

A REDESCRIPTION OF *HELIODIAPTOMUS CINCTUS* (GURNEY, 1907)
AND *ALLODIAPTOMUS MIRABILIPES* KIEFER, 1936 (COPEPODA,
CALANOIDA) AND THEIR OCCURRENCE IN COCHIN
BACKWATERS, INDIA

BY

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Indian diaptomids have been studied and described extensively by Gurney (1907), Kiefer (1932, 1936a, 1936b) and Brehm (1953). But the morphological characters of *Heliodiaptomus cinctus* and *Allodiaptomus mirabilipes* have not been adequately described by these authors and there has been considerable confusion regarding the nomenclature of these species. Gurney's (1907) description and illustrations of *Diaptomus cinctus* based on a few specimens of both the sexes obtained from Chakradharpur were so inadequate that much confusion was created in later years in the identification of the same from its related species. Sewell (1919) recorded *D. cinctus* from Chilka Lake but included no description; in 1924 he illustrated the male first antenna and fifth legs. Subsequently *D. cinctus* was placed in the genus *Heliodiaptomus* by Kiefer (1932a). His (1932b) *Heliodiaptomus rangunensis* from Rangoon resembled *H. cinctus* so much that he discussed the possibility that the former might be identical with the latter. Kiefer (1936a) created a new genus *Allodiaptomus* to include two new diaptomids, *A. raoi* and *A. mirabilipes* obtained from Nellore (Madras) and an unspecified locality in Mysore respectively. Later (1936b) after receiving from Gurney a drawing of the male fifth leg, he decided that the female he had thought to be *A. mirabilipes* was actually *H. cinctus*, apparently because in his collections from Madras this female was associated with males having a fifth leg agreeing with the drawing sent to him by Gurney. In the same collection were two males of *A. mirabilipes* and a single female (different from that of *H. cinctus*) which he decided must be the female of *A. mirabilipes*.

Brehm (1953) reviewed the identifications of *H. cinctus* (Gurney) and *A. mirabilipes* Kiefer based on his collections of these species from Tellichery, Mahe (*H. cinctus*), Quilon, Trivandrum and Ernakulam (*A. mirabilipes*). Though Brehm proved beyond doubt that *H. rangunensis* was a synonym of *H. cinctus*, the specific differences between *H. cinctus* and *A. mirabilipes* enabling a correct identification were not dealt with adequately. The present paper is written with the

object of describing and comparing the specific characters of these two co-existing species so that a correct identification may be possible in future.

While examining plankton samples taken from Cochin Backwaters during 1968, a few specimens of *H. cinctus* and *A. mirabilipes* were encountered. These species were found in plankton samples only during monsoon period when the salinity of the water was very low nearing fresh condition.

Previous records of the Copepoda from Cochin Backwaters were by George (1958), Kasturirangan (1963) and Wellershaus (1969). In none of these were species of the family Diaptomidae described or recorded. This family contains freshwater and estuarine species.

Heliodiaptomus cinctus (Gurney, 1907) (figs. 1-7, 11-17, 22-28)

Diaptomus cinctus Gurney, 1907: 29, pl. 1 figs. 11, 12; Tollinger, 1911: 109, fig. 22; Sewell, 1919: 1 (in list); Sewell, 1924: 783, pl. 45 fig. 4.

Heliodiaptomus cinctus - Kiefer, 1932a: 508 (in key); Brehm, 1953: 244-247, figs. 3, 4.

Allodiaptomus mirabilipes Kiefer, 1936a: 139-140, figs. 7, 8 (♀ only).

Allodiaptomus cinctus - Kiefer, 1936b: 323-324, figs. 11-15.

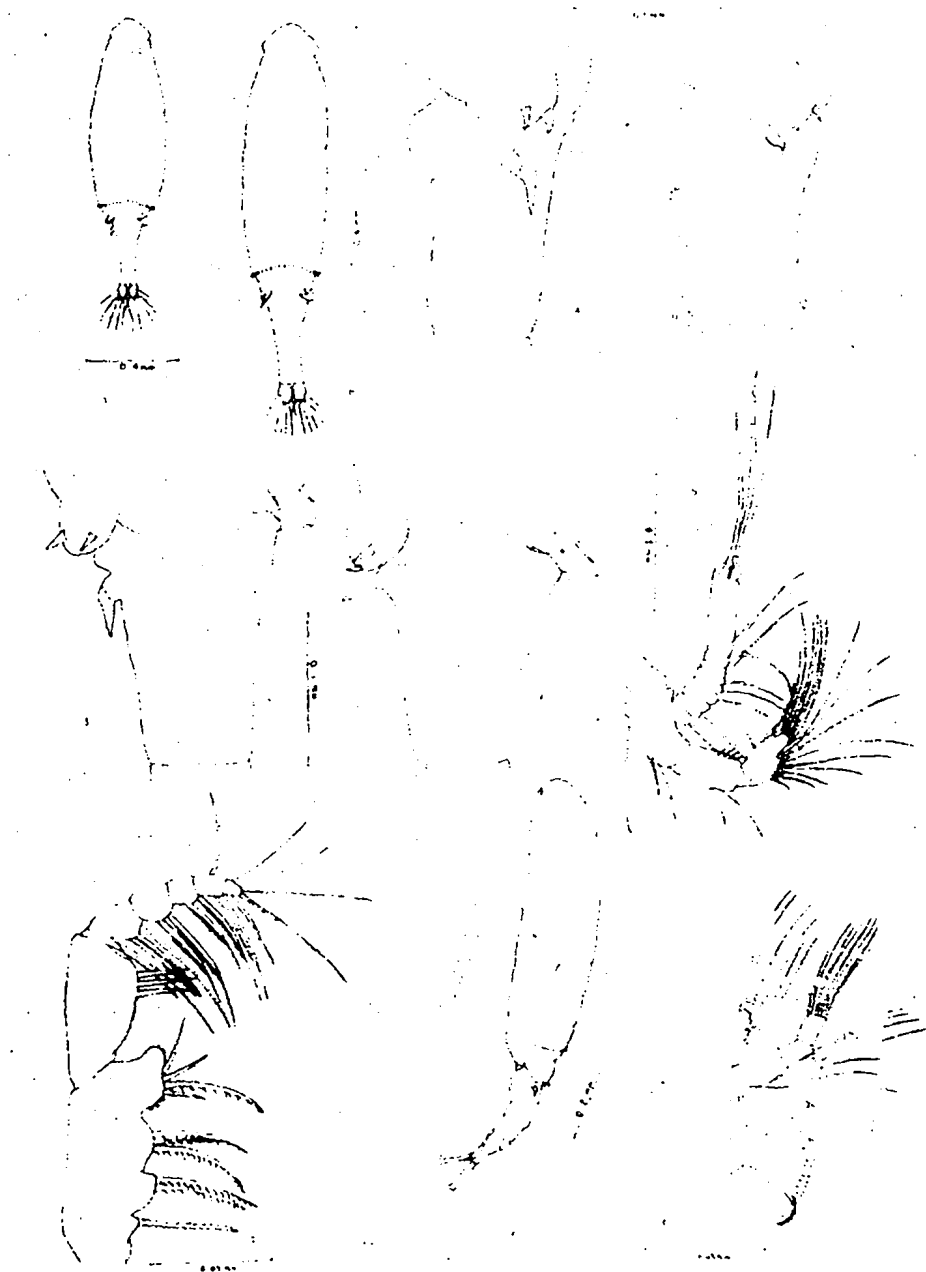
Heliodiaptomus rangunensis Kiefer, 1932b: 269-270, figs. 6-10.

Locality and material. — A few females and males in plankton samples collected in surface waters at Aroor in Cochin Backwaters on 18 July 1968, 14 August 1968, 12 September 1968 and 26 September 1968. Salinity of water in July 1968 was 0.6 to 0.8‰, in August 0.4 to 0.6‰ and in September 1 to 2‰. Three males and four females have been deposited in the Division of Crustacea, Smithsonian Institution, Washington, D.C., U.S.A., catalogue number 134483.

Female. — Total length 1.1-1.2 mm. Body slightly stocky, widest at midlength narrowed anteriorly, anterior end more or less rounded. Head separated from thorax by a constriction. Fourth and fifth pedigerous segments separated by a ring of spines closely set at the sides, more widely spaced in the middle and extending ventrally halfway down the lateral part of body (figs. 1, 2). Fifth pedigerous segment asymmetrical; right side evenly curved with a pair of spines, one dorsal and the other lateral; left side with a rounded lobe constricted at the base, bearing 2 subequal spines, one dorsal and the other lateral.

Urosome 3-segmented; relative lengths of segments and caudal rami about 10 : 3 : 3.5 : 3.5. Suture separating prosome and urosome very distinct. Genital segment only slightly dilated, about as long as following segments and caudal rami combined; asymmetrical, right side bearing a spine and left side a projection with a posteriorly directed large spine distinctly posterior to the spine on the right side. Caudal rami nearly twice as long as wide, medial margins and proximal outer lateral margins with short setules; each rami with four major, one minor and an accessory seta.

A1 25-segmented, reaching considerably beyond caudal seta. Ri1 of A2 with 4 dentate spines on lateral margin. Mandibular palpi with 4-segmented Re and 2-segmented Ri. Gnathal lobe of mandible with 9 teeth and a small seta; space between first tooth and the next very wide. Maxilla 1 and 2 normal for the genus. Ri of maxilliped 5-segmented, segments 1 to 3 with bifurcate setae.



Figs. 1-7. *Heliodiaptomus inctus* (Gurney, 1907). ♀. 1, dorsal view; 2, lateral view; 3, posterior region of prosome and genital segment, dorsal view; 4, the same as in fig. 3, lateral view; 5, second antenna; 6, mandible; 7, maxilliped.

Figs. 8-10. *Alldiaptomus mirabilipes* Kiefer, 1936, ♀. 8, dorsal view; 9, posterior region of prosome and genital segment, dorsal view; 10, same as fig. 9, lateral view.

P1 and P4 as in figures 11 and 12. P5 asymmetrical and biramous, a slender single segmented endopodite and 2-segmented exopodite. Endopodite bears small spines on its upper margin and is nearly as long as 1st exopodite segment which carries at the distal lateral margin a pair of spines between which is a long seta. Inner margins of claw-like second segment beset with hairs. B1 bears a stout spine and B2 a small seta, laterally.

Male. --- Total length 1.0 mm. Prosoma shape as in female; dorsal ring of spines less compactly formed; posterior aspect of fifth pedigerous segment slightly asymmetrical, without process but with a pair of spines, the bigger one on the right and the smaller one on the left. Urosome 5-segmented, relative lengths of segments and caudal rami about 3 : 4 : 3 : 3 : 2 : 3. First segment bears a long slender spine on the right and a very small one on the left. Second segment with a band of long hairs on the ventral side. Caudal rami nearly twice as long as wide, setae as in female; a small spine at the base of the accessory seta.

A1 reaching slightly beyond the caudal setae; geniculation between segments 18 and 19; antepenultimate segment prolonged into a process slightly indented at the tip reaching to 2/3 the length of succeeding segment and bearing on its distal half a narrow hyaline membrane (not shown in fig. 15). Spines on segments 8 and 10 to 15; longest on 13th and shortest on 12th.

Fifth leg: First basipodite segment of right leg bears a large spine on its posterior mid-distal margin; spine on the posterior side of identical segment of left leg small. Second basipodite segments of right and left leg bear lamella-like structures at midlength of inner margins; small setae at about 0.7 the distance along the lateral margin. Right endopodite small, conical and longer than first exopodite segment which bears on its distal lateral margin a stout short spine. Second exopodite segment bears proximally on outer lateral margin a longer spine at the base of which is a hook-like structure on the posterior side; posteriorly this long spine gives the appearance of having another slender spine appressed to it; this segment terminates in a double curved sickle-shaped claw with serrate inner distal margin and blunt tip. At the site of insertion of claw is a chitinous ridge-like structure. Both exopodite segments of left leg bear serrated and hairy oval lobes at their inner margins; second segment chela-like and bears a pair of transversely placed chitinous ridges proximally on inner margin.

***Allodiaptomus mirabilipes* Kiefer, 1936 (figs. 8-10, 18-21, 24-25)**

Allodiaptomus mirabilipes Kiefer, 1936a: 139-141, figs. 9-11 [♂ only; ♀ = *H. cinctus* (Gurney)]; Kiefer, 1936b: 323-325, figs. 16, 17 (♀); Brehm, 1955, 253-256, figs. 12-16.

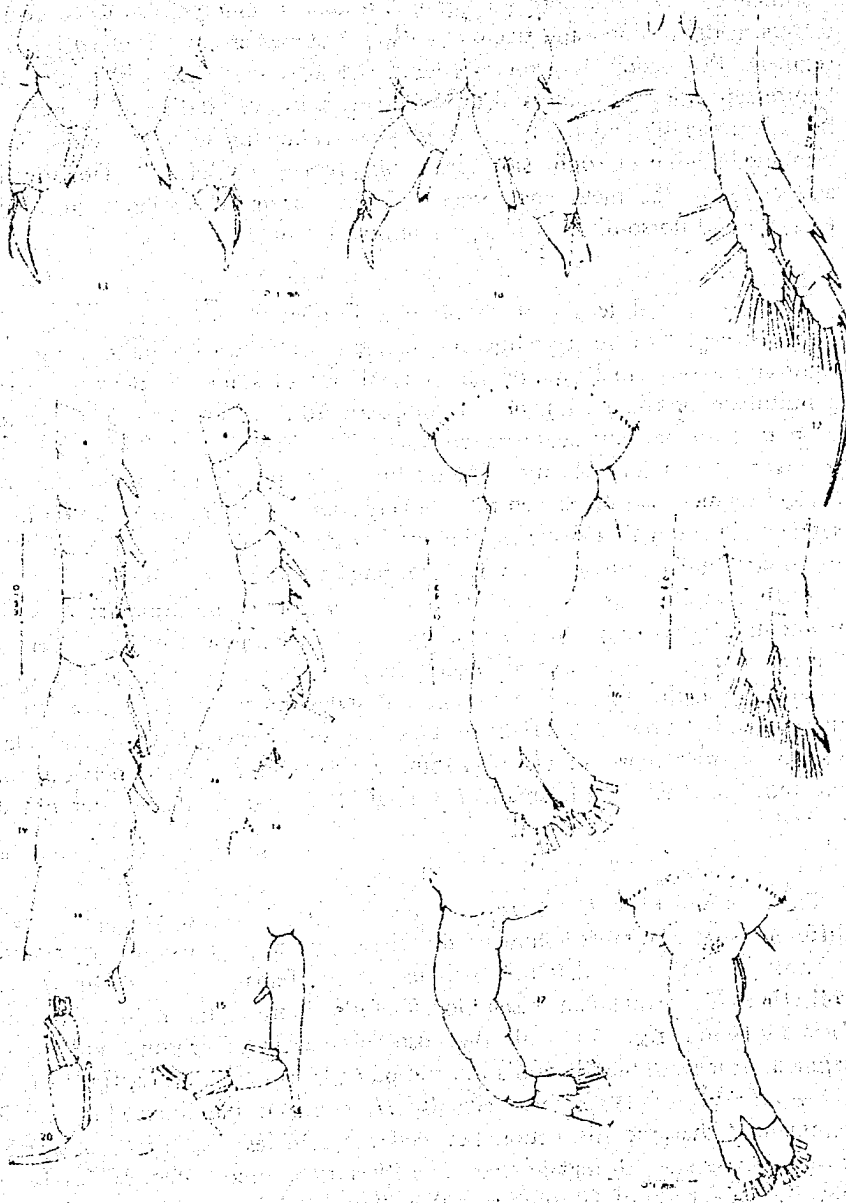
Locality and material. --- Same as for *H. cinctus*. Seven males and nine females have been deposited in the Division of Crustacea, Smithsonian Institution, Washington, D.C., U.S.A., catalogue number 134482.

Female. — Total length 1.03 mm. Prosome resembles *H. cinctus* female but differs in the position and size of the pair of spines on process of fifth pedigerous segment. Proportion of urosome segments and caudal rami is 9 : 3.5 : 3.5 : 3. Suture separating prosome and urosome very faint. Genital segment much dilated, broad proximally and hardly as long as the following segments and caudal rami combined. Spine on right side rather big, process on left side laterally directed and closer to the metasomal process. Right margin of genital segment concave (fig. 9) and dorso-distal part of it sclerotised (fig. 10).

Male. — Total length 0.85-0.9 mm. Prosome as in female except for the posterior aspect of fifth pedigerous segment which bears a rather long spine on right and a very small one on left. Dorsal ring of spines on posterior margin of penultimate prosome segment not compactly formed. Urosome 5-segmented, the proportion of urosome segments and caudal rami about 3 : 4 : 3 : 3 : 2 : 3. First segment bears a long strong spine on the right and a much smaller one on left. Second segment has on its ventral side very short hairs. Process on antepenultimate segment of A1 with a distal hyaline membrane and bifid tip. Spines on 8th, 10th to 14th segments; no spine on 15th. Segments 8 to 16 very broad.

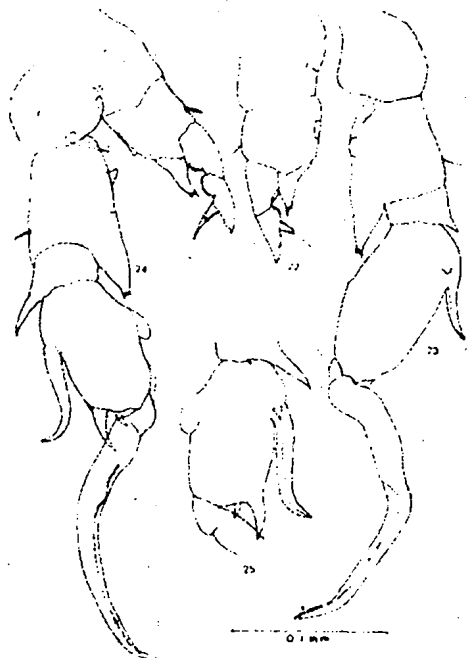
Fifth leg: Resembles that of *H. cinctus* except in the armature of exopodite segments of right leg. Outer lateral spine on first segment much longer. Second segment with an oval shaped projection at mid-inner margin and 3 spines on outer margin, the biggest and strongest at about 0.3 the distance along the lateral margin and appressed to it on its posterior side a slender spine and placed at its base a stout short spine; distal spine is shorter and the one between this and the terminal claw is still small. Terminal claw is sickle-shaped but not doubly curved.

Figs. 1-4 and 13 of *H. cinctus* and figs. 8, 9, 10, 18 of *A. mirabilipes* reveal the differences cited in table I showing that these two species are easily distinguishable. Brehm (1953) stated that the fifth leg of the female of *A. mirabilipes* in his collection from Ernakulam resembled Kiefer's figure of the fifth leg of *A. mirabilipes* (1936b, fig. 17) while the posterior margin of prosome and the genital segment of it resembled Kiefer's illustration of *H. cinctus* (1936a, fig. 7) (Kiefer's *A. mirabilipes* of 1936a, was actually *H. cinctus*). Based on this fact Brehm commented that the distinction between the females of these two species was uncertain. Female 5th legs of these two species are almost identical. Brehm might have had a female of *H. cinctus* as these two species occur together. He assumed that all the females in the sample belonged to *A. mirabilipes* as the males were exclusively of that species. Kiefer (1936b : 323-325) observed that these two female forms were distinguishable from one another by the shape and armature of the thoracic wing and the genital segment. He did not point out the other differences.



Figs. 11-17. *Heliodyptomus cinctus* (Gurney, 1907). 11, P1 ♀; 12, P4 ♀; 13, P5 ♀; 14, A1 ♂, segments 8 to 16; 15, last three segments of A1 ♂ showing the process on the antepenultimate segment; 16, urosome ♂, dorsal view; 17, urosome ♂, lateral view.

Figs. 18-21. *Allodyptomus mirabilipes* Kiefer, 1936. 18, P5 ♀; 19, A1 ♂, segments 8 to 16; 20, last three segments of A1 ♂ showing the process on the antepenultimate segment; 21, urosome, dorsal view.



Figs. 22-23. *Heliodiaptomus cinctus* (Gutney, 1907), ♂. 22, left P5, posterior view; 23, right P5, posterior view.

Figs. 24-25. *Allodiaptomus mirabilipes* Kiefer, 1936, ♂. 24, P5, anterior view; 25, second exopodite segment of right P5 (excluding terminal claw), posterior view.

Brehm (1953) described *H. cinctus* and *A. mirabilipes* collected from Tellicherry-Mahe and Quilon-Trivandrum-Ernakulam respectively. His descriptions and illustrations (figs. 3-4, 12-16) show that local variations are quite commonly exhibited by these two species. The important differences noted in his descriptions and illustrations from the specimens under study are:

H. cinctus — Tellicherry. The 16th segment of A1 of the male bears a small spine and 3rd urosome segment has short hairs on its ventral side.

A. mirabilipes — Quilon. In the male, the 15th segment of A1 bears a small spine and the spine on 14th segment is much longer than in Kiefer's illustration. Second exopod segment and its terminal claw of right fifth leg (fig. 12, p. 254) are different from those of the present specimens in the following: Size and nature of the mid-inner process, presence of indentation near the tip of the distal spine, the position of the spine in between this distal one and the terminal claw, and lastly the shape and lack of serration on the inner margin of the terminal claw.

Brehm described the process on the left side of the genital segment of the female as a cylindrical outgrowth with a strong horn whose tip is bent at an angle (fig. 13, p. 254). It seems that Brehm's fig. 13 was of an *H. cinctus* female, which he assumed had to be *A. mirabilipes* female, since the males in the samples were *A. mirabilipes*.

TABLE I

Comparative list of characters of *H. cinctus* and *A. mirabilipes* ♀

	<i>H. cinctus</i>	<i>A. mirabilipes</i>
Length, mm	1.12	1.03
I. Posterior margin of prosome:		
a. Spines on left side:	Stout almost of equal size, one dorsal and the other lateral.	Not of equal size, one slender and the other stout; former one distal and the latter one dorsal.
b. Position of thoracic process	Almost free from margin of genital segment.	Very close to genital segment.
c. Line of separation of prosome and urosome	Very distinct.	Very faint.
II. Genital segment	Long, not dilated, right margin not concave, as long as urosome segments + caudal rami.	Broad proximally, dilated, right margin concave, hardly as long as urosome segments + caudal rami.
III. Process on left side	A large spine directed posteriorly and mounted on a sidewardly directed process.	Laterally directed.
IV. Proportion of urosome segments + caudal rami.	10 : 3 : 3.5 : 3.5	9 : 3.5 : 3.5 : 3
V. Hairs on terminal claw.	Of equal size.	Long hairs on left claw.

A. mirabilipes — Trivandrum: Very few peculiarities are shown by the specimens from Trivandrum. The caudal ramus in female is sparsely haired externally and naked internally. Terminal claw of the female fifth leg bears on its inner aspect a longer row of hairs and externally a few hairs only.

A. mirabilipes — Ernakulam: Brehm's fig. 16 (p. 254) shows the male right fifth leg and the antepenultimate segment of A1. The endopodite of this leg is different in size and shape. The backwardly directed spine situated at the base of the terminal claw, and the serrated nature of the process on the antepenultimate segment of A1 are absent in the specimens under study.

The spines on the left thoracic wing of the female were knob-like rather than pointed (fig. 15, p. 254). First basals and second exopod segments of fifth leg had stouter spines (fig. 14a, b, p. 254).

It is very interesting to note that specimens of *A. mirabilipes* collected by Brehm (1953) from an unspecified locality in Ernakulam show morphological variations from those collected by the author from Aroor, a station in Cochin Backwaters about 12 km south of Ernakulam.

TABLE II
Comparative list of characters of *H. cinctus* and *A. mirabilipes* ♂

	<i>H. cinctus</i> 1.0	<i>A. mirabilipes</i> 0.95
I. Length, mm.		
I. Prosome: spine on right posterior margin.	Small.	Rather big.
II. 1st urosome segment: spine on right side.	Feeble and slender.	Well developed.
III. 2nd urosome segment.	Very long; hairs on ventral side.	Very short hairs on ventral side.
IV. A1	A small spine on 15th segment. Spine on 14th segment longer. Segments 8-16 not very broad Process on penultimate segment indented.	No spine on 15th segment. Spine on 14th segment shorter. Segments 8-16 quite broad. Process on penultimate segment bifid.
V. P5	Spine on 1st exopodite segment of right leg short. 2nd exopod segment with a single proximal spine. No projection on inner mid region of 2nd segment. Terminal claw doubly curved. A pair of chitinous ridges on inner margin of 2nd exopod of left leg.	Spine on 1st exopodite segment of right leg long and strong. 2nd exopod segment with very long, strong proximal spine, a well developed distal spine and a small spine between this and the terminal claw. An oval projection at mid-length of inner margin of 2nd segment. Terminal claw purely sickle-shaped. No such ridges present.

DISCUSSION

Diaptomus cinctus Gurney (1907) was placed in the genus *Heliodiaptomus* by Kiefer (1932a) and later transferred to the genus *Allodiaptomus* by him (1936b). Brehm (1953) kept *D. cinctus* in *Heliodiaptomus* although *A. mirabilipes* was placed by him in *Allodiaptomus*. The only clear-cut difference that could be observed between the diagnostic characters given for these two genera, is that the second exopod segment of the male right fifth leg has only one lateral spine in *Heliodiaptomus*, but has two lateral spines in *Allodiaptomus*. If this is a valid difference on the generic level, Brehm's (1953) view must be followed. If the difference is not considered to have generic value, then the two genera must be combined, in which case both species would be in *Heliodiaptomus*, since it is the earlier genus by 4 years. The author has kept the two separate following Brehm (1953).

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ZUSAMMENFASSUNG

Heliodiaptomus cinctus (Gurney, 1907) und *Alloidiaptomus mirabilipes* Kiefer, 1936, welche aus „Cochin Backwaters“ (Indien) gesammelt worden waren, werden neu beschrieben, und zwar unter Berücksichtigung vergleichender Aspekte. Insbesondere werden morphologische Charakteristiken und spezifische Unterschiede behandelt, die bisher noch keine Darstellung erfahren haben.

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