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The Freshwater Branchiopoda of Japan. II*
Cladocera of Hokkaidô

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(With Plates X-XI and 2 Text-figures)

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In this paper is given the result of studies of the Cladoceran fauna of 18 lakes and 7 small water-bodies of heterogenous origin in Hokkaidô. So far as the plankton samples from these waters are concerned, the species of the Cladocera do not seem to be very numerous, only 18 hitherto known species being found. The characteristic point to be noticed is that the low summer temperature in Hokkaidô only permits the presence of two cold-water forms, *Daphnia cucullata* and *Bosmina coregoni*. The fewness of the species of both Macrothricidae and Chydoridae may be due to incompleteness of collection, since our survey has not yet been extended to smaller water-bodies such as ponds, swamps or *Sphagnum*-moors, except those in the neighbourhood of Sapporo.

Seasonal succession, cyclomorphosis and reproductive methods of the species, though of considerable ecological importance, are not referred to in the present paper, as the most of the material was collected only in summer. In the last chapter the distribution, size and form of the species and their environments will be briefly discussed.

Before going further, I wish to take this opportunity of thanking Prof. T. KAWAMURA for his kind interest in the present work and his valuable criticisms. For some samples, I am greatly indebted to Mr. K. KOBA, Dr. D. MIYADI, Mr. H. ISHIZUKA, Prof. Dr. Yaichiro OKADA, Mr. K. SAWA and Prof. Dr. T. UCHIDA.

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Regional Characteristics of Locality

In all parts of the southern half and in many provinces of the northern half of the island of Hokkaidô, there are numerous lakes of various size and depth, most of which are of volcanic origin, viz. caldera or lava-dammed, and geologically of rather recent origin.

The lakes treated in the present paper may conveniently be divided into the following three types :

1. Deep lakes of volcanic origin : Tôya-ko, Kuttara-ko, Shikotsu-ko, Akan-ko, Panké-ko, Kutcharo-ko, Mashû-ko and Shikaribetsu-ko.

2. Shallow lakes of volcanic origin : Ô-numa, Ko-numa and Hangetsu-ko.

3. Shallow lakes of heterogenous origin in low plains : Tôro-ko, Abashiri-ko, Shup-tô, Kabuto-numa, Panke-tô, Osattô, and Utonai-tô.

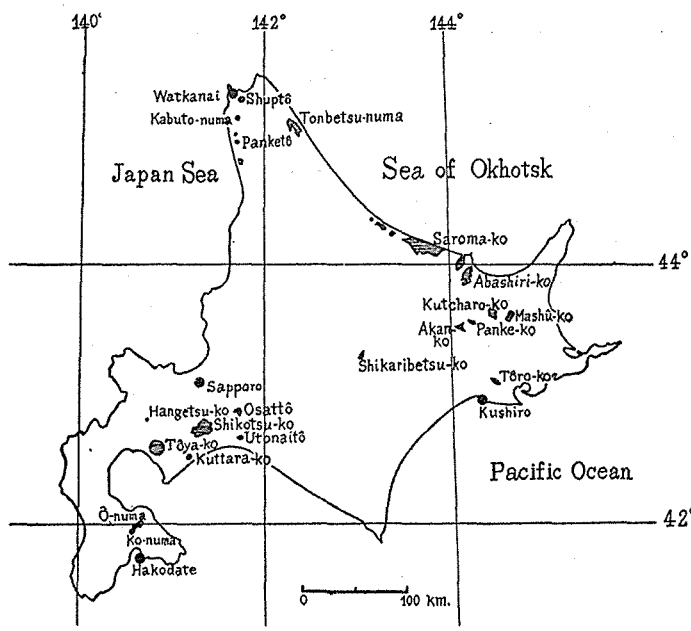

Fig. 1. Map of Hokkaidô, showing the distribution of main lakes.

According to recent works, most of the deep volcanic lakes in Hokkaidô are to be regarded as oligotrophic. The plankton productivity in such lakes is generally small, *Daphnia longispina* and *Diaptomus pacificus* being the prominent components. The development of " water-bloom " is usually a very rare phenomenon. The plankton of the shallow lakes in low plains is characterized by the great development of diatoms (chiefly *Melosira*) and cyanophyceae (chiefly *Microcystis*) and

Table I

Morphometric data relating to the lakes of Hokkaidô treated in this work.

Lake	Province	Altitude in *m.*	Surface area in *sq. km.*	Maximum depth in *m.*	Average depth in *m.*
Ô-numa	Toshima	130	5.12	13.6	6.4
Ko-numa	„	130	3.8	5.5	2.3
Hangetsu-ko	Shiribeshi	270	0.045	18.2	4
Tôya-ko	Iburi	83	70.3	183	116
Kuttara-ko	„	279	4.34	146.5	105
Shikotsu-ko	Ishikari	248	78	363	265
Akan-ko	Kushiro	399	11.86	36.6	17.8
Panké-ko	„	434	2.75	48.8	24.2
Kutcharo-ko	„	120	83.3	125	120
Mashû-ko	„	350	20	208	138
Tôro-ko	„	8	5.9	7	ca. 4
Shikaribetsu-ko	Tokachi	797	3.445	99	56.9
Abashiri-ko	Kitami	ca. 0.6	36.2	16.5	

also by the occurrence of certain cosmopolitan species of Rotifera. Most of such lakes may be either eutrophic or dystrophic, and, noticeably enough, in some of them (like Tôro-ko) the water contains an abundance of humic substances as well as a good amount of nitrogenous compounds. N- and P-standards are read as mostly polytype. Such lakes may be a mixture of two types and are to be regarded as of the " combination type " suggested by NAUMANN (1932) or JÄRNEFELT'S (1929) " para-mixotrophic type ".

Remarks on Species

Family : **Sididae**

Genus : *Diaphanosoma* S. FISCHER.

1. *Diaphanosoma brachyurum* (LIÉVIN)

Occurrence : Ô-numa, Ko-numa, Hangetsu-ko and Abashiri-ko.

It occurs uniformly in alkaline waters of the pH 7.1–8.8. Length of parthenogenetic females from Abashiri-ko, 340–460 μ.

Family : **Daphniidae**

Genus : *Daphnia* O. F. MÜLLER

There occur two species of the genus *Daphnia*, namely, *D. longispina* O. F. MÜLLER and *D. cucullata* G. O. SARS, both belonging to WOLTERECK'S so-called " P-daphnids ". *D. cucullata* with a pointed

helmet was recorded by KLOCKE (1903) from a lagoon Saroma-ko on the coast of the Sea of Okhotsk. The discussions on the geographical distribution of *D. cucullata* by both WAGLER (1923) and WOLTERECK (1930) are based upon this single record. However, this record is not taken into our consideration in discussing the Cladocera of Hokkaidô, since I myself have never met with this species from this historical locality.

If WOLTERECK's classification (1930), which divides the genus *Daphnia* into two main types according to the length of the head, i. e. dolichocephalic or brachycephalic, is adopted, all the races of *Daphnia* in Hokkaidô may be regarded as his *1-c*, typical pelagic hyaline brachycephalic *longispina* and its derivates in clear water lakes. *D. cucullata*, on the contrary, represents two different races, one without a helmet (his *3*) and the other with an elongated and pointed head (his *4-a*). *D. longispina* is rather widely distributed in large and deep oligotrophic lakes in volcanic districts, while *D. cucullata* is found only in Shikaribetsu-ko, a deep oligotrophic lake, and Tôro-ko, a shallow mixotrophic lake.

2. *Daphnia longispina* O.F. MÜLLER

According to WAGLER'S (1912) classification, *D. longispina* is divided into two subspecies: *longispina* s. str. and *hyalina* LEYDIG (WOLTERECK'S *1-c*). In Japanese waters *D. l. hyalina* seems to be rather widely distributed in large and deep lakes as a pelagic plankter, while the occurrence of *D. l. longispina* is always limited to small lakes and ponds as is a common case in Europe.* Since the present material from Hokkaidô is confined to rather larger lakes and does not extend to small ponds, most forms of *D. longispina* treated in the present paper are to be regarded as *hylina*, as mentioned already.

Occurrence: Tôya-ko Shikotsu-ko, Akan-ko, Panké-ko, Mashû-ko, Kutcharo-ko and Shikaribetsu-ko.

Remarks on local races: In the summer (August) forms of *Daphnia longispina* from seven lakes of mostly oligotrophic type, the size varies considerably, the total length ranging from 1100 μ to 1700 μ. Among them, a race of Panké-ko is the largest, measuring more than 1700μ. An ephippial female from Mashû-ko is as long as 2400 μ, but a male from the same lake does not reach 1400 μ. All the animals, though from different localities, are very hyaline.

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* I shall comment on the local races of Japanese *Daphnia* in a subsequent paper.

It is very striking to see that *D. longispina* has quite a different appearance in different lakes; in other words, every lake may be said to have its own race of difinite size and form. The relative length of the body parts is as follows:

Table II

Daphnia longispina of the lakes of Hokkaidô.

Lake	Length of head / Length of valve (per cent.)		Length of spine / Total length of animal (per cent.)	
	min.	max.	min.	max.
Tôya-ko	23	25	23	33
Shikotsu-ko	24	33	31	39
Akan-ko	20	25	10	15
Pankê-ko	16	20	14	23
Kutcharo-ko	20	23	12	17
Mashû-ko		21		2
Shikaribetsu-ko	18	19	6	9

These races may be separated into two main forms, one with a relatively long head and very long spine and the other with a short head and very short spine. Those appearing in Tôya-ko (Pl. XI, figs. 14–15) and Shikotsu-ko (Pl. XI, figs. 16–17) belong to the former type which corresponds to the typical form of *D. l. hyalina* of Europe or of America. In their general shape they resemble very much the European *lacustris* G. O. Sars (Richard 1896, Lilljeborg 1900, Keilhack 1909), but a form obtained from Tôya-ko on 31st July, 1931 has a much slenderer appearance like that of *galeata* G. O. Sars, though it is not dolichocephalic like that form.

The other form with a short head and a very short spine is widely seen in the lakes of Hokkaidô (Pl. XI, figs. 18–27). Among these races, that of Shikaribetsu-ko is the most peculiar; it is dwarf-like and lives most abundantly below the thermocline. The head of these races is usually 1/5–1/7 or 18–23 per cent. of the length of the valve, and the spine is usually less than 20 per cent. of the total length, often quite as short as in the race of Shikaribetsu-ko.

Investigations into the seasonal variations in the size and form of the plankton organisms in North European lakes show that there is great variation in the external appearance of *D. longispina* during summer, but, in winter, all the forms converge into one and the same type with a round head. Therefore, such a brachycephalic summer

form of *D. longispina* as mentioned above is a rare occurrence. It probably belongs to a form near the *primitiva* BURCKHARDT which is supposed to be a preglacial undifferentiated form of "P-daphnid". A similar peculiar form is also found in some oligotrophic mountain lakes in Honshû.

In all the races mentioned above, the ventral margin of the head is rather strongly concave, especially in those of Tôya-ko and Shikotsu-ko. Such a concave profile of the head has been observed by some authors. WAGLER (1912) observed such a form in certain races of *D. longispina* cultivated with insufficient nourishment. If such a phenomenon, the so-called "hunger-curve" of the head, may be assumed to occur in nature, the concavity of the head in the races of Tôya-ko and Shikotsu-ko could be explained by the oligotrophic nature of the water. According to BERG (1931), in *D. l. longispina* in Egekjærgaard Dam in Denmark such a "hunger-curve" of the head is more conspicuous in the ephippial females. In my material the parthenogenetic females also present such a concave profile.

3. *Daphnia cucullata* G. O. SARS

According to WOLTERECK's classification, *D. cucullata* of Hokkaidô may be divided into the following two forms.

1. Dolichocephalic *cucullata* (l. c., *4-a*) .....Torô-ko, a shallow eutrophic-dystrophic lake in a low plain containing peat deposits.

2. *Cucullata* without a helmet (l. c., *3*).....Shikaribetsu-ko, a deep (depth 99 m.) oligotrophic lake in the central mountains.

1. Tôro-ko (Pl. X, figs. 1–3). The animal is extremely hyaline, showing no trace of ocellus. The size is very small, the total length ca. 720 μ; this size nearly corresponds to that of the smallest form of WAGLER and BERG. The head is more than half of the length of the valve, forming an elongated and pointed helmet. The height is a little larger than half of the total length. The spine is about 400 μ, a little longer than half of the total length and turned upwards. Such a small form of *D. cucullata* has also been observed in North European lakes. According to BERG (1931, p. 97) *D. cucullata* developed at high temperatures is smaller than that found at low temperatures: in August the length of the animals becomes ca. 700–900 μ (length of the valve ca. 559–650 μ) and in May the total length is ca. 1200–1300 μ (valve ca. 900–1000 μ). WESENBERG-LUND (1904) also observed such a small form in Hestesko Dam.

2 Shikaribetsu-ko. (Pl. X, figs. 4–5). The largest individual taken

on 12th August, 1930 in this lake measures 830 μ. The animal is extremely hyaline and the ocellus is entirely absent. Although these individuals were collected when at the maximum of their cyclomorphosis i. e. in mid-August, the head is round and is not developed into a helmet; it is a little longer than 1/3 of the length of the valve. Certain younger animals, the length of which is shorter than 700 μ, have a somewhat bluntly pointed head (Fig. 5). The ventral and the dorsal outline of the valve are arched. The spine is about 450 μ in length and turned slightly upwards.

So far as our knowledge goes, the *cucullata*-race without a helmet has hitherto been recorded from small and shallow lakes or ponds of eutrophic nature (WAGLER 1923, WESENBERG-LUND 1926, GURNEY 1928–29, WOLTERECK 1930); it often occurs in small ponds with a depth of 1 m. (WAGLER, l. c, p. 64). If the present form can be identified with the European form mentioned above, the great depth (99m.) of its habitat is particularly interesting.

Genus: *Scapholeberis* SCHOEDLER

4. *Scapholeberis mucronata* (O. F. MÜLLER)

Occurrence: Ô-numa, Tôya-ko, Kuttara-ko, Shikotsu-ko, Mashû-ko and Shikaribetsu-ko.

This typical cosmopolitan species is also widely distributed in Japanese waters of oligotrophic nature. But in Hokkaidô it occurs only in volcanic lakes where the water has usually a weakly alkaline reaction (pH 7.1–7.5). The valve of the animal from Shikotsu-ko is dark brown, but that of Kuttara-ko is almost hyaline. The body length is 720–655 μ in the specimens from Ô-numa and 760–570 μ in the individuals from Shikotsu-ko. A sample collected on the surface of Tôya-ko on 4th October, 1930, containes numerous ephippia of *S. mucronata* besides a number of ephippial females.

Genus: *Simocephalus* SCHOEDLER

5. *Simocephalus serrulatus* (KOCH)

Occurrence: Ô-numa.

This species was collected in the littoral region of Ô-numa where the water was warm (27.5°C, 7. VIII. '30, 15^{h}), weakly acid (pH 6.7) and water plants were growing luxuriously. According to POULSEN (1928), *S. serrulatus* is the most pronouncedly acidophilous species in Danish waters (pH 3.8–6.0), abounding in *Sphagnum*-bogs. The largest specimen of Ô-numa is longer than 1.6 mm.

6. *Simocephalus vetulus* (O. F. MÜLLER)

Occurrence: Sapporo,—shallow rice-fields and ponds.

Genus: *Ceriodaphnia* DANA

7. *Ceriodaphnia pulchella* G. O. SARS

Occurrence: Ô-numa, Ko-numa, Abashiri-ko and Osattô.

This is a small species with a smooth hyaline valve, 500–600 μ long. It appears not only as a plankter but is also found among dense littoral vegetation. The range of pH of its habitats varies from 6.7 to 7.1, differing from the cases in Danish waters where, according to POULSEN (l. c.,), it may occur in strong alkaline waters.

8. *Ceriodaphnia reticulata* (JURINE)

Occurrence: Shallow rice-fields and ponds in Sapporo.

The present specimen may be identified with var. *kurzii* (STINGELIN), (Pl. X, fig. 13), but differs from it in having only three spines on the anal claw (Pl. X, fig. 13a). Length 650 μ.

Family: **Macrothricidae**

Genus: *Streblocerus* G. O. SARS

9. *Streblocerus serricaudatus* (S. FISCHER)

Occurrence: Small bog-pools on Mt. Daisetsu at about 1800 m. above the sea.

Family: **Bosminidae**

Genus: *Bosmina* BAIRD

10. *Bosmina longirostris* (O. F. MÜLLER)

Occurrence: Ô-numa, Ko-numa, Hangetsu-ko, Kuttara-ko, Tôya-ko, Utonai-tô and Kabuto-numa.

The length of the body is 0.4–0.5 mm., but the length of the mucro (M) as well as that of the antenna (C+D) is variable. In the race of Hangetsu-ko, M is short, ca. 4–6% of the total length (T) and C+D is 17–23% of T and strongly curved (probably *curvirostris* S. FISCHER). Such a form is also widely distributed in the other parts of Japan (Honshû and Kyûshû). The races of the other lakes, however, have a much longer mucro and antenna than the race of Hangetsu-ko. The races of Kuttara-ko and Tôya-ko, deep oligotrophic lakes of clear water, have long and less curved antennae; M is ca. 10–13% of T, C+D varies from 35% up to more than 40% of T. The number of eggs carried is always 1 or 2, rarely 3 or 4.

Table III

Bosmina longirostris of Hokkaidô. Examples of size of body (in μ). (Pl. X)

Lake	Date	T	H	C	D	C+D	M	Fig.
Hangetsu-ko	22. VII. '31	408	340	34	36	70	17	—
„	„	348	272	34	42	76	17	6
Tôya-ko	4. X. '30	425	306	50	145	195	42	—
„	31. VII. '31	510	425	50	152	202	68	—
Kuttara-ko	30. VII. '31	425	340	42	110	152	42	—
„	„	408	340	42	110	152	42	7
„	„	390	300	42	110	152	42	8
Kabuto-numa	3. VI. '30	315	255	34	102	136	50	—

B. longirostris in Hokkaidô seems to be one of the eurytrophic species, the pH of its habitats being 6.3–8.8. POULSEN observed the same species in Denmark inhabiting more strongly acid waters (range of pH 4.4–8.8) than in the present case.

11. *Bosmina coregoni* BAIRD

Occurrence: Shikotsu-ko, Akan-ko, Panké-ko, Mashû-ko, Kutcharo-ko, Shikaribetsu-ko and Tôro-ko.

Table IV

Bosmina coregoni of Hokkaidô. Examples of size of body (in μ). (Pl. X)

Lake	Date	T	H	C	D	C+D	M	Fig.
Tôro-ko	27. VII. '30	510	374	50	228	278	102	—
„	„	442	318	50	204	254	85	11
„	„	323	204	34	127	161	68	12
Shikaribetsu-ko	12. VIII. '30	680	460	68	187	255	136	9
„	„	595	442	68	204	272	110	—
Panké-ko	13. VIII. '30	612	460	77	238	315	120	—
Mashû-ko	17. VIII. '30	527	—	50	170	220	110	—
Akan-ko	18. VIII. '30	612	442	50	153	203	94	—
„	24. VII. '31	680	460	68	170	238	85	10

A. *Longispina*-group

11–a. *Bosmina coregoni seligoi* forma

Occurrence: Akan-ko, Panké-ko and Shikaribetsu-ko.

The races of these lakes all represent one form resembling *B. coregoni* subsp. *seligoi* RÜHE (1912, p. 20) of *longispina*-group. In size and form they agree rather well with RÜHE's *B. c. seligoi* of Rzunno

Lake caught on 15th August, and 6th October, especially the latter (RÜHE, l. c., Taf. I, fig. 9.). The race of Akan-ko has somewhat shorter antennae than this form.

The length is 520–790 μ. The antennae are short, slightly curved, directed downwards and backwards, C+D being 35–52% of T. The mucro is long, pointed, with a shallow depression behind the "seta kurzi"; M=13%–20% of T, except in one form of Akan-ko whose M is often less than 13% of T. The dorsal contour is rather greatly arched, but not so distinct as in RÜHE's summer form (cf. RÜHE, l. c, p. 21).

The pH of its habitats varies considerably, ranging from strongly acid to strongly alkaline (pH 5.5–8.0).

B. *Coregoni*-group

11–b. *Bosmina coregoni yezoensis* subsp. nov.

(Pl. X, Figs. 11–12)

Occurrence: Tôro-ko. Summer form.

The largest individual measured more than 500 μ. The antennae are long, directed forwards and not strongly curved; C+D being 50% to 57% of T. The ventral contour of the valve is nearly straight, but the dorsal contour is strongly arched, the height at the posterior margin being markedly less than the maximum height. The mucro is about 1/5 of T, or 20%–21% of T.

Such a peculiar form of *B. coregoni* has never before been recorded. *Bosmina amemiyai* V. BREHM (1925), which, according to my opinion, must be *B. coregoni amemiyai*, from Kawaguchi-ko in central Japan is the only allied form. In general appearance the form in question may be close to RÜHE's *longicornis-insignis*-group of *B. coregoni* and also resembles *B. c. berolinensis* IMHOF forma *typica*. In *berolinensis-typica*, however, the mucro is much longer than in the present form, i. e. M=30–60 (max. 70)% of T in mid-summer; and the antennae are 70–90 (max. 96)% of T and bent hook-like. The important characteristic feature of the present form is that the antennae are only slightly curved and directed forwards as in a summer form of *B. c. thersites* POPPE of the *eucoregoni*-series in the *coregoni*-group (RÜHE, l, c., Taf. VI, figs. 53, 57–59). *B. c. yezoensis* is, however, quite different in the shape of the valve from *B. c. thersites*.

The habitat of *B. c. yezoensis* is a shallow dystrophic-eutrophic lake of rather strongly alkaline water, the pH being often as high as 8.8.

Genus: *Bosminopsis* RICHARD

12. *Bosminopsis deitersi* RICHARD

Occurrence: Ô-numa, Ko-numa and Hangetsu-ko.

The distribution of this species in Hokkaidô seems to be limited to the south-western districts of milder climate, the range of the pH of the habitats being 7.1–8.8.

Family: **Chydoridae**

Genus: *Acroperus* BAIRD

13. *Acroperus harpae* BAIRD

Occurrence: Ô-numa.

This species representing one of the rare Cladocera in Japan, was found in the littoral region of Ô-numa where water plants grow luxuriously and the pH of the water is 6.7. The parthenogenetic female contains two eggs and is 600 μ in length. The dorsal contour is less arched than in the typical *harpae*; the height at the posterior margin is not very small. I assume this form to be identical with *A. harpae* subsp. *angustatus* G. O. SARS.

Genus: *Alona* BAIRD

14. *Alona guttata* G. O. SARS

Occurrence: Utonai-tô (Aug. 1929, coll. by K. SAWA), a small pond in Sapporo (July 1932, coll. by ISHIZUKA).

15. *Alona rectangula* G. O. SARS

Occurrence: Kabuto-numa (June 1930, coll. by SAWA), a rice-field in Sapporo (July 1932, coll. by ISHIZUKA).

Genus: *Chydorus* LEACH

16. *Chydorus sphaericus* (O. F. MÜLLER)

Occurrence: Ô-numa, Kabuto-numa, two bog-ponds on Mt. Daisetsu and four shallow ponds and rice-fields in Sapporo.

In Ô-numa it was found among the overgrowth of the littoral vegetation. The reaction of its habitats is rather wide in range (pH 6.3–7.1). According to POULSEN (l. c.) this species is found in Danish waters varying widely in pH. This is true also in Japanese waters, since it is often found in very strongly acid water, the pH of which is as low as 3.7 (UÉNO, *a forthcoming paper*).

Family : **Polyphemidae**
Genus : *Polyphemus* O. F. MÜLLER
17. *Polyphemus pediculus* (LINNÉ)

Occurrence : Akan-ko, Panké-ko and Shikaribetsu-ko.

The race of Akan-ko measures ca. 700 μ in length, but the race of Panké-ko is much larger, the length ranging from 880 μ to 1000 μ, as is the case with *Daphnia longispina*. The water of its habitats is generally rather alkaline (pH higher than 7.4).

Family : **Leptodoridae**
Genus : *Leptodora* LILLJEBORG
18. *Leptodora kindtii* (FOCKE)

Occurrence : Shup-tô near Watkanai.

This species is found only in this lake. In a sample taken on 8th August, 1930, it was accompanied by a large amount of plankton-diatoms.

Distribution of Species

1. Geographical Distribution

Although most freshwater planktic organisms are cosmopolitan, many species of Cladocera are an exception to this rule, showing distinct limitations in their occurrence. This fact has already been noticed (STEUER 1902, EKMAN 1905, WESENBERG-LUND 1904), and the Cladocera of Hokkaidô also show this characteristic.

The distribution of 18 species in 25 localities in Hokkaidô is shown in Table V.

Nearly all the species in the list are of wide distribution. Generally speaking, they are eurythermal cosmopolites, some of which, such as *Bosmina longirostris*, have a very extensive distribution. *Daphnia cucullata* and *Bosmina coregoni* are cold-water forms, the distribution of which is almost limited to the northern half of the Northern Hemisphere. *D. cucullata* seems to be distributed only in the northern half of the Palæarctic Region, from England to Japan, except the Arctic Region (WAGLER 1923). It is generally stated that this species is found in waters warmer than 20°C, but is not known from very warm water lakes, such as those in Southern Europe or tropical territories. WOLTERECK (1930, p. 364) observed that a race of *D. cucullata* in Attersee reaches its maximum number in autumn when the water becomes colder.

Table V

Distribution of Cladocera in Hokkaidô.

	1. Ô-numa	2. Ko-numa	3. Hangetsu-ko	4. Tôya-ko	5. Kuttara-ko	6. Shikotsu-ko	7. Utonai-tô	8. Osattô	9. Akan-ko	10. Panké-ko(Kushiro)	11. Kutcharo-ko	12. Mashû-ko	13. Tôro-ko	14. Abashiri-ko	15. Shuptô	16. Panké-tô (Teshio)	17. Kabuto-numa	18. Shikaribetsu-ko	19-22. Ponds and rice-fields in Sapporo	23. A Pond in Akkeshi	24-25. Bog-pools on Mt. Daisetsu
1. *Diaphanosoma brachyurum*	+	+	+	·	·	·	·	·	·	·	·	·	+	+	·	·	·	·	·	·	·
2. *Daphnia longispina* . . .	·	·	·	+	·	+	·	·	+	+	+	+	·	·	·	·	·	+	·	·	+
3. *Daphnia cucullata*	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·	·	·
4. *Scapholeberis mucronata* .	+	·	·	+	+	+	·	·	·	·	·	+	·	·	·	·	·	+	+	·	·
5. *Simocephalus serrulatus* .	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
6. *Simocephalus vetulus* . .	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·
7. *Ceriodaphnia pulchella* .	+	+	·	·	·	·	·	+	·	·	·	·	·	+	·	·	·	·	·	·	·
8. *Ceriodaphnia reticulata* .	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
9. *Streblocerus serricaudatus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
10. *Bosmina longirostris* . .	+	+	+	+	+	·	+	·	·	·	·	·	·	+	·	·	+	·	+	·	·
11. *Bosmina coregoni*	·	·	·	·	·	+	·	·	+	+	+	+	+	·	·	·	·	+	·	·	·
12. *Bosminopsis deitersi* . .	+	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
13. *Acroperus harpae*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
14. *Alona guttata*	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	+	·	·	·	·
15. *Alona rectangula*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·	·
16. *Chydorus sphaericus* . . .	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·	+
17. *Polyphemus pediculus* . .	·	·	·	·	·	·	·	·	+	+	·	·	·	·	·	·	·	+	·	·	·
18. *Leptodora kindtii*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Number of species	8	4	3	3	2	3	1	1	3	3	2	3	4	3	1	(1) *	4 5 **	5	6	1	3

*Sawa (1931) recorded *Camptocercus* sp. **Ilyocryptus* sp. (Sawa 1931).

Daphnia in Hokkaidô presents well-marked areas of distribution. *D. longispina* occurs in almost all large and deep lakes in the volcanic ranges of the southern half of the island. *D. cucullata*, on the contrary, is found only in two lakes in the south-eastern parts where the coldest districts are situated.

In the distribution of *Bosmina* a somewhat allied phenomenon is met with in *Daphnia*. *B. longirostris* seems to be principally spread in shallower lakes in the south-western part, while *B. coregoni* is known for the most part from the south-eastern region. In Europe, two

groups of *B. coregoni*, namely, *longispina* and *coregoni* s. str. are stated to have a different geographical distribution (WESENBERG-LUND 1904, p. 171 ; RÜHE 1912, p. 18), the group of *longispina* being found either in the northern countries or in the alpine regions, while they are extremely rare in Middle Europe, their place being taken by the group of *coregoni*. However, in Hokkaidô, as mentioned above, the two groups, *longispina* and *coregoni*, co-exist.

Bosminopsis deitersi is a species with a rather peculiar distribution, having been found in Russia, South America, China and Japan. In Hokkaidô, the range of this warm-water form seems to be confined to the south-western part of mild climate. The occurrence of this species and *Diaphanosoma brachyurum* may afford warm-water components in the Cladoceran fauna of Hokkaidô.

Among other rarer species, *Polyphemus pediculus* and *Leptodora kindtii* show a somewhat peculiar distribution. The former was obtained from the epilimnion of three rather deep lakes in the south-eastern Hokkaidô. The latter has, so far as our collections go, been found only in a small lake, Shuptô, near Watkanai, which lies at the northernmost corner of the island of Hokkaidô (ca. 44° 50′ n. lat.).

We have no record of *Holopedium gibberum* from any part of Hokkaidô, though it has been recorded from many lakes and ponds throughout Japan as far as the North Kurile Islands (UÉNO 1927 and 1932). It has been recently recorded from both Russian North Sakhalin (RYLOV 1932) and Iturup of the South Kurile Islands (UÉNO 1933).

2. Associations

In three shallow eutrophic lakes of volcanic origin (Ô-numa, Ko-numa and Hangetsu-ko), there occur some pelagic eurytrophic and eurythermal Cladocera. The most interesting fact in regard to the habitat is seen in Ô-numa. The main basin of this lake supports three pelagic forms, *Ceriodaphnia pulchella*, *Bosmina longirostris* and *Bosminopsis deitersi*, while its shallow auxiliary basins have various species living among densely growing water plants, such as *Diaphanosoma brachyurum*, *Scapholeberis mucronata*, *Simocephalus vetulus*, *Ceriodaphnia pulchella*, *Bosmina longirostris*, *Acroperus harpae* and *Chydorus sphaericus*.

The Cladocera seem to be generally very scanty in the lakes containing large amounts of humic substances, only a few littoral forms such as *Alona* and *Chydorus* being found. An exceptional case is

met with in Tôro-ko, where two noticeable species, *Daphnia cucullata* with an elongated head and a peculiar form of *Bosmina coregoni* are the important associated components.

The pelagic associations in deep oligotrophic lakes are composed of two or three, rarely four or five, species of Cladocera. *Daphnia longispina* is a typical inhabitant in such lakes. *Bosmina coregoni* and *Scapholeberis mucronata* also appear in some of them. No peculiar pelagic differentiates of *Daphnia* or *Bosmina* are developed in Hokkaidô, except in one lake, Shikaribetsu-ko, where two different races of pelagic *Daphnia*, namely, *D. longispina* (forma *primitiva*) and *D. cucullata* (mesocephala) are found. This is the only Japanese lake in which two different races of pelagic daphnids are coexisting in the planktic association.

3. Factors limiting Cladoceran distribution in Hokkaidô

a. Temperature

One of the most important factors limiting the distribution of the Cladocera must be the water temperature. According to FUKUI (1929), Hokkaidô can be divided into two main climatological territories, eastern and western divided by the central mountain ranges, besides the southernmost territory which has a climate somewhat similar to that of Honshû or Japan proper. The most severe winter is recorded in the southern provinces of the eastern half, especially in some inland districts surrounded by mountains. The mild climate of the southern parts and western coast (Japan Sea side) is due to the proximity of warm currents.

Both eurythermal cosmopolite *Bosmina longirostris* and warm-water form *Bosminopsis deitersi* seem to occur principally in the south-western districts, while the distribution of *Bosmina coregoni* and *Daphnia cucullata* is limited to the coldest south-eastern provinces. Hangetsu-ko lies in the south-western district where *Bosmina longirostris*, *Bosminopsis deitersi* and *Diaphanosoma brachyurum* are found; the highest record of surface temperature in summer comes from in this lake.

The record of the surface and the deep water temperature of the lakes of Hokkaidô in summer (July–August) is given by Table VI.

The surface temperature in summer varies considerably, at times from 18°C to 28.7°C, but generally 20°–23°C. Such a great difference in the water temperature in summer in Hokkaidô is closely connected with the wide divergence of the climatic condition in various districts.

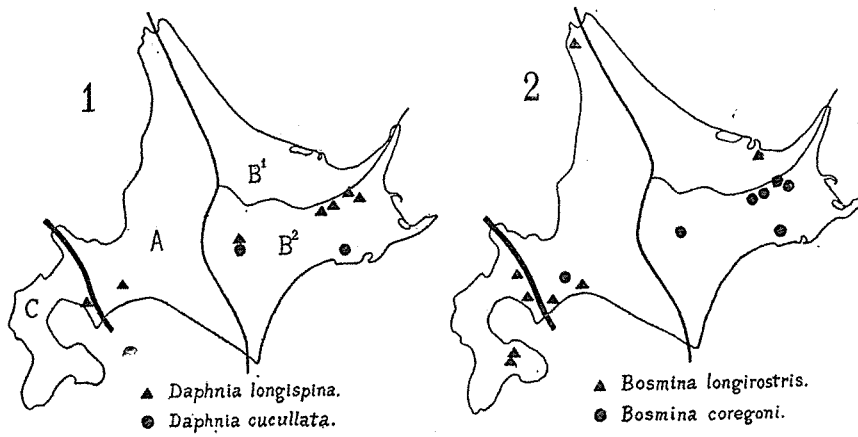

Fig. 2. Distribution map of the genus *Daphnia* (1) and genus *Bosmina* (2) in Hokkaidô. A, B¹ and B² are the territories of the Hokkaidô climate; C of the Honshû climate. (Modified from FUKUI 1929).

Table VI

Water temperature of the lakes of Hokkaidô in summer.

Lake	Epilimnion t°C	Hypolimnion t°C	Remarks
Ô-numa	±23	±15	frozen in winter
Ko-numa	±25*	*	„
Hangetsu-ko	28—24.6	8.7—5.5	„
Tôya-ko	21—17.8	9.1—4.0	partly frozen
Kuttara-ko	23—21	6.5—4.3	frozen
Shikotsu-ko	22—16	13 —3.6	partly frozen
Akan-ko	21—19	12 —9.0	frozen
Panké-ko(Kushiro) . . .	21—19	7.0—5.0	„
Kutcharo-ko	19.3—18.7	9.3—5.8	„
Mashû-ko	17—12	7.5—4.1	„
Tôro-ko	±23*	*	„
Abashiri-ko	±20*	*	„
Shikaribetsu-ko	22—21	8.0—4.5	„
Panké-tô (Teshio)	±20*	*	„
Kabuto-numa	±21*	*	„
Utonai-tô	±18*	*	„

*nearly homothermal.

The climatic conditions may be an important factor in the stratification of the Cladocera in each lake. Judging from the results obtained by several workers (TANAKADATE 1925, TAKAYASU and others 1930), it

may be concluded that the zones of habitation of the Cladocera, especially those of *Daphnia* and *Bosmina*, in deeper lakes are somewhat different from those found in several lakes in middle Japan. According to KIKUCHI (1930), *Daphnia longispina hyalina* lives in or below the thermocline of three lakes in middle Honshû. In Kizaki-ko (depth 29m.) it lives at a depth of 8–25m. and in Aoki-ko (depth 62 m.) in a stratum of 10–30 m. During winter, however, when the temperature of the surface water becomes low, *Daphnia longispina* in these lakes comes up near the surface (KIKUCHI 1930, p. 200; also cf. KIKUCHI 1927). Besides these, even in the lakes in middle Japan, *Bosmina longirostris* lives usually in the hypolimnion of Kizaki-ko, Aoki-ko and Biwa-ko, while, in Noziri-ko it appears in the epilimnion.

In the lakes of Hokkaidô *Daphnia* and *Bosmina* are, in many cases, most abundant either in the epilimnion or just below the thermocline (metalimnion) and not in the hypolimnion. They are most scarce in the thermocline. As an example, the stratification of four species of the Cladocera in Shikaribetsu-ko (depth 99m.) on 16th August, 1930 is shortly given below.*

On that day, when the plankton-samples were taken, the epilimnion was seen at 0–5 m. (22°–21°C) and below 5–12 m. the thermocline (21°–9.7°C) was recognized. The temperature at the depth of 50 m. was 4.5°C. *Daphnia longispina* (forma *primitiva*) was rather abundant in the epilimnion and the upper part of the thermocline; it gradually decreased in the lower part of the thermocline. At 20–30 m. it was very numerous and suddenly diminished again in the layers below 30 m.; then became extremely scarce at the depth of 40–50 m. *Daphnia cucullata* was, on the contrary, absent in the layers from the surface to 20 m., and most abundant in the hypolimnion, especially in the 20–30 m. layer or just below the thermocline. *Bosmina coregoni* was most abundant in the epilimnion and gradually decreased lower down. *Polyphemus pediculus* was observed in the surface layers only. In the Untersee of Lunz, Austria, RUTTNER (1929, p. 281) also observed that *Daphnia longispina* was distributed from the surface to 15–20 m., its maximum being met with at a depth of 3–5 m., and that in the autumnal circulation period its distribution was remarkably disturbed.

The conclusion may be drawn that such differences in the stratification of certain Cladocera in the lakes of Hokkaidô as compared with

*For a series of the samples of plankton collected in this lake, I am greatly indebted to Mr. K. SAWA.

those of middle Japan principally depend upon the water temperature, although light may serve as another important factor.

b. Certain Chemical Factors*

Hydrogen-ion concentration. The pH of the water in most of the Hokkaidô lakes is less than 7.0, though there are certain cases in which the pH is more than 8.0, or extremely acid. Abashiri-ko has rather alkaline water (pH 7.8–8.2) owing to its high salinity (*Cl* more than 85 mg. per litre). Tôro-ko which is para-mixotrophic in type, shows the pH 6.9–7.4 and often as high as 9.0. Extremely acid water is detected in Kutcharo-ko where the pH is usually 5.0–6.0 and often as low as 4.7. The source of this high acidity is an influx of water, the pH of which is as low as 2.0. Owing to the poverty of buffer substances in water, this lake might be soon polluted by the inflowing of such strongly acid water derived from a mineral spring. Several small and shallow lakes of dystrophic type are always filled with weakly acid waters.

There are no adequate investigations concerning the relation between the Cladocera and the pH of their habitats. SKADOWSKY (1923) indicated *Simocephalus serrulatus* and *Polyphemus pediculus* as the characteristic Cladocera in waters of pH 4.38–4.5 (his "zweite Zone"). POULSEN (1928) classified the Danish waters into four groups with regard to the Cladoceran fauna, pointing out that the optimum pH for the Cladocera was 6.1–7.9.

Daphnia longispina in Hokkaidô inhabits waters with a rather wide range of pH, often as high as 8.0 and as low as 5.5, while the range of *D. cucullata* seems to be limited to alkaline waters (pH 7.4–8.8). *Bosmina longirostris* is distributed in water from weakly acid to strongly alkaline (pH 6.5–8.8), but *Bosmina coregoni* seems to have a wider range, occurring even in rather strongly acid water such as that of Kutcharo-ko (pH 5.5). *Simocephalus serrulatus* is regarded as one of the most pronounced acidophilous species in Europe (SKADOWSKY. l. c., POULSEN, l. c.). In Japan, the species of *Simocephalus* may also be included in this category, viz. *S. serrulatus* occurs often in strongly acid lakes with pH as low as 4.4 (UÉNO, *a forthcoming paper*), and *S. vetulus* is recorded from very strongly acid lake with pH ranging from 3.0–4.0 (KOKUBO and others 1931). The habitat of *S. serrulatus*, though we have only a single record in Hokkaidô, is slightly acid water (pH 6.7).

*The Chemical data referred to in the discussion are summarized in Table VII.

Though SKADOWSKY (l. c.) has pointed out that *Polyphemus pediculus* is a characteristic species in strongly acid waters in Russia, in the present study quite a different result was obtained, the range of pH being 7.0–7.8. The range of pH of the water in which the Chydoridae live is generally inclined to the acid side of neutrality.

Dissolved Oxygen. In deeper volcanic lakes the dissolved oxygen is always present in sufficient amount to permit of animal life throughout the strata, as is generally the case in deeper oligotrophic lakes. For example, Kutcharo-ko has 5.76 ccm per litre of O_2 at the surface and 7.26 ccm at a depth of 100 m. (August 26th). Certain eutrophic shallow lakes contain, however, low values of O_2, which is often entirely absent in deeper strata as in Hangetsu-ko in summer. The surface water of Ô-numa shows 5 45 ccm per litre of O_2 (89 per cent. of saturation), while at the bottom, 12 m., the O_2 content is 0.74 ccm per litre (1 per cent. of saturation).

Total residue. The total residue of the lake waters of Hokkaidô is in general larger than in the other Japanese lakes (cf. YOSHIMURA 1931). The largest amount is recorded from Kutcharo-ko (208–255 mg. per litre), except for the brackish water of Abashiri-ko (more than 350 mg. per litre). The minimum amount is obtained in the water of Kuttara-ko, containing only 53.6 mg. per litre; the water of Hangetsu-ko holds in solution 64.6 mg. per litre of mineral matter.

With regard to the distribution of *Daphnia longispina* certain interesting relations can be detected. Its habitats cover a very wide range of salt contents, from more than 250 mg. (Kutcharo-ko) to less than 80 mg. per litre. A form *hyalina-lacustris* appears in the lakes of moderate salt contents (120–150 mg. per litre), while another form, *primitiva*, is frequent in far larger or smaller salt contents (Kutcharo-ko of 250 mg. to Shikaribetsu-ko of 80 mg.). *Daphnia cucullata* is another interesting form limited to much diluted water. *Bosmina longirostris* and *Diaphanosoma brachyurum* live both in the most concentrated (Abashiri-ko, 453 mg. per litre) and the most diluted water (50–70 mg. per litre).

Sulphate is present in most lakes, the maximum value having been obtained from Kutcharo-ko (more than 75 mg. per litre). *Daphnia longispina* appears in both concentrated and dilute sulphuric water, while *D. cucullata* is found only in water containing rather a small amount of sulphates. Water favourable for *Bosmina longirostris, B. coregoni, Bosminopsis deitersi* and *Diaphanosoma brachyurum* contains a wide range of sulphates.

Chloride is usually present in quantities from 6 mg. up to more

Table VI

Chemical Analyses of lake waters referred to in the discussion.
(Data given as mg. per litre)

Lake	Date	pH	Total residue	SiO_2	SO_4	Cl	Ca	Mg	Na	cons. of K-MnO_4	N	P_2O_5
O-numa	21/7/31*	7.1	181.6	21.0	—	10.5	13.2	—	10.1	12.0	0.12	0.02
„	5/30**	—	161.1	23.0	62.0	15.1	28.4	7.2	—	3.96	0.18	0.003
Ko-numa	21/7/31*	7.1	78.2	13.6	—	10.5	9.7	—	12.7	10.5	0.095	0.01
Hangetsu-ko	22/7/31*	(8.8)	64.6	22.0	0	7.5	15.4	—	7.9	13.5	0.35	0.05
Tôya-ko	31/7/31*	7.2	120.2	13.6	—	18.5	10.7	—	15.0	9.5	0.07	0
Kuttara-ko	30/7/31*	7.2	53.6	7.0	—	6.0	5.4	—	—	5.5	0.035	0.07
Shikotsu-ko	29/7/31*	7.5	150.0	22.2	(42)	25.5	15.4	—	25.7	5.0	0.05	0.01
Utonai-tô	6/29**	7.0	109.0	42.5	15.6	6.1	7.9	4.0	—	8.48	0.08	0.008
„	9/29**	6.9	108.75	39.5	0	6.6	6.61	2.67	—	10.78	0.172	0.006
Akan-ko	27/7/27**	7.8	231.4	12.6	60.8	25.4	14.2	14.1	—	3.63	trace	—
„	13/10/27**	7.45	225.6	19.9	52.9	26.8	18.7	14.2	—	3.96	0.08	—
„	24/7/31*	7.6	219.4	27.0	—	20.5	12.5	—	26.5	7.0	0.13	0.01
Mashû-ko	27/8/30**	7.3	87.4	10.2	—	8.9	7.4	6.2	—	1.9	0.014	0.006
Kutcharo-ko	26/8/30**	5.8	255.0	42.0	72.4	41.5	13.9	—	—	2.0	0.07	0.004
„	3/10/30**	5.5	251.0	43.0	75.5	43.0	16.4	—	—	4.0	0.2	0.005
„	26/7/31*	6.0	208.0	40.3	—	41.5	13.9	—	51.5	2.0	0.06	0.01
Tôro-ko	10/6/—**	7.35	—	39.4	2.3	—	3.1	1.5	—	20.3	0.3	—
„	13/10/—**	8.8	100.0	38.7	1.8	—	3.6	2.1	—	35.7	0.64	—
„	27/7/31*	—	131.2	29.0	—	6.0	7.2	—	11.2	23.0	0.76	0.03
Abashiri-ko	15/6/26**	7.4	353.0	—	—	85.5	10.8	16.8	—	10.5	0.1	—
Shikaribetsu-ko	8/29***	7.4	84.6	13.9	3.4	13.6	7.1	4.3	—	2.74	0.17	0.019
„	10/30***	7.5	78.2	24.2	4.7	11.7	5.5	3.3	—	3.98	0.076	0.003
Kabuto-numa	6/30***	6.7	80.4	15.0	4.1	14.6	3.8	3.1	—	38.88	0.333	0.002
„	9/30***	6.5	93.3	7.0	2.8	12.2	2.5	4.1	—	68.9	0.893	0.021

References for data: *YOSHIMURA (1931). **Reports of the Hokkaidô Fish. Exp. Station. ***Rep. Hokkaidô Fish. Exp. Station (*in litt.*).

than 85 mg. per litre. *Diaphanosoma brachyurum* and *Bosmina longirostris* endure a wide range of chloride, from 6 mg. to 85 5 mg. per litre. *Daphnia longispina* also shows a rather wide range of chloride tolerance (11.7–43 mg. per litre), while that of *D. cucullata* is comparatively limited. The occurrence of *Diaphanosoma brachyurum* in Abashiri-ko is of great interest, since this lake has a very high salinity (chloride 85.5 mg. per litre). REDEKE and VOS (1932) stated that this species occurs also in brackish water in Holland.

Calcium is found in all lakes in small quantities, usually less

than 20 mg. per litre but in a few cases more than 25 mg. per litre (Ô-numa). The medium of *Daphnia longispina*, *Diaphanosoma brachyurum*, *Bosmina logirostris*, *B. coregoni* and *Bosminopsis deitersi* contains various amounts of calcium as of the other salts, but *Daphnia cucullata* occurs only in water with a small calcium content.

The Magnesium content was estimated in a few lakes. Abashiri-ko shows the maximum value, having 16.8 mg. per litre and Akan-ko with 14 mg. comes next. Minimum values of 1.5–2.1 are obtained from Tôro-ko. Lakes of the dystrophic type usually contain small amounts of Mg and Ca. Akan-ko, one of the habitats of *D. longispina*, shows larger values, containing 14.1–14.2 mg. per litre of Mg, while two habitats of *D. cucullata* give smaller values: Tôro-ko with only 2.0 or less, and Shikaribetsu-ko, 3–4 mg. per litre in summer.

c. Concluding Remarks

Generally speaking, the scarcity of Cladoceran species in the lakes of Hokkaidô seems to be due to the relative deficiency of nutritive material in the water, i. e. the oligotrophic nature. There is further a chemical limitation. The inhabitants of Tôro-ko are represented only by four species in spite of the nutritive richness. This may be due to the presence of rather large amounts of humic substances (consumption of $KMnO_4$ 23–36 mg. per litre). Similar conditions are encountered also in other lakes. The Cladoceran fauna of Abashiri-ko, the only brackish water treated in this study, are scanty on account of the high salinity, although this lake contains a rather large amount of nutritive material. In Kutcharo-ko the most important cause of the poverty of species seems to be the high acidity and the relatively large amount of inorganic substances in solution, especially sulphate and chloride.

In alkaline waters of the oligotrophic type generally high in salt contents are found very numerous individuals of the eurytrophic cosmopolitan species, but relatively few species. In the lakes in the advanced stage of eutrophy in districts of milder climate, the number of species increases, and in provinces where there is a severe winter it is limited. When the pH of water falls below 7.0 owing to the presence of a large amount of humic substances, the number of species becomes very poor, and when the acidity attains as high as pH 5.0, only a very few species remain. For example, Kutcharo-ko, as mentioned above, has only two species.

Daphnia cucullata is confined to water of relatively small salt contents, but in *D. longispina* no such obvious correlation is observed

A similar condition is found also in other species of *Bosmina*, *Scapholeberis* and other genera. But in his extensive study of different habitats of *D. cucullata*, WAGLER (1923) could not find any obvious correlation between the physical and chemical nature of water and the occurrence as well as the body shape of that species. In the present study too, since the effect of each chemical component is difficult to separate, such a correlation is limited to a few species. In general its effect upon the body shape of the local races, for example *Daphnia longispina* and *Bosmina coregoni*, is inconspicuous.

In this connection, it is necessary to repeat here that *Daphnia cucullata* and *Bosmina coregoni* in two localities show a remarkable contrast in every characteristic. Tôro-ko contains a larger quantity of inorganic salts, peaty substances and nutritive material than Shikaribetsu-ko. *D. cucullata* living in this lake is characterized by a head with a pointed helmet and *Bosmina coregoni* of the same lake shows a peculiar shape in summer (*B. c. yezoensis*), while these two species in Shikaribetsu-ko are considerably different in appearance. In this lake *D. cucullata* has a shorter head and *Bosmina coregoni* has the ordinary appearance of those found in other oligotrophic lakes.

Summary

1. Plankton samples from 18 lakes and 7 small water-bodies in Hokkaidô were examined with special reference to the Cladoceran fauna.

2. 18 species of Cladocera are described. *Daphnia longispina* and *Bosmina coregoni* show the widest range of distribution. Two races of *D. cucullata*, with and without the helmet, were detected in two lakes.

3. Peculiar local variation is found among races of *Daphnia longispina* and *Bosmina coregoni*. One form of the first species with a round head and short spine is probably identical with an undifferentiated *Daphnia* (forma *primitiva* BURCKHARDT), and one type in the latter with straight antennae is believed to be a new subspecies.

4. Most species are cosmopolitan, but their distribution in Hokkaidô seems strongly influenced by climatic differences.

5. The paucity of the Cladoceran species in the lakes of Hokkaidô seems to be connected with the oligotrophic nature of the water. Weakly alkaline, less nutritive waters support a relatively large production of Cladocera, though few species.

6. No obvious correlation is found between the shape of species and the physical and chemical nature of the habitats.

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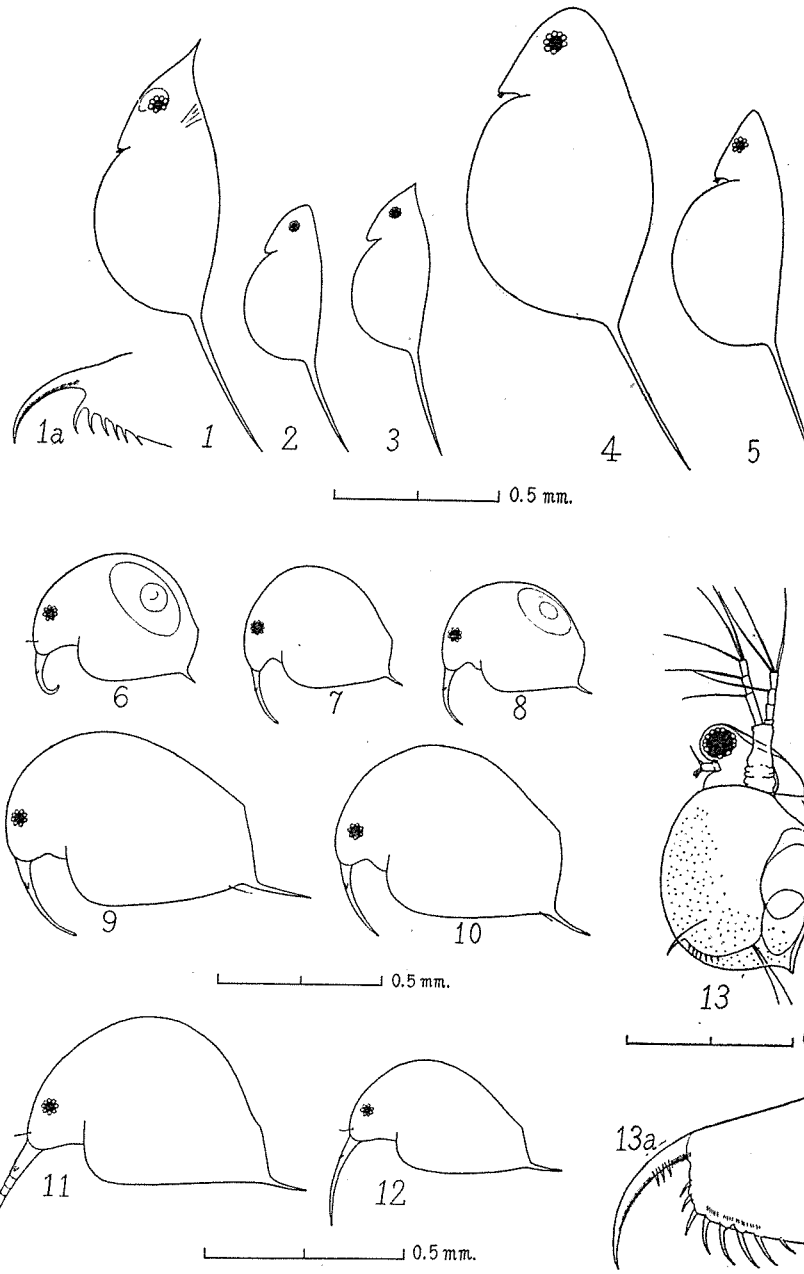
Explanation of Plates

Pl. X

Figs. 1–3. *Daphnia cucullata* G. O. SARS of Tôro-ko. August. Fig. 1a : claw of post-abdomen. Figs. 2 and 3 : young individuals.
Figs. 4–5. *D. cucullata* of Shikaribetsu-ko. August. Fig. 5 : younger animal.
Figs. 6–8. *Bosmina longirostris* (O. F. MÜLLER). Fig. 6 : Hangetsu-ko. Figs. 7–8 : Kuttara-ko.
Figs. 9–10 : *Bosmina coregoni* BAIRD. August. Fig. 9 : Shikaribetsu-ko. Fig. 10 : Akan-ko.
Figs. 11–12. *Bosmina coregoni yezoensis* subsp. nov. of Tôro-ko. August.
Figs. 13–13a. *Ceriodaphnia reticulata* (Jurine) of a shallow pond in Sapporo. July. Fig. 13a : Claw and anal spines of post-abdomen.

Pl. XI

Figs. 14–15. *Daphnia longispina* of Tôya-ko. Fig. 14 : ephippial female taken on 21st August, 1930. Fig. 15 : parthenogenetic female. 31st July, 1931.
Figs. 16–17. *D. longispina* of Shikotsu-ko. August. Fig. 17 : neonata.
Fig. 18. *D. longispina*, *primitiva*-type of Panké-ko (Prov. of Kushiro). August.
Figs. 19–21. *D. longispina*, *primitiva*-type of Kutcharo-ko. Parthenogenetic females taken on 16th Aug., 1930 (Figs. 19–20) and neonata taken. on 26th July, 1931 (Fig. 21).
Figs. 22–23. *D. longispina*, small race with short head living in Shikaribetsu-ko.
Figs. 24–26. *D. longispina* of Akan-ko, showing three different forms.
Fig. 27. *D. longispina*, large ephippial female found in Mashû-ko. August.



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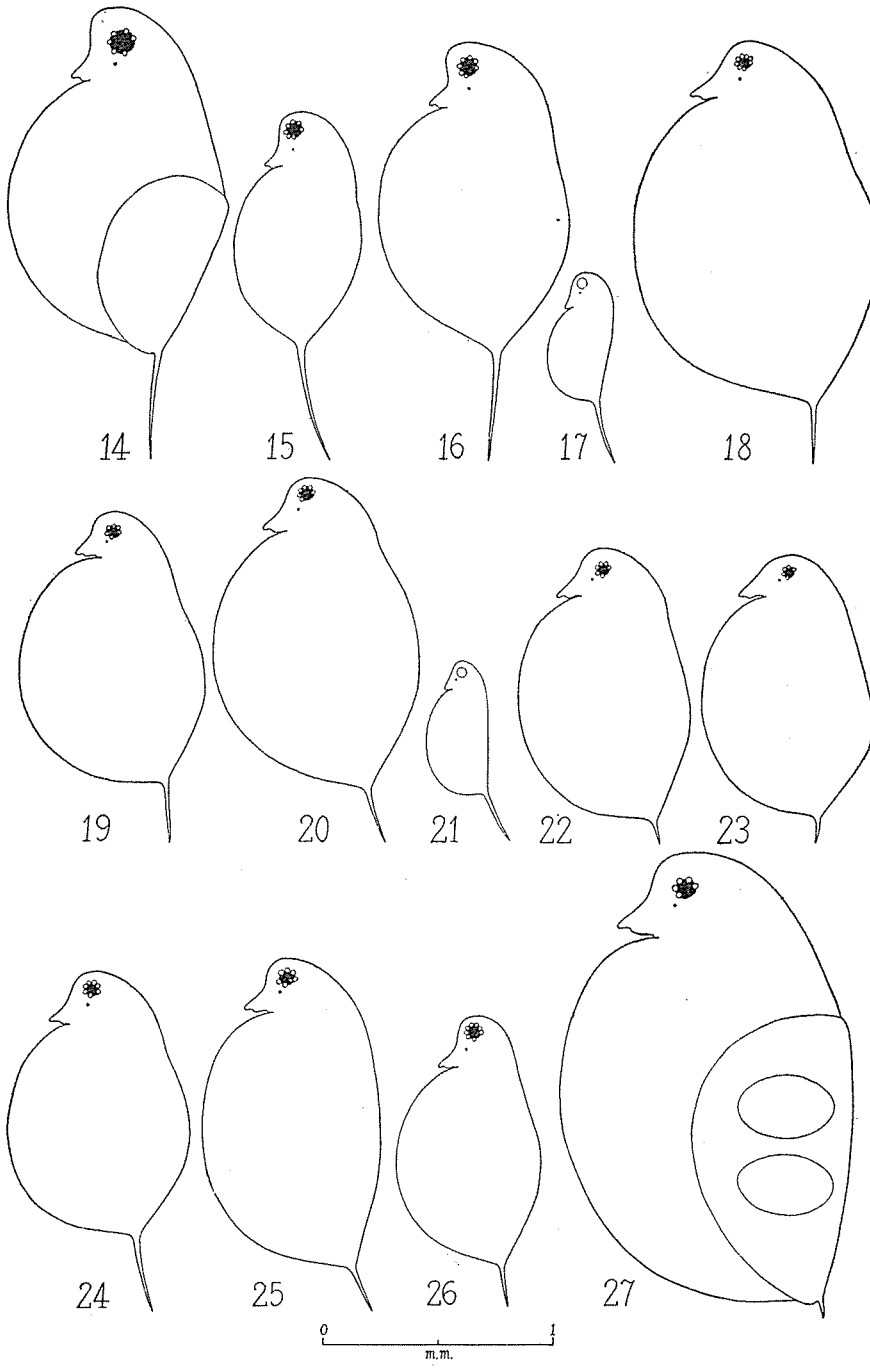

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