent, Belgium (UG).

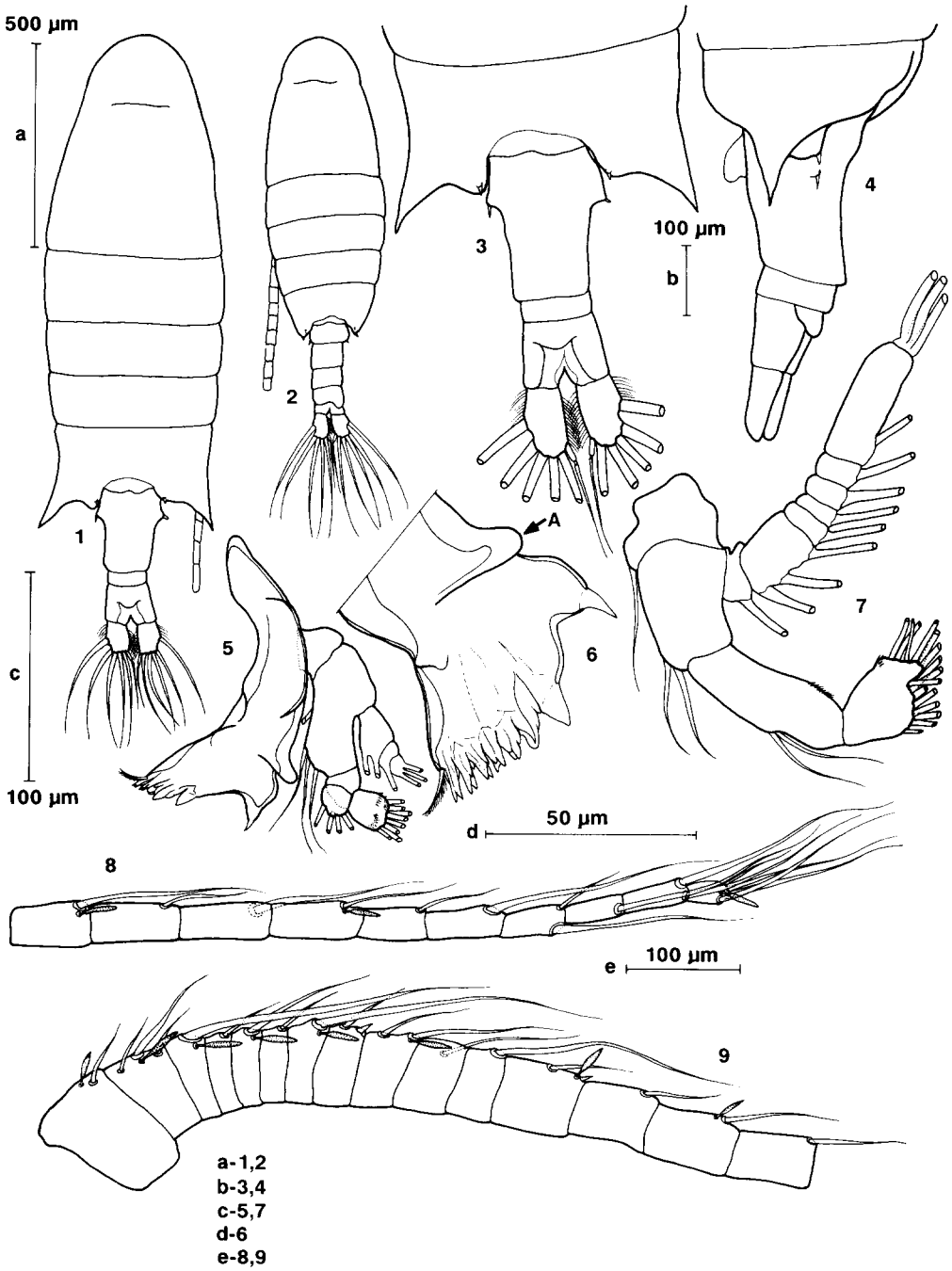


Fig. 1–9. Keraladiaptomus rangareddyi gen. nov. et sp. nov. 1. Female habitus, dorsal view; 2. Male habitus, dorsal view; 3. Female last prosomites and urosome, dorsal view; 4. idem, lateral view; 5. Female, Mandible; 6. Female, Gnathobase of mandible (arrow A: protruding lobe); 7. Female, Antenna; 8. Female, Antennule: segments 16–25; 9. Female, Antennule: segments 1–15.

Abbreviations used: P1–P5 for first to fifth pair of swimming legs; Exp3P1 for the third exopodite-segment of the first pair of swimming legs; type loc. for Mattam, the type locality; 2nd loc. for Irinjalakuda, the second locality.

Systematics

Genus Keraladiaptomus *gen. nov.*

Diagnosis

The new genus *Keraladiaptomus* belongs to the family Diaptomidae, subfamily Diaptominae: endopodite of P1 2-segmented, endopodites of P2–P4 3-segmented; Exp3P1 with only 1 marginal external spine, male geniculated antennule with 4 segments after the geniculation.

Animals of moderate length (1000–1550 μm).

Female. Slender with strongly pointed, weakly asymmetrical, thoracic wings, left one slightly larger. Urosome of 3 somites. Antennules of moderate length, reaching posterior margin of second urosomite. P5 with long, narrow first exopodite-segment and 1-segmented endopodite, endopodite without apical setae and with subapical oblique row of small spines. Exopodite 2 with slender end claw, spinulated on both sides; lateral spine pointed, strong. Exopodite 3, characteristically large and rounded, having pointed spinous process at outer distal corner and unusually long, naked, hooklike spine medially. Groups of hairlike setae occurring on basipodite and endopodite.

Male. Geniculated antennule with digitiform process on antepenultimate segment, caudal rami without ornamentation. Male P5 long and slender, lateral spine inserted near end claw. Right endopodite 1-segmented, strongly tapering, with small pointed outgrowth halfway. Left male P5 with 2-segmented exopodite, second segment with external, blunt digitiform projection and internal modified seta. Both processes of same length, with equally broad base and set with small spines along their entire length.

Left endopodite 2-segmented and tapering.

Etymology. The name, *Keraladiaptomus* is derived from Kerala State in India, where the type locality of the new species is situated.

Type species (by monotypy). Keraladiaptomus rangareddyi gen. nov. et sp. nov.

Keraladiaptomus rangareddyi *sp. nov.(Figs 1–38)*

Material examined

1) Kuttappan Kulam pond: temporary pond in the village of Mattam, Trichur District, Kerala State, India, now designated type locality of the new species, at lat. 10° 50′ N and long. 76° 15′ E. 9 Aug. 1991. Temp. 30 °C, pH 7.5, shallow (± 2m deep), with *Hydrilla* and filamentous algae.

11 ♂♂ and 17 ♀♀ form a plankton sample collected by one of us (F. K. Kakkassery).

2) Monastery pond Irinjalakuda: temporary pond near Christ College Monastery, in the town Irinjalakuda, Kerala State, India, at lat. 10° 30′ N and long. 76° 20′ E. 9 Aug. 1991. Temp. 29 °C, pH 7.8, shallow (± 3 m deep) with *Hydrilla*, *Pistia* and filamentous algae.

14 ♂♂ and 7 ♀♀ from a plankton sample collected by one of us (F. K. Kakkassery).

The ♂ holotype and ♀ allotypic paratype from type loc. and 3 ♂♂ and 2 ♀♀ paratypes from 2nd loc., all undissected in glycerol, were deposited in the USNM (accession numbers: ♂ holotype: USNM 259570; ♀ allotypic paratype: USNM 259571; 3 ♂♂, 2 ♀♀ paratypes: USNM 259569).

One ♂ and 1 ♀ paratype from type loc. and 2 ♂♂ and 1 ♀ paratypes from 2nd loc., all undissected in glycerol, were deposited in the BMNH (accession numbers: 1993.436–1993.440).

Two ♂♂ and 2 ♀♀ paratypes from 2nd loc., all undissected in glycerol, were deposited in the MNHN (accession number: MNHN Cp1034).

One ♂ and 1 ♀ paratype from type loc. and 3 ♂♂ and 2 ♀♀ paratypes from 2nd loc., all undissected in glycerol, were deposited in the IM (no accession numbers available before publication of the description).

One ♂ and 8 ♀♀ paratypes from type loc. and 4 ♂♂ paratypes from 2nd loc., all undissected in glycerol, together with 4 ♂♂ and 4 ♀♀ paratypes from type loc. mounted on a stub for SEM, and several ♂♂ and ♀♀ paratypes, dissected and mounted in glycerol, were kept in the plankton collection of UG.

Etymology. the specific name was given in honour of Dr. Y. Ranga Reddy, a well-known Indian copepodologist, in recognition of his valuable work on the calanoids of South-east Asia.

Description

Male (Figs 2, 17–21, 24–30). Total body length, excluding furcal setae: for type loc. specimens: 955–993 μm, mean length 981 μm ($n = 4$); for 2nd loc. specimens: 949–1012 μm, mean length 981 μm (n = *13).*

Male smaller and more slender than female. Thoracic wings small, more or less symmetrical with minute lateral spine and median sensillum on each wing.

Urosome of 5 somites, first somite somewhat broader with slender spine on each side. Fourth one with asymmetrical posterior border (Figs 2, 25). Caudal rami without ornamentation, except for setules lining inner margin. Antennules: left antennule composed of 25 segments, armature as in female. Right antennule geniculated, consisting of 22 segments. Geniculation between segments 18 and 19. Spines on segments 8, 10, 11, 13 and 15 as in Figs 17, 21 and 24. Largest spine on segment 13, small and thin ones on segments 10 and 11, still smaller spines on segments 8, 12 and 15. Digitiform process on antepenultimate segment moderate in length ($\pm$ two thirds of penultimate segment), with vague indication of striated hyaline outer border.

Antenna, mouth parts and P1–P4 as in female.

P5 long and slender (Figs 20, 26).

Posterior surface of left and right coxopodites each with hyaline spine on conical outgrowth.

Right leg 5 basipodite almost twice as long as broad, with small pointed membrane on inner distal edge (Figs 20, 26 and 29, arrow D) and sensory seta on outer distal corner. Exopodite 1 narrow, with series of triangular sclerotized projections on distal margin as shown in Figs 20, 27 and 28; outer distal corner produced into moderate spinous process. Exopodite 2 long and narrow, 2.5 times as long as broad. Lateral spine slender, inserted close to end claw, serrated along inner distal half. End claw long, slender, swollen at its base, slightly incurved and serrated over most of its length. Endopodite strongly tapering towards apex, with subapical row of spinules and small pointed outgrowth halfway (Figs 20 and 29, arrow E).

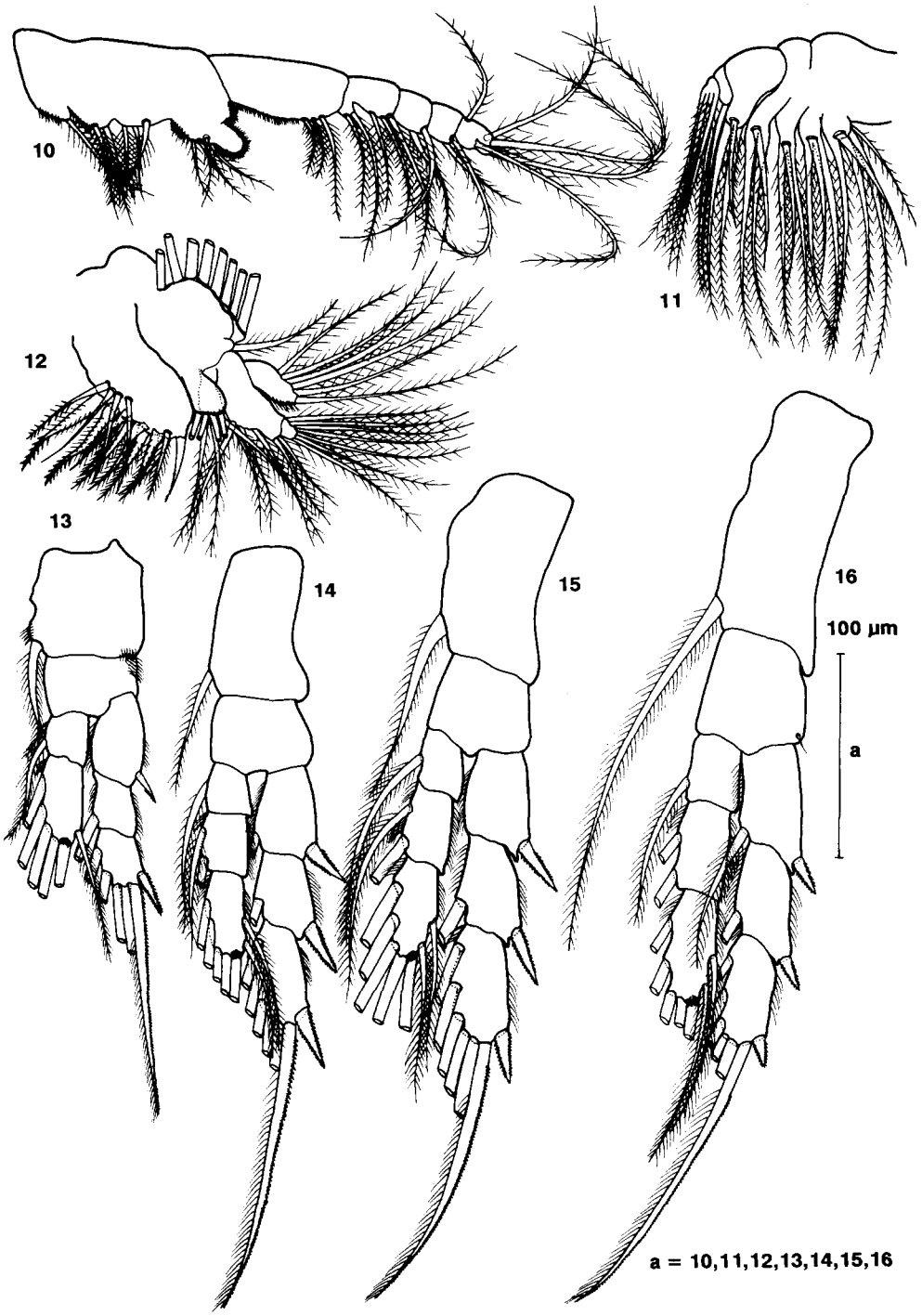
Left leg 5 basipodite with rounded ear-like membrane on inner edge (Figs 18 and 30, arrow B). Exopodite 2-segmented, with long first and short, almost round, second segment, both lined with hairy cushions on inner side. Second segment ending in 2 projections of similar length: external, blunt, finger-like projection, lined with 1 inner row of small spines and internal, more pointed projection, lined with 2 rows of small spines, tapering distally (Fig. 18, arrow F) or sometimes ending in 1 or 2 hairs (Fig. 19, arrow F). Endopodite 2-segmented, first segment short, with minute hyaline membrane at inner distal corner (Figs 18 and 30, arrow C); second segment longer, slightly tapering, apically ornamented with oblique row of spinules.

Female (Figs 1, 3–16, 22–23, 31–38). Total body length, excluding furcal setae: for type loc. specimens: 1392–1450 μm, mean length 1458 μm ($n = 10$); for 2nd loc. specimens: 1405–1563 μm, mean length 1481 μm (n = *6).*

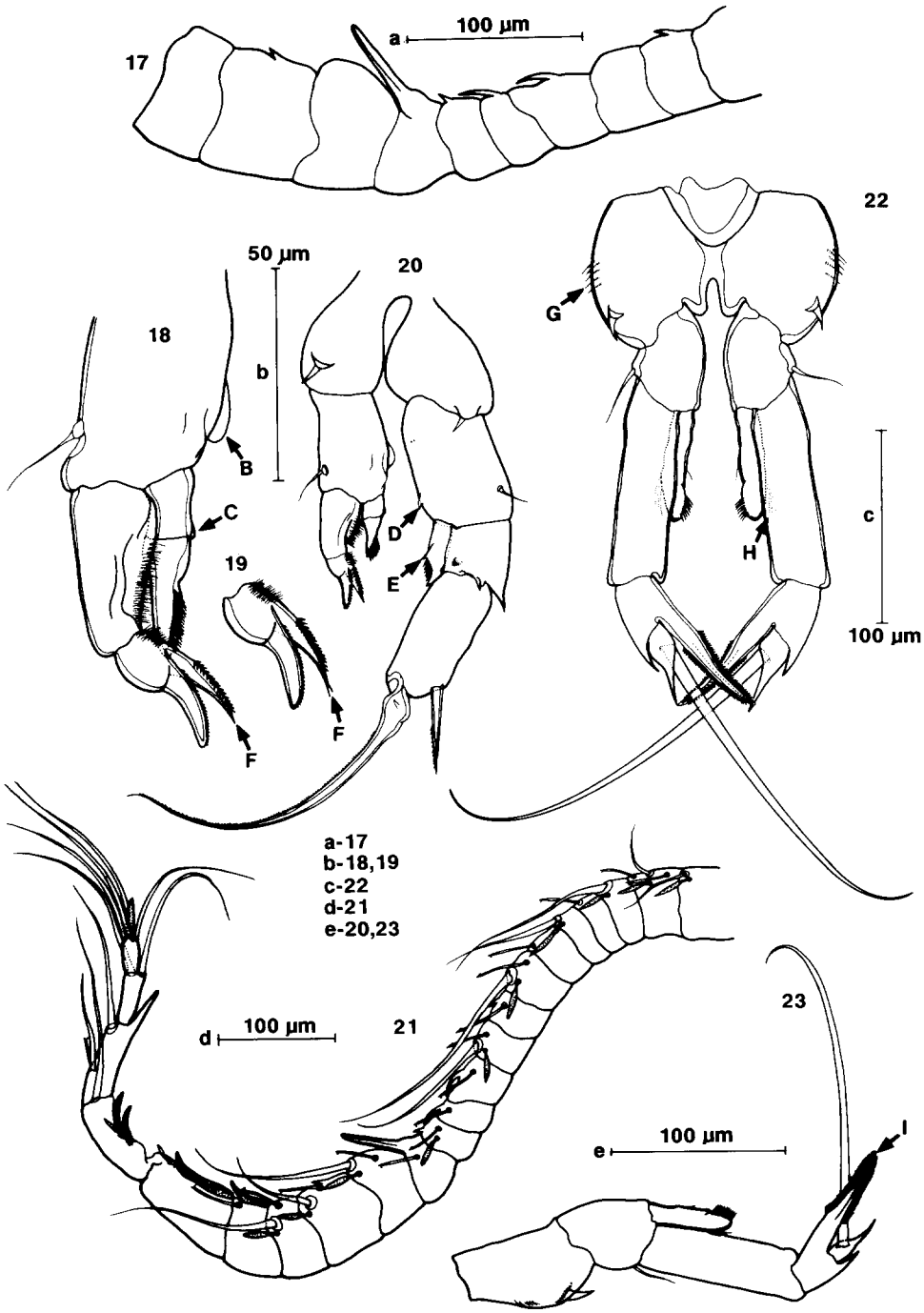
Body elongated. Fourth and fifth prosomites completely fused. Thoracic wings strongly pointed, weakly asymmetrical: left wing longer with inner lobe slightly more protruding. Both inner lobes of thoracic wings carrying small spine each (Figs 1, 3, 4, 37). Urosome of 3 somites. Genital somite twice as long as broad, subproximal part asymmetrically dilated: left side slightly rounded with small, distally-directed spine; right side more protruding, with small, laterally-directed spine. Furcal rami symmetrical, without any ornamentation except for setules on external and internal margins.

Antennules of moderate length, 25-segmented, almost reaching posterior end of second urosomite. Armature of both antennules as in Figs 8 and 9.

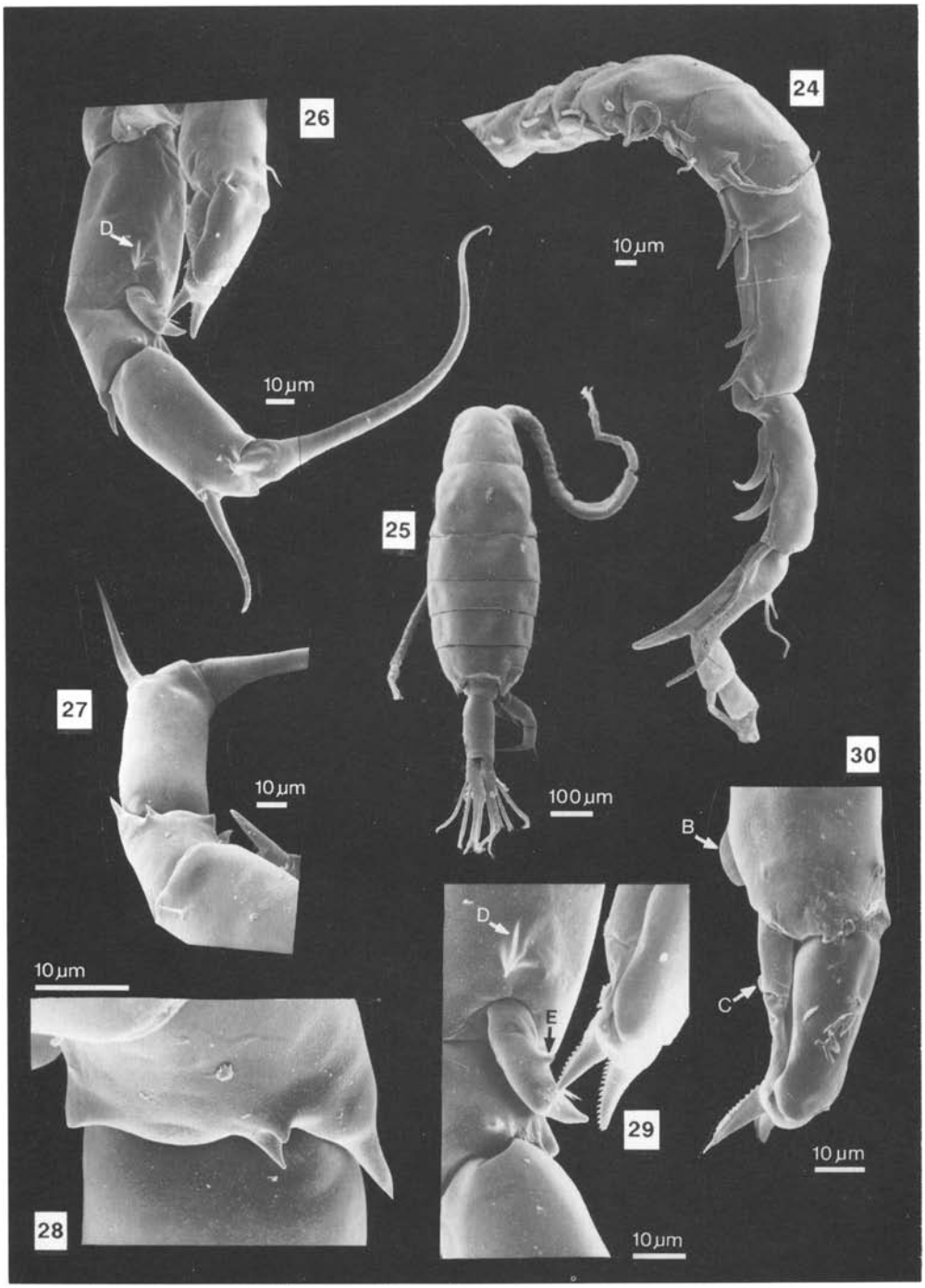
Antenna, mandible, maxillula, maxilla and maxilliped as in Figs 7, 5, 10, 12 and 11, respectively. Mandible with prominent lobe on proximal margin of gnathobase (Fig. 6, arrow A).



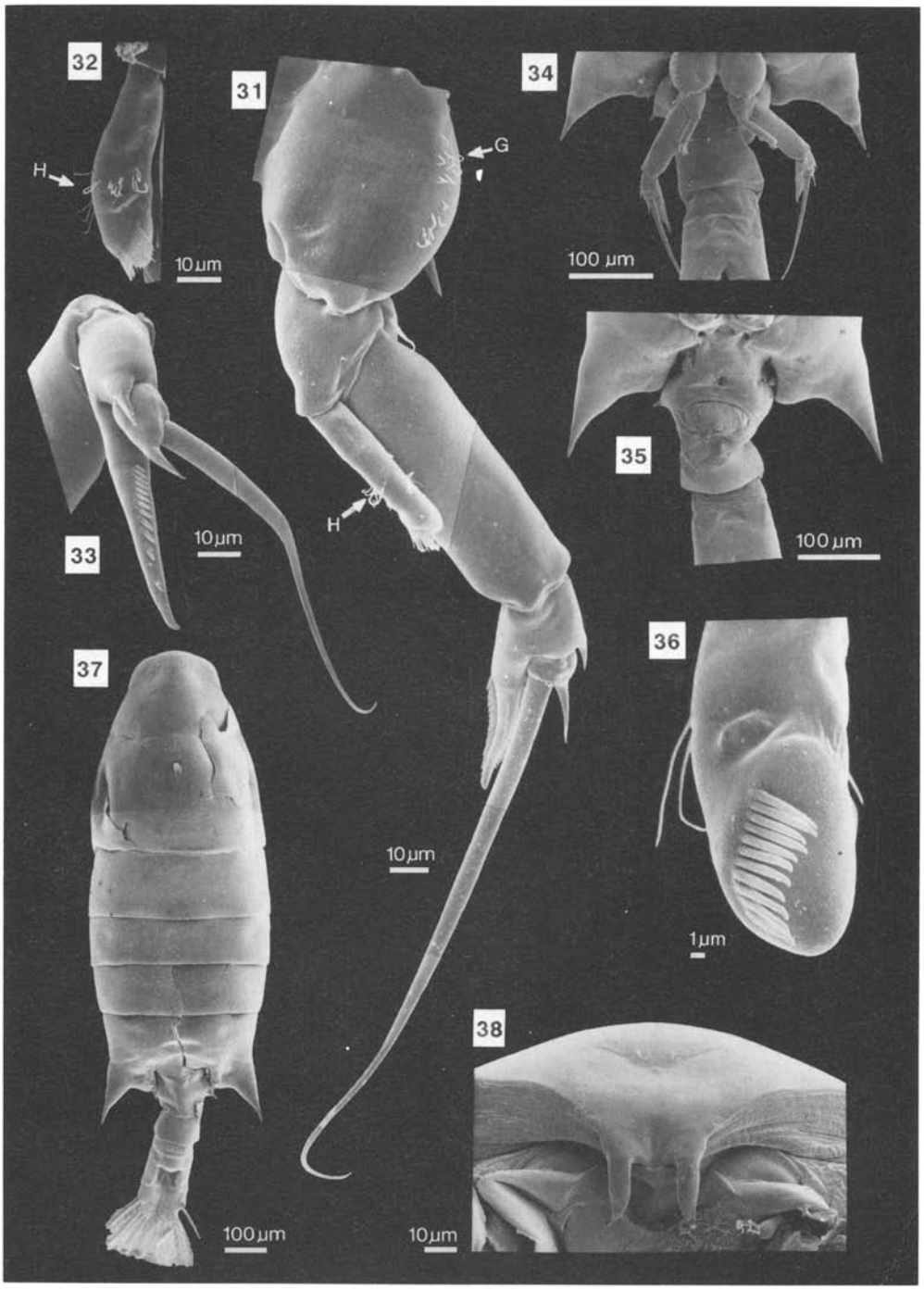
Figs 10–16. Keraladiaptomus rangareddyi gen. nov. et sp. nov. 10. Female, Maxilliped; 11. Female, Maxilla; 12. Female, Maxillula; 13. Female, Pl; 14. Female, P2; 15. Female, P3; 16. Female, P4.



Figs 17–23. Keraladiaptomus rangareddyi gen. nov. et sp. nov. 17. Male, Geniculated antennule: segments 8–16; 18. Male, left P5 (arrow B: ear-like hyaline membrane on left basipodite; arrow C: small hyaline membrane on left endopodite 1; arrow F: internal, apical projection); 19. Male, exopodite two of left P5 (arrow F: internal, apical projection); 20. Male P5, posterior view (arrow D: hyaline membrane on right basipodite; arrow E: small pointed outgrowth on right endopodite); 21. Male, Geniculated antennule: segments 1–22; 22. Female P5, posterior view; 23. Female P5, anterior view.



Figs 24–30. Keraladiaptomus rangareddyi gen. nov. et sp. nov. 24. Male, Geniculated antennule: segments 11–22; 25. Male habitus, dorsal view; 26. Male P5; 27. Male right P5; 28. Male right P5, detail exopodite 1; 29. Male P5, detail (arrow D: hyaline membrane on right basipodite; arrow E: small pointed outgrowth on right endopodite); 30. Male left P5, detail (arrow B: ear-like hyaline membrane on left basipodite; arrow C: small hyaline membrane on left endopodite 1).



Figs 31–38. Keraladiaptomus rangareddyi gen. nov. et sp. nov. 31. Female P5, anterior view (arrow G: group of hairs on basipodite; arrow H: group of hairs on endopodite); 32. Female P5, endopodite (arrow H: group of hairs); 33. Female P5, detail exopodite; 34. Female urosome with P5, ventral view; 35. Female urosome, ventral view; 36. Female P5, endopodite; 37. Female habitus, dorsal view; 38. Female rostrum.

Legs 1–4: armature of legs as in Figs 13–16.

Coxo- and basipodites of leg 1 with some groups of hairlike setae (Fig. 13).

Second endopodite-segment of leg 2 lacking organ of Schmeil. Leg 4 with long coxal seta, reaching midlength of third endopodite-segment and with tiny sensory seta on distal outer corner of basipodite (Fig. 16).

P5 (Figs 22–23, 31–34, 36) symmetrical, coxopodite with laterodistal spinous projection on posterior side and group of long, latero-proximal hairlike setae on anterior side (Figs 22 and 31, arrow G). Basipodite smaller, with short external sensory seta. Exopodite 1 long and narrow, cylindrical, 3.6 times as long as broad. Exopodite 2 tapering to narrow, straight or only slightly incurved end claw, showing thickened ridge (anterior side) and spinulated on both sides (internal margin with 25–30 spinules, external margin with 12–27 spinules).

Exopodite 2 produced at outer distal corner into pointed, strong, lateral spine of moderate length. Exopodite 2 and 3 distinct from each other. Exopodite 3 consisting of rather large, rounded segment, tapering on outer distal corner into pointed spine and carrying at midlength unusually long (± three times as long as end claw) naked spine, with hook-like incurved tip.

Endopodite 1-segmented, but with slight indentation on inner edge, without apical setae, overreaching midlength of exopodite 1, with rounded apex and subapical, oblique row of spines; some small groups of long hairlike setae, similar to those on coxopodite, difficult to see under light microscope (Figs 22, 31 and 32, arrow H), lying below this row.

Discussion

Comparing the new taxon with all the known diaptomid genera, it becomes clear that only two can be considered relatively close: *Arctodiaptomus* Kiefer, 1932 and *Eodiaptomus* Kiefer, 1932.

[For the diagnostic characteristics of the genus *Arctodiaptomus*, the diagnosis of Kiefer (1978) modified by Ranga Reddy (1994), was used.] In both the genera, the exopodite of the left male P5 is two-segmented with a long first and a short, almost round second segment on which two apical projections of the same length are implanted: a slender digitiform external process and an internal seta. Both the genera show hyaline membranes on the inner margins of the left and right basipodite. The proximity of the lateral spine to the end claw on exopodite 2 of right male P5) in *Keraladiaptomus* is similar to what is found in certain species of *Arctodiaptomus* [e.g. *A.* (*Arctodiaptomus*) *stephanidesi stephanidesi* (Pesta, 1935), *A.* (*Rhabdodiaptomus*) *alpinus* (Imhof, 1885) and *A.* (*Rhabdodiaptomus*) *bacillifer proprior* Kiefer, 1952]. The general structure of the female P5 of *Keraladiaptomus* also reminds strongly of the genus *Arctodiaptomus*: long and slender exopodite 2 with a narrow end claw, spinulated on both sides; the outer distal corner of this segment produced into a pointed lateral spine; a completely separated and rather large, rounded third exopodite-segment, tapering on the external side into a pointed spine; endopodite without apical setae and with a rounded apex and subapical row of minute spines.

There are however, a series of characteristics that exclude the new genus from *Arctodiaptomus*: the male P5 lacks the typical *Arctodiaptomus*' plug-like outgrowth on the proximal posterior face of the right basipodite; both lamellae on left and right basipodites of male P5 are much smaller than those usually found in *Arctodiaptomus* species; the apical processes on the second exopodite-segment of the male left P5 are short and sturdy, whereas they are longer and pincer-like in *Arctodiaptomus*; *Keraladiaptomus* has only one seta on segment 11 of the female antennule, instead of two setae as is the rule in *Arctodiaptomus*; unlike in all *Arctodiaptomus* species, the endopodite of P2 lacks the organ of Schmeil.

Another genus that shows some resemblance to *Keraladiaptomus* is *Eodiaptomus* Kiefer, 1932. (see the revised generic diagnosis by Ranga Reddy, 1994). Both the genera have the lateral spine on the exopodite 2 of the right male P5 inserted near the base of the end claw. The right endopodite of the male P5 of *Eodiaptomus* often

shows serrations similar to the single serration on the right endopodite of *Keraladiaptomus*. Also the shape of the first and second exopodite-segments of the left male P5 is somewhat similar. However, the unique structure of the female P5 of *Keraladiaptomus* and the differences between *Keraladiaptomus* and *Eodiaptomus* in the apical processes on the left male second exopodite, in the right endopodite of the male P5, and in the ornamentation of the geniculated antennule of the male, justify their separation into discrete genera.

Remarkable is the disjunct occurrence of the new taxon in the temporary waters of the peninsular horst of India, which is geologically and ecologically distinct, and geographically remote from the distributional centres of its close allies. Within the Indian subcontinent *Arctodiaptomus* is confined to the subtropical lakes of Kashmir, and *Eodiaptomus* to the rivers and reservoirs of central India. Strangely, the new genus shows little resemblance to *Megadiaptomus*, *Spicodiaptomus*, some members of *Heliodiaptomus*, *Neodiaptomus*, *Phyllodiaptomus* and *Sinodiaptomus*, which are typical of temporary waters in peninsular India.

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