proved by experimental observations. Though the compensation weight is a function of a latitude, practically we can not change its amount or position, during the operation of the Gyro-Compass, in other word, during a navigation. For what latitude we must make "$\beta_0 \to 0$" adjustment, must be determined by considering $\beta_0 - \lambda$ curve and the course of ship you take.

The author was formerly engaged in the Naval Technical Research Institute and Navigation Instrument Experimental Department of Yokosuka Naval Dockyard from 1942 to 1945. This report is founded on the researches and experimental observations at that time with some additional supplements later.

The Science Reports of the Kanazawa University, Vol. 1, No. 2, June, (1951). pp. 137—154.

Studies of the Fresh-water Plankton of Central China, II.*

Kikuya MASHIKO**

(Received May 31, 1951)

Remarks on the Principal Localities, Part II.

Hankow St. 2. A large-sized pond in the northern suburb of the city of Hankow (*ca.* 300×50m). The submerges such as *Potamogeton crispus*, *Ceratophyllum demersum*, *Hydrilla verticillata* and *Hydrodiction reticulatum* were abundantly seen in the summer season. After an examination of 14 samples collected in various seasons, the following species were identified :

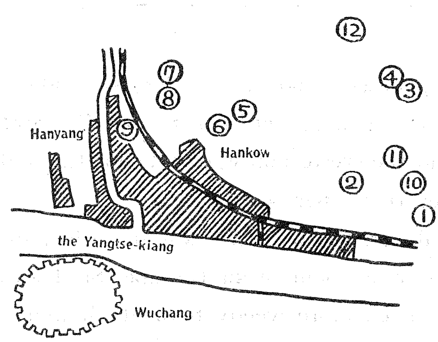

Fig. 1

Principal stations in the Hankow region.

Neodiaptomus handeli, *Macrocyclops fuscus*, *Eucyclops serrulatus*, *Cyclops vicinus*, *Mesocyclops leuckarti*, *Thermocyclops hyalinus* ; *Sida crystallina*, *Simosa vetuloides*, *Moina dubia*, *Bosmina longirostris*, *Alona rectangula*, *Pleuroxus trigonellus*, *Chydo-*

* Studies of the Fresh-water Plankton of Central China, I., Sci. Rep. Kanazawa Uuiv., Vol. 1. No. 1, (March, 1951), pp. 17—31.

During the last war, the writer spent about three years (1940 to 1943) in Central China as a soldier and was happy enough to make a number of plankton collections in the area extending from Kiukiang to Lake Tungting-hu along the Yangtse-kiang. The first report of his studies on the materials thus obtained has been published in the preceding paper, dealing with the materials, general discussion on the plankton collected, and remarks on the principal localities with special reference to the seasonal distribution of the plankton organisms.

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rus sphaericus ; *Brachionus calyciflorus*, *Br. quadridentatus*, *Br. forficula*, *Br. rubens*, *Platyias patulus*, *P. quadricornis*, *Keratella cochlearis*, *K. c.* var. *tecta*, *K. quadrata*, *K. valga*, *Euchlanis dilatata*, *Mytilina ventralis*, *Trichotria tetractis*, *Lecane luna*, *L.* sp., *Asplanchna brightwellii*, *Polyarthra trigla*, *Testudinella patina*, *Filinia terminalis*, *Ceratium hirundinella*, *Peridinium* sp., *Cosmarium* sp.

The seasoal distributions of five species of Cyclopoida were as shown in Table 1.

Table 1. Seasonal distribution of Cyclopoida in St. 2.

	1940	1941											1942
date	24/XI	27/I	14/II	6/III	15/III	15/IV	6/V	10/IX	16/X	1/XI	17/XI	7/XII	13/I
M. fuscus	—	—	—	r	r	r	?	—	—	—	—	—	—
E. serrulatus	r	—	r	r	—	—	+	—	—	—	r	—	—
C. vicinus	—	c	c	r	+	+	—	—	—	—	—	+	c
M. leuckarti	—	—	—	—	r	—	c	r	—	—	—	—	—
Th. hyalinus	—	—	—	—	—	—	—	c	c	c	c	—	—

Hankow St. 4. A large-sized pond (or lakelet) (*ca.* 400×50m). The greater part of the pond was covered with a luxuriant growth of *Potamogeton crispus* and *Trapa natans* var. *bispinosa*, and the westernmost part formed a shallower lotus pond. Depth about 3.5m in the summer rising period.

This station and the lakelet, St. 3, which was described in the preceding paper, face each other with a road between them in an L-shape. St. 4 was, however, a lakelet which was of smaller depth and much more weedy than St. 3, and, consequently, the plankton organisms in it were apparently different from those in St. 3.

The following 45 species and varieties, including two conspicuous species of Cladocera, *Latonopsis australis* and *Dunhevedia crassa*, were identified in this station :

Neodiaptomus handeli, *Macrocyclops fuscus*, *Eucyclops serrulatus*, *Cyclops strenuus*, *C. vicinus*, *Mesocyclops leuckarti*, *Thermocyclops hyalinus*, *Th. taihokuensis* ; *Sida crystallina*, *Latonopsis australis*, *Daphnia pulex*, *Ceriodaphnia rigaudi*, *Simosa vetuloides*, *Bosmina longirostris*, *Alona rectangula*, *A. karua*, *Pleuroxus trigonellus*, *Chydorus sphaericus*, *Dunhevedia crassa* ; *Brachionus calyciflorus*, *Br. quadridentatus*, *Br. urceus*, *Platyias patulus*, *P. quadricornis*, *Keratella cochlearis*, *K. c.* var. *tecta*, *K. valga* f. *monostrosa*, *Mytilina ventralis*, *Lecane luna*, *Monostyla bulla*, *M.* sp., *Trichocerca cylindrica*, *Asplanchna brightwellii*, *Polyarthra trigla*, *Testudinella patina*, *Filinia longiseta* var. *limnetica*, *Pedalia mira* ; *Ceratium hirundinella*, *Peridinium* sp., *Dinobryon* sp., *Closterium* sp., *Anabaena* sp.

The seasonal distributions of the principal species in this station were as shown in Table 2.

Table 2. Seasonal distribution of the principal species in Hankow St. 4.

date (1941)	27 I	14 II	6 III	15 III	22 IV	6 V	31 V	28 VI	24 VII	14 VIII	10 IX	16 X	17 XI	7 XII
wter temp. °C	9.5	4	11	19	21	27	29	28	32.5	32	23	27	—	12
N. handeli	—	—	—	—	—	—	—	—	—	—	—	—	—	+
Mac. fuscus	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Eu. serrulatus	r	c	c	—	r	+	—	r	r	+	—	—	—	rr
Mes. leuckarti	—	—	r	—	—	—	—	+	rr	+	r	—	—	—
Th. hyalinus	—	—	—	—	—	—	—	+	+	+	+	rr	—	—
Lat. australis	—	—	—	—	—	—	—	r	r	r	—	—	—	—
S. vetuloides	—	—	c	cc	r	r	—	+	—	—	—	—	—	—
B. longirostris	+	—	—	—	—	—	—	—	—	—	—	—	rr	rr
A. costata	r	r	r	+	+	rr	—	—	—	—	—	—	—	—
Dun. crassa	—	—	—	—	—	—	—	r	—	r	—	—	—	—
Ch. sphaericus	+	ccc	cc	cc	+	rr	—	—	r	—	—	rr	—	—
A. brightwellii	—	—	—	—	—	—	—	+	r	+	r	—	—	—
Peridinium sp.	—	—	—	—	—	—	—	c	cc	ccc	cc	—	—	—
Cosmarium sp.	—	—	—	—	ccc	—	—	—	—	—	—	—	—	—

Hankow St. 7. A round pond nearly in the center of Chunshan Park. Most of the collections made at this station have been lost and there are now only two samples left in the writer's hand. The following species could be identified :

Sinocalanus mystrophorus, *Daphnia longispina*, *Pleuroxus* sp., (Jan. 18, 1942) ; *Thermocyclops taihokuensis*, *Diaphanosoma brachyurum*, *Scapholeberis kingi*, *Schizocerca diversicornis*, *Trichocerca* sp., *Asplanchna brightwellii*, *Polyarthra trigla* (Sep. 21, 1941).

Hankow St. 8. A small pond with a fountain in its center, situated at the eastern part of Chunshan Park. When the collection was made (April 28, 1941), the fountain seemed to have long ceased playing and the bottom was all covered with the leaves and mud. A large number of *Daphnia* was found together with *S. sarsi* and *S. kingi*.

Sinodiaptomus sarsi (r)
Daphnia carinata (c), *D. pulex* (cc)
Scapholeberis kingi (+)

Hankow St. 9. A large-sized pond beside the railroad in the western part of the city. The pond is divided into two parts of nearly epual size by a road, and each pond was often filled with very dirty water because of the inflow of drainage.

The plankton fauna at this station was as shown in Table 3.

Hankow St. 10. A pond by a road on the eastern outskirts of the city. The following species were found at this station (May 28, 1941) :

Mesocyclops leuckarti (c), *Daphnia carinata* (c), *Scapholeberis kingi* (cc), *Simosa* *vetuloides* (c), *Platyias patulus* (r).

Table 3. Plankton fauna at Hankow St. 9.

species	28 / II	11 / III	24 / III	28 / IV	5 / VI	14 / IX
Neod. handeli	—	—	+	—	—	—
Cyclops vicinus	r	cc	c	—	r	rr
Daphnia carinata	—	+	—	—	—	rr
Ceriod. laticaudata	—	—	—	—	—	r
Moina macrocopa	rr	—	—	ccc	cc	—
M. dubia	—	—	—	—	—	+
Aspl. brightweellii	—	+	ccc	—	—	r
Br. calyciflorus	—	+	—	—	—	r
Br. quadridentatus	r	r	r	—	—	r
Br. rubens	—	—	—	—	—	r
Filinia terminalis	r	+	cc	rr	—	r
Polyarthra trigla	c	r	—	—	—	—
K. coch. tecta	—	—	r	—	—	—

Plankton of the Yangtse-kiang and Lake Tungting-hu

The collections of plankton in the Yangtse-kiang were made at Hankow and Kiukiang, and the collection in Tungting-hu was made off the city of Yochow which is situated, roughly speaking, on the northernmost coast of the lake. As, when the collection was made, the river water of the Yangtse-kiang was flowing backwards into the lake, the plankton collected may be considered practically as a part of that of the Yangtse-kiang. The water of Tungting-hu was as turbid and brownish yellow as that of the Yangtse-kiang. The localities, dates and the conditions of water observed are as shown in Table 4.

Table 4.

St.	date	locality	depth	temp.	pH
HA	29. I. 1941	Hankow	0m	4.0°	—
HB	〃	Hankow, mouth of the Han-sui	0	—	—
HN1	29. VII. 1942	Hankow, near the coast	0	31.0	—
HN2	30. VII. 1942	〃 , 25m off	0	31.0	—
HN3	〃	〃 , 135m off	0	30.8	7.5
HN4	〃	〃 , 〃	4	—	—
HNX	5. X. 1942	Hankow	0	—	—
K	9. X. 1941	Kiukiang	0	—	—
T1	18. V. 1941	off Yo-chow	0	23.0	7.4
T2	〃	〃	10	20.0	7.4

The temperature of the surface water of the Yangtse-kiang was 4°C on Jan. 29, 1941, when the atmospheric temperature was nearly the lowest through the year, and was 31.0° on July 30, 1942, when the atmospheric temperature was the highest. The hydrogen ion concentration was 7.5 when it was measured on July 30, at Hankow. In Tungting-hu (off Yochow) the water temperature was 23° and 20° at the depths of 0 m and 10 m, respectively, showing the difference of 3° between the former and the latter. The pH value was 7.4 both at the surface and the bottom.

The principal species occurred in each collection are as shown in Table 5.

Table 5.

Locality	Hankow							Kiu-kiang	Tungting-hu	
Date	29/I		29—30/VII				5/X	9/X	18/V	
Station	HA	HB	HN1	HN2	HN3	HN4	HNX	K	T1	T2
S. mystrophorus	—	—	r	+	+	+	—	r	c	c
E. sinensis	—	—	+	+	c	+	—	r	—	—
N. yangtsekiangensis	—	—	+	c	+	r	—	—	—	—
Ps. forbesi	—	rr	cc	cc	+	+	—	—	+	r
M. leuckarti	—	—	c	+	c	+	—	rr	—	—
Th. hyalinus	—	—	—	—	r	—	—	—	—	—
E. serrulatus	—	—	—	—	—	—	—	—	r	rr
copepodids	—	—	c	cc	c	c	r	rr	cc	c
nauplii	rr	—	r	r	r	r	r	rr	c	+
Diap. brachyurum	—	—	r	+	+	+	—	r	r	r
D. longispina	—	—	—	—	—	—	—	—	+	r
Sc. kingi	—	—	—	—	—	—	—	—	rr	rr
C. rigaudi	—	—	+	r	+	rr	—	—	—	—
M. dubia	—	—	+	r	+	rr	—	—	r	—
B. fatalis	—	—	c	cc	cc	+	r	r	cc	cc
Bps. deitersi	—	—	r	—	r	rr	—	—	rr	—
L. kindtii	—	—	c	—	+	—	—	—	rr	rr
K. cochlearis	—	—	r	r	r	rr	—	—	rr	—
K. valga	—	—	rr	rr	rr	r	—	—	—	—
D. biwae	—	—	+	rr	r	r	—	—	—	—
D. corona	—	—	c	c	cc	c	+	—	+	—
C. hyrundinella	—	—	rr	rr	r	—	—	—	—	—
Lamellibranch larva	—	—	—	—	—	—	—	—	+	—
Fish larvae	—	—	r	rr	—	—	—	—	+	rr

It was a remarkable phenomenon in the Yangtse-kiang that the plankton was found abundantly in the rising period of this river in summer, while in the falling period in winter it was very scanty and often it was not to be seen at all. Not only in the mid-winter collection, but even in the case of the collection early in October (HNX and K in the table) the plankton was very rarely found. As, in Central China, the plankton is generally found abundantly even in the winter period, it may safely be considered that the diminution of the plankton organisms in winter in this river is caused by the diminution or nearly practical cessation of their inflow from the drainage area as a result of the falling of the water level.

The biology of the plankton in large rivers has long been a subject of interest to many authors, and various ecological terms have been proposed according to the origin or states of living of the plankton in the river water (ZACHARIAS, 1898; SKORIKOW, 1902). ZIMMER classified the potamoplankton into three types, *viz.*, the autopotamic, eupotamic and tychopotamic. The above mentioned fact in the Yangtse-king, however, may give a suggestion that all of the plankton of this river originate in waters lying in the neighbouring area, in other words, the so-called "autopotamic" or endogenetic plankton does not exist in the Yangtse-kiang itself.

The observation of the horizontal distribution of the plankton in the Yangtse-kiang was made at Hankow on July 29—30, 1942 (Table 5). From this result we may recognized some distinct difference between the components of the plankton in the pelagic region and those in the littoral region. *Sinocalanus mystrophorus*, *Eodiaptomus sinensis* and *Diaphanosoma brachyurum* were obviously abundant in the pelagic region, and so was *Bosmina fatalis* at least in the surface layer. But some forms such as *Pseudodiaptomus forbesi*, *Mesocyclops leuckarti*, *Ceriodaphnia rigaudi*, *Moina dubia* and *Leptodora kindtii* were more commonly found in the littoral zone.

Though it is difficult to draw a clear-cut conclusion from this single observation, it may safely be said that the forms more commonly found in the pelagic region are better adapted to the waters of large rivers. Seeing that, in most cases of these pelagic forms, a large unmber of the young was also found, we may affirm that they have better adaptability to the rapid and turbid stream of the Yangtse-kiang than other forms found in the littoral region have. Judging from these facts, these pelagic forms may rightly be called "eupotamic" plankton, though it may be wrong to call them "autopotamic."

Most of the littoral forms, however, seem to be only temporal fauna in a limited part of this river in its rising period. From this point of view, therefore, the term "stenopotamic" plankton proposed by ZERNOV may rightly be adopted.

It is a noteworthy fact that the two species of *Difflugia*, *D. corona* and *D. biwae* were more or less commonly met with in the midchannel. They seem to have better adaptability to the pelagic environment than the common *Difflugia*, because they both have the characteristic shell with spine-like processes.

One of the most remarkable phenomena in the Yangtse-kiang plankton, in general, is that the diatoms and rotifers are, unlike in other large rivers, extremely scanty in every season. In the Yangtse-kiang proper, except for a small number of *Keratella valga* and a few individuals of other several species, none of the rotifers was found in the writer's collections. Of the diatom flora, only a few species were found with much difficulty in this river. This phenomenon, the extreme scantiness of the rotifers and diatoms in the Yangtse-kiang, seems to be, as already pointed out by LEMMERMANN (1907) as to the rotifers, due to the fact that these forms have less adaptability to the turbid stream than other forms. LEMMERMANN described a comparatively large number of species of diatoms in his report. They may be regarded, however, as the diatoms which flowed into the water of the Yangtse-kiang from Lake Tai-hu and other waters lying in the neighbourhood of Shanghai.

The following species were found in the materials of the Yangtse-kiang and Tungting-hu :

Sinocalanus mystrophorus, *Eodiaptomus sinensis*, *Neodiaptomus yangtaekiangensis*, n. sp., *Pseudodiaptomus forbesi*, *Eucycclops serrulatus*,* *Mesocyclops leuckarti*, *Thermocyclops hyalinus* ; *Diaphanosoma brachyurum*, *Daphnia longispina*,* *Scapholeberis kingi*,* *Ceriodaphnia rigaudi*, *Moina dubia*, *Alona rectangula*, *Bosmina fatalis*, *Bosminopsis deitersi*, *Chydorus sphaericus*, *Leptodora kindtii* ; *Brachionus angularis*, *Br. quadridentatus*,* *Platyias patulus*,* *Keratella cochlearis*, *K. valga* f. *asymmetrica*, f. *tropica*, *Euchlanis dilatata*,* *Trichotria tetractis*,* *Lecane luna*, *Trichocerca bicristata*,* *Asplanchna brightwellii*, *Testudinella patina*,* *Filinia termimalis*,* *Pompholyx complanata* ; *Difflugia corona*, *D. biwae*, *Ceratium hirundinella*, *Dinobryon sertularia*, *Volvox globator*, *Eudorina elegans* ; *Melosira varians*,* *M. granulata*, *Navicula* spp., *Gyrosigma* spp., *Epithemia* sp., *Synedra longissima* var. *subcapitata*, *Gomphonema* spp.,* *Cymbella* sp.,* *Amphora* sp.,* *Rhabdonema* sp.,* *Surirella elongata*, *S. spiralis*,* *S.* sp. ; Fish larvae, Mysis larva, Lamellibranchiata larvae,* *Tanypus* larva.

(*means the species which occurred in Tungting-hu only).

Remarks of the Principal Species, I.

Copepoda

1. *Sinocalanus mystrophorus* BURCKHARDT

(Figs. 2a–e)

Remarks. This is one of the most characteristic species in the Yangtse-kiang fauna, being apparently endemic in the Yangtse-kiang and the adjacent large-sized waters.

This species was first described by BURCKHARDT (1913) as occurring in the lower reach of the Yangtse-kiang, the Sutsau River and Lake Tai-hu, and was also recorded later by TUGE, KOKUBO and IMAI (1939) from the lower reach of the Yangtse-kiang.

In the present study, this species was abundantly found in the summer materials of the Yangtse-kiang and Tungting-hu, and, though not so commonly, it was also found at three lakelets and a pond in the vicinity of the city of Hankow.

This species can be distnguished from the closely allied species, *S. tenellus* (KIKUCHI), which is widely distributed in the surrounding teritories of the Sea of Japan, by the presence of a well-developed spine on the outer distal corner of the lst joint of the left exopodite of the male P5 and on the same corners of the lst joints of the exopodites of the female P5 (KIKUCHI, 1928 ; SMIRNOV, 1929, 1932). And the furcal rami are apparently much longer in *S. tenellus* than in *S. mystrophorus*.

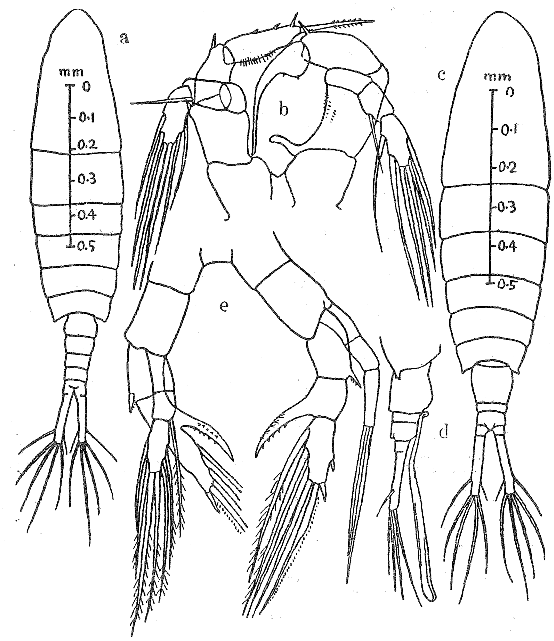

Fig. 2

Sinocalanus mystrophorus ; a) male, b) P5 ; c) female, d) abdomen (side view), e) P5 (HN3).

It may be a noticeable fact that this species is found only in fresh-water and even in such an inland region as Tungting-hu, while *S. tenellus* is found in brackish as well as fresh-waters near the sea coast as stated in the previous paper.

Localities. Yangtse-kiang (July 29—30, 1942), Tungting-hu (May 18, 1941), Hankow St. 12 (April 22, 1941), St. 3? (ditto), St. 5 (April 28, 1941), St. 7 (Jan. 18, 1942).

2. *Neodiaptomus handeli* (BREHM)

(Figs. 3a–j)

Diaptomus handeli, BREHM, 1921 : Sitz. Akad. Wiss. Wien, Mat. Naturw. Kl., **20** : 1.
RYLOV, 1925 : Zool. Anz., **63** : 313.
N. handeli, KIEFER, 1932 : Zool. Jahrb., Syst., **63** : 509.
KIKUCHI, 1940 : Rep. Limn. Survey Kwant. Manch., 292.

Remarks. This species was originally described by BREHM to occur in the plankton of Lake Ningyuën (1600m above sea level), Southwest Setschwan, China. RYLOV found this species in a small lake on the coast of the River Suifun, Siberia, and Kikuchi also reported occurrence of this species at 10 localities in Manchuria.

KIEFER established the present genus, *Neodiaptomus*, distinguishing the two closely related species, *N. schmackeri* (POPPE and RICHARD) and *N. handeli* from the others. The former species was first described in 1892 as occurring in Lake Tai-hu, and was found later by KIEFER (1928a) at Futschau, Fukien Province. GURUEY's Indian species, *Diaptomus strigilipes* is now regarded to be identical with *N. handeli*.

Judging from these records, it seems that *N. schmackeri* is a southern or warm water species, and *N. handeli* a northern or cold water one. In the writer's collections, however, *N. handeli* was found to occur at 11 localities, while none of *N. schmackeri* was found, in spite of expecting to find a wider distribution of the latter in Central China than the former.

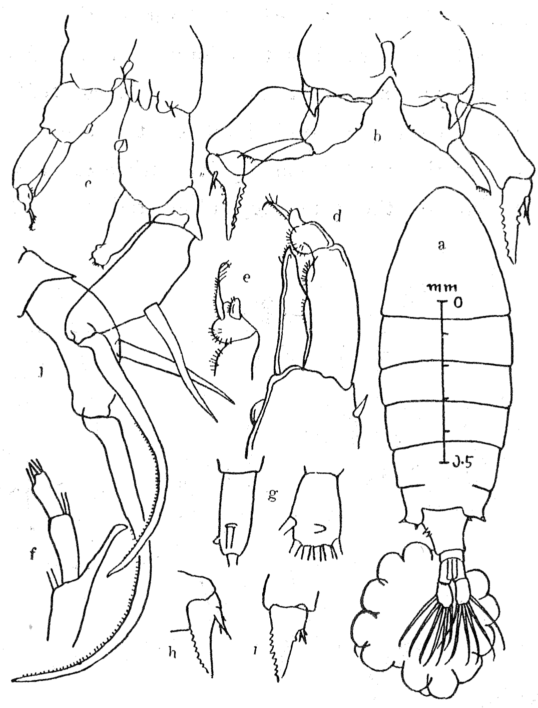

Fig. 3

Neodiaptomus handeli, a) female ; b) P5, h) i) terminal claw of P5 ; male, c) P5, d) e) left P5, j) right P5, f) last three joints of the prehensile antenna, h) i) furcal ramus. (a-h, H-5 ; i, H-6 ; j, Yochow)

These two species can be distinguished from each other by the following points (RYLOV , 1925) :

1) In the case of *N. handeli*, on the first joint of the right leg of the fifth pair (P5) of the male exists a hyaline membrane devided into two narrow lips but *N. schmackeri* lacks this membrane entirely ; 2) in the case of *N. handeli*, the end spine of the distal joint of the left P5 of the male bears three cilia, while in *N. schmackeri* there is none of these hairs and the armature of this spine is quite different.

Some specimens of the present writer have one to three teeth on the external face of the second joint or claw of the exopodite of the female P5. These teeth are usually seen in *N. schmackeri*, but have not hitherto been recorded in the case of *N. handeli*.

3. *Neodiaptomus yangtsekiangensis*, sp. nov.

(Figs. 4a–i)

Description. Male : body cylindrical ; last segment of the thorax nearly fused, the posterior corners slightly expanded, bearing a blunt tooth and several small spines on the left side and two stout teeth on the right ; first abdominal segment somewhat asymmetrical, with a spine on the right face ; furca with a process on its ventral face of the right ramus ; process of the antepenultimate joint of the prehensile antenna markedly long, being nearly as long as the last two joints ; terminal claw of exopodite of the right P5 large but somewhat smaller than that of *N. handeli*, bearing fine hairs on its inner face ; side spine of the second joint of the same ramus markedly small, located about the middle of the joint ; basal joint with a stout and pointed process on the outer edge ; endopodite of the same leg elongated rectangle in shape, carrying

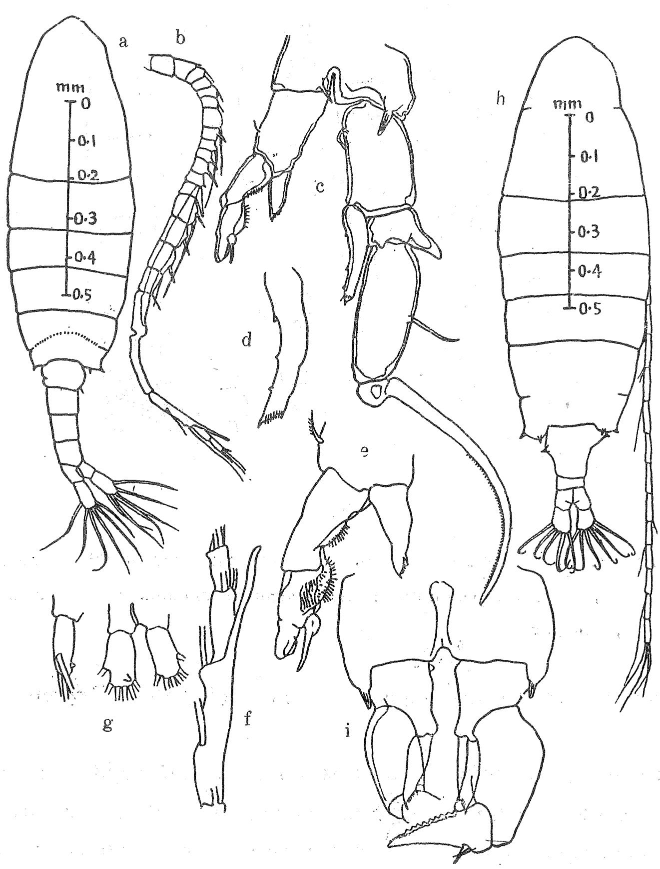

Fig. 4

Neodiaptomus yangtsekiangensis, sp. nov. ; a) male, b) prehensile antanna, c) P5, d) endopodite of right P5, e) left P5, f) last three joints of the prehensile antenna, g) furca ; h) female, i) P5. (HN3).

three teeth on the inner face and a spine on the distal edge ; endopodite of the left P5 more or less triangular ; second joint of the exopodite large and nearly as long as the first joint, carrying a smooth and stout spine on it.

Female : last segment of the thorax nearly fused, somewhat expanded, bearing two stout teeth on either side, one on the corner and the other on the dorsal face ; first or genital segment of the abdomen nearly as long as the rest of the abdomen, very asymmetrical in the dorsal view, having a short spine on either side ; basal joint of P5 with a conspicuous stout process (or spine) on each outer distal corner ; each terminal joint or claw with a row of well-marked serration on the inner face.

Length. Male : 1.3mm, female : 1.4mm.

Habitat. The Yangtse-kiang (Hankow).

Remarks. This species was found to occur in the Yangtse-kiang and Nanmen-hu. In the Yangtse-kiang, both the female and the male were rather commonly found in the summer collections together with *Eodiaptomus sinensis*. In Lake Namen-hu, a small number of male individuals was found among a large number of *Neodiaptomus handeli*, but no female individual could be found.

The male of this species can be recognized by the following characters : 1) the very long process of the antepenultimate joint of the prehensile antenna ; 2) the very small side spine of the exopodite of the right P5 ; 3) the peculiar form of the endopodite of the same leg ; 4) the relatively short triangular endopodite of the left P5 ; 5) the absence of any peculiar hairs as seen in *N. handeli* on the terminal spine of the same leg.

The writer found it a little difficult to determine the female of this species, because, as mentioned above, the closely allied species occurred together in each locality. Though the specimen described here has a close resemblance to *N. handeli*, no male of the latter was found in the Yangtse-kiang. The female of this new species can be distinguished from that of *N. handeli* by the well-marked process (or spine) which the former possesses on the outer distal corner of each first basal joint of the fifth leg, while in the latter, the corner forms an acutely pointed angle.

Localities. The Yangtse-kiang (Hankow), July 29—30, 1942 ; Nanmen-hu, July 29, 1941.

4. *Eodiaptomus sinensis* (BRUCKHARDT)

(Figs. 5a–f)

Diaptomous sinensis. BURCKHARDT, 1913 : Zool. Jahrb., Syst., **34** : p. 395, Pl. 13, K—M.

E. sinensis. KIEFER, 1932 : Zool. Jahrb., Syst., **34** : p. 473, 507.

TUGE, KOKUBO et IMAI, 1939 : Journ.Shang. Inst., IV, **4** : p. 72.

Remarks. This species was first described by BURCKHARDT to occur in his materials from the River Sutschau-ho near Shaghai. Later, KIEFER established the genus *Eodiaptomus*, consisting of three closely related species, *E. lumholtzi*, *E. sinensis* and *E. japonicus*. *E. sinensis* was found by TUGE, KOKUBO and IMAI also in their materials from the Yangtse-kiang, ranging from Nanking to Wusung. *E. japonicus* was described by BURCKHARDT as occurring in Lake Biwa-ko in the same paper in which he described *E. sinensis*, and it is now known to be widely distributed in Japan.

The present writer found many specimens identified as *E. sinensis* in the materials from the Yangtse-kiang collected at Hankow. According to BURCKHARDT, these very closely allied species, *E. sinensis* and *E. japonicus* seem to differ from each other in following points :

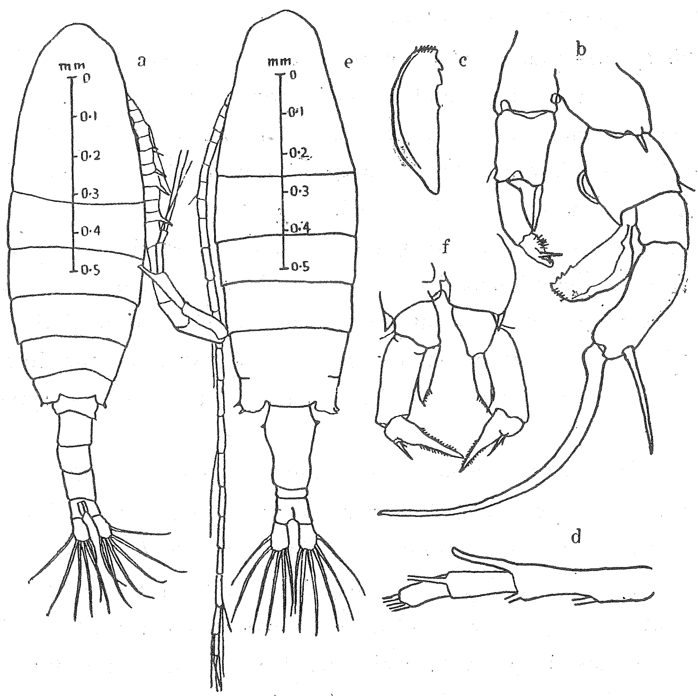

Fig. 5

Eodiaptomus sinensis, a) male, b) P5, c) endopodite of the right P5, d) last three joints of the prehensile antenna ; e) female, f) P5.

1) in *E. sinensis*, the abdomen is much shorter than that of *E. japonicus* ; 2) the last thoracic segment is more expanded in *E. japonicus* than *E. sinensis*, bearing two spines on each corner asymmetrically ; 3) the first antennae of the female are much longer in *E. sinensis* ; 4) the process of the antepenultimate joint of the prehensile antenna of the male in *E. sinensis* is almost or just as long as the 24th joint, while in *E. japonicus* it is much longer than the next joint ; 5) in *E. japonicus*, the 1st basal joint of the right P5 of the male has a chitinous strong process ; 6) the width of the 2nd joint of the exopodite of the same leg is 36 % of the length of the same in *E.*

sinensis, while it is 41 % in *E. japonicus*; 7) in *E. sinensis*, the endopodite of the same leg has two waves on the exterior face, while it has 3 or 4 waves in *E. japonicus*; 8) the serration of the distal part of the interior face of this endopodite is composed of 3 sharp teeth of similar size and a sign of the forth tooth in *E. sinensis*, while in *E. japonicus* the third tooth is large and blunt and the middle one is much smaller.

The Yangtse-kiang specimens obtained by the writer do not agree with the original descriptions of *E. sinensis* and *E. japonicus* given by BURCKHARDT. Namely, in most specimens, the abdomen of the female is apparently long as in *E. japonicus*, and the 1st antennae reach beyond the tips of furcal setae by the last 1—2 joints, but not so long as to reach beyond the furcal setae by 3 joints as in the case of *E. sinensis* which was shown by BURCKHARDT. The manner of arrangement of the spines on the hind corner of the last thoracic segment also resembles that of *E. japonicus*. The last thoracic segment, however, is less expanded than that of the specimens of *E. japonicus* which were collected by the writer in Lake Biwa-ko. The process of the antepenultimate joint of the prehensile antenna of the male is nearly equal in length to the following joint, but not so long as seen in *E. japonicus*. The 1st basal joint of the right P5 has not any well-marked chitinous process. The teeth on the distal portion of endopodite of the right P5 of the male are pointed and are almost of the same size. Often a 4th tooth exists.

If the writer had examined only the female specimens of the present collections, he would have identified them as *E. japonicus* because of the characters mentioned above. Judging from the characters of the male as well as the geographical point of view, the writer now determines the Hankow specimens as *E. sinensis*. A further study may be needed, however, for determining whether these two closely related forms are two distnct species respectively, or local forms of the same species.

It may also be a noteworthy fact that, so far as known at present, this species is not to be found at any locality outside of the Yangtse-kiang and its tributary, in spite of the fact that the autopotamic or endogenetic plankton does not seem to exist in the Yangtse-kiang.

In the Yangtse-kiang, this species was abundantly collected at Hankow July 29—30, rarely at Kiukiang Oct. 9, and was not found in the materials of Hankow Oct. 5 and Jan. 29, and even in those of Tungting-hu May 29. According to the writer's observation at Hankow, this species seems to be commoner in the pelagic region than in the littoral.

5. *Sinodiaptomus sarsi* (RYLOV)

(Fig. 6a–d)

Remaks. RYLOV (1923) first described this species as *Diaptomus chaffanjoni* var. *sarsi*, distinguishing the form, which had been reported under the name of *D. chaffanjoni* as occurring in Puching by SARS, from the type species. KIEFER (1928) recognized this variety as a distinct species in his investigation of the specimens obtained from Fuchow, Fukien Province, and later, he (1932) established a new genus *Sinodiaptomus* consisting of these two species.

According to KIEFER, the form reported by BREHM (1909) as *D. chaffanjoni* as occurring at Shanghai, too, duly belong to this species. KIKUCHI (1928, 1936, 1940) recorded this species, including those which were described by him under the name of *D. chaffanjoni*, to occur in Manchuria, Central and South-Western Japan.

In the present study, this large-shaped species was found in a small pond in Chunshan Park of Hankow and a pond north of the railroad station of Yochow (May 28, 1941). At the pond in Chunshan Park, *Daphnia carinata*, *D, pulex* and *Scapholeberis kingi* were found together with this species.

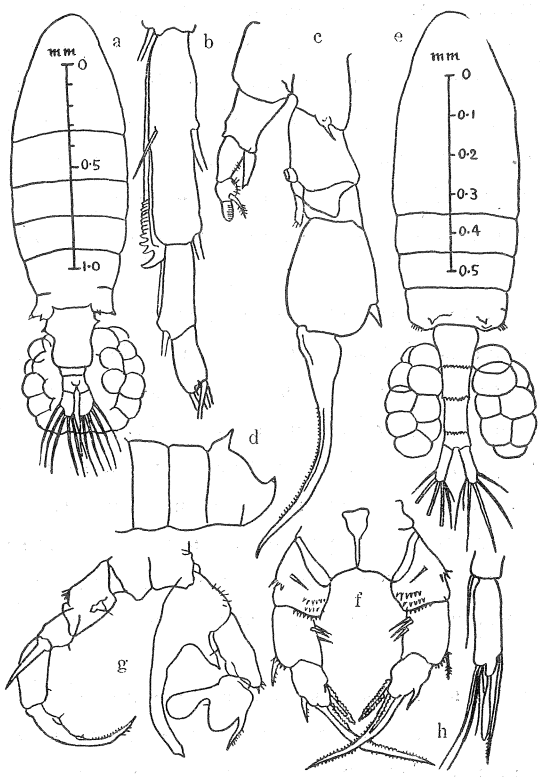

Fig. 6

a-b, *Sinodiaptomus sarsi*, a) female, b) last three joints of the prehensile antenna, c) male P5, d) side view of the last three thoracic segments of the female ; e-h, *Pseudodiaptomus forbesi*, e) female, f) female P5, g) male P5, h) last joint of the prehensile antenna.

The specimens collected by the present writer agree with *S. sarsi* in the main characters shown by KIEFER, though, in detail, it is not always identical with KIEFER's description. *S. sarsi* is distinguished from *S. chaffanjoni* by its very small side spine on the 2nd joint of the exopodite of the right P5 of the male. Namely, in the former, the length of the spine is less than 1/3 of the breadth of the joint, while in the latter, the spine is longer than the breadth of the joint.

Length. about 2.0 mm.

6. *Pseudodiaptomus forbesi* (POPPE et RICHARD)

(Fig. 6e–h)

Remarks. The present species was first described by POPPE and RICHARD and later by BURCKHARDT as occurring in the lowermost region of the Yangtse-kiang. KIKUCHI (1928) reported this species to occur in Lake Shibayama-gata which lies in Ishikawa Prefecture, Japan, and is situated near the coast of the Sea of Japan. Special attention must be drawn to this fact, because it is the only record of occurrence of this species at a locality other than the Yangtse-kiang region. The present writer has been studying the plankton of Shibayama-gata in various seasons during the last three years, but until now, he has not found this species in his collections. KIKUCHI did not record the date, conditions of the lake water and the number of individuals which occurred in his collection, and to the present writer the limnological condition at that time is not clear. The lake water, however, was more or less brackish, when the writer observed in 1946, because of the inflow of the sea water. But it is supposed that the salinity of the lake water seems to have rapidly diminished in recent years and today it is nearly a pure fresh-water lake. This change of salinity may be the reason why the present species has not occurred in the writer's collections.

Three closely related species of this genus, *Ps. forbesi*, *Ps. inopinus* and *Ps. japonicus*, are hitherto known in China, Japan and their adjacent territories. *Ps. forbesi*, however, can be easily distinguished from the other two species by the following characters :

In the male, the angle of concavity of the 2nd segment of exopodite of left P5 is 30° to 40°, while the angle is about 90° in *Ps. inopinus* and *japonicus* ; in the female, all of the furcal setae are uniformly thin in *Ps. forbesi*, while, in the other two species, they are markedly thick, especially the middle one. In regard to the geographical distribution as well as the degree of the adaptability of these three species to inland waters, a discussion was already made in the preceding paper (*loc. cit.*).

Localities. The Yangtse-kiang (Hankow), Lake Tungting-hu.

7. *Macrocyclops fuscus* (JURINE)*

(Figs. 7a–c)

Remarks. There were rare occurrences of this species at two stations.

Localities. Hankow St. 2, St. 4.

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* These two species had been overlooked when the list in the preceding report (*loc. cit.*) was made.

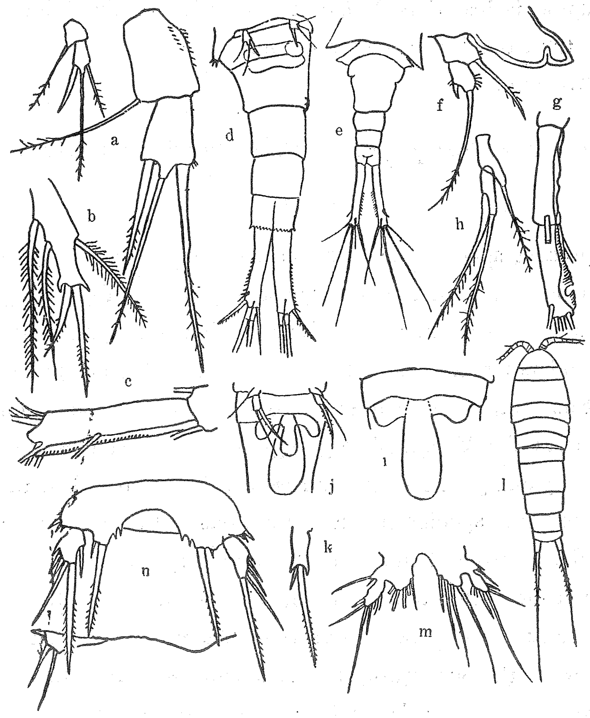

Fig. 7

a–c, *Macrocyclops fuscus* (female), a) P5, b) last joint of endopodite of P4, c) last joint of antenna ; d) *Eucyclops serrulatus* (ventral view of female abdomen) ; e, f, *Cyclops vicinus* (female), e) abdomen, f) P5 ; g, h, *Mesocyclops leuckarti*, g) last two joints of antenna, h) P5; i) *Thermocyclops hyalinus* (receptaculum seminis) ; j, k, *Th. taihokuensis*, j) female abdomen, k) terminal joint of endopodite of P4 ; l, m, *Canthocamptus staphylinus* , l) dorsal view, m) P5 ; n) *Schizopera* (?) sp. (P5)

8. *Eucyclops serrulatus* (FISCHER)

(Fig. 7d)

Remarks. This species was seen widely distributed in Central China, but the number of individuals found in one collection was comparatively small.

Principal localities. Hankow St. 2, St. 4.

9. *Cyclops strenuns* FISCHER*

Remarks. A small number of specimens was collected at Hankow St. 4 on march 6,1941.

10. *Cyclops vicinus* ULJANIN

(Figs. 7e–f)

Remarkks. A large number of individuals was collected in the Hankow region. In

Central China, this species seems to occur predominantly during the period from winter to early spring.

This species is distnguished from the preceding species by the elongated furca and the spine formula which is 2•3•3•3 while that of *C. strenuus* is 3•4•3•3.

11. *Mesocyclops leuckarti* (CLAUS)

(Figs. 7g–h)

Remarks. All of the specimens obtained by the writer in Central China have about 25 indentations on the hyaline membrane of the last antennal joint, besides the concavity at the place about one third of the whole joint length from the distal end. With regard to these indentations, GURNEY (1933) showed a comparison of many specimens of various localities in the world. The writer's specimens seem to have a resemblance most closely to those shown by GURNEY as occurring at Sarawak (Borneo) and Victoria Nyanza.

MARSH (1909), however, seems to be of the opinion that the manner of indentation of this kind is not always an important specific character, because he found specimens with different types of indentations in one collection which he made.

Though none of the specimens of this species with indentations of this kind has hitherto been recorded to occur in Japan, yet, in this country, the present writer has found many specimens which have the indentations of the same type with those of Central China.

12. *Thermocyclops hyalinus* (REHBERG)

(Fig. 7i)

Remarks. In Central China, the main occurrence of this species seems to be, in general, in the summer season, though at Hankow St. 2 it was rather commonly seen even in November (see Table 1, 2). This species is also found in the Japanese Islands in summer.

Principal localities. Hankow St. 2, St. 4, the Yangtse-kiang.

13. *Thermocyclops taihokuensis* (HARADA)

(Figs. 7j–k)

Remorks. This species is distinguished from the preceding species by the shape of receptaculum seminis and the proportion of the apical spines of endopodite of P4.

In Central China, this species seems not to be distributed in the waters of highly eutrophic type, and it is mainly found during the period from late summer to autumn (see Table 3, 4, 5 in the preceding paper).

Localities. Hankow St. 3, St. 5, Lake Nanmen-hu, Lake Kantang-hu.

14. *Canthocamptus staphylinus* JURINE
(Figs. 7l–m)

Remarks. A few specimens which could be regarded as this species were found at Hankow St. 5 on Feb. 20, 1941.

15. *Schizopera* (?) sp.
(Fig. 7n)

Remarks. One quetionable specimen which might be regarded to belong to the genus *Schizopera* was found in the sample collected at Hankow St. 12 (a lakelet the marginal part of which forms a shallow lotus pond) on April 22, 1941.

The present genus was established by G. O. SARS in 1905 with a species, *S. longicauda* G. O. SARS, which was found in a brackish lagoon on the Chathan Island. Later, the same author (1909) found eight species of this genus in the collection of Tanganyika. When GURNEY (1928) recorded three species from Tanganyika he included a new species in them. Some species of this genus have hitherto been known to occur in brakish-waters, *e. g.*, Chathan Island, Birket el Qurun in Egypt, Caspian Sea, and Lake Elton in South Russia.

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