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Aquatic Insect Survey of the River Kaunnai, with Special Reference to the Rocky Chute Bed Fauna*

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Synopsis The stream insect fauna in the River Kaunnai was surveyed. Total 50 species collected belong to four orders, Ephemeroptera, Plecoptera, Trichoptera and Diptera, except for one coleopteran species. On the basis of distribution of the insects the Kaunnai can be divided into three parts, up-, mid- and downstream. The fauna of the upstream part above timber-line is much simpler than that of the other parts. In midstream there are two main habitats, rocky chute stream bed (RC) and usual stream bed (US). The faunal makeup at RC is simpler than at US, reflecting the simpler substratum conditions of RC.

Recently several surveys on the stream insects have been carried out in Hokkaido (KIKUCHI, 1956; TOKUI and INOUE, 1968; ATODA and IMADA, 1972 a, b; OKAZAWA, 1974), but the needed information is still poorer than in other areas of Japan and confined to the rivers at lower altitudes. The aim of the present survey is twofold. First, it was attempted to accumulate the additional basic data on stream insect assemblage and distribution of each species in Hokkaido, and the river Kaunnai was chosen with the section running through the high mountain area above timber-line. The second purpose is to clarify the faunal makeup at rocky chute, the most characteristic part in this river, where water flows on the smooth rocky bottom realizing a sliding bed. The survey was conducted on July 7–13, August 21–27, 1971 and July 20–August 3, 1972.

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Description of the river surveyed. The Kaunnai is one of the numerous tributaries of the River Ishikari, born at the Daisetsu mountains, Central Hokkaido. From about 1,650 m high at the north col of Mt. Tomuraushi (2,141 m), a non-active volcano, with the snow valley remaining throughout the year, the river runs horizontally for ca. 11.5 km and falls vertically ca. 1,100 m (Fig. 1 a) till the confluence with the River Chubetsu at 560 m, which becomes the Ishikari at plains and finally enters into Ishikari Bay.

* Stream insect surveys in Hokkaido, II.

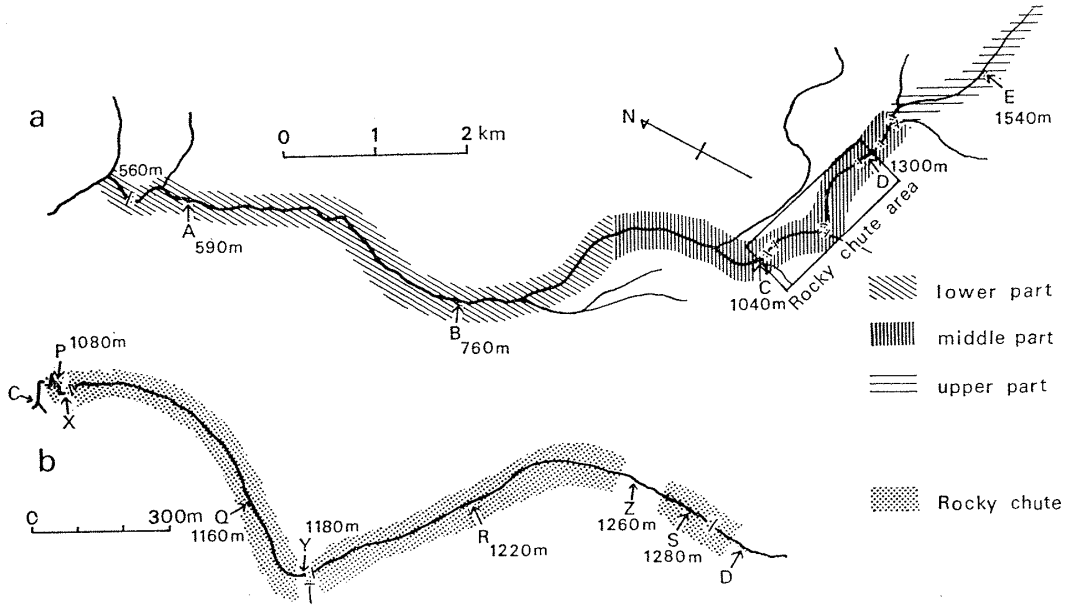

Fig. 1. The River Kaunnai with indication of sampling stations, altitudes, etc. a, General view; b, ditto.

By its scenery the Kaunnai can be divided into three parts, lower, middle and upper ones, each with physical and topographical features summarized in Table 1 (cf. also Fig. 1 a). The most characteristic part is the rocky chute section (Fig. 1 b), continuing for about 1.8 km in the middle part with rocky chute stream bed (henceforth abbreviated RC, while the section with usual stream bed US) and three fall-basin sets. The floor of RC consists of smooth slab like andesite plates, virtually without stones and sand except at basins and short riffles immediately below them. Water flows on the rock plate smoothly. RC is patchedly covered with mosses which are especially abundant at rocky cracks, on jugged rock plates and shores. The water depth is shallow, less than 40 cm except the basins. The current speed varies at different sampling points according to the inclination. The river runs through primary forest uninhabited and seldom visited by men, retaining primary conditions without any pollution except near a dam at 0.5 km upstream from the confluence with the River Chubetsu, where an elongate artificial lake is made for ca. 1 km.

In total twelve stations were chosen. Among them, five, A–E, were selected at non-RC section, two of which (St. A and B) are in the lower part, two (St. C and D) in the middle part surrounded by forest and last one (St.E) in the upper part within the area above timber line (Fig. 1 a). Affected by the remaining snow, water temperature at St. E was only about 4°C even in the summer. At St. A it rose up to 13°C in the daytime but decreased remarkably at night. Daily change of water and air temperatures at RC section on July 25–27, 1972, is shown in Fig. 2. The substrata of all five stations consist of pebble or gravel. At St. E stones are very jagged and pitted as characteristic in volcanos, whereas stones in the middle and lower parts, especially in the latter, are much rounded off. Among seven stations chosen in RC section, four (St. P–S) were provided with RC and three (St. X–Z) with US at

Table 1. Topographical and physical features of three parts.

	Lower part (St. A and B)	Middle part (St. C and D)	Upper part (St. E)	Rocky chute section (St. P–S and X–Z)
General features	Riffles long and pools large. Few exposed rocks. Water level higher than other two parts.	With small water falls and pools. Many big rocks exposed.	Shores narrow. Water level variable but usually low. Water trickling except snow melting season and in heavy rain.	Water flowing on the flat rock plates.
Approximate altitude	560–930 m	930–1,440 m	1,440–1,650 m	1,040–1,340 m
Approximate length	7 km	3 km	1.5 km	1.8 km
Inclination	Mild, 53/1,000	Very steep, 170/1,000	Very steep, 167/1,000	
Bed type after KANI's system	Aa–Bb	Aa	Aa	
Vegetation along shores	Forest	Forest	Alpine grassland dominated by bamboo with shrubs	Forest
Maximum temperature	13.6°C (St. A)	12.5°C (St. C)	4.1°C (St. E)	
PH (summer in 1974)	6.0 (St. A)	6.0 (St. C)	6.2 (St. E)	

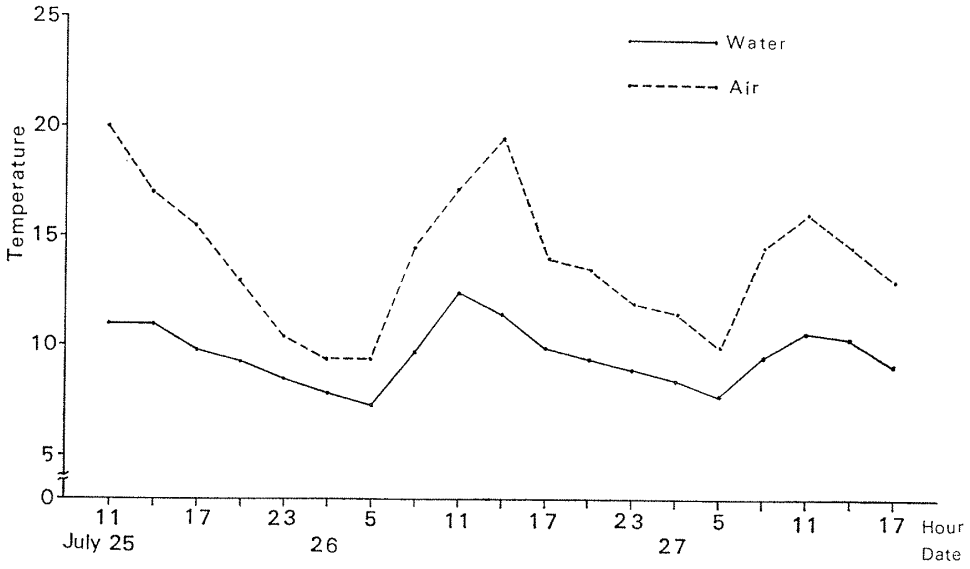

Fig. 2. Daily change of water and air temperatures at St. R on July 25–27, 1972.

fall-basin sets (Fig. 1 b). There were still much snow remaining at stream source in July 1971, but mostly thawed before late August. Correspondingly, the water level decreased remarkably, especially at St. E. In 1972 remaining snow was scarce in July as compared with the preceding year.

Method. Sampling was programed as follows:

	non-RC	RC
July 1971	Two samples from riffle at each of A–E	14 samples from P 10 samples from S
August 1971	Two samples from riffle, at each of A–E	25 samples from R
July–August 1972	Three samples from riffle, one from pool at each of A, B and E. Five samples from riffle, two from pool at each of C and D. At each of X–Z three samples from riffle.	19 samples from P 17 samples from Q 19 samples from R 21 samples from S

At RC samples were taken from arbitrarily chosen sites except in July 1971, in which sampling sites were chosen along the line crossing the stream.

Sampling was made using a metal quadrate (50 cm × 50 cm) with a sieve of dust-pan-shaped (0.4 mm mesh) at US (St. A–E and X–Z). Holding the sieve at just downstream the stones to be moved to sift the insects drifted, the collector put the stones and sand within the quadrate into the sieve and transferred them to the vat on the shore. Then insects attaching on stones, mixing in sand and sifted were collected. At RC (St. P–S) the method was slightly modified because of the peculiar floor structure. Instead of the sieve, the sift net was held at the downstream edge of quadrate. The collecter cleaned out the insects attaching on bed surface within the quadrate by means of nylon brush. The drifting insects were received by the net and preserved. Current speed was measured by the Pitot tube, at US at the water surface above the quadrate and at RC at the level of 0.5 cm above the floor in the quadrate, to know the speed which really affected the microdistribution of insects.

Results and discussions

1. *Faunal makeup*

In total 55,562 specimens belonging to 50 species were sampled (Chironomidae were excluded from the number of species). A list of all the species collected is given in the Appendix at the end of the paper. The number of species and individuals compared at order level in Tables 2 and 3 shows that the whole assemblage is virtually occupied by only four orders, Ephemeroptera, Plecoptera, Trichoptera and Diptera, except only a single individual of *Elmis* sp. (Coleoptera) taken at St. P. Relative abundance among four orders is not much different in species number: Ephemeroptera=Trichoptera>Diptera≥Plecoptera, but considerably different in

Table 2. Number of species and individuals of aquatic insects at US section and total US+RC in the Kaunnai, given at order level.

Sampling period	Number of species						Number of individuals						US+RC	
	Riffle				Pool	Total Riffle + Pool	Riffle				Pool	Total Riffle +Pool	Number of species	Number of individuals
	Jul. '71	Aug. '71	'72	Total	'72		Jul. 71 Pool	Aug. 71 (%)	'72 (%)	Total (%)	'72 (%)	(%)		(%)
Ephemeroptera	11	12	12	14	7	14	2,763 (42.9)	1,169 (42.2)	2,178 (52.3)	6,110 (45.7)	268 (47.2)	6,378 (45.8)	14	20,944 (37.7)
Plecoptera	8	7	9	9	4	9	165 (2.6)	131 (4.8)	282 (6.8)	578 (4.3)	16 (2.6)	594 (4.2)	10	1,298 (2.3)
Trichoptera	10	8	10	12	4	12	703 (10.9)	388 (14.0)	780 (18.7)	1,871 (14.0)	276 (48.6)	2,147 (15.4)	14	2,704 (4.9)
Diptera	7	4	8	10	—	10	2,806 (43.6)	1,081 (39.0)	922 (22.2)	4,809 (36.0)	9 (1.6)	4,818 (34.6)	11	30,615 (55.1)
Other order	—	—	—	—	—	—	—	—	—	—	—	—	1	1 (0.0)
Total	36	31	39	45	15	45	6,437 (100.0)	2,769 (100.0)	4,162 (100.0)	13,368 (100.0)	569 (100.0)	13,937 (100.0)	50	55,562 (100.0)
Number of samples	10	10	19	39	7	46	10	10	19	39	7	46	180	

Table 3. Number of species and individuals of aquatic insects at RC section in the Kaunnai, given at order level.

Sampling period	Number of species						Number of individuals					
	Jul. '71	Aug. '71	'72		'72		Jul. '71	Aug. '71	'72		'72	
Station	P, S	R	R, Q, R, S	Total	X, T, Z	Total	P, S (%)	R (%)	P, Q, R, S (%)	Total (%)	X, Y, Z (%)	Total (%)
Ephemeroptera	7	4	5	7	8	8	8,098 (67.9)	714 (15.9)	5,223 (21.4)	14,035 (64.2)	531 (64.2)	14,566 (35.0)
Plecoptera	3	1	5	5	6	8	145 (1.2)	5 (0.1)	502 (2.1)	652 (1.6)	52 (6.3)	704 (1.7)
Trichoptera	7	3	5	7	6	9	82 (0.7)	378 (8.4)	51 (0.2)	511 (1.3)	46 (5.6)	557 (1.3)
Diptera	6	4	7	9	4	9	3,598 (30.2)	3,401 (75.6)	18,600 (76.3)	25,599 (62.7)	198 (23.9)	25,797 (62.0)
Other order	1	—	—	1	—	1	1 (0.0)	—	—	1 (0.0)	—	1 (0.0)
Total	24	12	22	29	24	35	11,924 (100.0)	4,498 (100.0)	24,376 (100.0)	40,798 (100.0)	827 (100.0)	41,625 (100.0)
Number of samples	24	25	76	125	9	134	24	25	76	125	9	134

individual number: Diptera>Ephemeroptera≫Trichoptera≥Plecoptera, that is, more than half are dipteran larvae which together with the second ranked Ephemeroptera occupy more than 90%. Predominant species (those with the percentage ratio in individuals higher than 2.0, the reciprocal of total species number multiplied by 100) are seven, *Baetiella* sp. A (28.0%), *Baetis* sp. A (6.0%), *Bibiocephala* sp. A (4.3%), Limnophilidae sp. 1 (3.5%), *Prosimulium* sp. 1 (3.1%), *Simulium japonicum* (2.6%) and *Epeorus ikanonis* (2.4%). Their cumulative percentage ratio reaches only 49.9%, due to the exclusion of abundant chironomid larvae (44.9%), which remain still unidentified to species. The quantitative faunal makeup and number of samples vary between US and RC so that two sections are analyzed below separately.

1-1) US section (St. A–E)

In total 13,937 specimens belonging to 45 species were taken. The relative abundance in the number of species and individuals is: Ephemeroptera≥Trichoptera≥Diptera≥Plecoptera and Ephemeroptera>Diptera>Trichoptera>Plecoptera, respectively. Predominant species are eight, *Baetiella* sp. A (21.9%), *Baetis* sp. A (14.9%), Limnophilidae sp. 1 (13.7%), *Simulium japonicum* (8.9%), *Prosimulium* sp. 1 (8.7%), *Bibiocephala* sp. A (6.5%), *Epeorus ikanonis* (3.1%) and *Epeorus latifolium* (2.6%), in combination occupying 80.3%. Among these predominants, *Baetiella* sp. A, *Baetis* sp. A, Limnophilidae sp. 1 and two of three dipterans, *Bibiocephala* sp. A, *Prosimulium* sp. 1, *Simulium japonicum*, are counted within top five ranks in all sampling periods. These highly ranked species are almost constant in occurrence though the rank order is different, probably depending on the emergence of some species in July and August and flood between two sampling periods in 1971.

Regarding the riffle fauna alone, the rank orders in numbers of species and individuals as well as the predominant species are the same as mentioned above. At the pool only 15 species all common to the riffle were collected. Predominant species are Limnophilidae sp. 1 (47.5%), *Epeorus latifolium* (27.8%) and *Ephemerella basalis* (8.3%), occupying in combination 83.6% of total individuals. Compared with the riffle, the pool fauna is poorer and the number of individuals per quadrate is much less than those in many previous studies reported in Honshu (OHGUSHI *et al.*, 1956; NISHIMURA, 1958).

1-2) RC section (St. P–S and X–Z)

As shown in Table 3, total 41,625 specimens belonging to 35 species were taken from RC, which was entirely occupied by four major orders except for a single coleopteran speciemen as mentioned above. Relative abundance in species is Diptera=Trichoptera≥Ephemeroptera=Plecoptera and in individuals Diptera≫Ephemeroptera≫Plecoptera≒Trichoptera. As at US Ephemeroptera (34.4% against 45.7% at US) and Diptera (62.7% against 36.0% at US) combined occupy extremely high percentage ratio, 97% of individuals, though their ranks reversed from US. Predominant species are only three, *Baetiella* sp. A (30.1%), *Bibiocephala* sp. A (3.6%) and *Baetis* sp. A (3.1%), which occupy less than 40% of total individuals, whereas

unidentified chironomid larvae occupy in combination an extremely high percentage ratio, about 55%.

In this section there are two main habitat divisions: one involves St. P–S at real RC, the other St. X–Z at usual bed. Faunal makeup is very different between these as shown below:

Species:	St. P–S	Diptera≥Trichoptera=Ephemeroptera ≥Plecoptera (Total 29 spp.)
	St. X–Z	Ephemeroptera≥Plecoptera=Trichoptera ≥Diptera (Total 24 spp.)
Individuals:	St. P–S	Diptera≫Ephemeroptera≫Plecoptera ≒Trichoptera
	St. X–Z	Ephemeroptera≫Diptera>Plecoptera ≒Trichoptera

At St. P–S rankings of species number and percentage ratio of individual number at order level are not so different from these of total RC section but variable among sampling periods and stations. At St. P, S in July 1971 and St. P in 1972 Ephemeroptera occupied about 60–75%, Diptera about 15–35% and other orders only a fraction. On the other hand, at St. R in August 1971 and St. Q, R, S in 1972 Diptera was 75–90%, Ephemeroptera 10–20% and other orders also only fractional. Abundance of chironomids and baetids, *Baetiella* sp. A, *Baetis* sp. A, is due to the reversal of the ranking. Predominant species at St. P–S alone are all the same and their cumulative percentage ratio is nearly the same as total RC. Excluding Chironomidae, *Baetiella* sp. A occupied always more than almost half (48.7–83.6%) of total individuals at each station in each sampling period except at St. P in 1972 where *Baetiella* sp. A occupied 33.2% and *Baetis* sp. A 44.0%. The species occupying the top five ranks at each station in each period are almost constant in occurrence and limited to seven species, *Baetis* sp. A, *Baetiella* sp. A, *Epeorus ikanonis*, *Protonemura* sp., *Bibiocephala* sp. A, *Prosimulium* sp. 1 and *Simulium japonicum*.

All 24 species taken at St. X–Z are common to St. P–S and 11 species taken from St. P–S but not from St. X–Z are represented by less than ten individuals except *Apatania* sp. 1 and *Antocha* sp. 1. The scanty of species number at St. X–Z is caused by the smaller sample number. In percentage individual number, Ephemeroptera is higher (46.4–49.6%) at St. X–Z than that at St. P–S, followed by Diptera (12.7–30.4%). The relative poverty of Diptera is due to the small number of Chironomidae, 17.0%. Excluding Chironomidae, descending order of relative abundance in individuals is similar between these two divisions. Predominant species are four, all belonging to Ephemeroptera, *Baetiella* sp. A (34.7%), *Epeorus latifolium* (12.3%), *Baetis* sp. A (7.9%) and *Epeorus ikanonis* (5.0%), in combination 59.9%, being higher than that at St. P–S.

1–3) Comparison between US and RC

As shown in Tables 2 and 3, the numbers of species at US and RC are 45 and

35 respectively, with 30 species common to both sections. Excluding St. X–Z, where the substratum is not real rocky chute, 29 species were taken from RC (St. P–S) and 24 of which are common to US. Five species taken only from RC, *Amphinemura* sp. (2 specimens), *Micrasema* sp. (1), *Reptocerus* sp. (8), *Dixa* sp. (1) and *Elmis* sp. (1), are all tiny species even in the final immature stage and number of collected individuals is scarce for the number of samples. As they were taken from US in another river (OKAZAWA, 1974), they seem not to be confined to RC alone. The species taken from US in the middle part but not from RC section are four, *Megarcys* sp., *Alloperla* sp., *Rhyacophila* sp. 1 and *Apatania* sp. 2. They are large species or those preferring to live under stones, as well as five species, *Ephemerella yoshinoensis*, *Paraleuctra* sp., *Kamimuria quadrata*, Perlidae sp. 3, *Rhyacophila* sp. 5, taken from St. X–Z and US but not from St. P–S. In order to know the difference of assemblage, RC should be compared with US, especially with St. C and D. The ralative abundance at order level, combining St. C and D, are Ephemeroptera= Plecoptera (8 spp.)≥Trichoptera=Diptera (7 spp.) in the number of species and Diptera (49.9%)>Ephemeroptera (44.0%)≫Plecoptera (4.5%)≥Trichoptera (1.6%) in individuals. The rank order is different from that at St. P–S but the number of species is similar except Plecoptera. The descending order of relative abundance is the same but abundance of total chironomids is considerably different, 18.0% at St. C, D against 57.3% at St. P–S. Predominant species at St. C, D in combination are six, *Baetiella* sp. A (33.4%), *Prosimulium* sp. 1 (18.4%), *Bibiocephala* sp. A (6.8%), *Simulium japonicum* (6.7%), *Baetis* sp. A (6.0%) and *Epeorus ikanonis* (3.3%), occupying in combination 74.6% of total individuals. Reflecting the small number of chironomids the value is much higher than that at RC (St. P–S, 36.6%). Three predominant species at RC are also predominant at St. C, D. From these facts assemblages at RC and US are similar, but at RC, where the relative abundance of *Baetiella* sp. A is remarkably high, the faunal makeup estimated by the quadrate of 50 cm×50 cm is poorer than in the riffles of US, probably for simpler environmental conditions of RC. The substrata stones at US form several layers involving interspaces of variable sizes and arrangements which can create a complicated microhabitat system. At RC, however, habitable place is confined to the stone plate surface. Although the precise microdistribution was not studied, the species which can inhabit RC may be those living on the upper surface of stones at US. At St. X–Z samples were taken at the end of fall-basin sets where riffles are not typical as at US, they have also some features of pool so that the assemblage at St. X–Z shows a transition from riffle to pool at US.

2. *Spatial distribution*

2–1) Numbers of species and individuals

Figure 3 shows the spatial change of numbers of species and individuals in each sampling period. Number of species at St. E is always less than that at other stations. At St. A–E it is relatively constant among stations in each period except St.

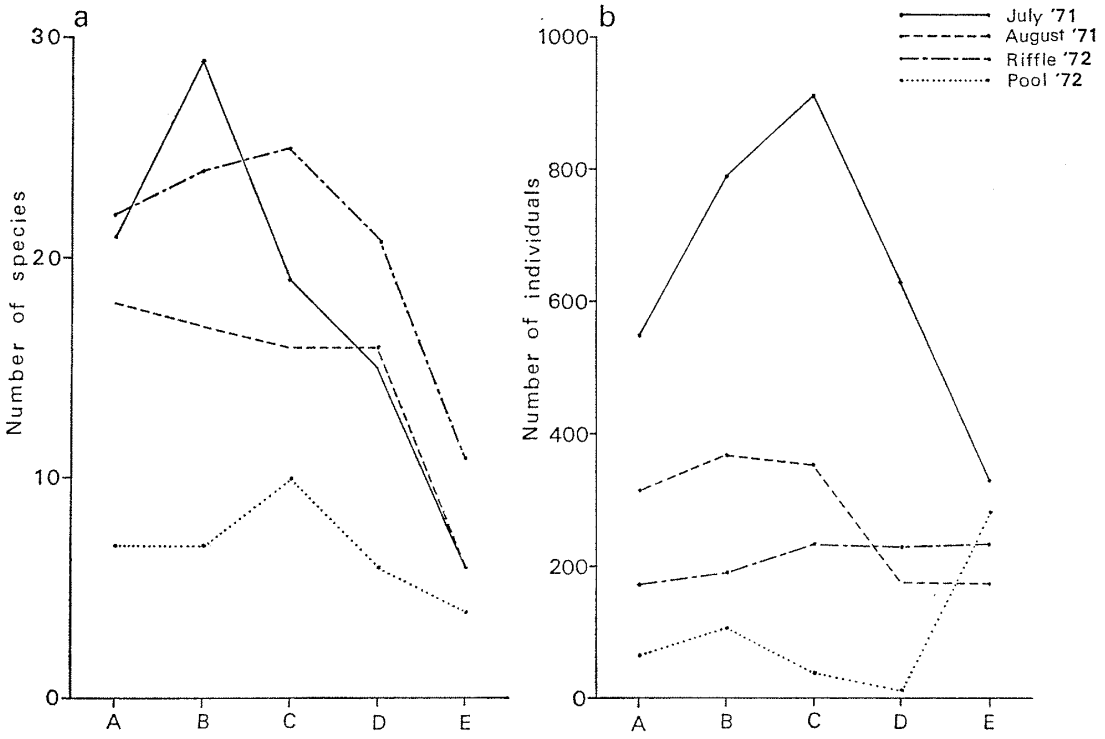

Fig. 3. Number of species and individuals collected at five stations A–E. a, Number of species; b, number of individuals.

B in July 1971, though it varied among three periods. Number of individuals also varied considerably among three periods except St. E. Especially between two sampling periods in 1971, there was a great difference which was seemingly in part caused by the flood between two periods and emergence of predominant species, *Baetiella* sp. A, *Baetis* sp. A, *Epeorus ikanonis* and *Prosimulium* sp. 1. Similarity at St. E among three periods depends on the special condition of St. E. At this station only one species of Limnophilidae sp. 1 occupied more than 90% of total individuals in each period. This species was usually found under stones and in small pits on the stone surface so that it is not much affected by flood. Furthermore in the upper section near the source of the river smaller amount of water flows even at flood. The species which occupied the top four ranks at each station are given in the descending order as follows (At St. C three species and at St. E one are given because other species were very scarce. Percentage ratios show the relative abundance of four species combined):

St. A (70.4%)	*Baetis* sp. A *Baetiella* sp. A *Simulium japonicum* *Bibiocephala* sp. A	St. B (75.6%)	*Baetis* sp. A *Baetiella* sp. A *Simulium japonicum* *Bibiocephala* sp. A
St. C (61.4%)	*Baetiella* sp. A *Baetis* sp. A	St. D (77.5%)	*Prosimulium* sp. 1 *Baetiella* sp. A

	Simulium japonicum	*Bibiocephala* sp. A
	Bibiocephala sp. A	
St. E	Limnophilidae sp. 1	
(93.5%)		

It is clear that four species and its relative abundance are similar among four stations A–D while quite different at St. E, where only Limnophilidae sp. 1 occupied a remarkably high percentage ratio. The species mentioned occupied in combination more than 70% of total individuals at each station except at St. C, where the relative abundance of Chironomidae is much higher (more than 25%) than in other stations (less than 10%).

2–2) Distribution of each species

The distribution of 30 species represented by more than ten individuals from five stations A–E combined are referred to (Table 4). The number of species having the up- and downstream limits of distribution between two adjacent stations are as follows: A/B (4), B/C (8), C/D (3), D/E (11), that is, D/E>B/C>A/B>C/D. From these facts the Kaunnai is divided into three parts, up-, mid- and downstreams, which also accord with divisions by topographical features. The difference is sharp between up- and midstreams while transitional between mid- and downstreams.

Based upon the distribution range, the collected species are classified into four biotope types: 1) Eurytopic type: Collected from all three parts. 2) Downstream type: Collected from only downstream. 3) Mid-downstream type: Collected from mid- and downstreams. 4) Up-midstream type: Collected from up- and midstreams. As shown in Table 4, mid-downstream type is most abundant followed by downstream type. There is no species collected from upstream or midstream alone. Species distributed in only one part are scarce. Downstream type species are guessed to have wider range. They may live in downstream of the part St. A though the survey was not conducted there.

2–3) Microdistribution at RC

Microdistribution of insects at RC is referred to in connection with the substrata and current speeds. The substratum of RC has three types, flat rocks without moss (FR), rugged rocks without moss (RR) and rocks with moss (MR). Number of species per quadrate at FR is similar to that at RR and less than at MR. No clear relation between number of individuals and current speed was confirmed but there was a tendency that Ephemeroptera was more abundant at lower speed while Diptera at higher speed. Among seven species, *Baetis* sp. A, *Baetiella* sp. A, *Epeorus ikanonis*, *Protonemura* sp., *Bibiocephala* sp. A, *Prosimulium* sp. 1, *Simulium japonicum*, which were abundant at RC, only *Protonemura* sp. showed a close relation with substratum, mostly collected from MR irrespective of current speed. *Bibiocephala* sp. A chiefly occurred at speeds over 40 cm/sec. and *Prosimulium* sp. 1, *Simulium japonicum* were more abundant at 30–180 cm/sec. These two simulids were chiefly collected from the stream center at St. P, S in July 1971, but no clear tendency was

Table 4. Biotope types and distribution of 30 species in the Kaunnai and the Hoshioki (thick line, Kaunnai; thin line, Hoshioki in July and August; broken line, Hoshioki in other seasons).

Biotope type	Species \ Station	Kaunnai A	Down A	Down B	Down C	Mid C	Mid D	Up E
1. Eurytopic type (6 spp.)	*Cinygma* sp.							
	Protonemura sp.							
	Nemoura sp.							
	Rhyacophila articulata							
	R. sp.							
	Prosimulium sp. 1							
2. Downstream type (7 spp.)	*Ephemerella trispina*							
	Baetiella sp. B							
	Epeorus uenoi							
	Rhithrogena japonica							
	Mistrophora sp.							
	Hydropsyche ulmeri							
	Prosimulium yezoense							
3. Mid-downstream type (13 spp.)	*Ephemerella yoshinoensis*							
	Paraleptophlebia sp.							
	Baetis sp. A							
	Baetiella sp. A							
	Epeorus latifolium							
	E. ikanonis							
	Paraleuctra sp.							
	Megarcys sp.							
	Perlodidae sp. 3							
	Kamimuria quadrata							
	Rhyacophila sp. RC							
	Bibiocephala sp. A							
	Simulium japonicum							
4. Up-midstream type (4 spp.)	*Baetis* sp. 3							
	Isoperla sp. 3							
	Apatania sp. 2							
	Limnophilidae sp. 1							

found in other species. All these species have wide preference of habitat; moreover, OHGUSHI (1953, 56) reported the daily rhythm in ephemeropteran nymphs, which change the place between day and night. The author also observed the preference for higher speed at night in *Bibiocephala* sp. A and baetid nymphs at RC. These facts suggest in combination that habitat preference of many species is much ampler than assumed from limited sampling and the necessity or further intensive studies.

3. *Comparison with the Stream Hoshioki*

The results in the Kaunnai (as to species number total US + RC, as to individual number US) are compared with those in the Stream Hoshioki (OKAZAWA,

1974), running from 700 m alt. to the sea near Sapporo City, in July and August. Total number of species in the Kaunnai is less than that in the Hoshioki (64 spp. belonging to seven orders); nevertheless the survey was more intensive and covered longer extent in the Kaunnai. Among these species, 34 (51.3% of the Hoshioki and 68.0% of the Kaunnai) are common to both the rivers, suggesting their wide distribution in Hokkaido. At order level the number of species and relative abundance of individuals in the Hoshioki are as follows: Species, Trichoptera (20 spp.)≥ Ephemeroptera (18)>Plecoptera (12)≥Diptera (11)>other orders (3), and individuals, Ephemeroptera (45.0%)>Trichoptera (26.8%)>Diptera (19.3%)>Plecoptera (8.6%)>other orders (0.3%). The four major orders already mentioned in section 1 occupy most of the species and individuals in both the rivers. In species number Ephemeroptera and Trichoptera are more abundant than Plecoptera and Diptera in both the rivers. The first two orders in the Hoshioki are more than in the Kaunnai while the last two are similar. In the relative abundance of individuals among four orders the rank at US in the Kaunnai reversed between Diptera and Trichoptera. Predominant species in the Hoshioki in July and August combined are 13 species, occupying in combination 73.9% of total individuals. In the Kaunnai at US the number of predominant species is smaller but their cumulative percentage in individual number is higher, suggesting a simpler assemblage structure. Among the predominant species, only two, *Baetis* sp. A and *Simulium japonicum*, having relatively wider distribution range, are common and counted within the top four ranks in both the rivers. The fauna in the Kaunnai is simpler than in the Hoshioki and the assemblage makeup is fairly different. Disparity of relative abundance of individual number at order level between the two rivers shows the different assemblage structure, partly attributed to altitudinal and topographical differences especially the size of the rivers.

Table 4 shows the distribution of 30 species mentioned in section (2–2) in the two rivers. Four up-midstream species in the Kaunnai were not collected in the Hoshioki, presumably representing the high alpine element. Some species collected in the Hoshioki only from upstream in the summer but from all sections in the winter and early spring were taken from the downstream in the Kaunnai in the summer, reflecting the retarded growth by lower temperature at high altitude. From the distribution of the species common to the two rivers, the downstream in the Kaunnai is comparable to mid to upstream sections in the Hoshioki. These parts are similar in water temperature, being 12–14°C in daytime, though other topographical features are different.

Summary

The stream insect fauna in the River Kaunnai running above timber-line and involving rocky chute section was surveyed.

1) The total sample, consisting of 50 species (excluding Chironomidae) and

55,562 specimens, was mostly, more than 98% in species and individuals, occupied by four orders, Ephemeroptera, Plecoptera, Trichoptera and Diptera. Predominant species were *Baetiella* sp. A (28.0%), *Baetis* sp. A (6.0%), *Bibiocephala* sp. A (4.3%), Limnophilidae sp. 1 (3.5%), *Prosimulium* sp. 1 (3.1%), *Simulium japonicum* (2.6%) and *Epeorus ikanonis* (2.4%), which occupied in combination 49.9% of total individual number.

2) The faunal makeup between usual stream bed (US) and rocky chute stream bed (RC) was considerably different, being simpler at RC than US. This is understood by the simpler substratum conditions of RC.

3) From the distribution of insects the River Kaunnai is divided into three parts, down-, mid- and upstreams, which also accord with divisions by topographical features. Upstream is quite different from other two parts by simpler faunal makeup. Thirty abundant species were classified by distribution into four types, eurytopic (6 spp.), downstream (7), mid-downstream (13) and up-midstream species (4).

4) The relations between individual number and substrata, current speeds at RC were studied in seven abundant species. Some but not all of them showed a preference for particular substrata and current speeds. All species have a fairly wide range of habitat preference.

5) Compared with the Stream Hoshioki, the faunal makeup and assemblage structure in the Kaunnai are simpler. Downstream of the Kaunnai is comparable to mid- to upstream sections of the Hoshioki.

Appendix: List of Species Collected

In each taxon the number of individuals sampled is given by the combination of thirteen figures, total number=number sampled at A+B+C+D+E+P+Q+R+S+X+Y+Z, followed by the numbers in three sampling periods at each station, shown by parenthetical figures (at St. A–E, the number in each sample separated by bar). The taxon sampled only at one or a few stations are specified respectively.

Order **Ephemeroptera** 20,944=1,336+2,073+1,837+1,110+22+6,704+736+1,598+4,997+113+296+122. **A.** 1,336=(284/281)+(141/217)+(122/138/89/64). **B.** 2,073=(724/497)+(272/125)+(148/76/130/101). **C.** 1,837=(293/424)+(169/81)+(136/284/182/135/63/15/55). **D.** 1,110=(218/41)+(75/85)+(128/33/97/240/11/170/12). **E.** 22=(1/0)+(4/0)+(3/3/1/10). **P.** 6,704=(5,180)+(1,524). **R.** 1,598=(714)+(884). **S.** 4,997=(2,918)+(2,079).

Ephemerella trispina UÉNO 39=18 at A+21 at B. **A.** 18=(5/3)+(1/0)+(1/4/3/1). **B.** 21=(10/8)+(0/0)+(1/1/1/0).

Ephemerella basalis IMANISHI 1 at B. 1=(0/1)+(0/0)+(0/0/0/0).

Ephemerella yoshinoensis GOSE 204=100 at A+100 at B+3 at C+1 at Y. **A.** 100=(0/0)+(4/1)+(28/43/13/11). **B.** 100=(0/0)+(2/0)+(16/10/38/34). **C.** 3=(0/0)+(0/0)+(0/0/0/0/1/1/1).

Ephemerella sp. nN 5 at B. 5=(4/0)+(1/0)+(0/0/0/0).

Paraleptophlebia sp. 31=1+9+5+7+0+4+0+1+1+0+0+3. **A.** 1=(0/0)+(1/0)+(0/0/0/0). **B.** 9=(4/1)+(1/1)+(0/2/0/0). **C.** 5=(2/0)+(2/0)+(0/0/0/1/0/0/0). **D.** 7=(0/0)+(2/0)+(4/0/0/0/0/1/0). **P.** 4=(1)+(3). **R.** 1=(1)+(0). **S.** 1=(0)+(1).

Baetis sp. A 3,361=571+1,102+393+7+0+954+126+67+76+6+59+0. **A.** 571=

(161/215)+(42/6)+(40/62/40/5). **B.** 1,102=(584/331)+(14/15)+(65/47/44/2). **C.** 393=(38/42)+(6/3)+(62/90/49/71/22/1/9). **D.** 7=(0/0)+(0/0)+(1/0/0/3/0/3/0). **P.** 954=(196)+(758). **R.** 67=(1)+(66). **S.** 76=(2)+(74).

Baetis sp. 3 64=0+0+4+16+21+0+0+0+1+11+0+11. **C.** 4=(0/0)+(0/1)+(3/0/0/0/0/0/0). **D.** 16=(0/0)+(0/0)+(0/0/0/5/1/2/8). **E.** 21=(0/0)+(4/0)+(3/3/1/10). **S.** 1=(1)+(0).

Baetiella sp. A 15,579=363+504+1,207+975+0+5,377+599+1,505+4,762+84+118+85. **A.** 363=(59/22)+(76/206)+(0/0/0/0). **B.** 504=(57/76)+(252/107)+(5/2/3/2). **C.** 1,207=(230/341)+(160/77)+(56/162/106/51/15/1/8). **D.** 975=(191/34)+(70/82)+(100/26/86/226/7/153/0). **P.** 5,377=(4,813)+(564). **R.** 1,505=(711)+(794). **S.** 4,762=(2,854)+(1,908).

Baetiella sp. B 30 at A. 30=(0/0)+(0/0)+(16/9/5/0).

Epeorus uenoi MATSUMURA 45=34 at A+11 at B. **A.** 34=(2/3)+(7/2)+(12/1/7/0). **B.** 11=(1/1)+(2/1)+(5/1/0/0).

Epeorus latifolium UÉNO 543=122+226+81+8+0+1+0+1+2+8+92+2. **A.** 122=(4/4)+(8/2)+(22/17/18/47). **B.** 226=(12/54)+(0/1)+(49/12/42/56). **C.** 81=(2/4)+(0/0)+(2/4/0/1/20/12/36). **D.** 8=(0/0)+(0/0)+(0/0/0/1/3/0/4). **P.** 1=(0)+(1). **R.** 1=(0)+(1). **S.** 2=(2)+(0).

Epeorus ikanonis TAKAHASHI 961=81+70+131+82+0+367+11+24+154+3+24+14. **A.** 81=(49/30)+(1/0)+(0/0/1/0). **B.** 70=(49/20)+(0/0)+(0/1/0/0). **C.** 131=(21/30)+(1/0)+(12/27/26/10/4/0/0). **D.** 82=(24/3)+(1/2)+(20/5/11/5/0/11/0). **P.** 367=(169)+(198). **R.** 24=(1)+(23). **S.** 154=(58)+(96).

Rhithrogena japonica UÉNO 13 at A. 13=(3/2)+(1/0)+(3/2/2/0).

Cinygma sp. 68=3+24+13+15+1+1+0+0+1+1+2+7. **A.** 3=(1/2)+(0/0)+(0/0/0/0). **B.** 24=(3/5)+(0/0)+(7/0/2/7). **C.** 13=(0/7)+(0/0)+(1/1/1/1/1/0/1). **D.** 15=(3/4)+(2/1)+(3/2/0/0/0/0/0). **E.** 1=(1/0)+(0/0)+(0/0/0/0). **P.** 1=(1)+(0). **S.** 1=(1)+(0).

Order **Plecoptera** 1,298=96+122+112+187+77+197+98+61+296+9+12+231. **A.** 96=(17/7)+(11/3)+(19/27/11/1). **B.** 122=(15/23)+(15/1)+(18/30/16/4). **C.** 112=(14/9)+(23/8)+(10/7/4/21/8/4/4). **D.** 187=(15/21)+(29/25)+(31/11/16/21/1/17/0). **E.** 77=(22/22)+(2/14)+(4/10/2/1). **P.** 197=(113)+(84). **R.** 61=(5)+(56). **S.** 296=(32)+(264).

Protonemura sp. 883=53+64+26+55+43+193+97+59+283+4+2+4. **A.** 53=(3/0)+(2/2)+(15/21/9/1). **B.** 64=(9/9)+(8/0)+(8/20/10/0). **C.** 26=(3/4)+(8/1)+(1/3/2/2/1/0/1). **D.** 55=(6/5)+(17/10)+(8/0/2/4/0/3/0). **E.** 43=(18/15)+(1/3)+(1/2/2/1). **P.** 193=(110)+(83). **R.** 59=(5)+(54). **S.** 283=(26)+(257).

Nemoura sp. 45=0+2+9+9+14+4+1+2+3+0+0+1. **B.** 2=(0/2)+(0/0)+(0/0/0/0). **C.** 9=(8/1)+(0/0)+(0/0/0/0/0/0/0). **D.** 9=(1/0)+(1/3)+(0/0/0/1/0/3/0). **E.** 14=(1/1)+(1/11)+(0/0/0/0). **P.** 4=(3)+(1). **R.** 2=(0)+(2). **S.** 3=(3)+(0).

Amphinemura sp. 2 at S. 2=(0)+(2).

Paraleuctra sp. 50=3+3+18+21+0+0+0+0+0+0+1+4. **A.** 3=(1/0)+(0/0)+(1/0/1/0). **B.** 3=(0/2)+(1/0)+(0/0/0/0). **C.** 18=(0/0)+(8/1)+(2/1/0/5/0/1/0). **D.** 21=(0/1)+(3/1)+(7/0/1/3/1/4/0).

Megarcys sp. 56=22 at A+28 at B+6 at C. **A.** 22=(5/3)+(6/1)+(3/3/1/0). **B.** 28=(3/3)+(5/0)+(7/5/2/3). **C.** 6=(0/0)+(0/1)+(0/2/0/0/3/0/0).

Isoperla sp. 3 73=14 at C+53 at D+1 at E+5 at S. **C.** 14=(0/0)+(5/2)+(1/0/0/3/3/0/0). **D.** 53=(8/9)+(6/2)+(4/7/10/4/0/3/0). **E.** 1=(0/0)+(0/0)+(0/1/0/0). **S.** 5=(3)+(2).

Perlodidae sp. 3 66=8+10+6+15+0+0+0+0+3+3+9+12. **A.** 8=(5/3)+(0/0)+(0/0/0/0). **B.** 10=(3/3)+(0/0)+(2/0/2/0). **C.** 6=(0/0)+(2/3)+(0/0/0/1/0/0/0). **D.** 15=(0/0)+(2/8)+(0/2/0/2/0/1/0) **S.** 3=(0)+(3).

Kamimuria quadrata (KLAPÁLEK) 86=7+10+32+27+0+0+0+0+0+2+0+8. **A.** 7=(2/0)+(3/0)+(0/2/0/0). **B.** 10=(0/4)+(1/1)+(0/1/2/1). **C.** 32=(3/3)+(0/0)+(6/1/2/10/1/3/3). **D.** 27=(0/2)+(0/1)+(10/2/3/7/0/2/0).

Perlidae sp. 3 5=3 at B+2 at Z. **B.** 3=(0/0)+(0/0)+(0/3/0/0).

Alloperla spp. 32=3 at A+2 at B+1 at C+7 at D+19 at E. **A.** 3=(1/1)+(0/0)+(0/1/0/0). **B.** 2=(0/0)+(0/0)+(1/1/0/0). **C.** 1=(0/1)+(0/0)+(0/0/0/0/0/0/0). **D.** 7=(0/4)+(0/0)+(2/0/0/0/0/1/0). **E.** 19=(3/6)+(0/0)+(3/7/0/0).

Order **Trichoptera** 2,704=68+64+37+77+1,901+82+5+390+34+2+14+30. **A.** 68=(7/2)+(9/12)+(11/13/11/3). **B.** 64=(14/19)+(17/6)+(2/3/3/0) **C.** 37=(9/6)+(3/1)+(4/2/0/6/4/1/1) **D.** 77=(14/8)+(10/6)+(9/2/3/10/2/9/4). **E.** 1,901=(426/198)+(167/157)+(354/185/149/265). **P.** 82=(70)+(12). **R.** 390=(378)+(12). **S.** 34=(12)+(22).

Rhyacophila sp. RC 159=20+39+5+7+0+49+4+12+17+0+6+0. **A.** 20=(4/1)+(3/8)+(2/2/0/0). **B.** 39=(4/13)+(14/6)+(0/2/0/0). **C.** 5=(1/0)+(1/1)+(0/1/0/0/1/0/0). **D.** 7=(0/0)+(0/0)+(0/0/0/7/0/0/0). **P.** 49=(40)+(9). **R.** 12=(4)+(8). **S.** 17=(0)+(17).

Rhyacophila articulata 106=1+10+13+27+18+8+0+1+6+0+3+19. **A.** 1=(0/0)+(0/0)+(0/1/0/0). **B.** 10=(4/2)+(2/0)+(0/1/1/0). **C.** 13=(2/1)+(1/0)+(3/1/0/3/0/1/1). **D.** 27=(3/3)+(4/3)+(4/1/2/2/0/4/1). **E.** 18=(4/6)+(0/1)+(1/3/2/1). **P.** 8=(6)+(2). **R.** 1=(1)+(0). **S.** 6=(4)+(2).

Rhyacophila sp. 1 13=2+3+1+0+1+0+0+0+0+0+1+5. **A.** 2=(0/0)+(0/0)+(0/1/1/0). **B.** 3=(1/0)+(0/0)+(1/0/1/0). **C.** 1=(0/0)+(1/0)+(0/0/0/0/0/0/0). **E.** 1=(0/0)+(0/0)+(0/1/0/0).

Rhyacophila sp. 2 37=1+5+9+0+1+4+0+3+9+0+0+5. **A.** 1=(1/0)+(0/0)+(0/0/0/0). **B.** 5=(2/3)+(0/0)+(0/0/0/0). **C.** 9=(4/5)+(0/0)+(0/0/0/0/0/0/0). **E.** 1=(0/0)+(0/0)+(1/0/0/0). **P.** 4=(4)+(0). **R.** 3=(0)+(3). **S.** 9=(7)+(2).

Rhyacophila sp. 5 9=2 at B+6 at C+1 at Z. **B.** 2=(0/1)+(0/0)+(0/0/1/0). **C.** 6=(1/0)+(0/0)+(1/0/0/2/2/0/0).

Mistrophora sp. 30=29 at A+1 at B. **A.** 29=(0/0)+(4/0)+(7/6/10/2). **B.** 1=(0/0)+(0/0)+(1/0/0/0).

Hydropsyche ulmeri TSUDA 16=14 at A+2 at B. **A.** 14=(2/1)+(2/4)+(2/3/0/0). **B.** 2=(1/0)+(1/0)+(0/0/0/0).

Polycentropus sp. 3 1 at B. 1=(1/0)+(0/0)+(0/0/0/0).

Apatania sp. 1 378=2 at E+2 at P+373 at R+1 at S. **E.** 2=(0/0)+(1/1)+(0/0/0/0). **P.** 2=(2)+(0). **R.** 373=(373)+(0). **S.** 1=(1)+(0).

Apatania sp. 2 19=2 at C+16 at D+1 at E. **C.** 2=(1/0)+(0/0)+(0/0/0/1/0/0/0). **D.** 16=(1/3)+(1/1)+(3/1/1/0/0/5/0). **E.** 1=(0/0)+(0/0)+(1/0/0/0).

Micrasema sp. 1 at P. 1=(1)+(0).

Reptocerus sp. 8=7 at P+1 at Q. **P.** 7=(6)+(1).

Dinarthrodes sp. 2=1 at A+1 at B. **A.** 1=(0/0)+(0/0)+(0/0/0/1). **B.** 1=(1/0)+(0/0)+(0/0/0/0).

Limnophilidae sp. 1 1,925=0+0+1+27+1,878+11+0+1+1+2+4+0. **C.** 1=(0/0)+(0/0)+(0/0/0/0/1/0/0). **D.** 27=(10/2)+(5/2)+(2/0/0/1/2/0/3). **E.** 1,878=(422/192)+(166/155)+(351/181/147/264). **P.** 11=(11)+(0). **R.** 1=(0)+(1). **S.** 1=(0)+(1).

Order **Diptera** 30,615=831+737+1,822+1,425+3+2,197+2,774+12,330+8,298+18+100+80. **A.** 831=(252/252)+(67/166)+(51/23/20/0). **B.** 737=(179/110)+(111/187)+(23/120/5/2). **C.** 1,822=(524/548)+(331/96)+(41/73/162/32/11/1/3). **D.** 1,425=(91/849)+(17/106)+(22/29/220/53/2/35/1). **E.** 3=(1/0)+(0/0)+(1/1/0/0). **P.** 2,197=(1,873)+(324). **R.** 12,330=(3,401)+(8,929). **S.** 8,298=(1,725)+(6,573).

Bibiocephala sp. 1 6=1 at A+3 at P+2 at S. **A.** 1=(1/0)+(0/0)+(0/0/0/0). **P.** 3=(3)+(0). **S.** 2=(2)+(0).

Bibiocephala sp. A 2,392=294+175+322+119+0+242+350+549+326+0+15+0. **A.** 294=(149/124)+(9/8)+(2/0/2/0). **B.** 175=(89/47)+(6/21)+(12/0/0/0). **C.** 322=(95/102)+(1/1)+(1/34/78/9/0/0/1). **D.** 119=(0/14)+(13/39)+(3/14/17/18/0/1/0). **P.** 242=(183)+(59). **R.** 549=(137)+(412). **S.** 326=(8)+(318).

Prosimulium yezoense SHIRAKI 31=17 at A+14 at B. **A.** 17=(14/0)+(0/1)+(1/1/0/0). **B.** 14=(8/2)+(0/0)+(0/4/0/0).

Prosimulium sp. 1 1,702=0+21+137+1,056+1+77+27+150+201+5+13+14. **B.** 21=(1/0)+(1/5)+(0/14/0/0). **C.** 137=(25/49)+(10/14)+(1/14/23/1/0/0/0). **D.** 1,056=(60/756)+(0/7)+(9/0/185/23/0/16/0). **E.** 1=(1/0)+(0/0)+(0/0/0/0). **P.** 77=(72)+(5). **R.** 150=(2)+(148). **S.** 201=(32)+(169).

Simulium japonicum MATSUMURA 1,472=370+438+383+53+0+117+12+78+15+0+6+0. **A.** 370=(66/12)+(57/157)+(45/18/15/0). **B.** 438=(47/37)+(98/157)+(3/96/0/0). **C.** 383=(10/8)+(242/59)+(3/10/49/2/0/0/0). **D.** 53=(2/7)+(4/36)+(0/0/1/3/0/0/0). **P.** 117=(114)+(3). **R.** 78=(71)+(7). **S.** 15=(13)+(2).

Simulium sp. 3 8=1 at C+1 at E+2 at S+4 at Y. **C.** 1=(0/0)+(0/0)+(0/0/0/1/0/0/0). **E.** 1=(0/0)+(0/0)+(1/0/0/0) **S.** 2=(0)+(2).

Antocha sp. 1 42=0+1+1+0+0+33+2+4+1+0+0+0. **B.** 1=(1/0)+(0/0)+(0/0/0/0). **C.** 1=(0/0)+(0/0)+(1/0/0/0/0/0/0). **P.** 33=(20)+(13). **R.** 4=(1)+(3). **S.** 1=(0)+(1).

Antocha sp. 5 3=1 at A+1 at C+1 at Q. **A.** 1=(0/0)+(0/0)+(0/1/0/0). **C.** 1=(0/0)+(0/0)+(0/0/0/1/0/0/0).

Dixa sp. 1 at S. 1=(0)+(1).

Pericoma sp. 2=1 at C+1 at S. **C.** 1=(0/1)+(0/0)+(0/0/0/0/0/0/0). **S.** 1=(1)+(0).

Pedicia sp. 1 at E. 1=(0/0)+(0/0)+(0/1/0/0).

Chironomidae spp. 24,955=148+88+976+197+0+1,725+2,383+11,549+7,749+13+62+66. **A.** 148=(22/116)+(1/0)+(3/3/3/0). **B.** 88=(33/24)+(6/4)+(8/6/5/2). **C.** 976=(394/388)+(78/22)+(35/15/12/18/11/1/2). **D.** 197=(29/72)+(0/24)+(10/15/17/9/2/18/1). **P.** 1,725=(1,481)+(244). **R.** 11,549=(3,190)+(8,359). **S.** 7,749=(1,679)+(6,070).

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