ZOOPLANKTON OF THE SOME ALPINE PONDS ON MT. HAKUSAN

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白山の高山池沼の動物プランクトン

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In the alpine range of Mt. Hakusan, there are a number of ponds of various forms and sizes, and also of various origins. It has been known that there live some species of zooplankters, such as *Acanthodiaptomus pacificus* and *Chydorus sphaericus* in the several ponds (TOGASHI, personal communication), but there has been no report on the plankton fauna and distributions of the plankters among these water bodies. The senior auther (HIRAI) had oppotunities to make collections of plankton at the region.

In the present report, a short account is given to the fauna of the zooplankters, based on the materials collected from eleven water bodies scattered in the alpine range in the summers of 1978, 1979 and 1982 and the autumn of 1982. The collection of plankton was made by five times hauling of a 15-mesh net 20 cm in diameter with 5 m rope.

Before going further, we wish to express our thanks to Messrs. Makoto YAMADA and Noboru TAKEHARA the Faculty of Education, Kanazawa University, for their kind assistance in our collection. We also thank for the kind permission from the Shirayama-hime Shrine, and want to note that the study by the junior author was partially supported by the fund for the natural historical studies of the alpine zone of Mt. Hakusan granted by Ishikawa Prefecture.

Water bodies

The water bodies investigated by the writers are as shown in Table 1 and its location in Fig. 1. The six lakes listed in the upper part of the table (nos.1～6) were located near the summit of the mountain, between 2560 and 2590 meters above sea level. These six lakes seem to have been formed by volcanic actions which happened in geological past (YAMASAKI *et al.*, 1964).

Midoriga-ike, which is the largest lake in the present study, is deep crater lake fed by rain and melted snow at the southern wall. The igneous rocks and stones are lying on greater part of the surface of the bottom, and no organic sediments were found any where in the bottom. Koyaga-ike is also a crater lake, and environmental conditions resemble closely those of Midoriga-ike, exclusive of being of small size. Aburaga-ike, which is an oval in form, is about 870 m^2 in superficies. In autumn, the lake sometimes goes down or runs dry as its water soaks into the ground.

Chino-ike is situated in the basin with igneous ashes and sands. Thus, whitish turbidity due

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Table 1. Characters of water bodies in the alpine range of Mt. Hakusan

	Name of water bodies	Altitude (m)	Area (m^2)	Depth (m)	Origin	Water temperature(℃) Aug. 4	Oct. 16	pH Oct. 16	Bottom sediment
1	Goshiki-ike	2565	60	1~2	depression	16.0	6.2	5.7	rocks & sand
2	Hyakusho-ike	2565	100	1.5	depression	5.0	6.2	5.8	rocks & sandy mud
3	Chino-ike	2576	680	1.5	crater	15.6	5.1	5.6	ash, sand & rocks
4	Konyaga-ike	2680	1400	?	crater	10.5	4.8	5.5	volcanic rocks & sand
5	Midoriga-ike	2660	8370	?	crater	9.8	5.0	4.9	volcanic rocks & sand
6	Aburaga-ike	2680	870	2.0	depression	5.0	4.6	5.2	gravel & mud
7	Tonoga-ike I	2025	15	0.2	natural dam	12.0	15.3	5.7	humus & litter
8	Tonoga-ike II	2020	10	0.4	natural dam	8.5	11.0	5.1	humus
9	Fukube-ike	2445	20	0.2	bog, depression	—	7.5	5.8	litter & gravel
10	Nanryu pond	2015	10	0.2	bog	—	13.0	5.8	humus
11	Jinnosuke pond	1940	15	0.5	bog, depression	—	12.2	5.1	humus

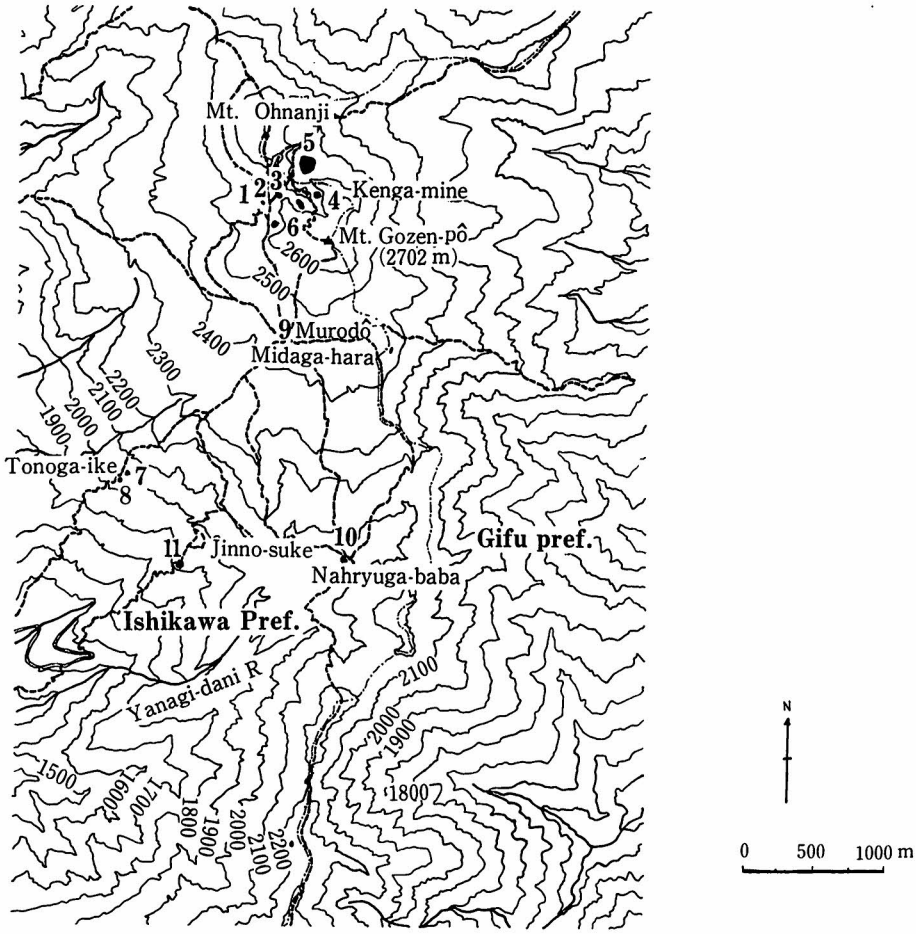

Fig. 1. Map of the study area, Mt. Hakusan in central Honshû, and the locations of the ponds (numerals see Table 1). Dashed lines show paths.

to suspended ash particles was always seen in the water. On the surface of the bottom, there are a small amount of fragments of fallen plants from marginal area.

Hyakushô-ike and Goshiki-ike are both small lakes lying in the ground of igneous rocks. Owing to the melted water of the snow which was lying contiguously to the Hyakushô-ike, the water temperature of the pond was fairly low even in the summer season. The color of both of the waters were reddish brown.

Fukube-ike is a small and shallow pond located on the Murodô-daira Plain. In this pond, a thin layer of detritus deposits on the surface of the gravelly bottom was observed, and aquatic plants like rush grew thick around the marginal zone of the pond.

The form and size of the Nanryû pond, situated on the Nanryû Plain, resemble closely those of Fukube-ike except that Nanryû pond has a thick layer of brownish humus deposit on the bottom.

There are two small ponds, one of which is called Tonoga-ike (we named Tonoga-ike II) and the other is a nameless pond (Tonoga-ike I), abutting on the Kankô-shindô path. These ponds seem to be formed naturally by damming up the water course, and have thick layer of brownish humus deposit on the bottom. The water surface is covered with aquatic plants. Tonoga-ike I is always fed by a streamlet oozing out of grounds, and the water discharges at the opposite corner. On the other hand, the drain connected with Tonoga-ike II always runs dry in the summer season. The water color of the pond is strongly brownish for the humus.

The pond at Jinnosuke, which lies about 50 meters below the Jinnosuke refuge hütte, is a depression filled with collected water. Greater part of the bottom was covered with a considerable amount of fragments of fallen leaves from the surrounding clump of the pond. The color of the water is pale brown.

Plankton fauna

The plankton fauna and the relative abundance of zooplankters observed by writers in the waters are as shown in the Table 2. Three species of Copepoda, three Cladocera and a Rotifer were found in the materials collected from nine water bodies. As for Koyaga-ike and Aburaga -ike, no plankton organisms were found in materials obtained from these lakes throughout the present surveys. This fact seems to suggest that these two waters are not habitable for zooplanktonic species.

The species which appeared the most extensively and abundantly in the lakes and the ponds are *Acanthodiaptomus pacificus* and *Chydorus sphaericus*. The dominant species, *A. pacificus*, was not found in Chino-ike and in Midoriga-ike among the nine waters shown in the Table 2. Also *C. sphaericus* did not occur in Midoriga-ike and the pond at Jinnosuke. *Eucyclops serrulatus*, *Maraenobiotus brucei* and *Alona quadrangularis* were partly found in a few lakes and ponds, and were small in quantity at all the water bodies. On the other hand, *Daphnia ambigua* occurred in only two ponds, the pond at Jinnosuke and Tonoga-ike II, which have a large quantity of detritus or organic sediments on the surface of the bottom and whose water color is brownish. A rotifer, which is not identfied yet, is found only in Fukube-ike. The reason why this species occurred in

this pond is not known, but it is interesting to note that two species of desmids also occurred only in this pond.

Table 2. Zooplankton in alpine lakes and ponds of Mt. Hakusan

name of pond	Midoriga-ike	Goshiki-ike			Hyakusho-ike			Chino-ike				Tonoga-ike I		Tonoga-ike II		Fukube-ike	Nanryu pond	Jinnosuke pond
Name of species	Oct. '82	Aug. '79	Aug. '82	Oct. '82	Nov. '78	Aug. '82	Oct. '82	Nov. '78	Aug. '79	Aug. '82	Oct. '82	Aug. '82	Oct. '82	Aug. '82	Oct. '82	Oct. '82	Oct. '82	Oct. '82
Acanthodiaptomus pacificus		CCC		*	rr		r					+	C	C	CC	+	C	CCC
Eucyclops serrulatus				*								+	C	rr	rr	rr	+	rr
nauplii		r	CC	*								r						
Maraenobiotus brucei	rr		rr	*	r	r	r			rr	rr						rr	
Daphnia ambigua														r	C			CC
Alona quadrangularis		rr	r	*	rr								rr				rr	
Chydorus sphaericus		r	+	*	rr	r	+	r	+	C	+	CCC	CC	C	+	r	+	
Rotifer (Bdelloidea)																+		

rr : very rare, r : rare, + : common, C : numerous, CC : very numerous, CCC : exceedingly numerous
* : present but abundance is not known

Some notes on the species

Acanthodiaptomus pacificus (BURCKHARDT)

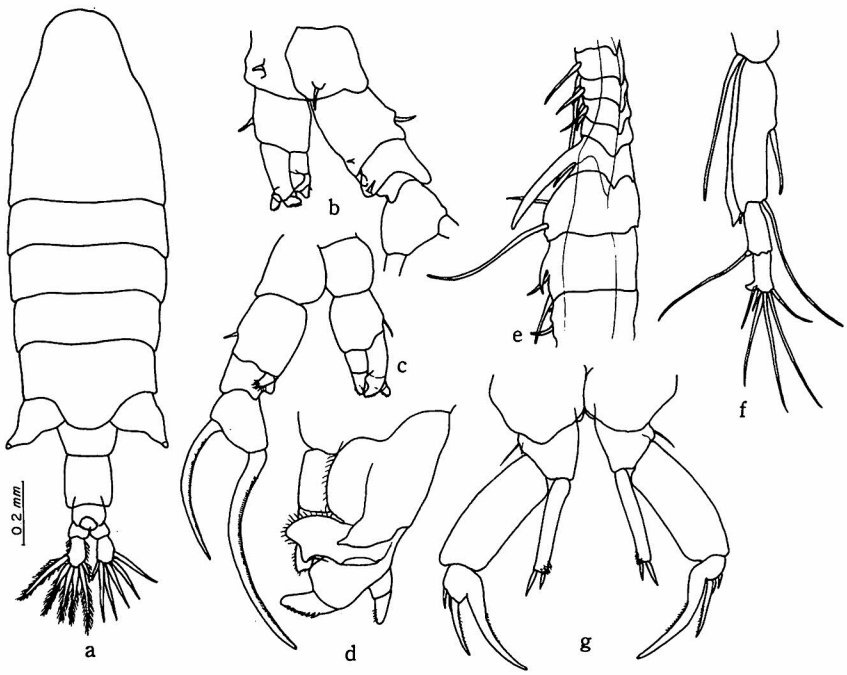

Fig. 2 *Acanthodiaptomus pacificus* (BURCKHARDT)
(a) dorsal view ♀ (b) dorsal view of leg 5 ♂ (c) ventral view of leg 5 ♂ (d) detail anterior aspect of left pods of leg 5 ♂ (e) segments 9 to 15 of right antenna ♂ (f) apical three segments of right antenna ♂ (g) leg 5 ♀

This species is very widely distributed in the mountain lakes as well as in the lowland lakes and ponds from Hokkaidô to Kyûshû in Japan (MASHIKO and INOUE, 1952 ; ITO, 1953 and KADOTA, 1971). In the Hokuriku District, this species was occasionally found in some brackish water lakes distributed along the coast of the Sea of Japan (MASHIKO, 1955 and MASHIKO and INOUE, 1952), and also occurred in ponds lying on Midaga-hara Plain on Mt. Tateyama (TANAKA et al., 1975).

In the present study, this copepod was widely found in the lakes and ponds, and it was especially abundant in distrophic waters of various extents. As pointed out by KADOTA (1971), this Copepoda seems to be one of the characteristic species in alpine lakes and ponds.

The general morphological characteristics of the specimens collected in lakes on Mt. Hakusan (Fig. 2), agree with the description made by ITO (1953). All of the individuals obtained were markedly reddish brown.

Eucyclops serrulatus (FISCHER)

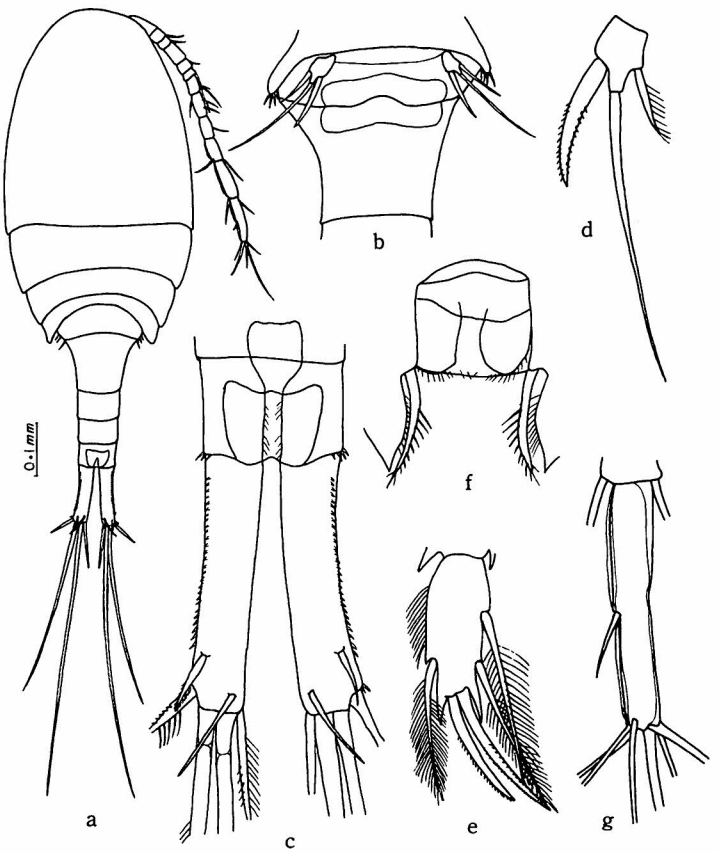

Fig. 3A *Eucyclops serrulatus* (FISCHER) ♀
(a) dorsal view (b) genital segment with outline of seminal receptacle and leg 5 (c) dorsal view of last body segment and caudal rami (d) leg 5 (e) terminal segment of endopod, leg 4 (f) connecting plate, leg 4 (g) last segment of first antenna.

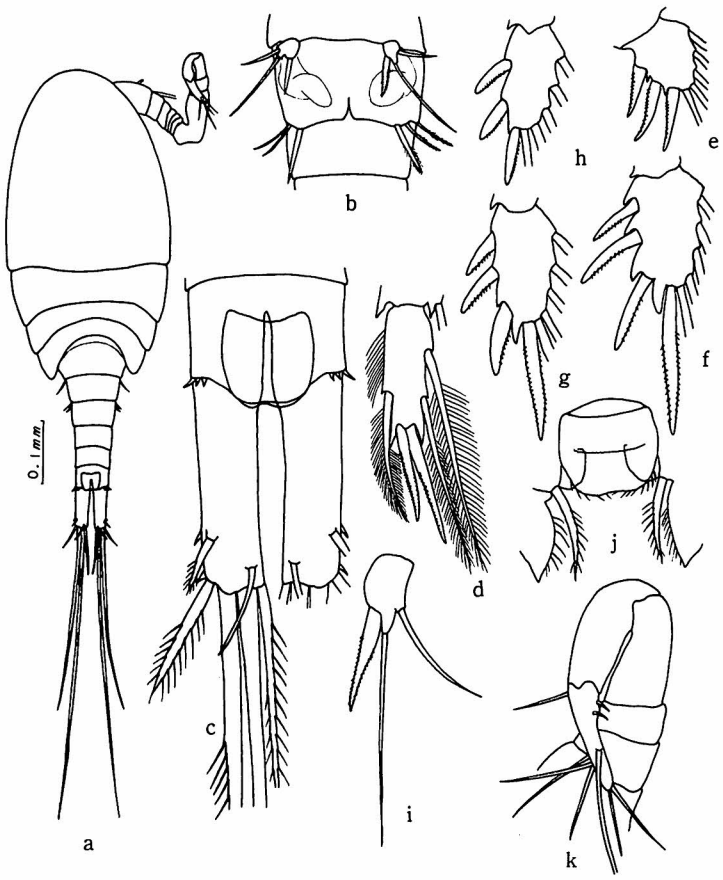

Fig. 3B *Eucyclops serrulatus* (FISCHER) ♀
(a) dorsal view (b) ventral view of first and second abdominal segments with legs 5 and 6 (c) dorsal view of last body segment and caudal rami (d) terminal segment of endopod, leg 4 (e)~(h) terminal segment of exopod, legs 1 to 4 (i) leg 5 (j) connecting plate, leg 4 (k) last five segments of first antenna

This species was found widely in distrophic ponds, though its density was not so high as *A. pacificus* was. MASHIKO and INOUE (1952) reported that this species was found in two lakes in Ishikawa Prefecture, Lake Ôchi-gata and Lake Kiba-gata, and KADOTA (1971) also reported that it was found in Midori-ike on Mt. Yatsugatake. But in the alpine lakes of Hokuriku District, this species had not been found till present surveys.

Some morphological remarks are as follows:

Female: Length 0.8-1.1 mm. Furcal rami variable in length, 3.8-4.8 times as long as wide; outer margin with lateral denticles (Fig. 3Ac). First antenna of 12 segments reaching beyond cephalothrax; last three segments with a narrow hyaline membrane (Fig. 3Ag).

Male: Length 0.7-0.9 mm. Furcal rami without lateral denticles (Fig. 3Bc), shorter than female, 2.7 to 3.7 times as long as wide. Distal part of first antenna as shown in Fig. 3Bk.

Lengths of furcal setae from the inner to the outer, the lateral and the dorsal, in both sexes

are as follows:

		length	I (in)	II	III	IV (ou)	V (la)	VI (do)	
Tonoga-ike I	♀	1020	88	382	274	65	24	53	μ
	♂	740	73	485	295	73	41	48	μ

Maraenobiotus brucei (RICHARD)

Only three adult specimens of this species could be obtained in Chino-ike, during the present surveys. The specimens collected in Chino-ike, we identified as *Maraenobiotus brucei* because of its morphological characteristics described below. But further study on the taxonomy of this species may be needed.

Female: Length 0.45-0.50 mm. Body white in color. Anal operculum with 7 to 11 spinules (Fig. 4h). Post-ventral margin of anal segment with discontinuous spinules (Fig. 4i).

Caudal rami short, 1.2 to 1.3 times as long as wide, with group of inner medial and ventral side of distal spinules (Fig. 4h). First antenna with 8 segments (Fig. 4b).

Leg 1 endopod slightly longer than or as long as exopod; leg 2 to leg 4 endopods not reaching beyond exopod segment 2. Legs 1 to 4 segment formula 2,2/2,3/2,3/2,3, apical exopod segment with 5,4,5,5 spines and setae, endopod segment 2 with 3,4,5,5 setae and spines. Leg 5 basal

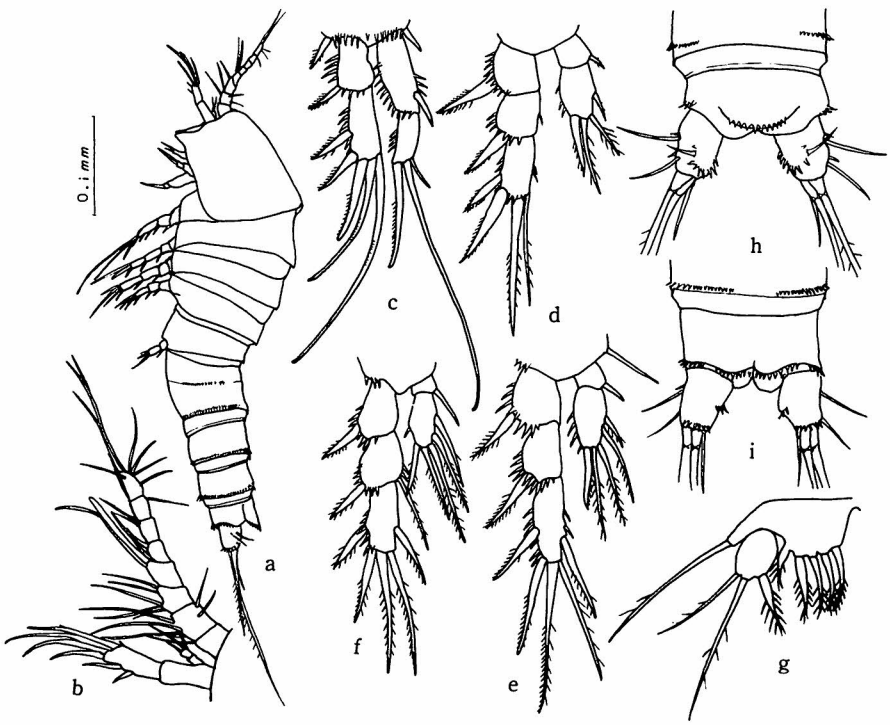

Fig. 4 *Maraenobiotus brucei* (RICHARD)
(a) lateral view (b) antennule and antenna (c) leg 1 (d) leg 2 (e) leg 3 (f) leg 4 (g) leg 5 (h) dorsal view of last body segment and caudal rami (i) ventral view of same

expansion with 5 setae, exopod with 3 setae (Fig. 4g).
Male : Adult was not found.

So far as we know, up to the present there has been no record on the existence of this species in Japan.

Daphnia ambigua SCOURFIELD

According to UENO (1959), this *Daphnia* is known as a characteristic species of alpine lakes in the Tôhoku District and Hokkaidô Island. In the Hokuriku District, this species was first recorded by UENO and TANAKA (1960) to exist in the lakes on Mt. Tateyama, Lake Mikuriga-ike and Lake Midoriga-ike, and according to TANAKA *et al.* (1975) the daphnid also lives in the ponds at Midaga-hara Plain on Mt. Tateyama. It became manifest from the present survey that the southern limit of its geographical distribution was extended to the Mt. Hakusan region.

A general morphological characters of both sexes are as shown in Fig. 5. As seen in UENO and TANAKA (1960), morphological variations of the species, especially in the length of the shell spine, are very large irrespective of sex (Plate II).

Alona quadrangularis (O. F. MÜLLER)

This species is generally regarded as one of the few Cladocera occurring in alpine lakes, and it was found in such regions as Mt. Tateyama (TANAKA et al.,1975) and Mt. Yatsugatake (KADOTA,

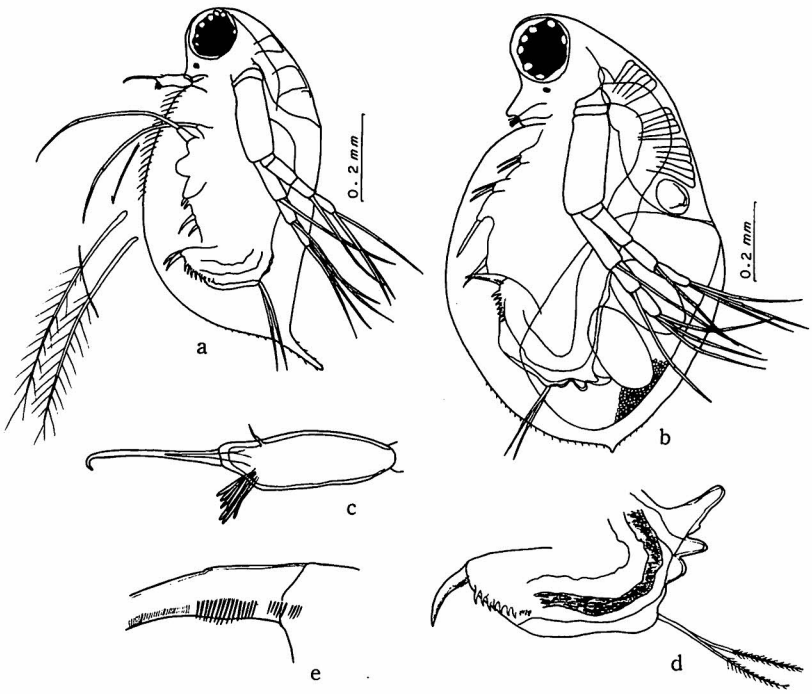

Fig. 5 *Daphnia ambigua* SCOURFIELD
(a) male (b) female (c) first antenna of male (d) postabdomen, female
(e) postabdomen claw with basal combs

1971). A few specimens, which are recognizable as male of this species, were found in the materials collected from Hyakushô-ike and Tonoga-ike II on October 16, together with a small number of ephippial females.

Some morphological remarks are as follows:

Length of well-grown female 0.80 mm, yellowish or brownish in color. The postabdomen is rather elongated, and distal end rounded. On each side of dorsal margin of female with about 14 denticles and group of spinules on the lateral side corresponding to the denticles (Fig.6b); dorsal side of male with spinules instead of denticles (Fig. 6c).

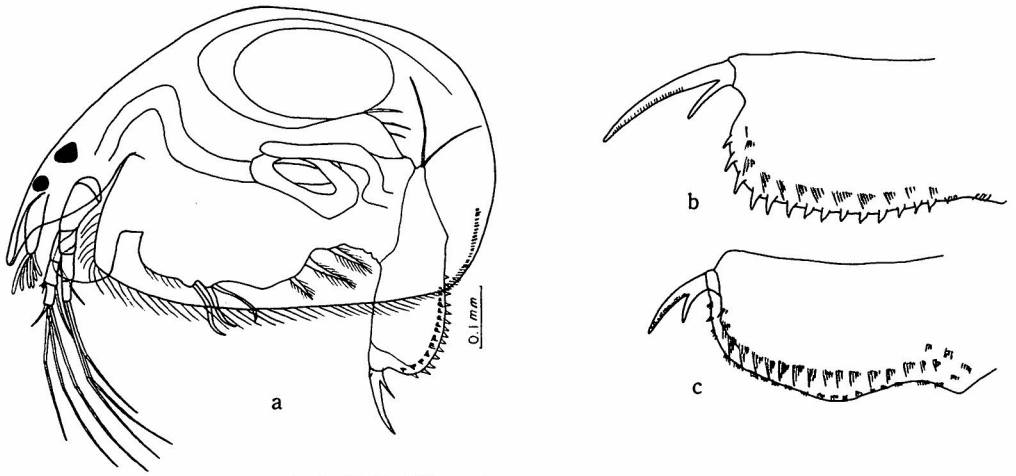

Fig. 6 *Alona quadrangularis* (O. F. MÜLLER)
(a) female (b) postabdomen ♀, with marginal anal spines (c) postabdomen ♂, without anal spine

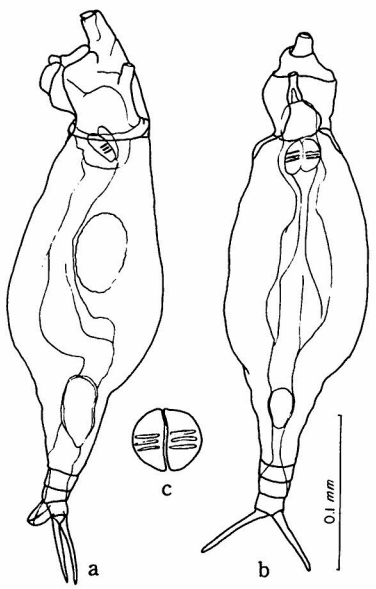

Fig. 7 Rotifer (Bdelloidea)
(a) lateral view (b) dorsal view
(c) ramate trophi

Chydorus sphaericus (O. F. MÜLLER)

This species is one of the most predominant forms not only in alpine lakes but also in lowland lakes and ponds, being found commonly in weedy waters. In the present study, this cladoceran was also found at many ponds, and it occurred abundantly especially in Tonoga-ike I, where aquatic plants grew thick almost all over the surface.

Rotifer (Order: Bdelloidea)

As the specimens obtained in the present surveys were preserved with formalin, the ciliated corona, which is an important character for identification was contracted into the somatic cavity. For this, the species name could not be decided, but it is certain that the rotifer belongs to Bdelloidea judging from its ramate trophi (Fig. 7c).

Summary

A short account is given to the zooplankton of alpine lakes and ponds on Mt. Hakusan. Three species of Copepoda, *Acanthodiaptomus pacificus, Eucyclops serrulatus* and *Maraenobiotus burcei,* three species of Cladocera, *Daphnia ambigua, Alona guadrangularis* and *Chydorus sphaericus,* and a species of rotifer are recorded in the present surveys. In nine lakes and ponds out of eleven, the zooplankton consisted of 1-5 species, among which *A. pacificus* and *C. sphaericus* occurred most widely and abundantly. In the other two lakes, located near the summit of the mountain, no plankton organism was found throughout the present surveys.

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要　　約

白山の高山帯池沼の動物プランクトン相とプランクトンの生態を知るために調査を進めているが，本報ではその一段階として，プランクトン相の概略を述べた。今回は 11 の池沼で採集を行った結果についてふれた。

翠ヶ池・紺屋ヶ池・血ノ池・油ヶ池・百姓池・五色池の 6 つは山頂付近に存在し，いずれも火山活動によって形成されたと考えられる池である。これらのうち，前三者は火口湖と考えられているもので，翠ヶ池と紺屋ヶ池の水深は深い。ふくべ池は室堂平にある小さな浅い池で，池底に薄い有機物の堆積が認められる。南竜の池も小さなもので，池底には有機物が堆積する。

殿ヶ池には池が 2 つ存在する。標高の高い方の池（殿ヶ池 I）にはたえず小量の水が流れ込んでいて，水面を被う水生植物が生えている。もう一方の池（殿ヶ池II）は，夏季の平時には水の流入が無く，褐色をした腐植栄養の池である。また水生植物も若干認められる。甚之助の池は，凹地に水の貯ったもので，周囲のかん木からの落葉の多い腐植栄養型の池である。

以上の池の水温，pH・水深ほかの環境条件は Table 1 に示すとおりである。

これらの池のうち，紺屋ヶ池，油ヶ池の2つについては，各4回の採集でプランクトンは見つかっていない。残りの9つの池では，それぞれ1～5種の生息が確認されていて，計7種が見つかっている。その7種は以下に示すものであるが，ワムシについては種名を確めることができなかった。

Acanthodiaptomus pacificus (BURCKHARDT)
Eucyclops serrulatus (FISCHER)
Maraenobiotus brucei (RICHARD)
Daphnia ambigua SCOURFIELD
Alona quadrangularis (O. F. MÜLLER)
Chydorus sphaericus (O. F. MÜLLER)
Bdelloidea の1種（種名は不明）

M. brucei 以外の6種はいずれも他地域の高山帯に出現している種で，種類構成からは共通点がある。これらの種の中で，*A. pacificus* と *C. sphaericus* は最も多くの池に出現し，生息量も多い。*D. ambigua* は殿ヶ池IIと甚之助の池にのみ出現したが，これらの池は腐植栄養型で水は褐色をしている。この種は東北地方以北の高山湖と立山の湖に出現している記録があるが，今回の発見は分布の南限を白山域まで広げたことになる。

M. burcei は5つの池で見つかったが，採集された量は少なく，特に成体は3個体と少ない。この種については，日本での採集記録が見当らないので，白山での記録が最初であると思われる。

以上のほかにワムシが1種見つかっているが，種名は未確認である。そしゃく板の形態は Bdelloidea に特徴的な枝部型をしている。

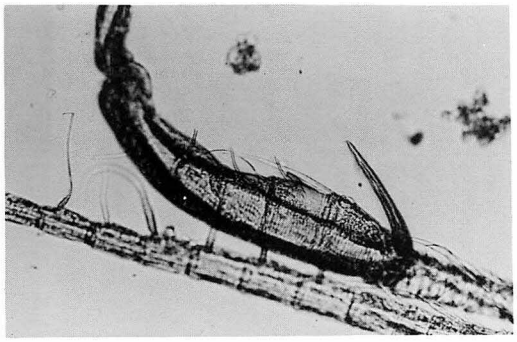
EXPLANATIONS OF THE PLATES

Plate I. *Acanthodiaptomus pacificus* (BURCKHARDT), A-D, (A) apical segments of right antenna of male, (B) lateral view, (C) leg 5 of male. (D) last body segments. (E) *Eucyclops serrulatus* (FISCHER), female ventral view. (F) *Maraenobiotus brucei* (RICHARD), young dorsal view.

Plate II. *Daphnia ambigua* SCOURFIELD, A-D, (A) : male, (B) : female, (C & D) : shell spines of females. *Chydorus sphaericus* (O. F. MÜLER) E-F, (E) : lateral view, (F) : postabdomen.

PLATE I

A



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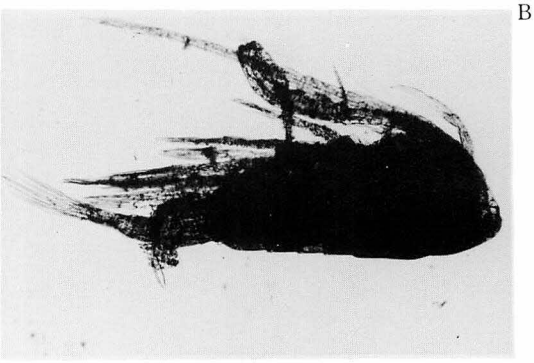
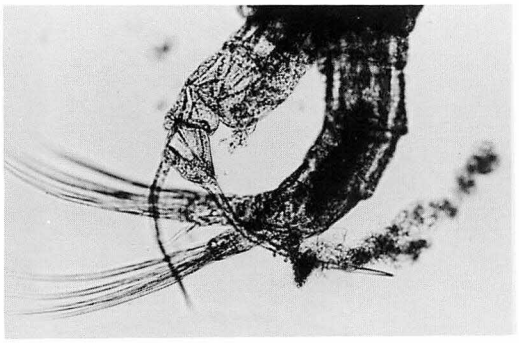


C



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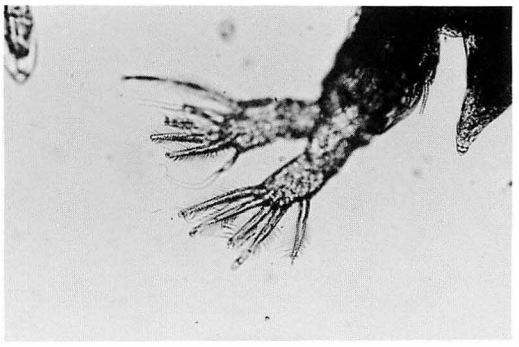

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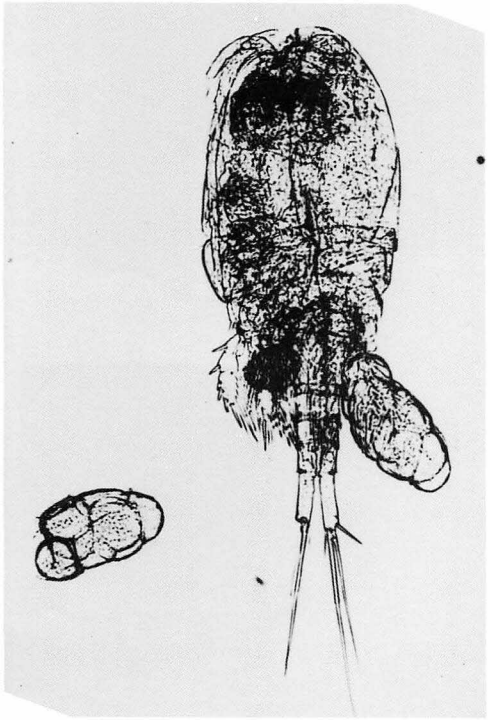

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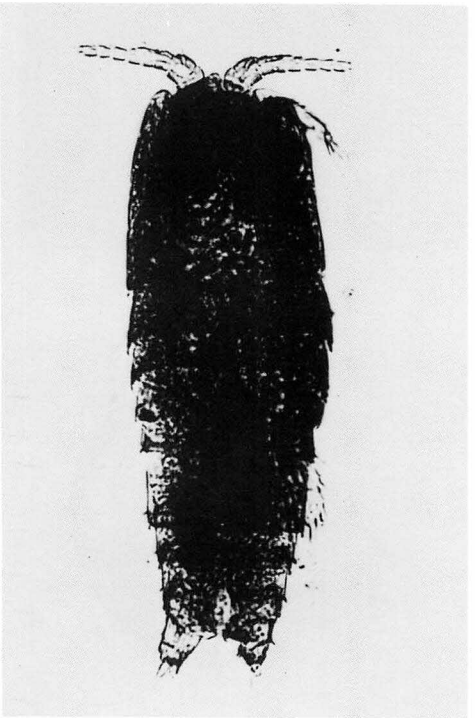
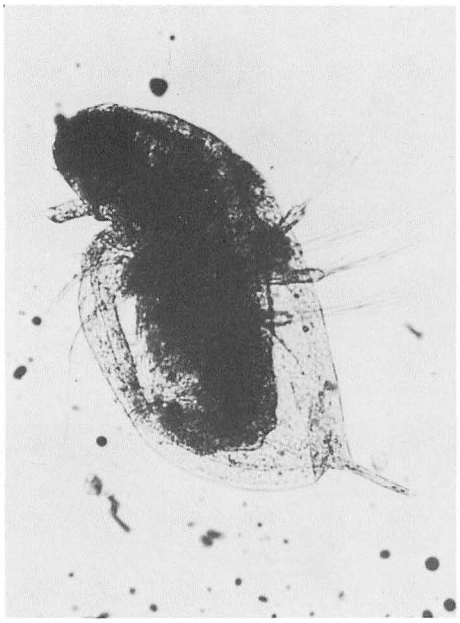


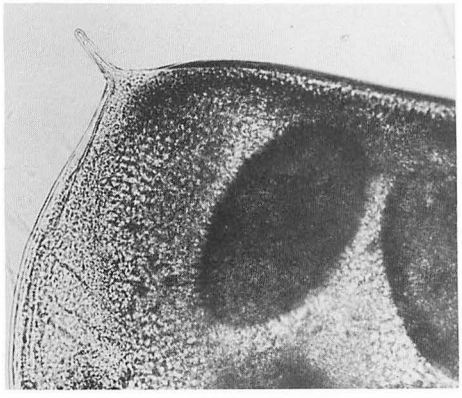
PLATE II

A



B

C



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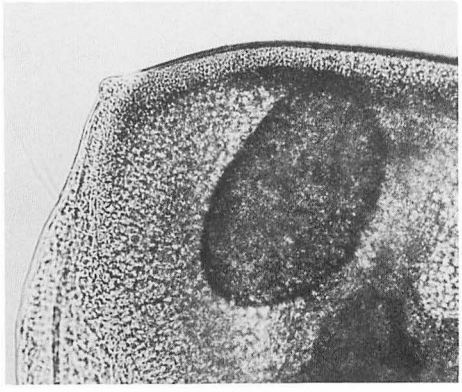

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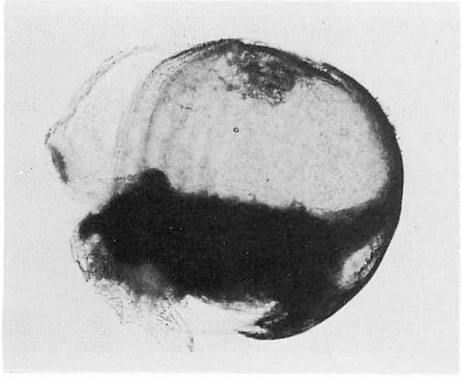

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