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A note on the Diaptomidae of Thailand, including redescription of three species and description of a new species (Copepoda, Calanoida)

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Key words: Diaptomidae, Copepoda, Calanoida, taxonomy, *Allodiaptomus rarus* n.sp., Thailand

Abstract

A brief taxonomic review is made of the diaptomid copepods of Thailand. The updated list contains 21 species; the records of some species, however, are unreliable. *Neodiaptomus botulifer* Kiefer, *N. yangtsekiangensis* Mashiko, and *Allodiaptomus calcarus* Shen & Tai are redescribed. The extensive morphologic variability observed in *N. botulifer* casts serious doubt on the validity of *Neodiaptomus malaindosinensis* Lai & Fernando; hence the synonymy of these two species is discussed. It is clarified that Lai & Fernando (1981) and others had erroneously identified and/or described *N. yangtsekiangensis* and *A. calcarus* as *Arctodiaptomus bacillifer* (Koelbel) and *Neodiaptomus mephistopheles* Brehm, respectively, and that the occurrence of the latter two species in Thailand is hardly likely. *Mongolodiaptomus uenoi* (Kikuchi) and *Heliodiaptomus elegans* Kiefer are reported for the first time from Thailand. Also included in this paper is an illustrated description of a new species, *Allodiaptomus rarus* n.sp., which is closely related to *A. calcarus* Shen & Tai.

Introduction

Except for Daday's (1906) distribution record of *Diaptomus doriai* Richard, 1894 (now in the genus *Tropodiaptomus* Kiefer), practically nothing about the Thai Diaptomidae was known prior to 1970s. Sangkhakul (1974), Bricker et al. (1978), Boonsom (1984) and a few others provided only some baseline data on the species composition and distribution of freshwater zooplankton in diverse habitats. It was Lai & Fernando (1981), who made an extensive survey of the inland waters in Thailand and gave a fairly detailed account of the systematics and biogeography of the Diaptomidae for the first time. They treated as many as 14 species of freshwater Calanoida and also constructed an identification key for them. Not surprisingly, several Thai diaptomids were also discussed by Lai & Fernando (1978b) and Lai (1986) in their reports on the freshwater Calanoida of Singapore and peninsular Malaysia, and of Indonesia, respectively. Lai & Fernando (1980) also mapped the freshwater calanoid distribution in the

Southeast Asia. Recently, two new species of the genus *Phyllodiaptomus* Kiefer by Dumont & Reddy (1994) and Dumont et al. (1996), and one new species of the genus *Eodiaptomus* Kiefer by Reddy & Dumont (1998) have been added to the Thai Diaptomidae.

This paper provides a brief taxonomic review of the diaptomids occurring in Thailand. Our present study together with the earlier reports reveals a total of 21 species, all belonging to the major subfamily Diaptominae (Table 1); the Thai records of at least three species, however, are questionable. *Neodiaptomus botulifer* Kiefer, *N. yangtsekiangensis* Mashiko, and *Allodiaptomus calcarus* Shen & Tai are redescribed. In the light of the extensive morphologic variability observed in *N. botulifer*, the validity of *Neodiaptomus malaindosinensis* is now open to question. Hence the synonymy of these two species is briefly discussed. It is clarified that *N. yangtsekiangensis* and *A. calcarus* have hitherto been confused with *Arctodiaptomus bacillifer* (Koelbel) and *Neodiaptomus mephistopheles* Brehm, respectively, by various workers including Lai & Fer-

Table 1. List of diaptomid species from Thailand

Species	Reference
1. <i>Neodiaptomus schmackeri</i> (Poppe & Richard, 1892)	Lai & Fernando, 1981; Boonsom, 1984; This report
*2. <i>Neodiaptomus mephistopheles</i> Brehm, 1933	Bricker et al., 1978; Lai & Fernando, 1981; Boonsom, 1984; Lai, 1986
3. <i>Mongolodiptomus uenoi</i> (Kikuchi, 1936)	This report
4. <i>Neodiaptomus blachei</i> Brchm, 1951	Bricker et al., 1978; Lai & Fernando, 1981; Boonsom, 1984
5. <i>Neodiaptomus yangtsekiangensis</i> Mashiko, 1951	This report
6. <i>Neodiaptomus botulifer</i> Kiefer, 1974	Lai & Fernando, 1978a, 1981; Boonsom, 1984; This report
7. <i>Neodiaptomus laii</i> Kiefer, 1974	Lai & Fernando, 1981
8. <i>Neodiaptomus malaindosinensis</i> Lai & Fernando, 1978	Lai & Fernando, 1981
9. <i>Tropodiptomus doriai</i> (Richard, 1894)	Daday, 1906
10. <i>Tropodiptomus vicinus</i> Kiefer, 1930	Lai & Fernando, 1980, 1981; Lai, 1986
*11. <i>Arctodiptomus bacillifer</i> (Koelbel, 1885)	Lai & Fernando, 1981
+12. <i>Sinodiptomus chaffanjonii</i> (Richard, 1897)	Boonsom, 1984
13. <i>Dentodiptomus javanus</i> (Grochmalicki, 1915)	Bricker et al., 1978; Lai & Fernando, 1981; Boonsom, 1984
14. <i>Heliodiptomus viduus</i> (Gurney, 1916)	Lai & Fernando, 1980, 1981; this report
15. <i>Heliodiptomus elegans</i> Kiefer, 1935	This report
16. <i>Allodiptomus raoi</i> Kiefer, 1936	Bricker et al., 1978; this report
17. <i>Allodiptomus calcarus</i> Shen & Tai, 1965	This report
18. <i>Allodiptomus rarus</i> n.sp.	This report
19. <i>Phyllodiptomus praedictus</i> Dumont & Reddy, 1994	Dumont & Reddy, 1994; this report
20. <i>Phyllodiptomus christineae</i> Dumont et al., 1996	Dumont et al., 1996; this report
21. <i>Eodiaptomus sanoamuangae</i> Reddy & Dumont, 1998	Reddy & Dumont, 1998; this report

* Misidentification + doubtful record

nando (1981), and that the occurrence in Thailand of the latter two species is hardly likely. *Mongolodiptomus uenoi* Kikuchi and *Heliodiptomus elegans* Kiefer are reported for the first time from Thailand. This paper also contains description of a new species, *Allodiptomus rarus* n.sp., a third allodiptomid in Thailand.

The other species that we came across in this study are not treated here since they are already well characterized in the literature.

Systematic account

Subclass Copepoda Milne-Edwards, 1840

Order Calanoida G.O. Sars, 1903

Family Diaptomidae G.O. Sars, 1903

Subfamily Diaptominae Kiefer, 1932

Neodiaptomus botulifer Kiefer, 1974 (Figures 1–36)

Synonymy

?*Diaptomus visnu* Daday, 1906: 200–201, Pl. 16, Figures 17–20; Tollinger, 1911: 32–33, Figures S; Brehm, 1954: 418.

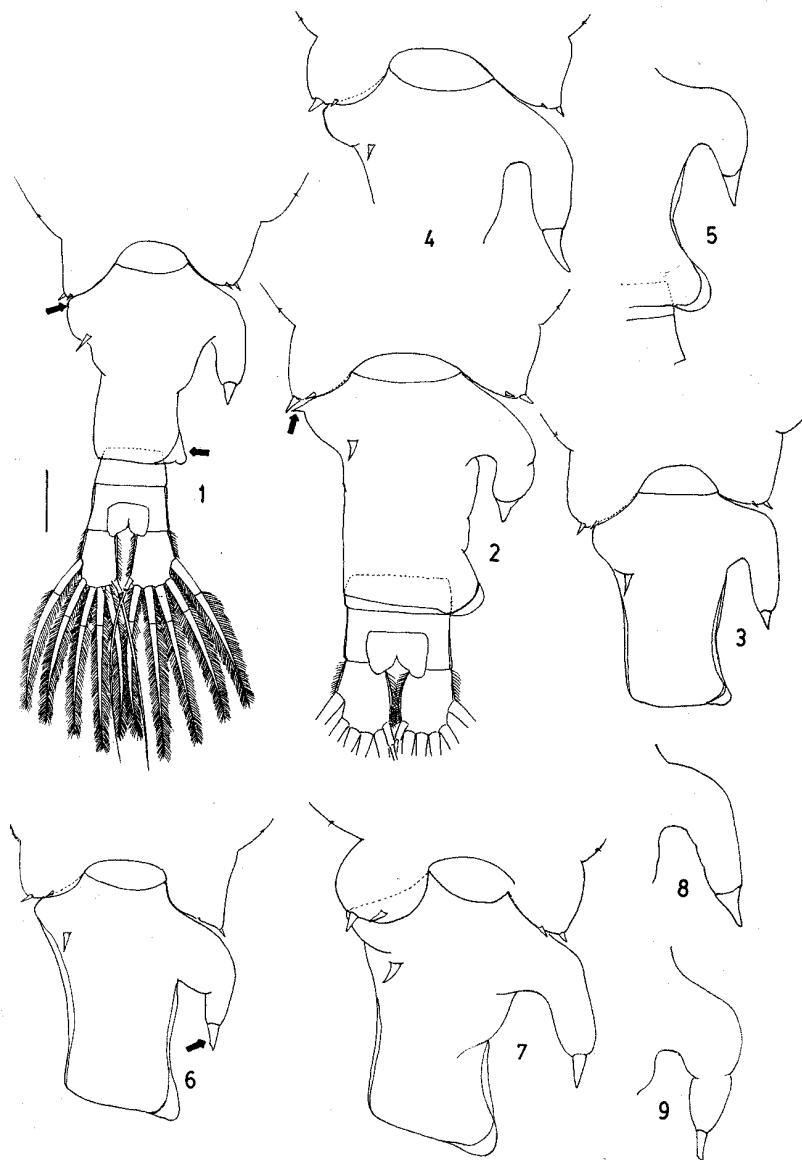
?*Heliodiptomus visnu*: Kiefer, 1932: 474.

Neodiaptomus botulifer: Kiefer, 1974b: 420–424, Figures 1–13; Lai & Fernando, 1978a: 230–232, Figures 1–11; Lai & Fernando, 1978b: 118–119, Figures 22–27; Lai & Fernando, 1980: 53–54; Boonsom, 1984: 227; Lim & Fernando, 1985: 85; Reddy, 1994: 64–67, Figures 357–369.

Localities and material examined

1. Bhumipol Reservoir. 10 ♂♂, 10 ♀♀. July 17, 1978.

2. Chao Phya reservoir, Chai Nat Province. 10 ♂♂, 10 ♀♀, May 2, 1993. Water temp. 37 °C, pH 5.6, conductivity 180 μS cm⁻¹.



Figures 1–9. *Neodiaptomus botulifer* Kiefer, 1974. Female. 1, pedigers 4, 5 and urosome, dorsal (arrows point to right posterior and left anterior expansions of genital somite); 2, same, different specimen (arrow points to spinous projection); 3, 4, 6, 7, pedigers 4, 5 and genital somite, dorsal (arrow points to variable spine on right genital process); 5, genital somite, right side; 8, 9, right genital process; scale bar = 50 μm .

3. Sakaekrung River, Uthai Thani Province. 5 $\sigma\sigma$, 5 ff . May 2, 1993. Water temp. 36 $^{\circ}\text{C}$, pH 6.0, conductivity 190 $\mu\text{S cm}^{-1}$.

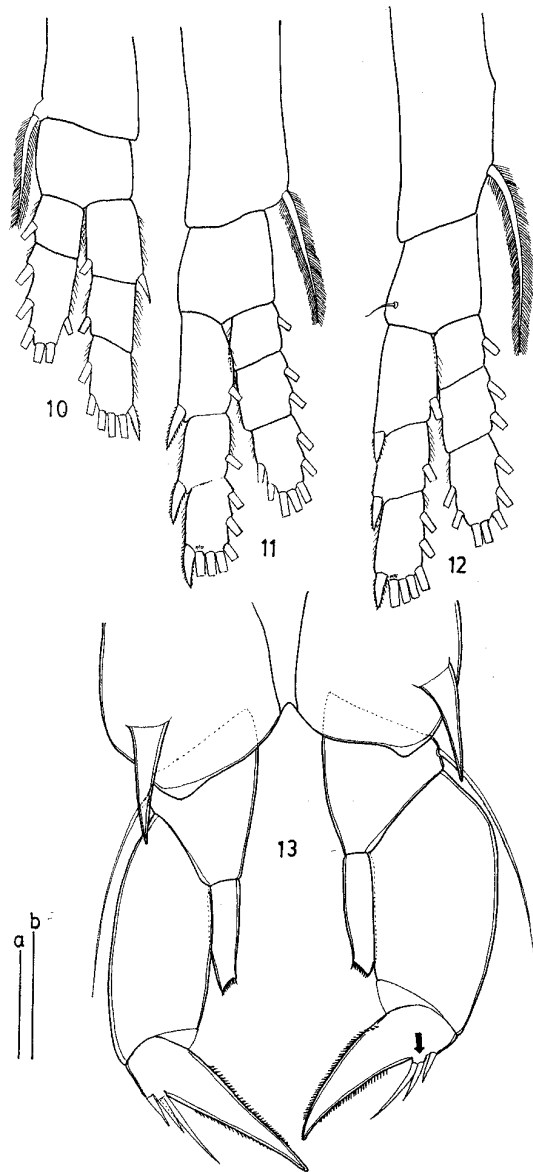
4. Boeng Boraphet, a natural shallow lake, Nakhon Sawan Province. 20 $\sigma\sigma$, 20 ff . May 2, 1993. Water temp. 33 $^{\circ}\text{C}$, pH 5.0, conductivity 370 $\mu\text{S cm}^{-1}$.

5. Nong Takai (right), Sakonnakhon Province. 15 $\sigma\sigma$, 15 ff . June 5, 1993. Water temp. 32 $^{\circ}\text{C}$, pH 7.2, conductivity 90 $\mu\text{S cm}^{-1}$.

Fifteen $\sigma\sigma$ and 10 ff from Boeng Boraphet were deposited in the British Museum (Natural History), London. Registration numbers 1995: 891–900.

Adult female (Figures 1–13)

Total length exclusive of caudal setae 1.09–1.43 mm, mean 1.28 mm ($n = 35$). Lateral wings of fifth pediger generally equal in length and nearly symmetrical (Figures 1, 2); sometimes right wing either longer (Fig-



Figures 10–13. *Neodiaptomus botulifer* Kiefer, 1974. Female. 10, P1; 11, P2; 12, P4; 13, P5 (arrow points to ill-defined third exopodite-segment). Scale a, Figures 10–12; scale b, Figure 13; scale bars = 50 μ m.

ures 6, 7) or shorter (Figure 3) than left wing; left wing more variable than right wing. Each wing with 2 (1 posterolateral, 1 inner) highly variable spines, generally lying close to each other; inner spine always sublateral in position. Genital somite undivided; right side carrying botuliform process, tipped with variable apical spine; left side with variable bulge, often lacking lateral spinous projection. Left genital spine occurring on

dorsolateral surface, just below the bulge. Expansion of genital somite at right distal corner highly diagnostic, though somewhat varying in form. Second urosomite partially or completely telescoped into genital somite. Anal somite slightly shorter than caudal rami. Caudal rami c. 1.3 times as long as wide; all principal setae jointed proximally; lateral seta on either ramus somewhat shorter than other setae.

Antennule (no figure) 25-segmented, surpassing caudal setae by last 4 or 5 segments.

All other cephalic appendages of normal structure and armature.

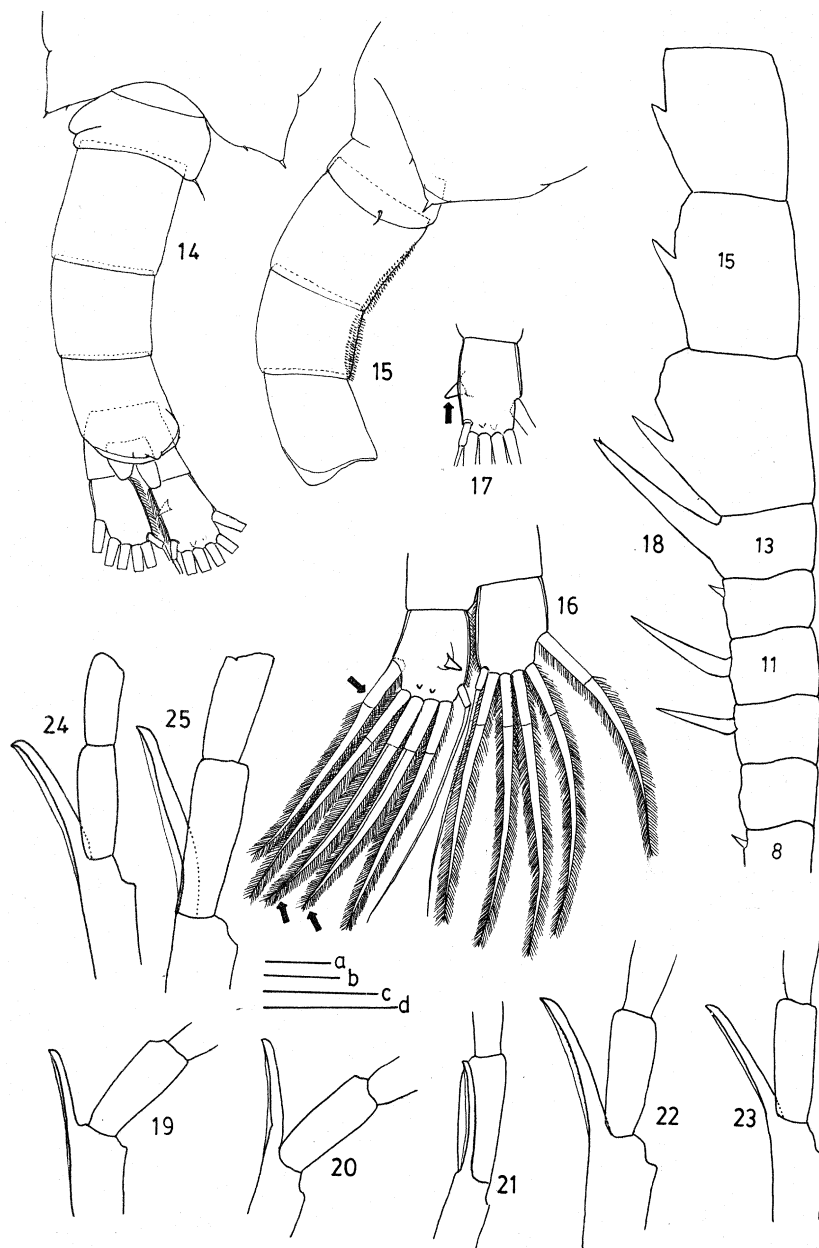
P1–P4 (Figures 10–12) with full complement of setae and spines. Coxal seta on P4 of normal length.

P5 (Figure 13). Coxal spine larger than depicted by Kiefer (1974); no difference in size between coxal spine of right leg and that of left leg. Sensory seta on basis long, reaching at least 2/3 length of outer margin of first exopodite-segment. End claw of right leg shorter and more outcurved than its counterpart; either claw serrate on both margins. Lateral spine on second exopodite-segment shorter than outer spine on third exopodite-segment. Third exopodite-segment small and unarticulate; outer spine almost half as long as inner spine; inner spine setiform and extending to about 2/3 length of end claw. Endopodite unsegmented, 2/3 as long as inner margin of first exopodite-segment; apical region obliquely truncate, with pointed extremity.

Females fewer than males in all the samples studied. Oviparous females common, each with 18–26 eggs in spherical egg sac. Abnormality: one adult female with geniculate right antennule as in male, but all other appendages including P5, and habitus typifying female.

Adult male (Figures 14–36)

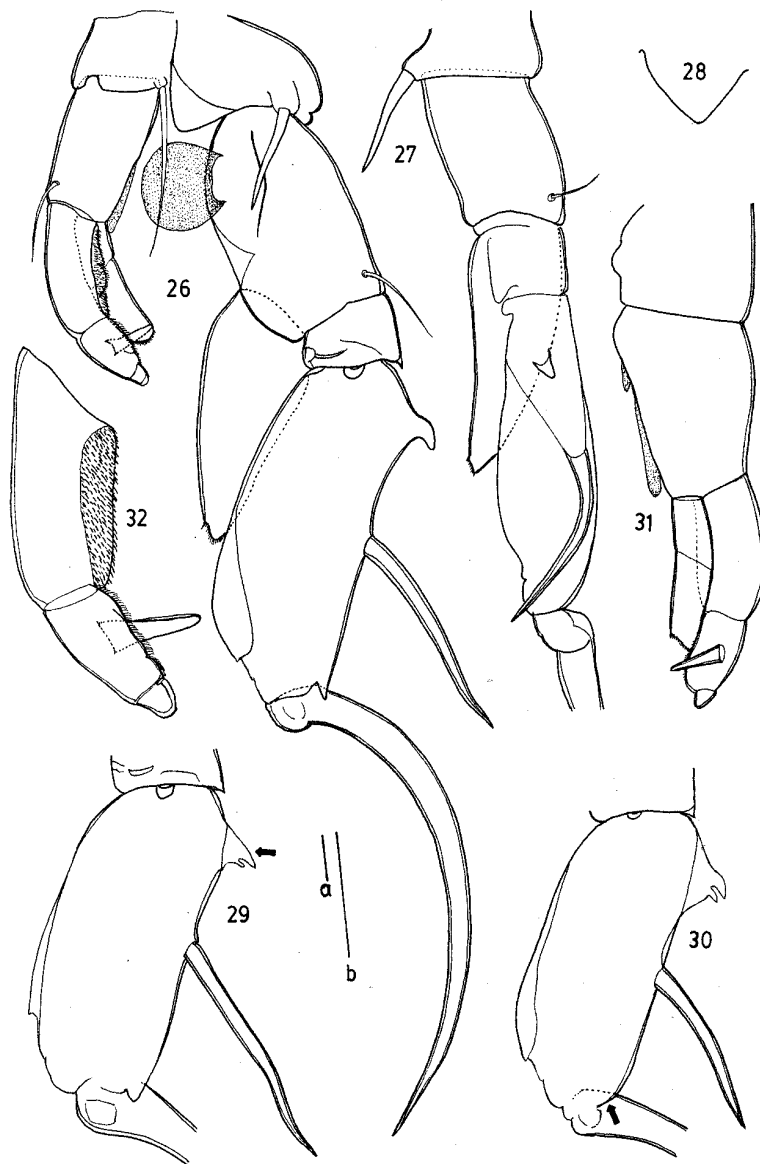
Total length excluding caudal setae 1.17–1.32 mm, mean 1.24 mm ($n = 35$). Fourth and fifth pedigers completely fused. Lateral wings of fifth pediger of moderate size, triangular and asymmetrical, right wing being larger than left wing (Figure 14). Genital somite with small setiform spine at distal outer corner. Second and third urosomites with minute hair-like setae on ventral margin (Figure 15). Caudal rami 1.6 times as long as wide, with hairy inner margins, right ramus armed ventrally with 1 large, conical, chitinous process at about the middle and 2 minute outgrowths near second and third terminal setae (Figures 16, 17); setae on both rami distinctly jointed proximally; second and



Figures 14–25. *Neodiaptomus boulifera* Kiefer, 1974. Male. 14, pedigers 4, 5 and urosome, dorsal; 15, same (without caudal rami), lateral; 16, caudal rami (under coverslip), ventral (arrows point to modified setae); 17, right caudal ramus (under coverslip); 18, right antennule, segments 8–16; 19–25, same, spinous process on antepenultimate segment. Scale a, Figures 14, 15; scale b, Figures 16, 17; scale c, Figure 18; scale d, Figures 19–25; scale bars = 50 μ m.

third terminal setae of right ramus lanceolate, thicker than the rest and with narrow chitinous ridge close to outer margin as in Figure 16; lateral caudal seta on right ramus somewhat dilated in the proximal section; on left ramus, lateral seta slightly stouter than others.

Right antennule (Figure 18). Spines on segments 8 and 10–16; spines on segments 10 and 11 relatively strongly developed, and on segments 8 and 12 rudimentary and almost equal in size; relative lengths of all spines in descending order as follows: 13 > 11 > 10 > 14 > 15 > 16 > 12 = 8; spinous

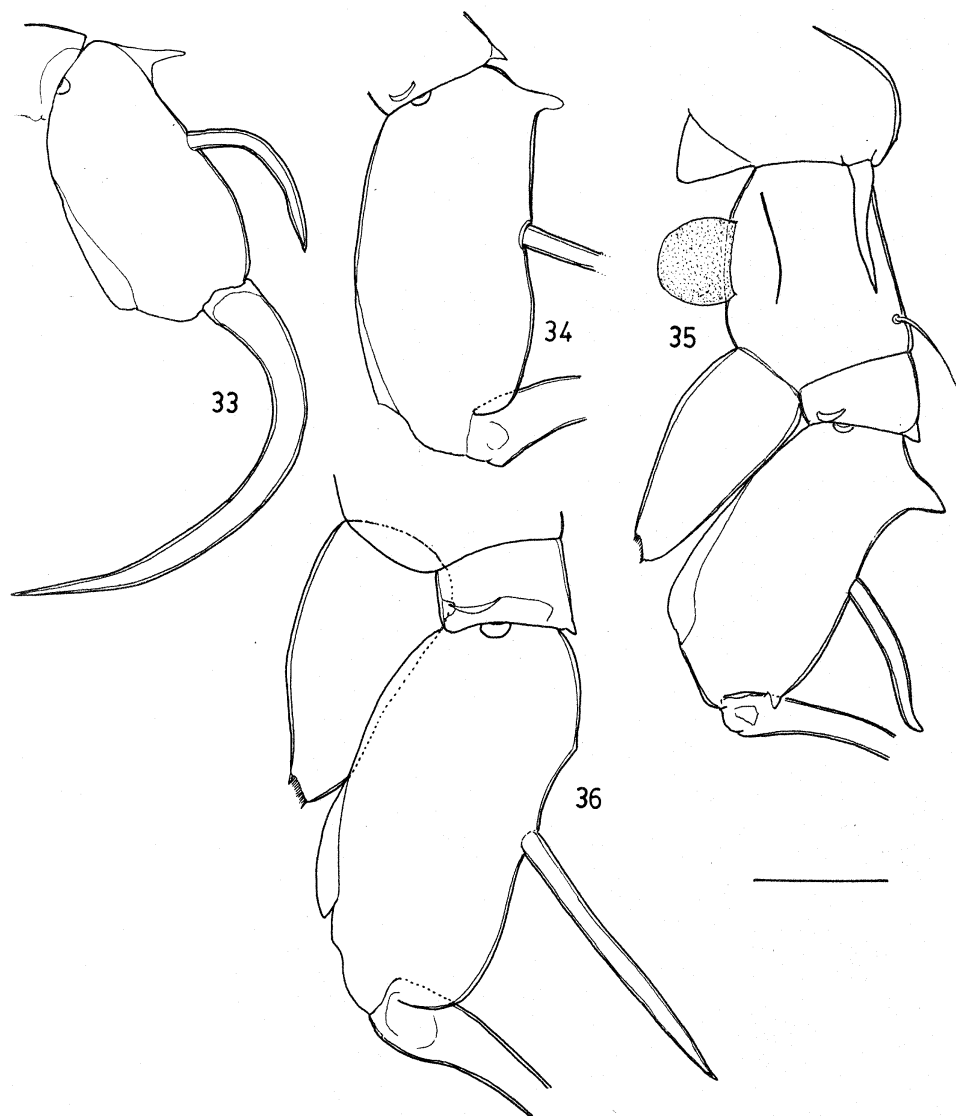


Figures 26–32. *Neodiaptomus botulifer* Kiefer, 1974. Male. 26, P5, posterior; 27, right P5, lateral; 28, same, coxal plate; 29, same, exopodite (arrow points to modified proximal spine); 30, same (arrow points to smooth distal corner); 31, left P5, lateral; 32, same, exopodite, posterior. Scale a, Figures 26–30; scale b, Figures 31, 32; scale bars = 50 μ m.

process on antepenultimate segment slender, nearly straight, generally as long as, or occasionally longer or shorter than, next segment, and with hooked tip and narrow hyaline membrane on outer margin (Figures 19–25).

Right P5 (Figures 26–36). Coxa produced into obconic plate at distal inner corner (Figures 26, 28); spine unusually long and sturdy. Basis obovate, with

large, spherical hyaline lamella on inner proximal margin, somewhat long sensory seta at distomedial corner and longitudinal chitinous ridge at about the middle of proximal half. First exopodite-segment short, with pointed or blunt spinous process at distal outer corner. Second segment somewhat oblong or rarely obovate (Figure 33); outer margin nearly straight or concave, inner margin convex, with narrow chitinous flange,



Figures 33–36. *Neodiaptomus botulifer* Kiefer, 1974. Male. 33, 34, right P5 exopodite, posterior; 35, 36, same, exo- and endopodites, posterior. Scale bar = 50 μ m.

often ending in minute spinous projection; principal lateral spine slender, shorter than its segment, highly varying in form with pointed or blunt tip, and inserted at about the middle of outer margin; proximal spinous process less chitinized, larger and more variable than distal spinous process; sometimes distal process (Figures 30, 34), and, rarely, both processes (Figure 36), absent. End claw of moderate size, smoothly curved, sickle-shaped, gradually attenuating to pointed extremity. Endopodite large, obovate, nearly 3/4 as long as second exopodite-segment.

Left P5 (Figures 26, 31, 32). Coxal spine setiform, unusually long, extending beyond basis. Basis rectangular, 1.7 times as long as wide at base; distal half of inner margin with long, narrow hyaline lamella, sticking out beyond posterior border of this segment, and, in lateral view (Figure 31), appearing as conical lobe; sensory seta same as its counterpart on right leg. First exopodite-segment 1.5 times as long as second segment, slightly incurved and with large hairy lobe near inner margin. Second segment with hairy inner margin. Apical process short, thumb-like and lined with nar-

row hyaline membrane, as illustrated. Seta short, thick, digitiform and apparently without setules. Endopodite strong, incurved, 2-segmented and reaching midway of second exopodite-segment.

Remarks

This study brings out the extensive range of intra- and inter-population variation among such taxonomically important body parts and appendages of *N. botulifer* as the lateral wings of the fifth pediger and the lateral process of the genital somite in the female, the armature of the grasping antennule, and the form of the second exopodite-segment and of the endopodite in the male right P5. Such wide variation is attributable to the possible allometric growth in the adult population, caused by some unknown factors. The characters cited above were always less differentiated in small, translucent, newly emerged individuals than in relatively large, less translucent, full-grown adults.

As regards the grasping antennule, a short spinous projection occurs almost invariably on the 16th segment, but it finds no mention in Kiefer's (1974) original account. Also, the spines on segments 14 and 15 are somewhat larger in the present specimens than depicted by Kiefer. According to Kiefer, the spinous process on the antepenultimate segment of the same appendage is shorter than the next segment. This statement is only partially true since the above process has been found to be distinctly longer than the next segment as well. The modified caudal setae of the male, which are unique for the species, are also not mentioned in Kiefer's work.

Some discrepancy is noticed in the literature in regard to the position of the hyaline lamella on the basis of the male left P5. The lamella actually occurs in the distal half of the inner margin of the basis, corroborating Lai & Fernando (1981, Figure 11), but not at the middle, as depicted by Kiefer. Further, the coxal spines on the female P5 are pointed, and longer than in Kiefer's figure.

The enormous variation exhibited by *N. botulifer* casts serious doubt on the validity of its closely allied congener, *N. malaindosinensis* Lai & Fernando, 1978. None of the six 'key differences' between these two taxa, cited by Lai & Fernando (1978a: 234), while erecting the latter taxon, are reliable: (1) The botuliform process, as already pointed out, is subject to much variation. While it is generally somewhat dilated in the distal region, in some specimens, however, it attenuates towards the tip, thus appearing conical (Figures 5, 6, 8, 9) as in *N. malaindosinensis*. (2) The coxal spines on

the female P5 of *N. malaindosinensis* were described as longer than in *N. botulifer*. In all the present specimens of the latter species, these spines do surpass the distal border of the basis. Strangely, Lai & Fernando (1981: Figure 9) contradicted themselves subsequently by depicting longer spines for *N. botulifer* as well. (3) The spines on segments 14, 15 and 16 of the grasping antennule were said to be longer in *N. malaindosinensis*. A close comparison, however, reveals no such valid difference between the two taxa on this point. (4 & 5) The shape of the endopodite, and the chitinous flange on the second exopodite-segment of the male right P5 are variable and hence cannot help separate the two species. (6) Lai & Fernando (1978) referred to 'blunt setae' on the female antennular segments 1 and 2 of *N. malaindosinensis* and 1–5 of *N. botulifer*. We have observed no such modified setae in our specimens. Hence we propose to sink *N. malaindosinensis* (no types available) into the synonymy of *N. botulifer*.

Among its congeners, *N. botulifer* displays closest affinity to *N. mephistopheles* Brehm, 1933 in various details of P5 in both sexes. Its uniqueness, however, is evident, inter alia, from the following features: the lateral outgrowths of the female genital somite, especially the botuliform process; in the male, the large spherical hyaline lamella on the basis, the structure and armature of the second exopodite-segment on right P5, and the apical thumb as well as modified seta on left P5.

Ecology and distribution

A eurytopic species, *N. botulifer* occurs in fish ponds, reservoirs, lakes and rivers. It is quite dominant in Thailand, with males outnumbering females. It has also been recorded in Malaysia, Singapore, Cambodia, and Vietnam (Lai & Fernando, 1980).

Neodiaptomus yangtsekiangensis Mashiko, 1951 (Figures 37–63)

Synonymy

Neodiaptomus yangtsekiangensis: Mashiko, 1951: 10–11, Figures 4a–i; Shen & Tai, 1962: 103–104; Shen & Sung, 1965: 178; Shen & Song, 1979: 141–143, Figures 72a–h; Dussart & Defaye, 1983: 95; Borutzky et al., 1991: 428, Figure 190; Reddy, 1994: 60–62, Figures 319–326.

Locality and material examined

An unspecified locality in Thailand. 20 ♂♂, 20 ♀♀. 8 ♂♂ and 8 ♀♀ were deposited in the British Museum.

um (Natural History), London. Registration numbers 1995: 901–910.

Adult female (Figures 37–42)

Total length excluding caudal setae 1.33–1.43 mm, mean 1.36 mm ($n = 15$). Rostral spines (Figure 40) of moderate size. Dorsal spinules separating fourth and fifth pedigers distinct. Right wing of fifth pediger short, rounded and bilobed; left wing long and postero-laterally directed; each wing with 1 lateral and 1 inner spine; spines on both wings alike. Genital somite almost symmetrical, subproximally dilated and constituting 55% of urosome length including caudal rami; spine on each side drawn over dorsolateral surface just below lateral protuberance and postero-laterally directed; both spines equal in size, only slightly larger than, or same as, those on wings, and lying opposite to each other. Anal somite somewhat shorter than preceding somite and caudal rami. Caudal rami about 1.5 times as long as wide, with hairy inner and outer margins; setae slender and unjointed.

Antennule (no figure) extending beyond caudal setae by last 2 or 3 segments.

P1–P4 typical of Diaptominae. Third endopodite-segment of P2–P4 with 7 setae. Coxal seta on P4 (Figure 41) of normal length.

P5 (Figure 42). Coxal spines of moderate size, pointed and each arising from hyaline lobe; right spine slightly smaller than left one. Sensory seta on basis about 1/3 as long as outer margin of first exopodite-segment. Lateral spine on second exopodite-segment somewhat larger than outer spine on third exopodite-segment. Third exopodite-segment small but distinct with 2 unequal spines; inner spine setiform and over 3 times as long as outer spine. End claws with spinules on both margins. Endopodite vaguely 2-segmented and about 2/3 as long as inner margin of first exopodite-segment; apex rounded, with transverse row of spinules.

Adult male (Figures 44–63)

Total length exclusive of caudal setae 1.11–1.19 mm, mean 1.15 mm ($n = 13$). Rostral spines (Figure 46) slender. Right wing of fifth pediger and its spines larger than their counterparts on left wing. Second and third urosomites without hair-like setae on ventral margin (Figure 45). Caudal rami symmetrical, about twice as long as wide; inner margins alone hairy; right ramus with elongate chitinous ridge dorsomedially, and short chitinous tooth postero-ventrally (Figures 47, 48). Lat-

eral caudal seta on right ramus falcate and stoutest, and its counterpart on left ramus also falcate but relatively slender; all other setae slenderer than lateral setae (Figure 47).

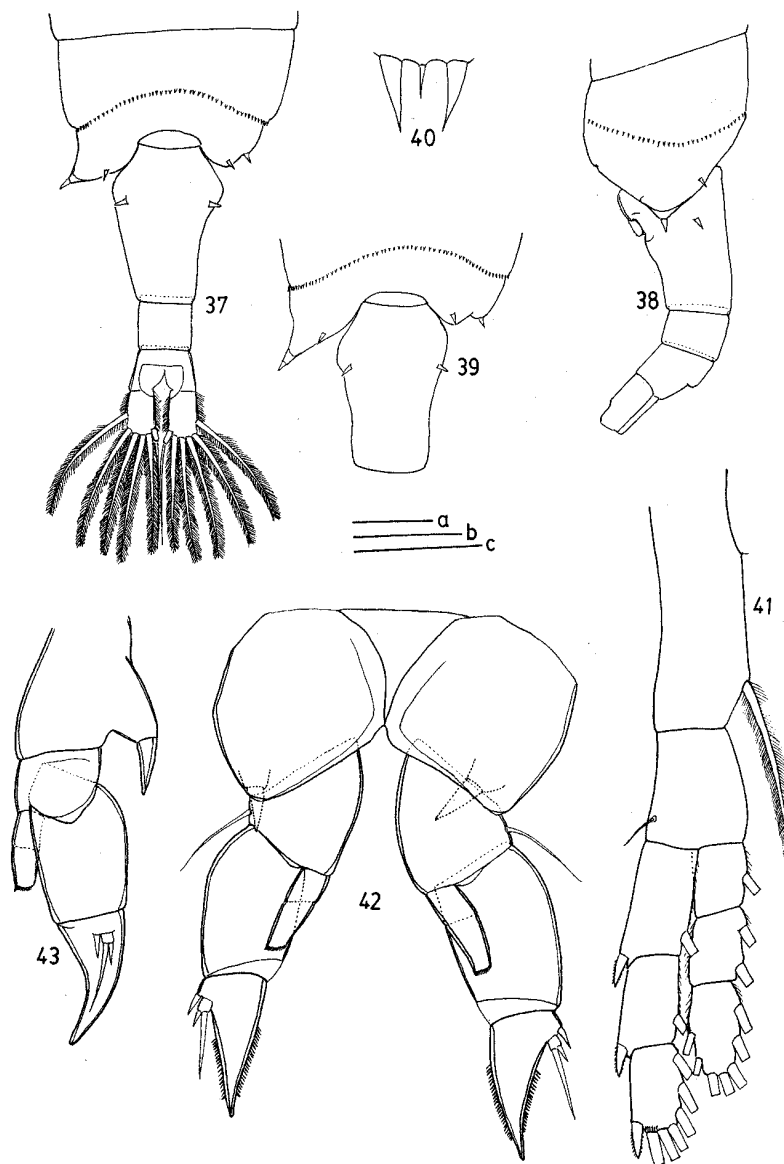
Right antennule (Figure 49). Spines on segments 13, 11, 10, 8, 14, 15, and 12, decreasing in length in the same order; spines on segments 12, 14 and 15 rudimentary, and that on 8 strongly developed; spinous process on antepenultimate segment (Figures 50–54) slender, straight, distinctly longer than next segment, almost equaling next 2 segments combined; generally with hooked tip; hyaline membrane absent, or, when present, greatly reduced and confined to apical outer margin.

Right P5 (Figures 55–61). Coxa with small, triangular plate at distal inner corner, and moderately strong spine arising from small lobe near distal outer corner. Basis nearly rectangular and with small hyaline lobe on proximal inner margin. First exopodite-segment produced into massive spinous process at distal outer corner. Second segment about 2.4 times as long as wide, with convex lateral margins; lateral spine unusually small, slender, doubly curved, laterally oriented and inserted midway on outer margin. End claw of moderate size, nearly as long as preceding 3 segments combined, proximal half straight, distal half gently curved, and inner margin with minute spinules. Endopodite elongate, cylindrical or somewhat conical, extending close to the level of lateral spine on second exopodite-segment; inner margin with 3 minute tubercles, clearly visible only in lateral view (Figures 59, 60).

Left P5 (Figures 55, 62, 63). Coxal spine much slender and short. Basis roughly rectangular and with narrow hyaline lamella on distal inner margin; sensory seta extending at least up to midway of first exopodite-segment. First exopodite-segment slender, about as long as basis, both margins straight, inner margin with hairy lobe; second segment oval in outline, about half as long as first segment; inner convex margin with long hairs in the anterior half and short hairs posteriorly. Apical thumb somewhat elongate. Inner seta strong, outcurved and pointed. Endopodite more or less triangular, extending beyond posterior border of first exopodite-segment; small hyaline structure occurring on distal region, visible in lateral view (Figures 62, 63).

Remarks

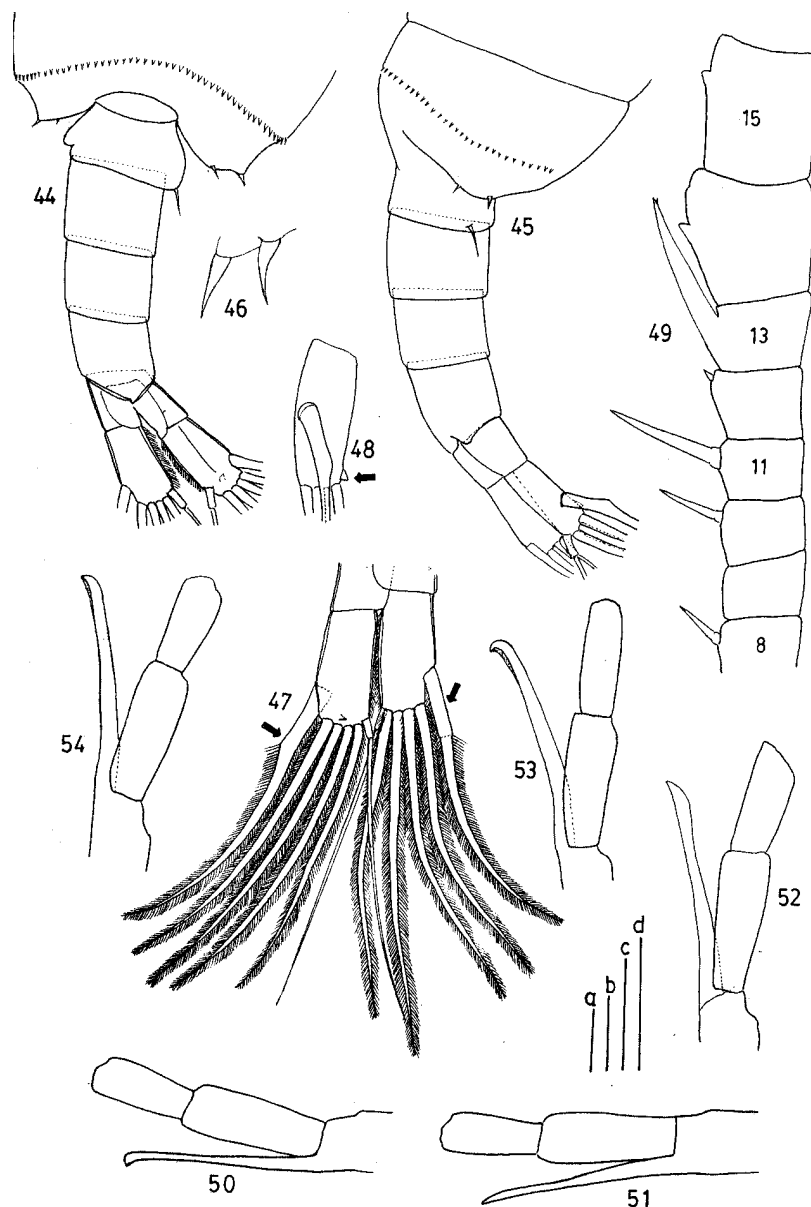
Right at the time of erecting *N. yangtsekiangensis* from China, Mashiko (1951) expressed an element of doubt



Figures 37–43. *Neodiaptomus yangtsekiangensis* Mashiko, 1951. Female. 37, pedigers 4, 5 and urosome, dorsal; 38, same, lateral; 39, pedigers 4, 5 and genital somite, dorsal; 40, rostral spines; 41, P4; 42, P5, anterior; 43, same, lateral. Scale a, Figures 37–39; scale b, Figures 41, 43; scale c, Figures 40, 42; scale bars = 50 μ m.

about his identification of the female of this species, and even hinted at the possibility of its belonging to *Neodiaptomus handeli*, Kiefer, 1932, now a synonym of *Neodiaptomus schmackeri* (Poppe & Richard, 1892). Later, Shen & Song (1979) discovered the true female of *N. yangtsekiangensis* and provided a brief but precise description of both sexes. Admittedly, identification of the females of closely allied species in *Neodiaptomus* as well as in several other diaptomid genera

is a tricky job, whereas such difficulty is experienced but rarely with males. *N. yangtsekiangensis* females, however, stand out from those of their congeners by having a complete transverse row of spinules between fourth and fifth pedigers, and strongly asymmetrical lateral wings on fifth pediger. The uniqueness of the males is apparent from the extraordinarily long spinous process on the antepenultimate segment of the right antennule, the diminutive size and unusual orientation

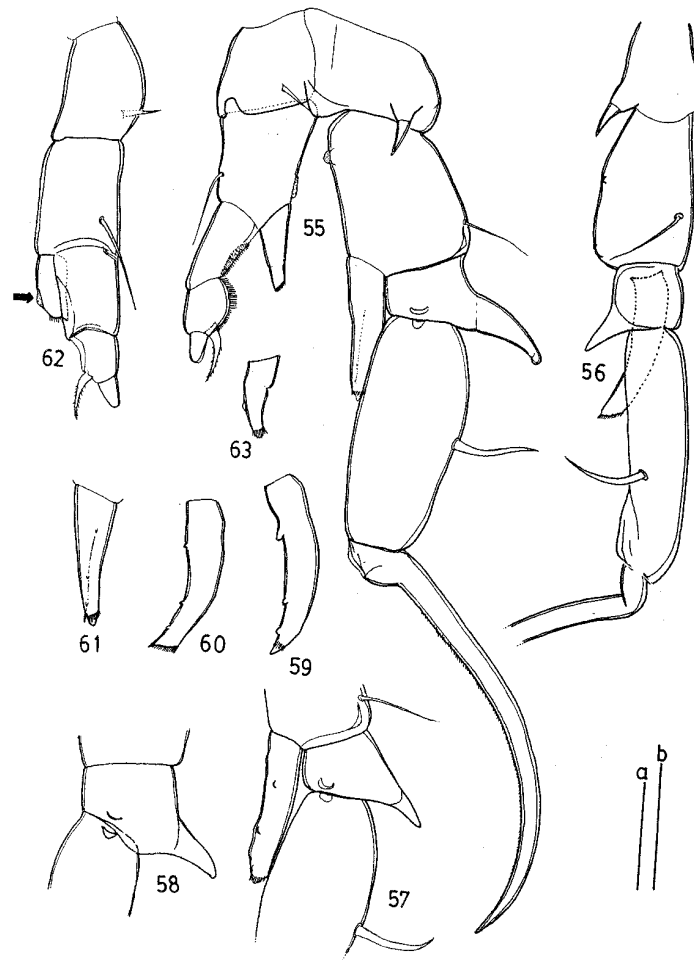


Figures 44–54. *Neodiaptomus yangtsekiangensis* Mashiko, 1951. Male. 44, pedigers 4, 5 and urosome, dorsal; 45, same, lateral; 46, rostral spines, ventro-lateral; 47, caudal rami, ventral (arrows point to falcate lateral setae); 48, right caudal ramus, lateral (arrow points to small chitinous tooth); 49, right antennule, segments 8–15; 50–54, same, spinous process on antepenultimate segment, Scale a, Figures 44, 45; scale b, Figure 47; scale c, Figures 48, 49; scale d, Figures 46, 50–54; scale bars = 50 μ m.

of the lateral spine on the second exopodite-segment, and the immense spinous process on the first exopodite-segment of the right P5.

Interestingly, *N. yangtsekiangensis* has some strong affinities to the genus *Arctodiaptomus* Kiefer, 1932, which are particularly reflected by the characteristic form of the endopodite on the male right P5 and by

the apical structures, i.e. elongate thumb and well-developed seta, on the male left P5. Perhaps considering these features, among others, and being definitely unaware of *N. yangtsekiangensis* in the literature, Lai & Fernando (1981) misidentified this species with *Arctodiaptomus bacillifer* (Koelbel, 1885). *A. bacillifer* is no doubt out of place in Thailand. The above authors



Figures 55–63. *Neodiaptomus yangtsekiangensis* Mashiko, 1951. Male. 55, P5, posterior; 56, right P5, lateral; 57, same, exo- and endopodites, posterior; 58, same, exopodite, posterior; 59–60, same, endopodite, lateral; 61, same, endopodite, posterior; 62, same, endopodite, posterior; 63, left P5, endopodite, posterior. Scale a, Figures 55–62; scale b, Figure 63; scale bars = 50 μ m.

overlooked the armed right caudal ramus of the male, which is being regarded by many, rightly or wrongly, as the major criterion of the genus *Neodiaptomus*. The females dealt with by them under the so-called *A. bacillifer* do not, unlike the males, belong to *N. yangtsekiangensis*, and no guess as to their exact identity can be made because of their poor characterization.

Ecology and distribution

N. yangtsekiangensis inhabits ponds, reservoirs, and rivers. Mashiko (1951) reported it as a dominant element in the Yangtsekiang River at Hankow, central China, in July 1942 when the surface temperature was about 31 °C and pH 7.5. According to Shen & Lee (1963), it was 'more numerous in brackish water than

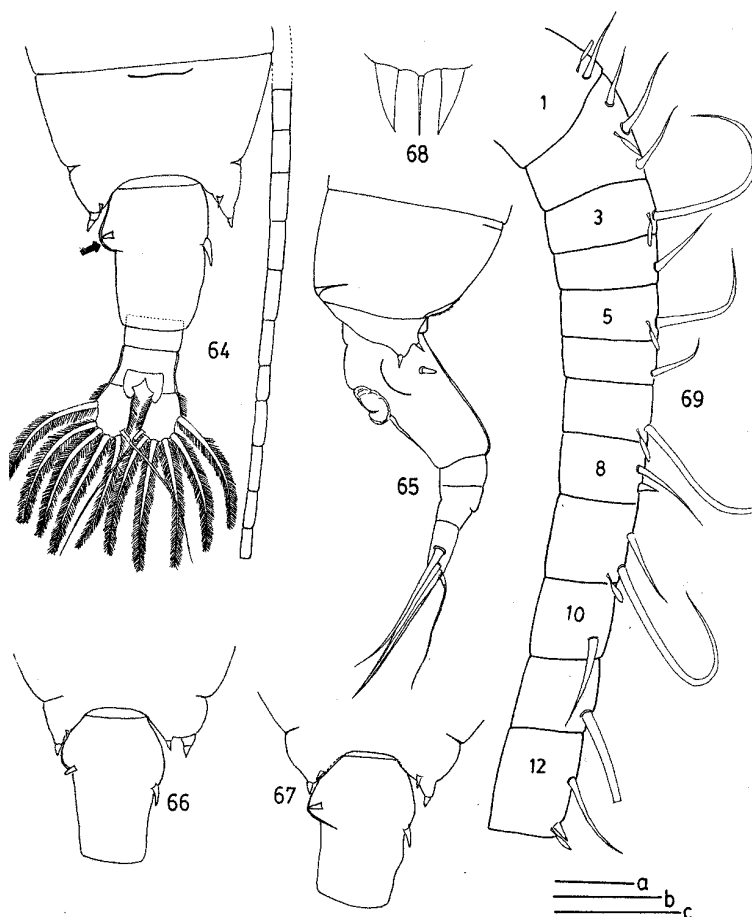
in freshwater region of the Chiekong River'. In China, it is distributed not only in the middle and lower reaches of the Yangtse, but also in the deltaic region of the Pearl River. The present report confirms the earlier record of this species, under the false name *Arctodiaptomus bacillifer*, by Lai & Fernando (1981).

Mongolodiaptomus uenoi (Kikuchi, 1936)

Synonymy

Diaptomus uenoi Kikuchi, 1936: 198–200, Figures 1–6.

Mongolodiaptomus uenoi: Kefer, 1939: 56; Dusart & Defaye, 1983: 104.



Figures 64–69. *Allodiaptomus calcarus* Shen & Tai, 1965. Female. 64, pedigers 4, 5 and urosome, dorsal (arrow points to lateral expansion of genital somite); 65, same, lateral; 66, 67, pedigers 4, 5 and genital somite, dorsal; 68, rostral spines; 69, antennule, segments 1–12. Scale a, Figures 64–67; scale b, Figure 69, scale c, Figure 68; scale bars = 50 μm .

Neodiaptomus uenoi: Lai & Fernando, 1980: 56; Lai, 1986: 43–45, Figures 10–15.

Locality and material examined

Nong Sim, Kalasin Province. 1 σ , 1 q July 4, 1993. Water temp. 36 $^{\circ}\text{C}$, pH 8.7, conductivity 350 $\mu\text{S cm}^{-1}$; 2 σ , 3 q October 9, 1993. Water temp. 31 $^{\circ}\text{C}$, pH 9.2, conductivity 230 $\mu\text{S cm}^{-1}$.

One σ and 2 q from the above locality were deposited in the British Museum (Natural History), London. Registration numbers 1995: 887–890.

Remarks

This species was first described by Kikuchi (1936) from Ryurantan at Kosyum, southern Taiwan. Kiefer (1938) rightly placed it in the genus *Mongolodiptomus* Kiefer. However, Lai & Fernando (1980), while

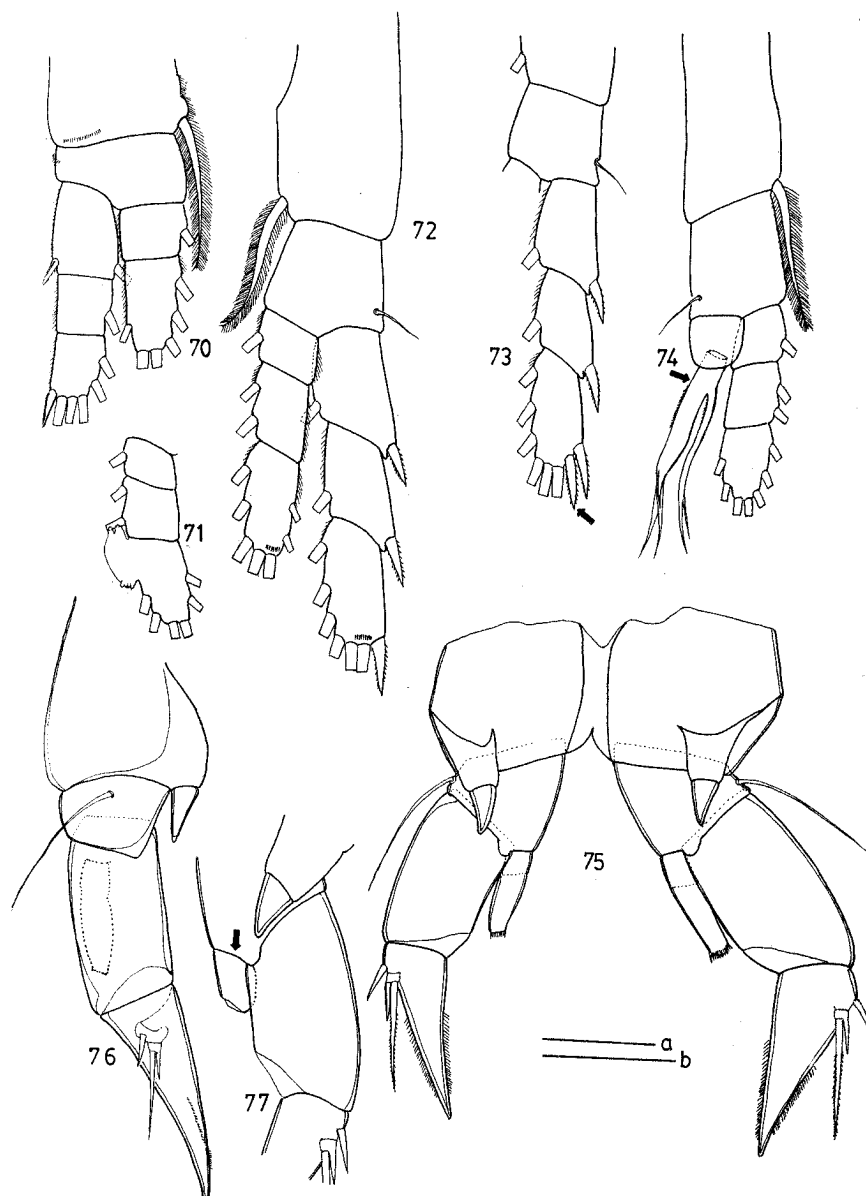
reporting it from Jatiluhur Reservoir in West Java, shifted it, to the genus *Neodiaptomus* Kiefer. *M. uenoi* was also found in West Java as well as West Kalimantan by Lai (1986). This is the first record of the species from Thailand. Its detailed morphology will be given separately.

Allodiaptomus calcarus Shen & Tai, 1965 (Figures 64–94)

Synonymy

Allodiaptomus calcarus: Shen & Tai, 1965: 126–128, Figures 1–7; Shen & Song, 1979: 155–156, Figures 80a–g; Dussart & Defaye, 1983: 100; Reddy, 1994: 38–39, Figures 170–176.

Neodiaptomus mephistopheles: Lai & Fernando, 1978b: 119–120, Figures 28–34; Bricker et al., 1978:



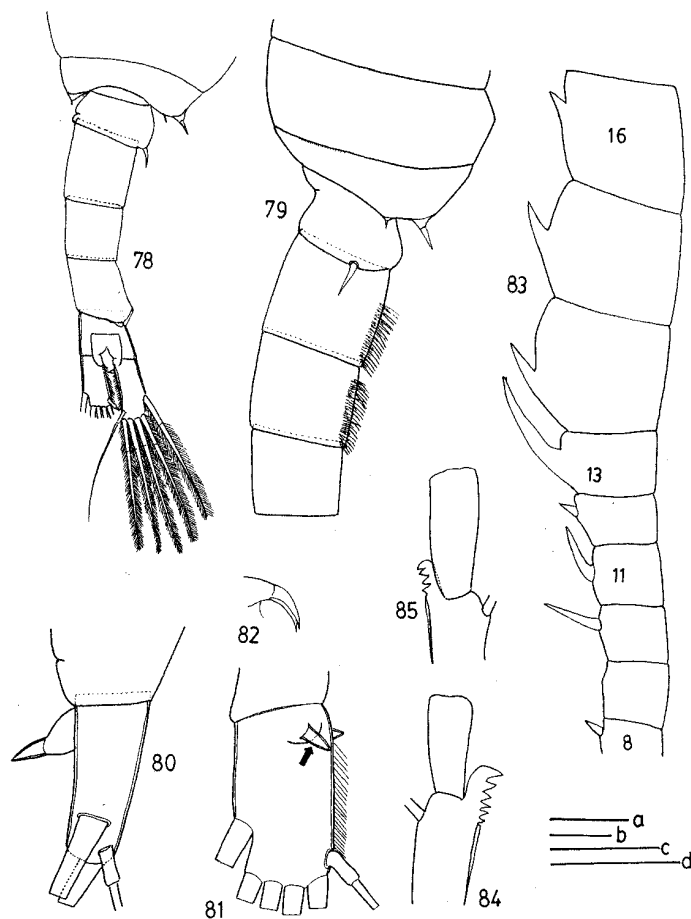
Figures 70–77. *Allodiaptomus calcarus* Shen & Tai, 1965. Female. 70, P1; 71, P3, endopodite (abnormal); 72, P4; 73, same, exopodite (arrow points to additional spine); 74, same (arrow points to abnormal endopodite); 75, P5, posterior (outer and inner margins of end claws with c.15 spinules each, and not as figured here); 76, same, lateral; 77, right P5 (arrow points to abnormal endopodite). Scale a, Figures 70–74; scale b, 75–77; scale bars = 50 μm .

1–14; Lai & Fernando, 1980: 53; Lai & Fernando, 1981: 165, Figures 73–76; Boonsom, 1984: 227; Lai, 1986: 43.

Locality and material examined

Roadside canal, Khon Kaen III, Khon Kaen Province, Thailand. 40 ♂♂, 40 ♀♀. September 15, 1993. Water temp. 31 °C, pH 7.4, conductivity 230 $\mu\text{S cm}^{-1}$.

Eighteen ♂♂ and 15 ♀♀ were deposited in the British Museum (Natural History), London. Registration numbers 1995: 931–940.

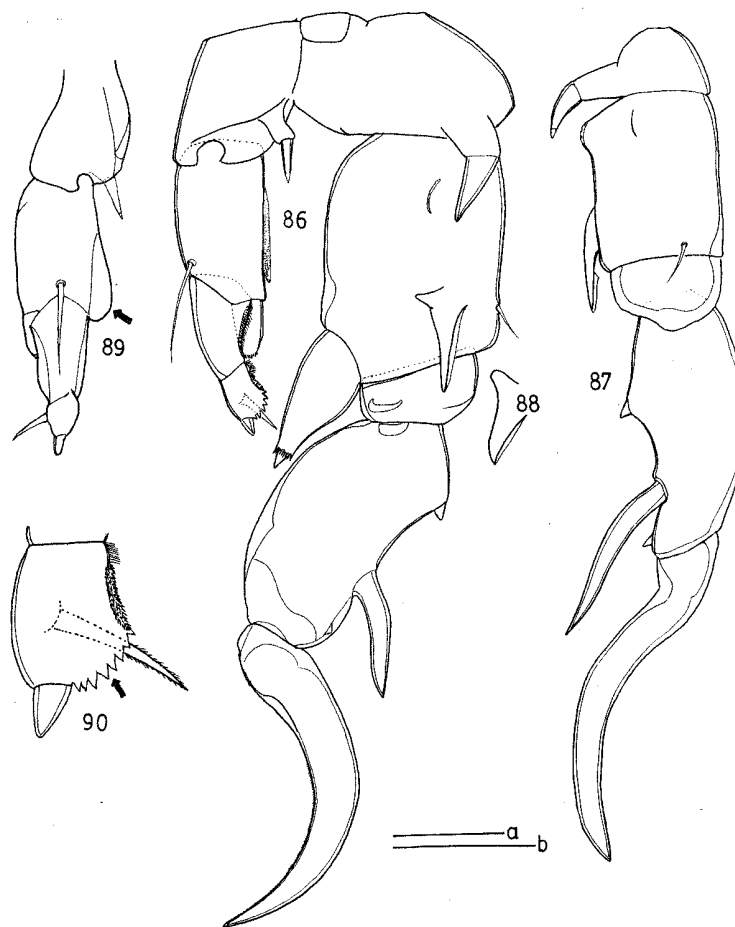


Figures 78–85. *Allodiptomus calcarus* Shen & Tai, 1965. Male. 78, pedigers 4, 5 and urosome, dorsal; 79, same (without anal somite and caudal rami), lateral; 80, right caudal ramus, lateral; 81, same, ventral; 82, rostral spines, lateral; 83, right antennule, segments 8–16; 84, 85, same, spinous process on antepenultimate segment. Scale a, Figure 78; scale b, Figure 79; scale c, Figure 83; scale d, Figures 80–82, 84, 85; scale bars = 50 μ m.

Adult female (Figures 64–77, 91, 92)

Total length exclusive of caudal setae 1.17–1.39 mm, mean 1.25 mm ($n = 25$). Rostral spines (Figure 68) moderately strong. Fourth pediger with chitinous ridge on middorsal surface near proximal septum. Fourth and fifth pedigers fused, but indented laterally; numerous very minute spinules occurring between these segments on dorsal surface; some spinules also seen at posterior border of pedigers 3 and 5; all spinules visible only in SEM (Figure 91). Lateral wings almost symmetrical, narrow, triangular, produced backwards, but barely reaching respective genital spine; right wing occasionally wider than left wing and bilobed (Figure 66); each wing with 1 posterior and 1 inner dorsal spine; posterior spine relatively large. Genital somite

slightly longer than the rest of urosome including caudal rami, asymmetrical, left margin proximally produced into rounded lobe, but straight behind; right margin somewhat convex (Figure 64) or slightly dilated proximally (Figure 66), carrying large, posteriorly bent proximal spine; left side spine small, laterally directed and lying over dorsal aspect of lobe, both spines occurring opposite to each other. Clasping site of genital somite wide, moderately deep, symmetrical and mid-dorsal in position (Figure 91). Relative lengths of urosomites and caudal rami as follows: 58: 8: 16.5: 17.5 = 100. Second urosomite with proximal third telescoped into genital somite and separated from anal somite by weak septum. Anal somite with concave lateral margins. Caudal rami nearly 1.5 times as



Figures 86–90. *Allodiaptomus calcarus* Shen & Tai, 1965. Male. 86, P5, posterior; 87, right P5, lateral; 88, same, spurlike process; 89, left P5, lateral; 90, same, distal exopodite-segment (arrow points to serrate margin). Scale a, Figures 86–89; scale b, Figure 90; scale a = 50 μm , scale b = 25 μm .

long as wide, with hairy outer and inner margins; setae unjointed and somewhat arched; dorsal setae longer than principal setae.

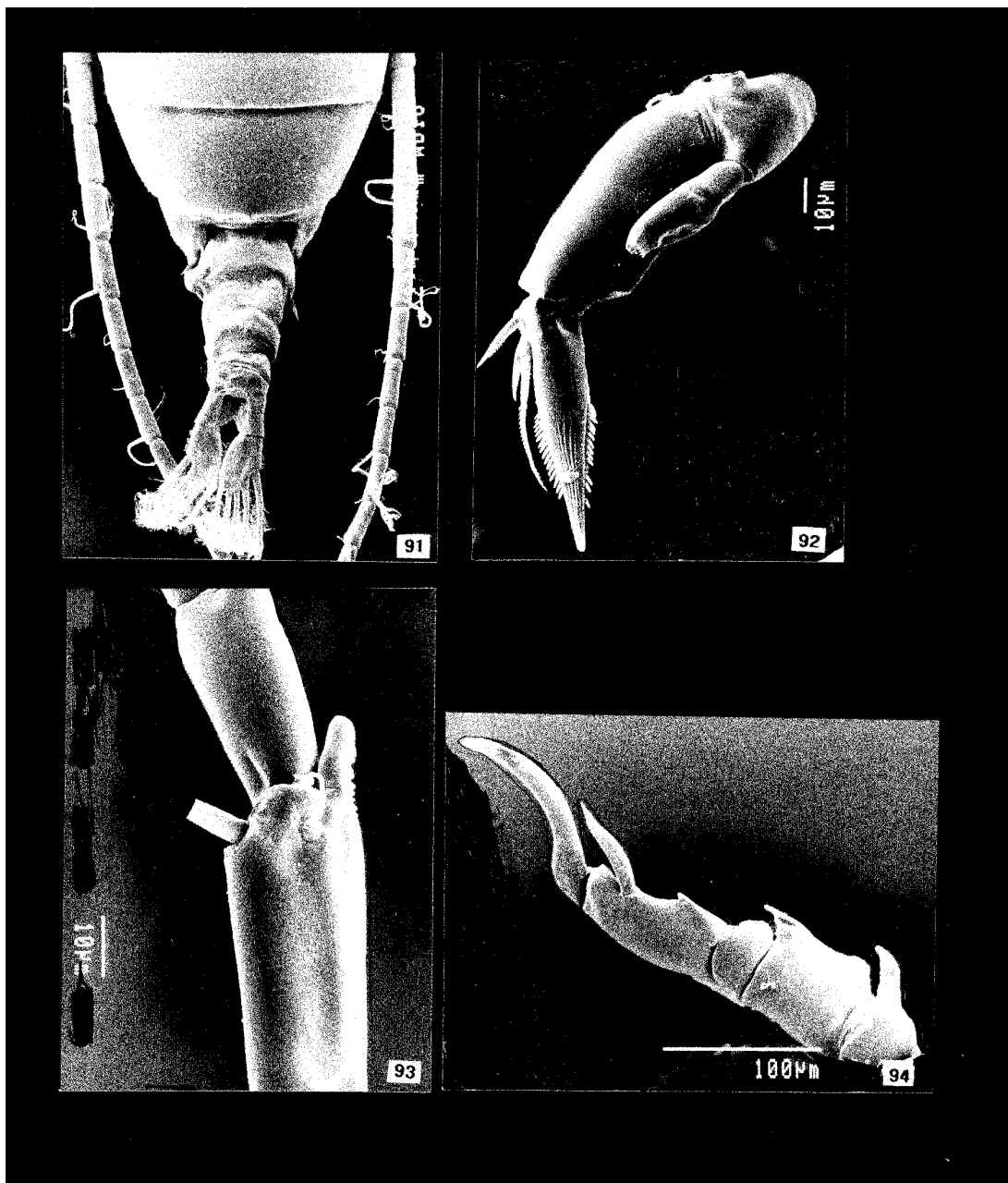
Antennule (Figure 69) 25-segmented, extending up to the end of caudal setae; armature normal.

Other cephalic appendages (no figures) as in *Allodiaptomus intermedius* Reddy (see Reddy, 1987).

P1–P4 (Figures 70–74). P1 typical of subfamily Diaptominae with 1 outer spine on third exopodite-segment. P2–P4 with full complement of 7 setae on third endopodite-segment. Abnormality: Third endopodite-segment of P3 with aberrant structure in one specimen (Figure 71); third exopodite-segment of P4 in another specimen carrying 1 additional spine (Figure 73); entire endopodite of P4 transformed into

unsegmented, branched structure in yet another specimen (Figure 74).

P5 (Figure 75, 76, 92). Coxal spines on both legs equally short, strong and mounted on large, rectangular lobes. Sensory seta on basis reaching about 2/3 distance of outer margin of first exopodite-segment. Lateral spine on second exopodite-segment larger than outer spine on third exopodite-segment. End claw nearly straight, with about 15 spinules each on outer and inner margins; conveyer canal wider anteriorly, subdivided by 3 straight, longitudinal ridges, converging posteriorly. (Figure 92) Third exopodite-segment small but distinct; inner spine setiform and shorter than end claw. Endopodite vaguely 2-segmented and 3/4 as long as inner margin of first exopodite-segment; apex rounded and provided with row of spinules. Abnor-



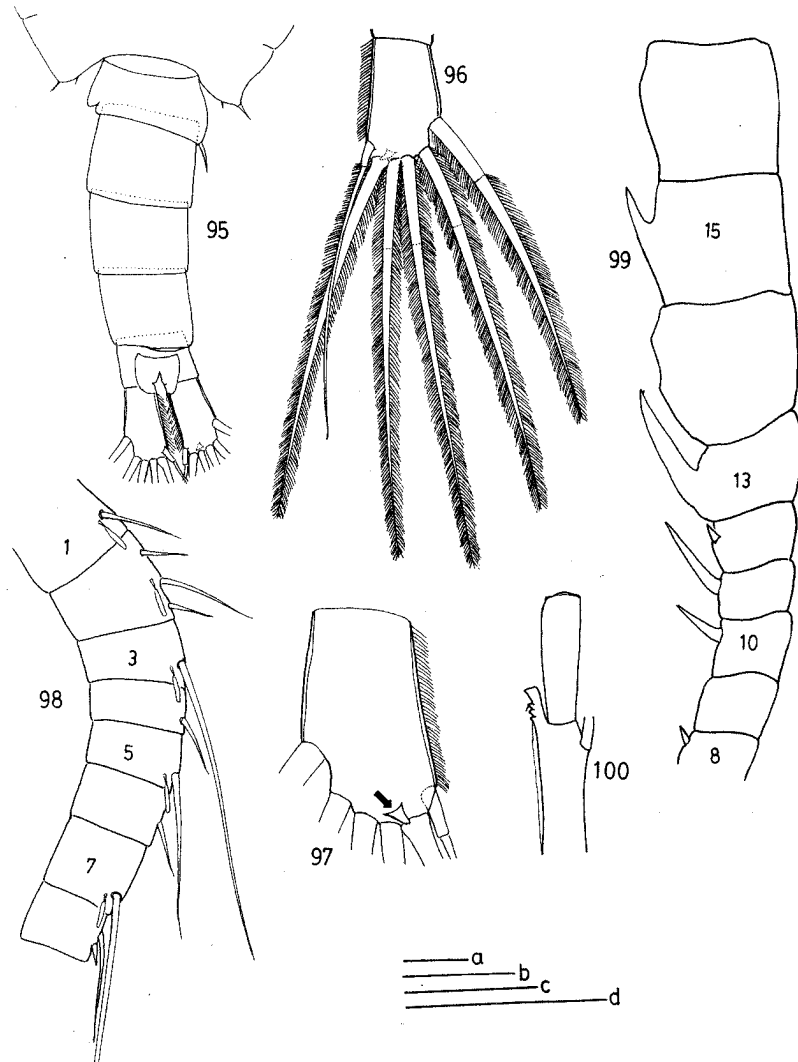
Figures 91–94. SEM of *Allodiaptomus calcarus* Shen & Tai, 1965. Female. 91, pedigers 3–5 and urosome, dorsal; 92, P5, posterolateral. Male. 93, right antennule, spinous process on antepenultimate segment; 94, right P5, lateral.

mality: Endopodite greatly reduced in size and apex without spinules in one specimen (Figure 77).

Adult male (Figures. 78–90, 93, 94)

Total length excluding caudal setae 1.15–1.25 mm, mean 1.21 mm ($n = 24$). Rostral spines (Figure 82) as in female, but slender. Fourth and fifth pedigers

completely separated by septum, bearing extremely fine spinules (not figured). Lateral wings of fifth pediger triangular; right wing larger than left wing and with 1 somewhat strong postero-lateral spine and 1 minute inner spine; spines on left wing much reduced in size. Genital spine slightly larger than postero-lateral spine on right wing. Second and third urosomites with

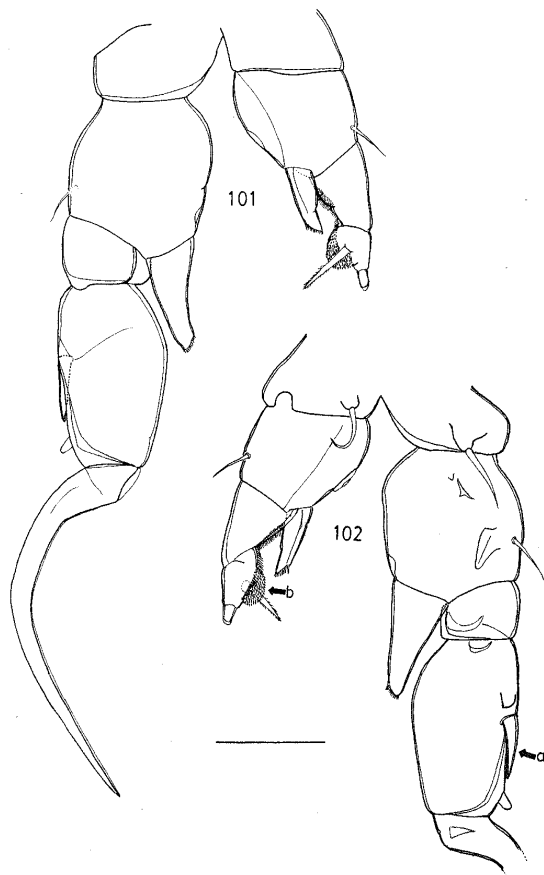


Figures 95–100. *Allodiptomus rarus* n. sp. Male. 95, pedigers 4, 5 and urosome, dorsal; 96, right caudal ramus, dorsal; 97, same, ventral (arrow points to chitinous tooth); 98, left antennule, segments 1–8; 99, right antennule, segments 8–16; 100, same, comb on antepenultimate segment. Scale a, Figure 95; scale b, Figures 96, 98; scale c, Figure 100; scale d, Figure 97; scale bars = 50 μ m.

relatively long hair-like setae on ventral margin (Figure 79). Caudal rami asymmetrical, right ramus slightly longer than left ramus, either ramus about twice as long as wide and with delicate hairs on inner margin. Right ramus (Figure 81) armed with 2 dissimilar, chitinous teeth: 1 small tooth, projecting laterally from proximal inner margin, and 1 large tooth, lying at proximal inner corner on dorsal surface and arising from lobed structure, clearly visible only in lateral view (Figure 80). Setae on either ramus slender, proximally jointed and straight, lateral seta unmodified; dorsal seta shorter than principal setae.

Right antennule (Figures 83, 93) with spine on segments 8 and 10–16, spine on segment 8 rudimentary like that on segment 12, spine on segment 11 sharply bent backward and as long as that on segment 10; relative lengths of all spines in descending order as follows: $13 > 11 > (\text{or } =) 10 > 14 > 15 > 16 > 8 = 12$; spinous process on antepenultimate segment short, comb-like, with 4–7 teeth, below which the segment is fringed with narrow hyaline membrane.

Right P5 (Figures 86–88, 94). Coxa much wider than long and without any outgrowth at distal inner corner; spine large, arising from rectangular lobe at distal



Figures 101,102. *Allodiaptomus rarus* n. sp. Male. 101, P5, anterior; 102, same, posterior (arrow a points to short lateral spine on second exopodite-segment of right P5; arrow b points to crescentic lobe on second exopodite-segment of left P5). Scale bar = 50 μ m.

outer corner on caudal surface. Basis sturdy, rectangular in outline, about 1.3 times as long as wide and with prominent 'spur-like process' near distal outer corner; spur slightly variable and fringed with hyaline lamella on outer margin; small arc of chitinous ridge occurring at about the middle of proximal half in line with spur; inner margin without any hyaline structure, but with short rounded prominence proximally in lateral angle (Figure 87); sensory seta at distomedial corner short. First exopodite-segment rather small, shorter than its own width and unproduced at distal outer corner. Second segment almost twice as long as its median width, outer margin nearly concave, inner margin convex; principal lateral spine strong, half as long as its segment, bent toward posterolateral direction, and located distal to middle of outer margin of the segment; proximal spine denticle-like, only slightly chitinized and

arising from basal 1/3 of outer margin; distal spine smaller than proximal spine and arising from caudal surface close to outer margin (Figure 86). End claw unusually thick, short and sickle-shaped, inner margin finely serrulate. Endopodite conical, surpassing proximal third of inner margin of second exopodite-segment, tip pointed, with subapical row of spinules.

Left P5 (Figures 86, 89, 90) reaching distal border of first exopodite-segment of right P5. Coxa longer than wide and with relatively slender spine, mounted on a lobe, lying at distal inner corner. Basis rectangular, nearly twice as long as wide; inner margin, barring short distance on either end, fringed with narrow hyaline lamella, and somewhat dilated distally in lateral angle (Figure 89); sensory seta longer than its counterpart on right leg. First exopodite-segment over twice as long as second segment and with hairy lobe near inner margin. Second segment nearly oval; inner margin highly differentiated – proximal corner hairy, beyond which is a field of spinules, distal half serrate, consisting of about 8 small teeth, median ones relatively large. Apical thumb and inner seta of second exopodite-segment of moderate size.

Remarks

Most of the conventional characters concerning the habitus and the fifth pair of legs in both sexes, and also the grasping antennule of *A. calcarus* were fairly accurately depicted by Shen & Tai (1965). Strangely, however, this species has not yet been correctly identified by any of the later workers. In the monograph on Fauna Sinica, Shen & Song (1979) just included a brief diagnosis and some figures of *A. calcarus*, taking them directly from Shen & Tai's (1965) original account.

The present specimens accord with Shen & Tai's (1965) brief original account of *A. calcarus* in all essential details. Among the additional details observed by us, the following are diagnostic of the species:

- i. The female genital somite has a small rounded lobe on its left margin.
- ii. The second and third urosomites in male are provided with hair-like ventral setae.
- iii. The male right caudal ramus has not one, but two dissimilar, chitinous teeth, the larger proximal one arising from a lobed structure at the inner corner.
- iv. The basis of left P5 is dilated at distal outer corner and its inner margin has an elongate hyaline lamella.
- v. The second exopodite-segment of the left P5 in male has serrate inner margin, a unique structure,

possibly suggesting a queer affinity to the genus *Tropodiptomus* Kiefer.

As already mentioned, *A. calcarus* is a little known species in the literature. The reason is not its rare occurrence, but misidentification. A perusal of the existing literature on the Southeast Asian diptomids shows that on several occasions *A. calcarus* has been confused with the Javan *Neodiptomus mephistopheles* Brehm, 1933. The confusion began with Lai & Fernando (1978b), who, with no knowledge of *A. calcarus* from China, assigned their Malaysian material to *N. mephistopheles*, despite obvious discrepancies. A close look at the brief description and illustrations given by them leaves no one in doubt that what they dealt with was in fact *A. calcarus*, and not *N. mephistopheles*. For example, as to the all-important male, the peculiarly armed right caudal ramus, the short comb on the grasping antennule, the distinctive features of the right P5 such as the strong coxal spine, the spur on the basis, the unproduced first exopodite-segment, the thick distal lateral spine on the second segment, the stout and short end claw, and on the left P5, the serrate inner margin ('saw-like blade') of the second exopodite-segment are all typical of *A. calcarus*. Similarly, even the much incomplete picture of the female also shows for *A. calcarus* the diagnostic short and thick coxal spines, arising from prominent lobes on P5.

On the other hand, *N. mephistopheles*, for which no authentic record exists since its erection over 60 years ago, has a distinct protuberance on the male penultimate urosomite. The comb on the grasping antennule is relatively long. On the male right P5, the coxal spine is slender, the basis has a hyaline lamella on inner margin, the first exopodite-segment is produced into short spinous process at the distal corner, and the second exopodite-segment has a slender lateral spine and a short spinous projection at the middle as well as at the distal angle of outer margin. The left P5 possesses an unusually long coxal seta, a hyaline lobe on the basis and non-serrate inner margin on the second exopodite-segment. None of these characters show any overlap between the two species, and *N. mephistopheles* has so far been known as a Javan endemic.

That Lai & Fernando clearly and consistently mistook *A. calcarus* for *N. mephistopheles* is also borne out by their subsequent papers of 1980 and 1981, which carry short diagnosis and/or figures under the same name, *N. mephistopheles*. It seems extremely likely that an identical error has crept into the reported occurrence of the so-called *N. mephistopheles* from Thailand

by Bricker et al. (1978) and Boonsom (1984), and West Java by Lai (1986) as well.

Ecology and distribution

A. calcarus occurs in both stagnant waters such as ponds and slow-flowing canals and rivers. It was first discovered in Kwangsi and Kwangtung Provinces of China. Under the false name, *Neodiptomus mephistopheles*, it was subsequently reported by several workers from Thailand, Malaysia, and West Java (see above). It appears to be one of the most common diptomids in Thailand. In the sample under study, this taxon was found in great abundance, with *Eodiptomus sanoamuangae* Reddy & Dumont as strays.

Allodiptomus rarus n. sp. (Figures 95–102)

Locality and material examined

Unspecified freshwater body in Thailand. Only one male, whose right antennule and P5 were dissected, mounted in glycerol on a single slide, designated the holotype and deposited in the British Museum (Natural History), London, under the registration number 1995.941.

Diagnosis

Male. Fourth and fifth pedigers fused except at lateral margins. Spine on genital somite barely half as long as next urosomite. Caudal rami nearly twice as long as wide; right ramus armed with small chitinous tooth on ventral aspect; lateral caudal seta unmodified. Right antennule without spine on segments 14 and 16; comb on antepenultimate segment small. Right P5: Coxal spine setiform, basis with small chitinous peg on caudal plane near outer distal corner, and without hyaline lamella on inner margin; on second exopodite-segment, principal lateral spine short, closely adpressed to margin and arising from posterior face, proximal to the middle of outer margin; a flat hyaline lobe lying just below the base of principal spine; accessory spine short and located distally near end claw. Endopodite conical and sturdy. Left P5: Coxa with setiform spine. Basis without hyaline lamella on inner margin. Second exopodite-segment with highly characteristic spinulose, crescentic lobe on inner side. Apical process short, slender and digitiform. Seta small and spiniform. Endopodite small and nearly cylindrical.

Female not known.

Adult male (Figures 95–102)

Total length exclusive of caudal setae c. 1.15 mm. Fourth and fifth pedigers fused together, except at lateral margins. Lateral wings of fifth pediger moderate in size, almost triangular, right wing larger than left wing and with lateral spine and inner sensillum; left wing with 2 unequal sensilla.

Urosome of 5 somites and slightly bent to right side. Genital somite widest, right distal corner with small spine, barely half as long as succeeding somite. Ventral hair-like setae on second and third urosomites not clearly visible. Fourth urosomite only slightly asymmetrical. Caudal rami symmetrical, nearly twice as long as wide, with hairy inner margins; right ramus with small chitinous tooth on ventral aspect near the base of inner seta. Lateral caudal setae only slightly stouter than others; innermost seta with slightly dilated base; all setae except the innermost one vaguely jointed proximally; dorsal, jointed seta shorter than principal setae.

Right antennule (Figures 99, 100). Setation normal; spine on segments 8, 10–13 and 15; spine on segment 13 largest, bent over next segment and with incised tip; spine on segment 12 rudimentary like that on 8; relative lengths of all spines in decreasing order as follows: $13 > 11 > 10 > 15 > 8 = 12$; spinous process on antepenultimate segment fringed with narrow hyaline membrane. Armature of proximal segments of left antennule as in Figure 98.

Right P5 (Figures 101, 102). Coxa unproduced at distal inner corner; spine setiform, moderately large and arising from small hyaline lobe near distal border on caudal surface. Basis somewhat squarish; caudal surface with short, blunt chitinous peg near the base of short, distomedial sensory seta, and 2 small, asymmetric chitinous projections at about the middle of proximal half; inner margin without any hyaline structure. First exopodite-segment wider than long and unproduced at distal outer corner. Second segment elongately oval, 1.7 times as long as maximum width, outer margin almost straight, inner margin convex; principal lateral spine short, pointed, closely adpressed to the margin and articulated not to margin but to caudal surface, somewhat proximal to the middle of outer margin; rounded hyaline lobe of moderate size occurring near the base of principal seta on caudal plane; accessory spine short, blunt, hyaline and located distally near end claw. End claw slender, 1.4 times as long as exopodite; proximal half smoothly curved; distal half nearly straight and gradually tapering to acuminate tip;

inner margin covered with narrow hyaline membrane. Endopodite sturdy, roughly conical, surpassing proximal third of second exopodite-segment, inner apical region with a row spinules, and a minute inner spine subapically.

Left P5 (Figures 101, 102) reaching proximal third of second exopodite-segment of right P5. Coxa squarish, armed with long, slender setiform spine, arising from small hyaline lobe near distal inner corner. Basis stout, shorter than its own width at base, outer margin straight, inner margin proximally swollen and without hyaline outgrowth; sensory seta near distal outer corner small. First exopodite-segment conical and with large hairy lobe near inner margin. Second segment with a highly characteristic spinule-studded crescentic lobe at about the middle of inner margin; proximal inner margin, as usual, with hairy lobe. Apical process short, slender, digitiform and tipped with minute hyaline lobe. Seta small, straight, spiniform and covered with fine spinules. Endopodite nearly cylindrical, reaching crescentic lobe on second exopodite-segment and with oblique row of spinules on apical inner margin and elongate chitinous ridge, parallel to inner margin on posterior surface.

Etymology

The species name *rarus* is an adjective (masculine gender, nominative singular), alluding to the apparent sparseness of the species.

Remarks

For species identification among diaptomids, the adult male is decisive. The lone specimen of the adult male that we discovered was in perfect order for study. A critical examination of its habitus, antennules, and fifth pair of legs has revealed several distinctive features. Our long experience with Asian diaptomids has convinced us beyond doubt that the specimen in question represents a hitherto undescribed species of the genus *Allodiaptomus* Kiefer, named *Allodiaptomus rarus* n. sp.

The new species is placed in the genus *Allodiaptomus*, considering, *inter alia*, the typical armature of the second exopodite-segment of the male right P5. Amongst its seven known congeners (see Reddy, 1994), *A. rarus* n. sp. has closest affinity to *A. calcarus*, as can be easily seen from the chitinous peg (= 'spur') on the basis of the right P5. In both species, the inner margin of the same segment is naked, the grasping antennule has a comb on the antepenultimate segment

and rudimentary spines on the 8th and 12th segments, and the male right caudal ramus is armed, despite differences in armature. Further, the nature of the second exopodite-segment and its associated structures on the male right P5 also bring *A. rarus* n. sp. much closer to *A. calcarus* than to any other congener.

A. rarus n. sp. is, however, distinctly different from *A. calcarus* in various other characters. For example, the 14th and 16th segments of the grasping antennule are unarmed in *A. rarus* n. sp., whereas they are provided with a spiniform process each in *A. calcarus*. The end claw on the male right P5 is relatively much more slender and elongate in *A. rarus* n. sp. Likewise the size and position of the principal spine on the second exopodite-segment, and the shape of the basis as well as the endopodite of the same leg are markedly different between the two taxa. Also, the second exopodite-segment of the male left P5 bears a spinulose crescentic lobe in *A. rarus* n. sp., as opposed to the serrate inner margin in *A. calcarus*.

Heliodiaptomus elegans Kiefer, 1935

Synonymy

Heliodiaptomus elegans: Kiefer, 1935: 91–93, Figures 6–10; Brehm, 1951: 104–105, Figures 18–19; Brehm, 1953: 303; Dussart & Defaye, 1983: 97. Reddy, 1994: 16–18, Figures 78–83.

Locality and material examined

Nong Takai (right), Sakonnakhon Province 7 ♂♂, 16 ♀♀. June 5, 1993. *Watertemp.* 32 °C, pH 7.2, conductivity 90 $\mu\text{S cm}^{-1}$.

Five ♂♂ and 8 ♀♀ from the above locality were deposited in the British Museum (Natural History), London. Registration numbers 1995: 911–920.

Remarks

The specimens perfectly agree with Kiefer's (1935) brief description and figures of *H. elegans* from Myanmar (erstwhile Burma).

It was also recorded from Cambodia (Brehm, 1951) and Bangladesh (Reddy, 1994). This is the first record of *H. elegans* from Thailand. A detailed redescription of this little known species will be published elsewhere.

Acknowledgement

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