

Freshwater Zooplankton of Southeast Asia

by

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During his journey to Southeast Asia in March 1965, Professor Riozo Yosii of Kyoto University collected plankton in some freshwaters of the Philippines, the Malay peninsula and Thailand. Most of those waters are small and shallow, with the exceptions of Lake Taal and Lake Tale Sap. The plankton in March consisted mostly of animals, especially the Cladocera and the Copepoda, and were very poor in algal components. The result of examination will be given in the following pages. The writer's grateful acknowledgement is expressed to Professor Yosii for providing plankton material collected by himself.

List of Localities

A. The Philippines

1. Lake Taal, Luzon; northern basin, 4 March 1965.
2. "Crocodile Lake", a small maar located on the hill near Los Baños, Luzon, 6 March.

B. Malaysia

3. Gopeng, Perak, on the west coast of the Malay peninsula, a pond, 21 March.
4. Sungei Bertena, near Gopeng, an artificially dammed lake, 21 March.
5. Ipoh, Perak, a small pond of the PIMCO (Perak Iron Mining Company) at the foot of a calcareous mountain, 21 March.
6. Chom Sam, near Ipoh, a pisciculture pond, 21 March.
7. Tapah, near Ipoh, a pool at a tin mine, 21 March.
8. Dipang, Perak, a pool, 21 March.
9. Taiping, a small pond in the park of the city, 22 March.

C. Thailand

10. Tale Sap, on the east coast of the Malay peninsula, 31 March.
11. Bangkok, a creek, 9 March.

List of Zooplankton Species

I. Rotatoria

1. *Brachionus quadridentatus* Hermann, — locality no. 9.
2. *B. forficula* Wierzejski, — localities nos. 3, 4 and 9.
3. *B. calyciflorus* Pallas, — loc. nos. 1, 2, and 4.

4. *Keratella valga tropica* (Apstein) (*Keratellaeopsis valga tropica* (Apstein)), — loc. nos. 4 and 9.
5. *Pompholyx complanata* Gosse, — loc. no. 4.
6. *Asplanchna* sp., — loc. no. 10.

II. Cladocera

1. *Latonopsis australis* G. O. Sars, — loc. no. 1.
2. *Diaphanosoma paucispinosum* Brehm, — loc. nos. 7 and 9.
3. *D. sarsi* Richard, — loc. no. 1.
4. *Ceriodaphnia cornuta* G. O. Sars, — loc. nos. 1, 5 and 10.
5. *Moina dubia parva* Rammner, — loc. nos. 1, 3, 5, 8 and 9.
6. *Bosminopsis deitersi* Richard, — loc. nos. 9 and 10.
7. *Alona cambouei* de Guerne and Richard, — loc. nos. 2 and 8.
8. *Chydorus barroisi* (Richard), — loc. no. 9.

III. Copepoda

1. *Neodiaptomus handeli* Brehm, — loc. nos. 3, 4, 5, 6, 7 and 9.
2. *Mesocyclops* cf. *thermocyclopoides* Harada, — loc. nos. 1 and 2.

Characteristics of Plankton

The plankton of two Philippine lakes visited by Yosii differ markedly from those of the waters in the Malay peninsula. In one of the former, Lake Taal in Luzon, the plankton consisted mostly of *Ceriodaphnia cornuta*, with only a few other Cladocera, *Latonopsis australis*, *Diaphanosoma sarsi* and *Moina dubia parva*. Such a disharmonious appearance of plankton with only a few species of animals is probably due to the lake water of high salt content, which is derived from the Taal volcano in the small island amidst the lake¹⁾. In another lake, a small maar popularly known as "Crocodile Lake" on the hill near Los Baños in southeastern Luzon, *Brachionus calyciflorus* was abundant in the plankton, almost devoid of other species.

Various small bodies of water in the Malay peninsula visited by Yosii are located in Perak facing the Straits of Malacca and lie entirely within the equatorial zone²⁾. The zooplankton are by no means uniform throughout these waters, differing from each other in component species. *Neodiaptomus handeli* is the representative species occurring in most of those, with a few individuals of *Moina dubia parva*. A small pond in the park of the city of Taiping was the only locality in which *Keratella valga tropica* and *Chydorus barroisi* were found. In this pond the occurrence of *Chaoborus* larva was noticed. Tale Sap on the east coast of the peninsula (it belongs to Thai-

- 1) The great eruption of the Taal volcano on September 28, 1965, may have brought about a harmful effect on the lake water and plankton. It is probable that the northern basin of the lake visited by Yosii has received less influence than in the southern basin.
- 2) The characteristics of the Malayan freshwater life are summarized by Johnson (1956).

land) is peculiar, its plankton in March being poorly represented by only two Cladocera, *Bosminopsis deitersi* and *Ceriodaphnia cornuta*. It is noted that no species belonging to the genera *Daphnia* and *Bosmina* were found in all the present material.

Notes on Some Species

I. Rotatoria

Brachionus quadridentatus Hermann

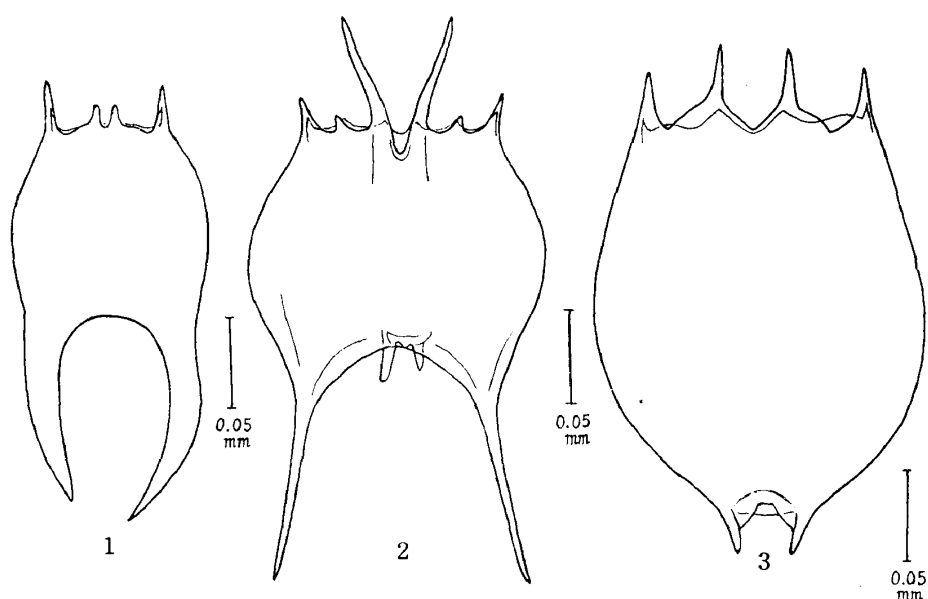
This species occurred in the waters of the Malay peninsula. The median occipital spines are long, divergent and bent downwards at the extremity (Fig. 2). The post-lateral spines are as long as the lorica, slender and divergent.

Brachionus forficula Wierzejski

This species was found in the samples taken from Gopeng, Sungei Bertena and Taiping. Its posterior spines are very stout, a little longer than the lorica, nearly parallel or slightly convergent at their tips, the left usually a little shorter than the right (Fig. 1). There are no knee-like swellings on the inner side near their base. In the shape of the posterior spines, the present specimens may be identical with var. *laevis* Apstein (1907), which was recorded also from the freshwaters of Taiwan (Uéno 1938, p. 138).

Brachionus calyciflorus Pallas

In two Philippine lakes, Lakes Taal and "Crocodile", this species was the only



Figs. 1-3. *Brachionus*

1. *Brachionus forficula* Wierzejski of Sungei Bertena.
2. *Brachionus quadridentatus* Hermann of Taiping.
3. *Brachionus calyciflorus* Pallas of "Crocodile Lake" in Luzon.

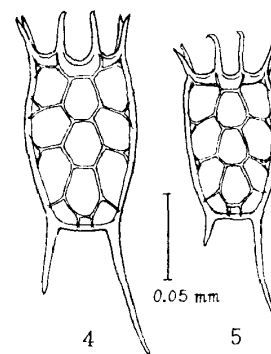
rotifer in the plankton. The short posterior spines are present; the foot-opening wide (Fig. 3). This is the *dorcus* form rather than the *calyciflorus* form.

Keratella valga tropica (Apstein)

This rotifer has long been known as *Keratella valga* Ehrenberg var. *tropica* Apstein (1907). Recently Bérziņš (1955) raised it to the rank of species as *Keratella tropica* by the presence of Ahlstrom's so-called the "post-median remnant" on the dorsal lorica. In *K. valga* the hindmost median hexagonal plate ends directly on the posterior margin of the lorica and is not followed by an additional small quadrate plate as in *K. tropica*. Bérziņš recognized this feature valid as a specific character of *K. tropica* and he was unable to find any transition form from *K. valga* to *K. tropica*. The lorica of *K. tropica* becomes narrow posteriorly, while in *K. valga* it is not markedly narrowed. Suzuki (1964) is of the opinion that the "post-median remnant" is valid only for sub-specific diagnosis, and he distinguished *tropica* as *K. valga tropica* from the typical *K. valga valga*. The relative length of the posterior spines of *K. valga tropica* varies greatly. In the Taiping specimens (Fig. 5) the left is about 1/4 the length of the right, but in the specimens from Sungei Bertena (Fig. 4) the left is half as long as the right.

To separate the species of *Keratella* with two posterior spines from those with only a single posterior spine, like *K. cochlearis*, Suzuki (l. c.) has proposed a new genus *Keratellaeopsis*. According to this taxonomy, the present form is expressed as *Keratellaeopsis valga tropica* (Apstein).

Keratella valga tropica is a representative warm water species in the genus, being distributed rather widely in the inland waters in Asia. In the districts south of Japan, it was known from Taiwan (Uéno 1938) as well as Kita-daitojima, one of the Borodino Islands, ca. 240 km east of the Island of Okinawa (Uéno 1937).



Figs. 4-5.

Keratella valga tropica (Apstein)

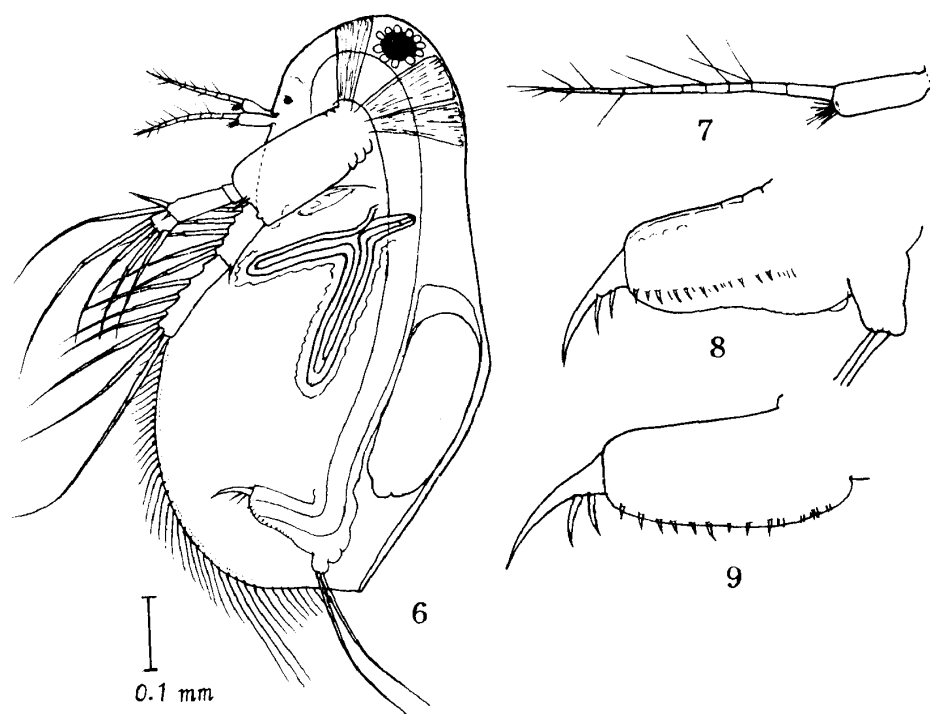
4. A specimen from Sungei Bertena.
5. A specimen from Taiping.

II. Cladocera

Latonopsis australis G. O. Sars

In the plankton of Lake Taal in Luzon, a few specimens of this species were found. It was already recorded by Brehm (1938) from the same lake and Balut.

The head is large, without a distinct rostrum; the eye is located in the dorsal part of the head (Fig. 6). The flagellum of the antennule (Fig. 7) is about three times as long as the basal part, distinctly articulated into more than 10 joints and with long hairs. The ventral margins of the shell are fringed with numerous long and movable setae, three of which, on the post-ventral corner of each valve, are especially long, but



Figs. 6-9. *Latonopsis australis* G. O. Sars

6. A female, in lateral aspect, of Taal Lake in Luzon.
7. Antennule of female. 8.-9. Post-abdomen of female.

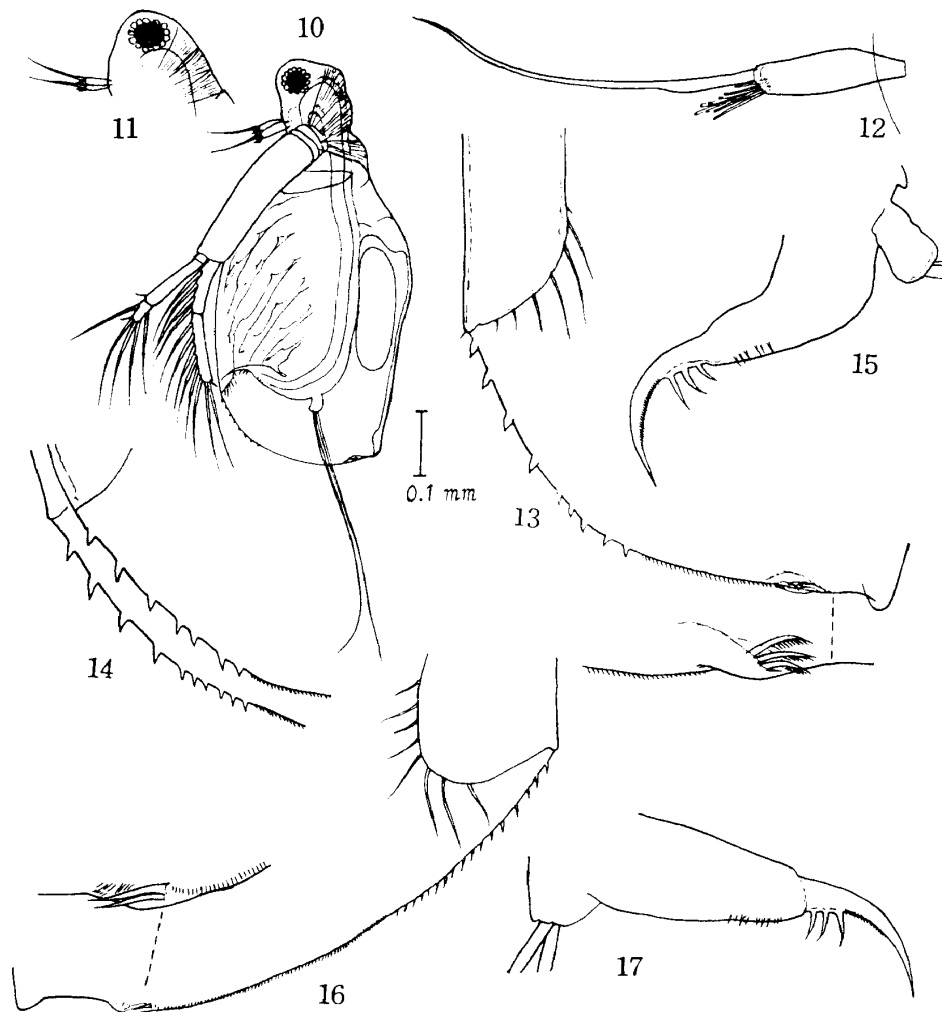
are not so elongated as in Sars' original description and figure (Sars 1888, p. 9, pl. 1, fig. 2). The form of the shell-gland is characteristic of this species; its posterior branch is, however, not so long as in the type specimen, in which it extends beyond the middle of the valve (Fig. 6). The post-abdomen is small; marginal spines 9-10 on each side or near the dorsal margin (Figs. 8 and 9). The claws are large and curved, with two basal spines.

This tropical species which was first described from Queensland, Australia, is distributed beyond the equator as north as Central China (Uéno 1944, p. 405, Mashiko 1953, p. 52). Rammner's (1937) specimens of this species from Pandjaloë in Java have also the typical characters of the species. Recently Harding and Petkovski (1963) found this species in a rice field near Vinica, eastern Macedonia, Yugoslavia, and discussed its synonymy and distribution.

Diaphanosoma paucispinosum Brehm

In the plankton of Taiping and Tapah in the Malay peninsula some individuals of this species were found. The head is quadrate (Fig. 10), often rounded (Fig. 11), the eye comparatively small. The flagellum of the antennule is a little longer than twice the length of the basal segment (Fig. 12); in the specimens from Ranu Pakis (Brehm 1933) it is twice as long as the basal segment. The ventral margin of each valve has an inner duplicature which is fringed with 6-7 ciliated setae. The free margin

posterior to this duplicative part is armed with 7-9 denticles, succeeded by fine spines (Fig. 13). In one female specimen, the number of such denticles is 7 on the left valve and 10 on the right (Fig. 14). In most of specimens, however, the first four denticles are larger than the remaining smaller 3-6. Brehm (1933) has pointed out that such denticles fluctuate in number from 5-6 in the populations of Ranu Pakis and Tjigombong, Java, and 4-6 in the population of Telaga Pasir of the same island. In the Taipung specimens, four such denticles succeeded by 3-6 smaller ones seem to be fundamental to the species, as Brehm (l. c.) has given in his original diagnosis as "am Schalenrand weniger als 10 Dornen." Inside the posterior margin near the junction of both valves,



Figs. 10-15. *Diaphanosoma paucispinosum* Brehm

10. A female from Taipung. 11. Head of a female from the same locality.
12. Antennule. 13. Ventral and posterior margin of the valve.
14. Parts of the ventral margins of both valves of another specimen.
15. Post-abdomen.

Figs. 16-17. *Diaphanosoma sarsi* Richard, female, from Lake Taal

16. Ventral margin of the valve. 17. Post-abdomen.

there are present a group of three ciliated spines (Fig. 13). The post-abdomen is slender; the claws large and curved, with three long basal spines and fine spinules on the inner margin.

Diaphanosoma paucispinosum was first described by Brehm (1933, p. 656, pl. 80, figs. 17-19) from Java. It is also recorded from Cambodia (Brehm 1954).

Diaphanosoma sarsi Richard

This species was found in the plankton taken from the northern basin of Lake Taal. The eye is large, filling the head end. The ventral margin of each valve forms an inner duplicature, with about 8 ciliated setae; the free margin posterior to the duplicative part is armed with about 17 denticles, succeeded by a row of spinules continuing to the posterior margin (Fig. 16). Two ciliated spines are present inside the posterior margin near the junction of both valves. The post-abdomen is narrowed towards the claws which have three long basal spines (Fig. 17); marginal spines 6-7.

This species was first described by Sars (1888, p. 6-15, pl. 1) from Australia and is widely distributed in the tropical and subtropical fresh waters in both the hemispheres, i. e. New Caledonia, New Hebrides, Africa, South America, and so on. In Southeast Asia its occurrence is known in Sumatra, Java, Celebes, New Guinea, etc. In the collection of the Wallacea-Expedition by R. Woltereck, Brehm (1938) found it in Lake Taal as well as in the five other localities including Lakes Dolores and Crater in the Philippine Islands. Johnson's recent article (Johnson 1956) gives its occurrence in Lake Toba of North Sumatra.

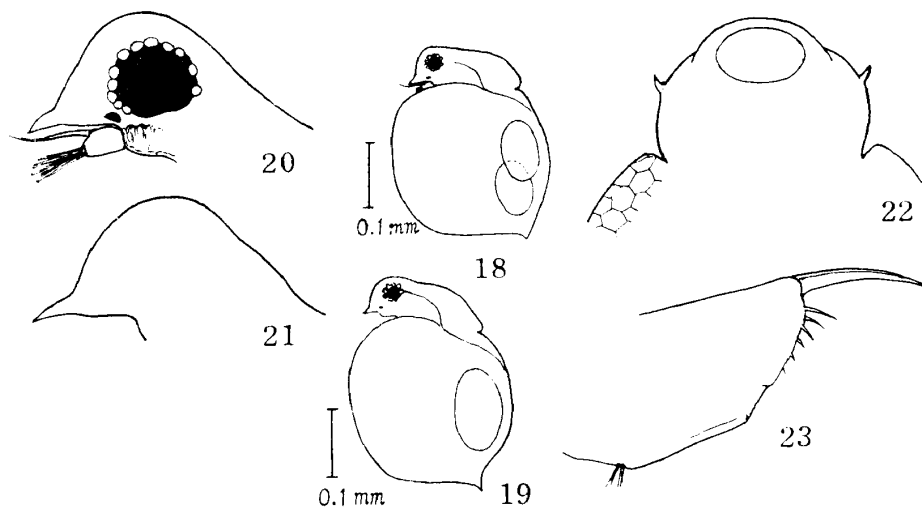
Besides *Diaphanosoma paucispinosum* and *D. sarsi*, the following five species of this genus have been recorded from Southeast Asia: *Diaphanosoma excisum* Sars, *D. singalense* Daday, *D. modigliani* Richard, *D. perarmatum* Brehm and *D. senegal* Gauthier (= *D. hydrocephalus* Brehm, 1952).

Ceriodaphnia cornuta G. O. Sars

Ceriodaphnia cornuta was the dominant Cladocera in the plankton of Lake Taal early in March (Figs. 18 and 19). It is characterized by its accute rostrum and the presence of a pointed process on the fornices (Figs. 20, 21 and 22). Examination of a great number of specimens revealed that they had no horn at the vertex of the head. This led the writer to feel hesitation to identify the Taal specimens with *Ceriodaphnia rigaudi* Richard which has a similar distribution to *C. cornuta* Sars. The validity of *C. rigaudi* and *C. cornuta* whether a distinct two species or not has been discussed by many authors since Stingelin (1904, p. 578) and Daday (1905, p. 206). Most of these authors have recognized both species, while saying *C. rigaudi* and *C. cornuta* are to be difficult to separate into two different species. Now the writer agrees with Rzóška's opinion (Rzóška 1956, p. 505) that both species form a single variable species and must bear the name *Ceriodaphnia cornuta* Sars (1885) which is prior to *C. rigaudi*

Richard (1894).

According to the writer's earlier observations in the Kyoto region (Uéno 1929, 1932), the species that the writer referred to *C. rigaudi* occurred during the summer and autumnal seasons, lasting from June till the end of November. Both the males and the females with ephippia were found in October. It was noticed that a great number of individuals in July possessed a horn at the vertex as well as on the dorsal side of the head. They had, however, no pointed process on the fornices and no bifid ending of the shell. On account of these results, the writer (Uéno 1930, p. 247) agreed in Bär's opinion (Bär 1924, p. 99) that *C. cornuta* was probably a local variation of *C. rigaudi* rather than Daday's view (1910, p. 144) that *C. rigaudi* was nothing but a variety of *C. cornuta* (cf. also Jenkin 1934, p. 147, footnote). Having examined a series of plankton from Lake Bagendit, Java, Rammner (1937) found that there occurred a great number of *Ceriodaphnia rigaudi*, of which a number of individuals possessed a horn on the head (*C. cornuta*). The head horn was the longest in January and was quite absent in immature animals. The results show that temporal variations occur in the tropical Cladocera, too. Rammner's observations are useful, though he did not determine his specimens whether they were two different species, *C. rigaudi* and *C. cornuta*, or not. As stated above, Rzöska's careful observations on fifteen populations of *Ceriodaphnia* in the plankton of the Nile system have drawn the conclusion that *C. rigaudi* must be regarded as a synonym of *C. cornuta*.



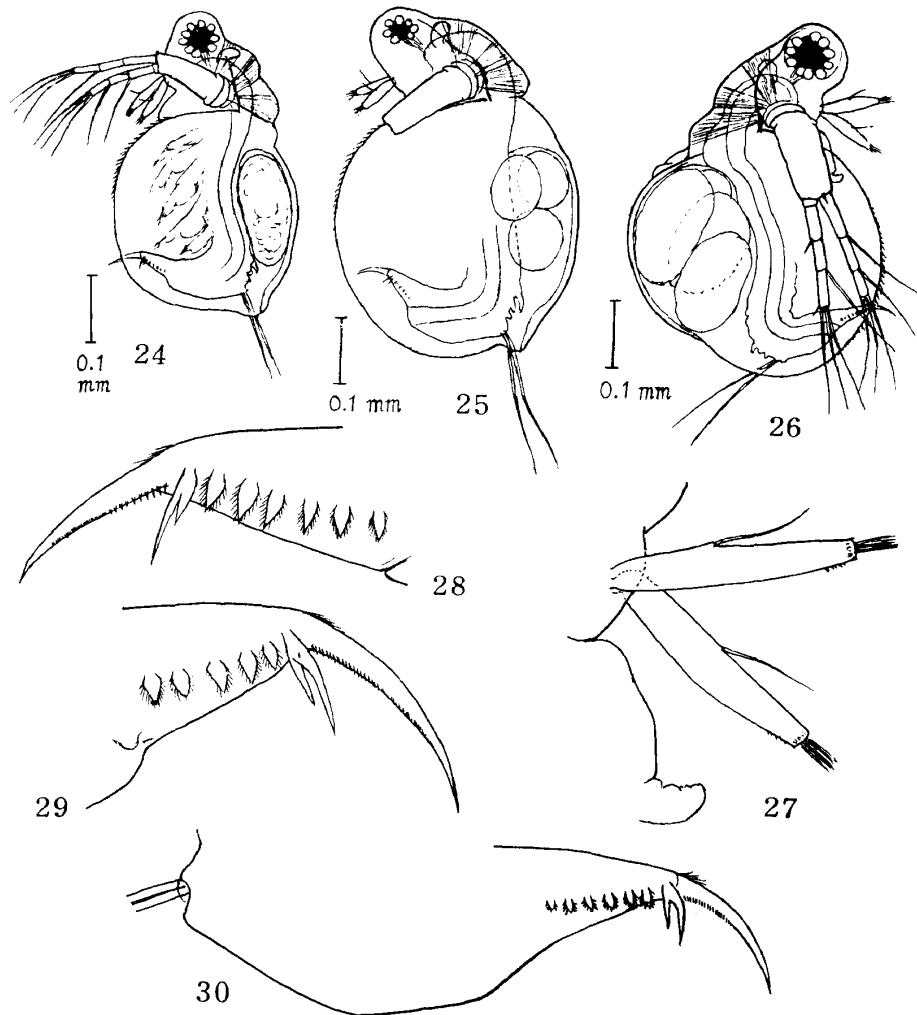
Figs. 18-23. *Ceriodaphnia cornuta* G. O. Sars

18-19. Females from Lake Taal. 20-21. Head in profile.
23. Head in dorsal aspect. 24. Post-abdomen.

Moina dubia parva Rammner

The female specimens of *Moina* found in the plankton from Taiping and Dipang in Perak agree with Rammner's description (1931, p. 631) of his variety *parva* in most

characters. A small species with transparent shell. The head is semierect and its position varies between Guerne and Richard's type of *M. dubia* (1892, p. 327, fig. 1) and Rammner's var. *parva* (1931, p. 632, fig. 5). The eye is rather small in Guerne and Richard's type as well as in Rammner's *parva* (cf. also Jenkin 1934, p. 152). In the present specimens, however, the eye is comparatively large with about 10 large lenses and is situated in the middle of the frontal part of the head (Figs. 24 and 25). One female specimen from Dipang has especially large eye and its head is long in proportion of the shell (Fig. 26). The antennules vary in length, shorter in the Gopeng specimens and much longer in the Dipang ones (Fig. 27). They are slightly dilated in the middle, where a long seta is inseted; on the side present sparse fine hairs which form usually a row.



Figs. 24-30. *Moina dubia parva* Rammner

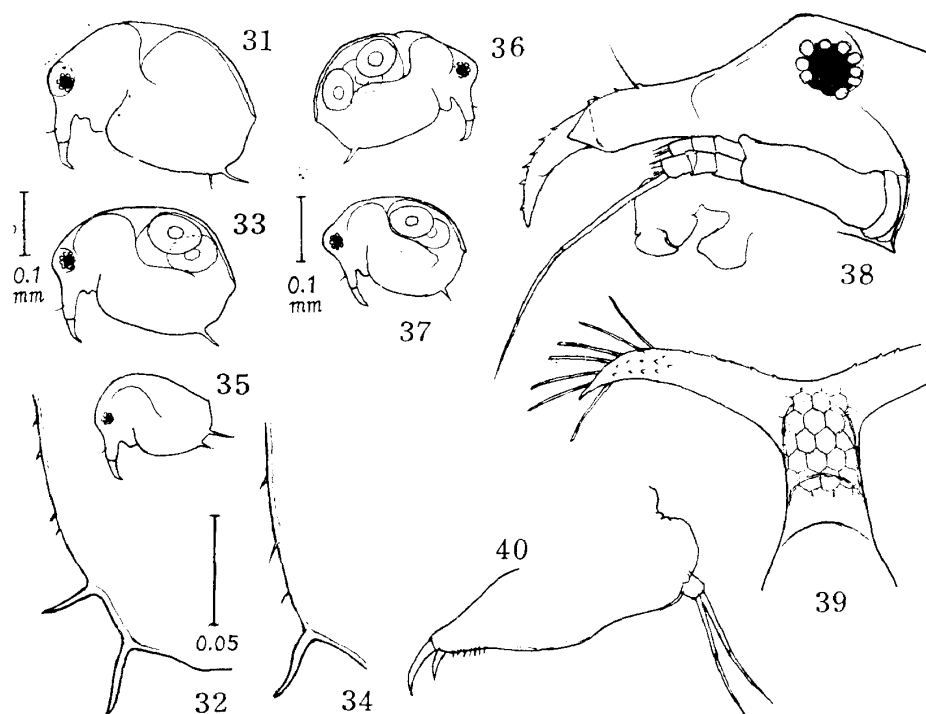
24. A female from Gopeng. 25. A female from Taiping. 26. A female from Dipang. 27. Female antennules, Dipang specimen. 28. Post-abdomen of a female from Taiping. 29. Post-abdomen of a female from Dipang. 30. Another example from the same.

The ventral margin of each valve is armed with short bristles which are replaced posteriorly by fine ciliation. There is no sharp indentation between the anus and the tapered post-anal part, as in Guerne and Richard's type (1892, p. 328, Fig. 2). The claws are long and have a comb at the basal $2/5$ and very fine ciliation extending to the tip. The forked spine at each side of the post-abdomen is long and the accompanied feathered setae vary from 5 to 6 in number (Figs. 28-30).

This species is distributed in Africa, Australia and Java. It will probably be found everywhere in Southeast Asia. Its occurrence in Leipzig, Germany, is a peculiar example.

Bosminopsis deitersi Richard

This species was common in the plankton of Taiping. A few specimens were also found in the plankton of Tale Sap. The free margins of the shell have a mucro-like slender process at the post-ventral corner and 2-3 spinules before it (Fig. 34). Such spinules give place to slender processes in immature individuals. The Taiping specimens are peculiar in having one more shorter process before the mucro-like process even in adult (Figs. 31 and 32). The post-abdomen bears about 7 small spines on the post-anal edge (Fig. 40); the claw with a large basal spine. The Tale Sap specimens



Figs. 31-40. *Bosminopsis deitersi* Richard

31-35. Females from Taiping. 32. Post-ventral margin of the valve of a large female. 34. The same of a primipara. 38. Head, in profile. 39. Antennules in dorsal aspect. 40. Post-abdomen. 36-37. Females from Tale Sap.

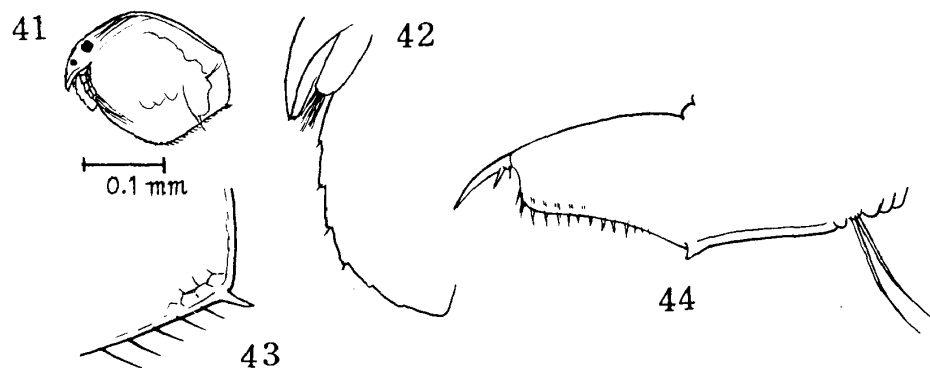
(Figs. 36 and 37) are much smaller than those from Taiping (Figs. 31, 33 and 35). The number of eggs in the brood-pouch is usually one or two.

Woltereck's Wallacea-Expedition collected this species from several localities in the Philippine Islands, i. e. two reservoirs near Manila as well as Lakes Lanao, Dapao and Uyaän in the Island of Mindoro (Aurich 1934, p. 72). This species was not found in the present material of Lake Taal. Outside Asia, *Bosminopsis deitersi* is known to occur in Africa, North and South America. In the Japanese Islands, it is distributed as far north as the southern part of Hokkaido. Aurich (l. c.) noticed that the specimens from Lake Kizaki-ko (Central Japan), supplied by the present writer to Professor Woltereck, did not differ essentially from those of the Philippines. He (l. c., p. 70 ff.) has also pointed out that the differentiation of *Bosminopsis deitersi* in Eurasia is very slight, i. e. it is an "oligotypische Form". Although three forms, *ishikawai* Klocke, *pernodei* Burckhardt and *klockei* Burckhardt, have been distinguished, they are local forms of a single species *B. deitersi*.

Chydorus barroisi (Richard)

A few specimens of this species were found in the Taiping sample. They are markedly small, not exceeding 0.2 mm in length. The post-ventral corner of the valve is produced into a small tooth-like projection (Fig. 43). The labrum has 4 (or 5) serrations on the frontal edge (Fig. 42). The ocellus is smaller than the eye. The supra-anal angle of the post-abdomen is prominent; marginal denticles about 11, three of which, near the anus, are longer than the middle ones. There are present a few groups of fine lateral setae, too. The claws bear two unequal spines at their base.

Brehm (1933) recorded this species from Java and Sumatra. Besides Southeast Asia, it is known from South America, Africa and certain other places. Rammner (1937) also found it in Java, and Johnson (1956) recorded it from the area of Lake Toba of North Sumatra. The so-called *barroisi* group of the genus *Chydorus* (Brehm



Figs. 41-44. *Chydorus barroisi* (Richard) from Taiping

41. A female in lateral aspect. 42. Labrum. 43. Post-ventral margin of the valve. 44. Post-abdomen.

1933), which comprises the species of having a small projection or serrations on the frontal edge of the labrum, is mainly distributed in South America. *Chydorus barroisi* is the only exception among them. It is also found in the tropical and subtropical fresh waters other than South America.

III. Copepoda

Neodiaptomus handeli Brehm

The calanoid copepod found in many waters of the Malay peninsula visited by Yosii is identical with *Neodiaptomus handeli* by the following features: 1) The antepenultimate segment of the male right antenna is produced into a smooth process, 2) the male right fifth leg has a hyaline lamella of two lobes on the basal segment, 3) the long and ciliated terminal claw, and 4) the endopod of the male fifth leg is brush-like at its apex.

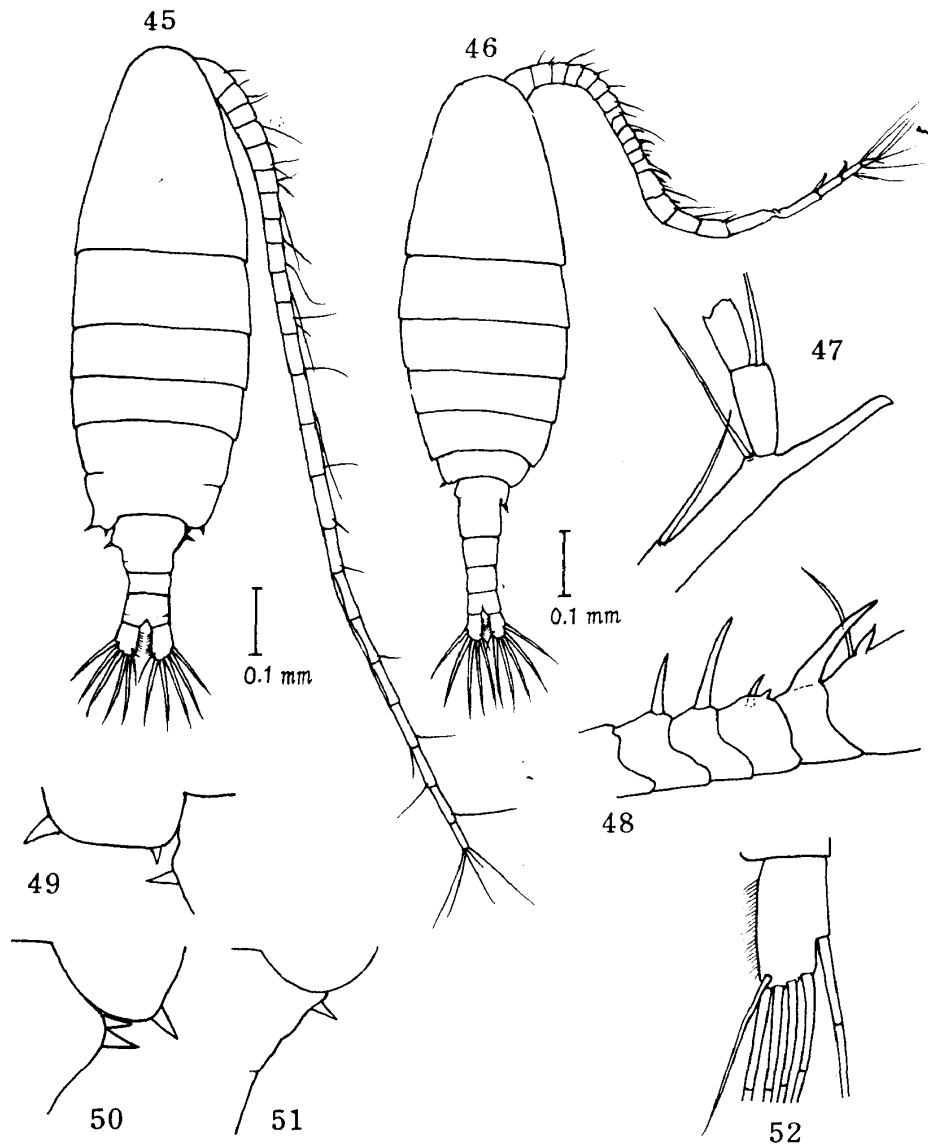
The last thoracic segment of the female is somewhat asymmetrical (Fig. 45). Its left side (Fig. 49) is expanded, armed with two small teeth, but the right side (Figs. 50 and 51) is less expanded, with one or rarely two teeth. The first, or genital, segment of the abdomen bears a short spine on the left and one or two on the right (Figs. 49, 50 and 51). The antennae extend far beyond the furcal end. The male right antenna is not much expanded in the middle segments; a spine arrangement is as shown in Fig. 48; the antepenultimate segment is produced into a smooth and somewhat halberd-like process (Fig. 47). The furcal rami are fringed with hairs on the inner side (Fig. 52).

The basal segment of the male right fifth leg bears a small hyaline lamella composed of two lobes, one of which is shorter than the other (Figs. 53, 54 and 55); a semi-circular chitinous lamella with an apical seta is present exterior to the hyaline lamella and on the basal segment of the left leg facing the right leg. The terminal claw is long and sickle-shaped, ciliated on the inner margin (Fig. 53). The endopod of the left leg is brush-like at its apex with 4-5 fine setae (Fig. 53).

The female fifth leg bears a big tooth on the external face of its basal segment (Figs. 56-58). The endopod is nearly as long as the first segment of the exopod, pointed, with a small spine on the inner side of the ciliated extremity. The claw has 8-10 conspicuous jags on the inner margin, the third segment small, with two or rarely three spines (Figs. 56-59).

Length: female, up to 1.3mm, male 1.0 mm in the Dipang specimens; the Gopeng specimens are the smallest, not exceeding 1.0 mm in the female.

Neodiaptomus handeli Brehm was first described from Southwestern Szetschwan in the middle course of the Yangtse river, and was later from East Siberia (Rylov 1925) and Manchuria (Kikuchi 1940). In the original locality, Lake Ningyüen, at an altitude



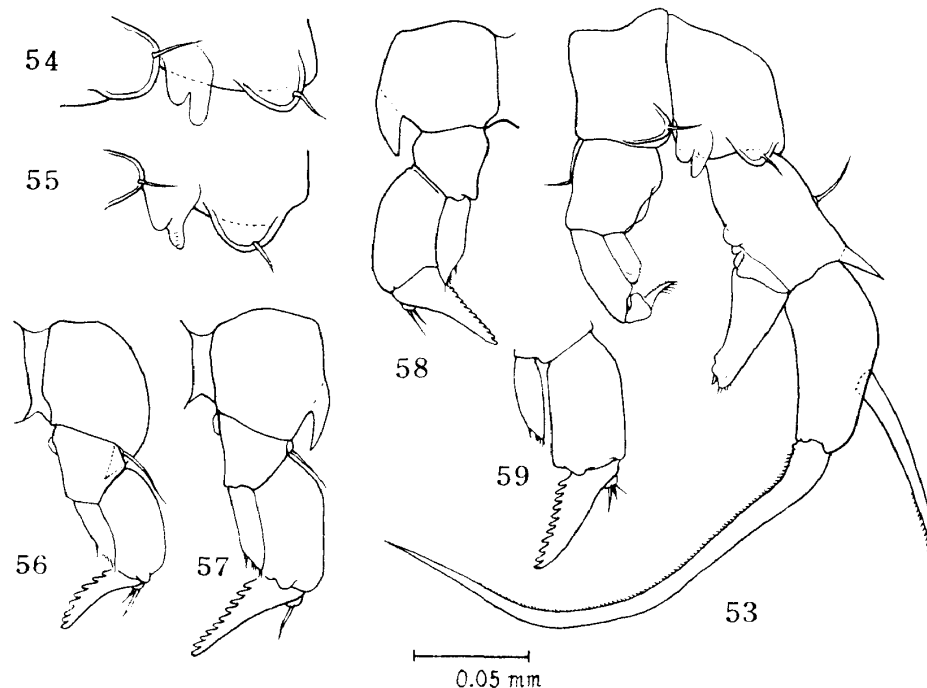
Figs. 45-52. *Neodiaptomus handeli* Brehm

45, A female, and 46, a male from Sungei Bertena. 47-48. Male right antenna, 47, antepenultimate segment, 48, middle segments. 49-51. Last thoracic segment of a male from Dipang, 49, left side, 50-51, right side. 52. Right furcal ramus.

of 1600 m, it was found as a plankter. Recently Mashiko (1951) recorded it from the lower course of the Yangtse. In the districts south of Szetschwan no records have been obtained (Brehm 1930). Although Mashiko (l. c.) has suggested that *N. handeli* is to be a northern or cold water species, the present records show that its occurrence extends as far south as the tropical Malay peninsula. It will be probable that its original home was the Yangtse valley and extended its range of geographical distribution north- and southwards as well as eastwards. To find a solution to this problem, explorations will be necessary to the districts south of the Yangtse valley and

north of the Malay peninsula.

Mashiko (l. c.) has regarded *N. strigilipes* Gurney (*Diaptomus strigilipes* Gurney 1907, p. 30) to be identical with *N. handeli*. The former species is, however, separable from the latter, as Brehm (1953) has discussed fully. In the *schmackeri* group of the genus *Neodiaptomus* (*N. strigilipes* and *N. schmackeri*) are closely allied to each other rather than the difference between *N. strigilipes* and *N. handeli*, as Rylov (1925, p. 317) has emphasized that "diese Form (*strigilipes*) nur eine Varietät (möglich Abart) des *D. schmackeri* darstellt." *N. strigilipes* is known to be distributed in India and does not extend its range to the districts east of the Bay of Bengal.



Figs. 53-59. *Neodiaptomus handeli* Brehm

53. Male fifth leg, Sungei Bertena. 54-55. Basal segment of the male fifth leg showing the hyaline lamella, 54, from Chom Sam, 55, from Gopeng. 56-59. Female fifth legs, 56, from Ipoh, 57, from Sungei Bertena, 58, from Gopeng, and 59, from Chom Sam.

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