The fauna in two cold springs and in an epirhithral pool in southern Finland

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Hirvenoja, M. 2002: The fauna in two cold springs and in an epirhithral pool in southern Finland. — Sahlbergia 7: 7-25. Helsinki, Finland, ISSN 1237-3273.

Observations were made on the macrofauna of two cold springs (eustatic akratopegs): a mes-oligotrophic limnocrene and a rheocrene; a little eutrophied epirhithral pool was also studied, all north-northeast of the town Riihimäki, in southern Finland. The number of species found in each varied between 7 and 33 and the approximate number of macrofauna between 2500 and 4500 indiv./ m^2. A state of near xenosaprobity has been estimated to prevail in the rheocrene and a state of oligosaprobity in the epirhithral pool. Probably because of the conditions in winter, the fauna in the limnocrene studied contains numerous species that are known to have a beta-mesosprobic indication value. A small amelioration in the composition of the fauna was observed after a dig of the limnocrene. The felling of timber around the limnocrene seemed not cause negative changes in its fauna. The article illustrates the emergence (phenology) of the Chironomidae in the limnocrene and describes the larva of *Micropsectra (Lundstroemia) fusca* (Meigen) (Diptera, Chironomidae). *Dixella naevia* (Peus) (Diptera, Dixidae) and *Chironomus luridus* Strenzke (Diptera, Chironomidae) are confirmed to be new to the fauna of Finland.

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Keywords: Springs (eustatic akratopegs, limnocrene, rheocrene) epirhithral pool, macrofauna, saprobity, biodiversity.

The purposes of the present study have been to obtain material on the community structure of the macrobenthon in cold springs as well as the habitat preference of the species and/or the phenology of the insects (for the terminology — "benthon" instead of "benthos" etc. — see Steffan 1965, Lehmann 1971, Fittkau 1976, 1977). The results given below have not been obtained from the specific studies on the springs, but from the study of different kinds of water habitats, which were located on the same area.

In terms of the methodology of the sampling of the material, the present examples are not uniform and the methods are therefore described together with a description of each sample. The biotopes observed are 4-8 km north, north-east of the city of Riihimäki (about 62º50'N, 24º50'E), in southern Finland. They are more precisely indicated below by a uniform grid system (Grid 27°E: Heikinheimo & Raatikainen 1971, 1981).

A limnocrene in a forest north of the town of Riihimäki

The site (Grid 27ºE: 67427:3791)

The site of the open water of this spring is in a small remnant of a birch-spruce-hardwood peat moor (Fig. 1). Most of this forest, including a long inundation meadow along a brook (Hirvenoja), had been cleared for fields during 1800-1900. The raised bog, (the historical name Uramonsuo, see Varmanen 1946: 15), inside this partly wooded zone was cleared for fields by the Riihimäki prison during the 1920's and 1930's, but because of the present day agricultural crisis, this area of about 200 hectares (500 acres) has been used for commercial peat digging since the 1970's; the

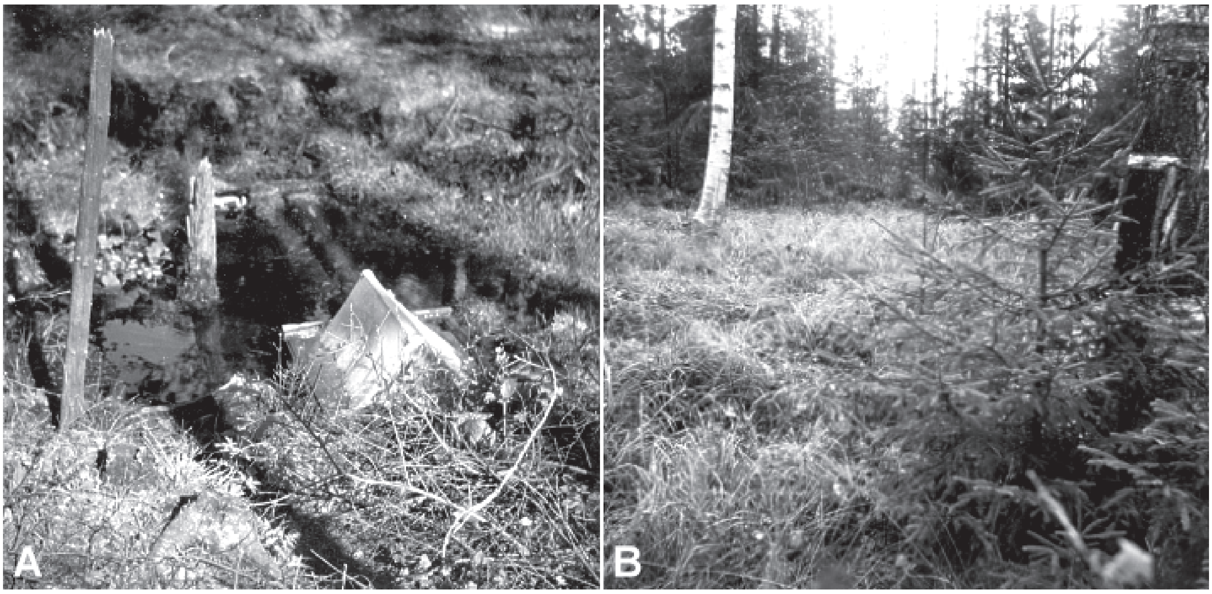

Fig.1. A floating cage trap in the limnocrene (A) studied in Riihimäki and the adjacent environment (B) in the autumn 1956.

limnocrene is about 200 m from the digging area. Because of human activities, the spring is surrounded on almost all sides by only 30-100 m a forest. (the site is under pool Nr. 3 in Fig. 1 in Hirvenoja 1962. The flowing directions of the groundwater to the spring are unknown, but a small, approximately 20 cm wide tricklet runns westward from the spring, towards the largest fields (and the brook mentioned).

In the 1930's numerous springs still existed on the NE side of the raised bog Uramonsuo; during studies in the 1950's the limnocrene observed was the only open spring known to the author in the study area about 1 km^2 on the NE side of the bog. Without slight, occasional digging for drinking water for the field workers, this spring would probably not have been an open limnocrene, but a helocrene as early as the 1950's. Shallow mounds on the sites, where the ground water was near the surface of the earth (?ancient springs), were present during the 1950's. They, some ditches, as well as the brook mentioned in the previous paragraph, still contained among others four species of sedges (*Carex*, Cyperaceae), which are very rare in Finland (Hirvenoja 1960d); these had up until this time totally disappeared from the study area.

A drinking water pumping station for the town of Riihimäki (now a reserve station) was built on the largest mound during the 1950's. The pumping station is about 0.8 km from the limnocrene discussed here, but when in operation, its effect was occasionally visible in the amount of water in the limnocrene.

The water level of the ponds in the surroundings more or less decreased at that time and most of them dried up. The whole area, including the rest of the raised bog Uramonsuo has also became increasingly drier because of the drainage required by the local governmental authorities during the 1960's. The radical changes at that time, for instance in the fauna of the birds in the area were obvious to everyone.

The substrate of the environment of the limnocrene studied here consists of leaf-sedge peat, being only <0.5 m thick on the clay. The middle part at the bottom of the open water (diameter in 1956-1957 about 2 m, depth about <0.5 m) consists of continuingly moving very loose organic material because of the ground water current.

Long birch dominated during the 1950's, but spruces which during the 1950's were small seedlings dominated in the 1990's. The spring con-

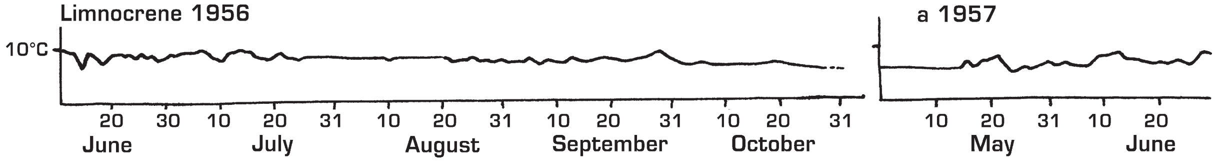

Fig. 2. Annual variations of the surface water temperature in the limnocrene studied in Riihimäki.

tained some partly submerged blocks of wood and large roots of the surrounding trees. As a firm substrate to the fauna the steep sides of the spring of bog were also available. A part of the fauna (Table 4) inhabited the loose organic substratum (dark mud, type dy containing also small pieces of wood). Because of the occasional cleanings of the spring basin the macrovegetation consisted of sparse *Calliergon cordifolium* (Amblystegiaceae).

Water chemistry

The biotope studied is quite a stable (two disturbances are known) cold spring or eustatic akratopeg (Thienemann 1941: 21; Brinck 1949: 191; Zavrel & Pax 1951: 647). Because of the slow flow of current, the temperature of the water, in spite of the shade of the trees was a little influenced by the air temperature and sunshine, being 5-9°C (measured every day) in May-October 1956 (Fig.2).

The measurements of the water chemistry (Table 2) give values of total phosphorus which, according to Forsberg and Ryding (1980), refer to the oligotroph or mesotroph waters, but those of total nitrogen refer to the eutroph or hypertroph waters; the ratio N_{tot}:P_{tot}, according to those authors, shows that the phosphorus is the limiting factor in the limnocrene studied.

During the studies of 1956-1957 the saturation of oxygen varied in May-August from 73% to 88% (N = 3). In winter, under the occasional cover of ice and/or snow, the concentration may be much lower, a delimitating factor for the composition of the community. In severe winters, for instance in 1939-1940, an ice cover was present and numerous dead frogs were found on the bottom in May 1940.

Values of pH, 6.5-6.7 (N = 5) were measured in 1956-1957 (cf. Hirvenoja 1960a); later, pH values of 6.3-6.9 (<7.3 in the laboratory) were found. The water color has mostly been clear, 0 mg Pt/l (N = 6). Color values < 5 mg Pt/l (N = 2) have been measured after the heavier rains. Occasional measurements of the conductivity are also available from the years after the working period 1956-1957 (Tables 1 and 2).

There are good indications to suggest, that the earliest (1964) measured value of conductivity (4.3 mS/m; Table 1) was near the values prevailing during the sampling of the macrofauna in 1956 and 1957, but it may have been even lower. The later increase in values of conductivity may be associated with the development in the water quality of the ground waters in Finland. As mentioned, this spring is in the forest, but not very far from the fields. The small increase in sulphur may not have originated from the field but from the air. The taste of the water has been good and was used as drinking water by field workers in the summer at least during the 1950's.

Spring waters from the Riihimäki district (the Salpausselkä 1 area) were some 100 years ago sold in Helsinki on the streets for drinking because of the good taste; in 1880 446000 litres of water were transported by train (Hoffrén & Penttilä 1979: 178).

The macrofauna in 1956-1957

The main material was collected with a cage (or "tent") trap (area 0.25 m^2, Fig. 1a) floating on the surface; the type is illustrated in Fig. 1 in Hirvenoja 1960a). The trap was emptied every day with a suction bottle containing some drops of alcohol (70%), from June 10th 1956 to October 20th 1956 and the sampling was continued from May 1st 1957 to June 30th 1957. The number of the individuals that emerged thus approximates roughly

Table 1. Observations of the water chemistry in the limnocrene studied in Riihimäki after the sampling period 1956-1957 (*the water flow had stopped temporarily, the water level was found to be 10 cm below the surface of the mud).

	Cond. mS/m(γ25)	COD_{Mn} mg/l	O_2 mg/l	O_2 sat. %	Alkal. meq/l	Hardn. meq/l	Hardn. °dH	pH	Color Ptmg/l
05.06.1964	4.3	–	–	–	–	–	–	–	–
11.06.1980	5.9	–	–	–	–	–	–	–	–
31.07.1980	6.4	–	–	–	–	–	–	–	–
26.08.1980	6.1	–	–	–	–	–	–	–	–
07.09.1980	6.1	–	–	–	–	–	–	–	–
26.09.1981	6.6	–	–	–	–	–	–	–	–
12.05.1985	9.0	–	–	–	–	–	–	–	–
27.03.1989	8.7	–	–	–	–	–	–	–	–
24.06.1990	8.9	1.2	8.0	70	0.30	0.7	1.9	6.9	–
03.08.1990	8.4	–	–	–	0.25	0.8	2.2	–	0
01.09.1990	7.7	–	–	–	–	–	–	–	–
*19.09.1991	9.0	–	–	–	–	–	–	6.6	0

the population density of the insects during one year in the given area (0.25 m²). Some of the results have been published earlier (Hirvenoja 1960b, 1960c, 1964), but the total catch of the trap is included here in Table 3.

Altogether 23 aquatic taxa emerged into the cage trap and nine other semiaquatic or aquatic taxa belonging to the macrofauna were recorded. An annual emergence of about 2300 limnic insects per square metre can be approximated from the results from the limnocrene studied (Table 3).

One tentative bottom sample was taken in 1956 from the loose substrate with a bottom sampler (Ekman type, 400 cm²); it was sieved (mesh 0.5 mm) and only large individuals were picked up from the sieving residue. The results are shown in Table 4. The relative abundance of the species of Plecoptera was roughly similar to the results of the emergence, but the small number in comparison to the emerged individuals from a given area is probably a result of the larvae living more abundantly on the submerged wood than in the loose substrate.

Observations on the same limnocrene after 1957

After 1957 it was not possibile to study the fauna in the same manner as in 1956-1957, but a few parameters of the water chemistry were occasionally measured (Table 2). Before 1990 the area of the open water of the limnocrene had been enlarged to a shallow pool of 3 x 10 m, depth < 0.5 m.

At 03.08.1990 bottom mud (roughly 1.5 l) was netted (hand net, mesh 0.4 mm). The sample was only slightly sieved in the same net to avoid

Table 2. Measurements of the water chemistry in the limnocrene studied in Riihimäki by the laboratories of Viljavuuspalvelu Oy (26 August,1980), Insinööritoimisto Paavo Ristola Oy (March 27, 1989) and Viljavuuspalvelu Oy (June 24, 1990 and September 19, 1991; method 1990-91: ICP = induction coupled plasma measurement).

Date		26.8.80	27.3.89	24.6.90	19.9.91
P_{tot}	mg/l	0.020	0.010	0.024	0.20
N_{tot}	mg/l	4.9	1.1	–	–
K	mg/l	1.1	–	1.3	1.3
Ca	mg/l	1.8	–	7.2	7.0
Mg	mg/l	1.6	–	2.3	2.0
Na	mg/l	–	–	3.8	3.8
Cl	mg/l	5.3	3.3	–	–
Fe	mg/l	0.86	0.23	<0.05	<0.05
Cu	mg/l	–	–	<0.01	<0.01
Zn	mg/l	–	–	<0.01	<0.01
Mn	mg/l	–	–	<0.01	<0.01
Al	mg/l	–	–	<0.05	<0.05
S	mg/l	2.1	2.4	4.5	4.5
Si	mg/l	–	–	6.8	6.8

Table 3. Number of individuals of insects, which emerged in a cage trap, 0.25 m^2 of area, from the limnocrene in Riihimäki June 10, 1956-June 30, 1957.

Taxon	♂♂/♀♀	Σ/0.25m²
Plecoptera		
Nemoura cinerea (Retzius)	11/19	30
N.(Nemurella) picteti Klapalek	123/193	316
Sisyridae		
Sisyra fuscata (Fabricius)	0/1	1
Trichoptera		
Micropterna lateralis (Stephens)	7/7	14
Cyrnus sp. (Pupa)	1	1
Diptera		
Dixidae		
Dixella sp.	0/1	1
Chironomidae		
Tanypus punctipennis Meigen	2/0	2
Macropelopia notata (Meigen)	5/9	14
Zavrelimyia barbatipes (Kieffer)	5/2	7
Pseudodiamesa branickii (Nowicki)	2/3	5
Prodiamesa olivacea (Meigen)	7/7	14
Heterotrissocladius marcidus (Walker)	30/26	56
Trissocladius brevipalpis Kieffer	1/0	1
Orthocladius sp.	2/0	2
Psectrocladius limbatellus (Holmgr.)	1/0	1
Nanocladius balticus (Palmén)	1/0	1
Chaetocladius cinereipennis (Lundström)	40/30	70
Parakiefferiella bathophila (Kieffer)	1/3	4
Metriocnemus obscuripes (Holmgr.)	4/4	8
Limnophyes sp.	0/1	1
Phaenopsectra flavipes (Meigen)	3/1	4
Micropsectra fusca (Meigen)	8/14	22
M. recurvata (Goetghebuer)	1/1	2

Number of taxa 23
Number of emerged individuals 577 / 0.25m^2

losing of the smallest larvulae. The animals, which were readily observable were picked up from several small amounts of mud using a preparation microscope and subsequently preserved in ethyl alcohol (75%). The possibly remaining individuals still in the mud were reared to adult stage at the room temperature in an aerated vessel. The method was the same as the author used in the handling samples from the river Vantaanjoki (Hirvenoja 2000). The results are given in the Table 5.

The fauna found in the limnocrene in 1990 was mainly the same as 25 years earlier. The Oligochaeta were not sampled in 1956-57.

Table 4. Number of individuals in a sample of continuously moving substratum, which is loose because of the ground water current in the limnocrene. The sample was taken with the bottom sampler (Ekman type, 400 cm^2) in June 26, 1957.

Taxon	Ind. / 400 cm²
Crustacea, Isopoda	
Asellus aquaticus Linnaeus	5
Hydracarina sp.	2
Plecoptera	
Nemoura cinerea (Retzius)	1
N.(Nemurella) picteti Klapalek	5
Diptera	
Pedicia rivosa (Linnaeus)	1
Prodiamesa olivacea (Meigen)	1
Coleoptera, Dytiscidae	
Agabus sp. larvae	1
Coleoptera, Helodidae	
Cyphon sp. , larvae	1

A conspicuous difference is the lack of *Nemoura cinerea* and *Chaetocladius cinereipennis*, but the occurrence of *Tanytarsus palettaris* and *Protanypus caudatus* in the material. Further instead of *Zavrelimyia barbatipes Z.melanura* emerged in 1990, all of which may refer to a small amelioration in conditions. Characteristic, however, is the continuous presence of *Heterotrissocladius marcidus* and *Micropsectra fusca* but the sparseness of other important, often predominating spring species of *Micropsectra*.

The phenology of insects in the limnocrene

In Plecoptera, a continuous emergence from May to September was observed in *Nemurella picteti*, but the individuals of *Nemoura cinerea* emerged mainly in June (Fig.1 in Hirvenoja 1960b). The adults of *Micropterna lateralis* (Trichoptera) emerged from the end of May to the middle of July (Hirvenoja 1960c)

In the shallow lakes and ponds of southern Finland lentic chironomid species usually have two generations or at least two emergence periods in one year. The first generation emerges roughly in May-June and the second in July-August; the same is to be seen from the emergence in Lake Erken, Sweden (Sandberg 1969). Some species have

Table 5. Percentage of individuals partly picked up immediately or reared as adults in a hand net bottom sample (about 1.5 l substratum) taken from the limnocrene in Riihimäki in August 3, 1990.

Taxon	%
Turbellaria	
Dendrocoelum lacteum (Müller)	1.04
Oligochaeta	
Rhynchelmis limosella Hoffmeister	1.04
Crustacea	
Cyclopoida	
Eucyclops serrulatus (Fischer)	1.04
Isopoda	
Asellus aquaticus Linnaeus	22.92
Hydracarina spp.	2.08
Plecoptera	
N.(Nemurella) picteti Klapalek	7.30
Diptera	
Dixidae	
Dixella naevia (Peus)	1.04
Chironomidae	
Conchapelopia melanops (Meigen)	1.04
Macropelopia notata (Meigen)	1.04
Zavrelimyia melanura (Meigen)	1.04
Protanypus caudatus Edwards	4.17
Pseudodiamesa branickii (Nowicki)	1.04
Prodiamesa olivacea (Meigen)	2.08
Heterotrissocladius marcidus (Walker)	8.33
Rheocricotopus effusus (Walker)	1.04
Phaenopsectra flavipes (Meigen)	1.04
Micropsectra fusca (Meigen)	17.72
Tanytarsus palettaris Verneaux	23.96
Coleoptera, Dytiscidae	
Hydroporus sp.	1.04
Total of 18 taxa, (96 indiv.)	

obviously several seasonal emergence periods (*Corynoneura*).

Hibernation often seems to determine the time of the first emergence period and synchronize the emergence between the individuals in a population. The sum of day temperatures is perhaps the most important factor for the length of development of single larvae and pupae and the emergence of the possible second generation in the same summer. Low temperature may reduce the number of generations of one season, especially in northern latitudes (Rempel 1936, Andersen. 1946). In the lakes the individuals in deeper (colder) waters of a biotope do emerge later than in shallow ones (Reiss 1968). According to Jonasson (1972) oxygen content and food are the growth determining factors in the profundal,as well. Examples of the relationships between temperature and times of the pupation and emergence of the adults of different species in arctic conditions have been reported by Oliver (1968); the annual emergence was closely synchronized in each of the species investigated.

Two generations are not to be seen, at least clearly, in the seasonal pattern of total emergence (Figs. 3-6) of the species caught in the limnocrene studied here. The species which are abundant enough show one quite broadly concentrated emergence period with or without spreaded emergence over the summer months. The time of maximum emergence varies in different species.

The univoltine constant emergence period may be in spring, summer or in the autumn, but a single compact period may also glide over the summer months in successive years in the same biotope. Such event, the mechanism of which is not clear, was observed in *Cricotopus festivellus* Kieffer in a pool in Riihimäki in 1953-1957 (author´s unpublished material). The emergence periods seen in Figs. 3-6 are thus not necessarily specific for the species, nor necessarily for a biotope.

A univoltinous life cycle also requires a synchronizing mechanism. With the day length combined ovarial diapause was shown, for instance, by Novak and Sehnal (1963) in the species of Trichoptera, but this is probably not possible in small chironomid midges. Mothes (1968) suggest *Corynocera ambiqua* Zetterstedt aestivating as eggs in Stechlinsee, Germany; this was considered questionable in Hirvenoja (1998:15). The life cycle of *Corynocera* may resemble that of *Trissocladius brevipalpis* Kieffer, which lives and emerges together with the species of Culicidae in the vernal pools in May-June in Finland. In a tentative rearing experiment (unpubl.) the adults of

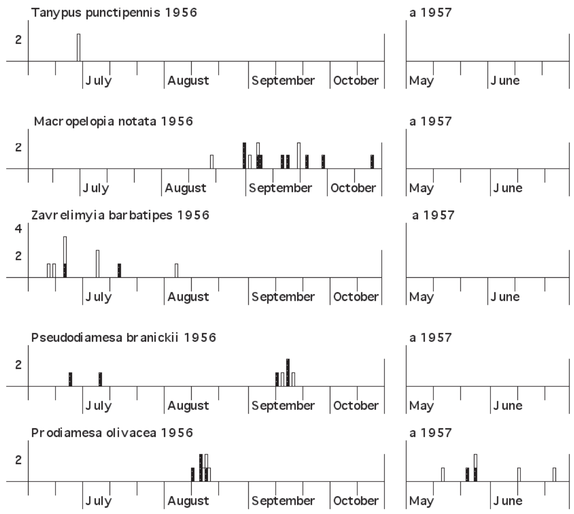

Fig. 3. Number of daily emerged individuals (ordinate) of the chironomid species *Tanypus punctipennis* Meigen, *Macropelopia notata* (Meigen), *Zavrelimyia barbatipes* (Kieffer), *Pseudodiames branickii* (Nowicki) and *Prodiamesa olivacea* (Meigen) in a floating cage trap (0.25 m^2) on the limnocrene in Riihimäki during the time indicated (abscissa) 1956-1957. White columns = males, dark columns = females.

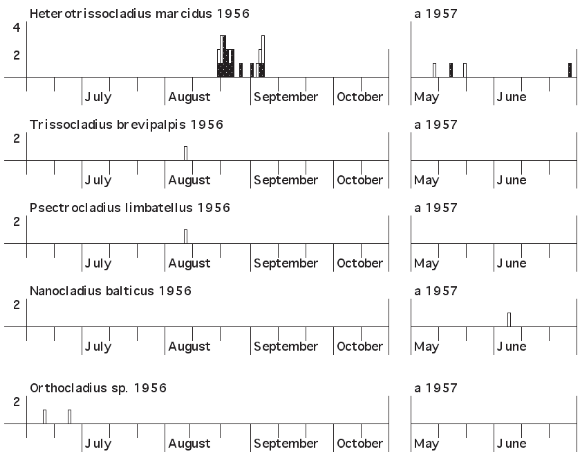

Fig. 4. Number of daily emerged individuals (ordinate) of the chironomid species *Heterotrissocladius marcidus* (Walker), *Trissocladius brevipalpis* Kieffer, *Psectrocladius limbatellus* (Holmgren), *Nanocladius balticus* (Palmén) and *Orthocladius* sp. in a floating cage trap (0.25 m^2) on the limnocrene in Riihimäki during the time indicated (abscissa) 1956-1957. White columns = males, dark columns = females.

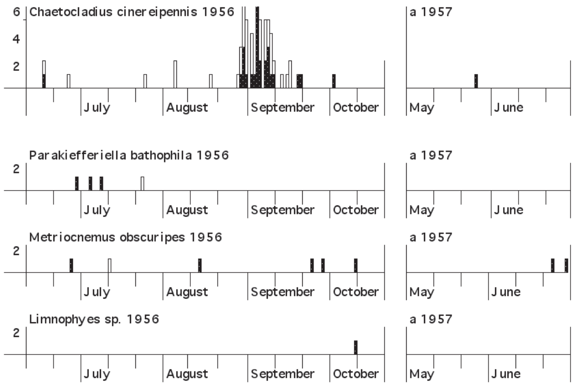

Fig. 5. Number of daily emerged individuals (ordinate) of the chironomid species *Chaetocladius cinereipennis* (Lundström), *Parakiefferiella bathophila* (Kieffer), *Metriocnemus obscuripes* (Holmgren) and *Limnophyes* sp. in a floating cage trap (0.25 m^2) on the limnocrene in Riihimäki during the time indicated (abscissa) 1956-1957. White columns = males, dark columns = females.

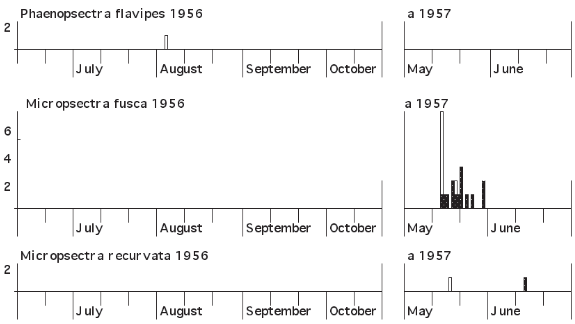

Fig. 6. Number of daily emerged individuals (ordinate) of the chironomid species *Phaenopsectra flavipes* (Meigen), *Micropsectra (Lundstroemia) fusca* (Meigen), and *M.(Micropsectra) recurvata* (Goetghebuer) in a floating cage trap (0.25 m^2) on the limnocrene in Riihimäki during the time indicated (abscissa) 1956-1957. White columns = males, dark columns = females.

Trissocladius beginn the copulation on a firm substrate with clasping lasting 25-35 minutes and with the females laying eggs after a few (?6-9) hours. The larvae aestivated in the experiment as the 1st and 2nd larval stage in an aquarium with aerated water in an unheated variable room temperature (15-20°C) from June to October. The larvae began to grow in ?November approximately when the temperature fell to under 10°C; the first adults of the new generation emerged in February. In natural conditions, the aestivation of this species occurs in the substrate of the nearly constantly dry pools. The emergence of *T. brevipalpis* in August in the limnocrene (Fig. 4) may indicate a continuous growth of the larvae without aestivation, because the temperature in this biotope was constantly under 10°C.

Emergence in the limnocrene occurred still in September or October (Figs. 3,5,6), which in southern temperate latitudes (Reiss 1968, Orendt 1993), but usually in Fennoscandia, is not possible in the lakes. During the emergence of the last individuals in the limnocrene in October 1956 the water temperature was 5.5-6.0°C, but in the environment the daily maximum air temperature was 7.5-11.5°C. The same water temperature was measured when the emergence began in May 1957 (Fig. 4-5, see also Fig.1 in Hirvenoja 1960b), but the daily maximum air temperature had already exceeded 20°C at times.

The insects, emerging from the cold waters are obviously able to utilize the higher air temperature. In Lapland in summer 1959 the insects were collected by the author with a submerged funnel trap from a large and deep limnocrene (akratopeg) at the upper course of the rivulet Kotaoja, in Sodankylä. The larvae were able to pupate in the temperature, which was about 3-5°C on the bottom. When ready to emerge, the pupae swam towards the surface, and some into the trap. As long as the submerged bottle of the trap was under the water surface, or was closed with a cork above the surface, a significant number of the individuals were not able to cast the pupal skin in the low temperature, which was still < 10°C in the bottle. As soon as the cork was opened enough to allow the air to flow into the bottle, a very sudden emergence took place in the bottle.

On the contrary, according to a tentative laboratory experiment with the chaoborid midges in 1957, the emerging adults were not able to completely leave the pupal exuviae if the temperature of the air was too low, i.e. at least some degrees below zero. In such cases the individuals are paralysed by the cold air on the water surface, where they then gradually die; the abdomen, wings and/ or legs stay more or less inside the pupal exuviae. This may be the reason why emergence in the northern latitudes (see the wide literature in Danks and Oliver 1972; Hirvenoja 1964) has been evolved to take place in the warmer daytime.

A rheocrene and a dammed epirhithral pool situated below it

The site and the water chemistry

There is a spring (akratopeg) on a slope at the border of a forest and a field, some 3 km east of the limnocrene discussed earlier (Grid 67428: 3816). It was visited on July 22,.1990 and August 1, 1992. The site, the farm Vanajanaho, belongs to the municipality Hausjärvi. The spring can be classified as a rheocrene. (The flow of current has not been measured in the steep rill, but it was estimated as being more than 50 cm/sec.) The water first ran 2-3 m into a dammed, shallow (depth < 0.5 m) pool about 30 m^2 in area (for temperature and gas conditioning), here called a epirhithral pool. From there the water was led to a fish pool, where *Salmo gairdneri* were raised. The bottom of the spring itself (rheocrene) consists of a fine sand, which contains very small amount of fine pieces of dark organic matter. The epirhithral pool has a clay bottom with the remains of higher vegetation, most of which was submerged non aquatic vegetation, indigating a dry period. This pool resembles a limnocrene, which in reality it is not. Some values concerning the water chemistry are given in Table 6.

The measurements of the water chemistry in the epirhithral pool (Table 2) give a value of total phosphorus which, according to Forsberg and Ryding (1980), refer to the eutroph waters, but those of total nitrogen refer to the hypertroph waters; the ratio N:P shows according to those authors, that the phosphorus is the limiting factor in the pool studied.

Table 6. The water chemistry in a rheocrene and a epirhithral pool studied in Vanajanaho, Hausjärvi.

	Rheocrene 22.07.90	Epirh. pool 01.08.92
Temperature °C	5.0	9.2
pH	6.9	6.8
Alkalinity meq/l	–	0.27
Color mg Pt/l	0	10
O_2 mg/l	8.0	–
O_2 satur.%	65	–
COD_{Mn} mg/l	2.0	13.4
BOD_5 mg/l (N=2)	0.5-0.7	–
Conductivity mS/m(γ25)	7.6	5.8
Hardness meq/l	0.7(=1.9 d°H)	–
Below measurements made by the laboratory of Viljavuuspalvelu Oy		
P_{tot} mg/l	–	0.05
N_{tot} mg/l	–	16.1
K mg/l	–	0.88
Ca mg/l	–	10.0
Mg mg/l	–	1.22
Cl mg/l	–	12.0
Fe mg/l	–	0.10
S mg/l	–	6.6

The Macrofauna

Only one bottom sample was taken from each of the two biotopes (Table 7) with the bottom sampler of the Ekman type (324 cm^2). Identifiable animals were selected from the samples under the binocular microscope and the rest of the mud was kept in an aerated vessel in the room temperature, from where the adults emerged into a cage; the method was the same used for the material given in Table 6.

The total number of the individuals reared from the bottom sample of the rheocrene (7 taxa) was 79 indiv./324 cm^2 (= 2438 indiv./m^2). The corresponding values from the epirhithral pool (16 taxa) were 144 indiv. / 324 cm^2 (= 4444 ind./m^2).

Table 7. Total number of the taxa picked up and/or reared to adults from the bottom samples (324 cm^2 each) from a rheocrene and a epirhithral pool studied in Vanajanaho, Hausjärvi.

Taxon	Rheocrene 22.07.1990	Epirh. pool 01.08.1992
Oligochaeta		
Lumbriculus variegatus (Müller)	-	33
Crustacea		
Asellus aquaticus Linnaeus	8	28
Megaloptera		
Sialis lutaria (Linnaeus)	-	1
Ephemeroptera		
Baetis niger (Linnaeus)	-	2
Centroptilum luteolum (Müller)	-	5
Paraleptophlebia tumida Bengtsson	-	15
Diptera		
Dixidae		
Dixella aestivalis Meigen	-	1
Chironomidae		
Macropelopia nebulosa (Meigen)	1	-
Zavrelimyia melanura (Meigen)	-	1
Pseudodiamesa branickii (Nowicki)	14	-
Prodiamesa olivacea (Meigen)	7	-
Heterotrissocladius marcidus (Walker)	40	-
Cricotopus fuscus (Kieffer)	-	7
C. tibialis (Meigen)	-	13
Rheocricotopus sp. (*?fuscipes* Kieffer)	-	1
Polypedilum sp.	-	1
Micropsectra apposita (Walker)	-	16
M. notescens (Walker)	8	7

Notes on the species found in the waters studied

Turbellaria

Dendrocoelum lacteum (O.F.M.). According to Sládeček (1973) this species is known from oligosaprobity to alfa-mesosprobity and indicates nearest beta-mesosaprobity. According to Luther (1961) it occurs in Finland in springs, lentic and lotic waters of different kinds and in brackish water (<5-7‰).

Oligochaeta

Lumbriculus variegatus (Müller). The ecological valency of this species does not seem to be well known in the literature (see Brinkhurst 1971: 9). In the author´s materials the species is common, for instance, in the profundal and/or littoral of shallow, humous, not polluted lakes in northern Finland. In the polluted river Vantaanjoki in Pitkäkoski *L. variegatus* was not found in the slack water (alfa-mesosaprobity) but occasionally in the rapids (beta-mesosaprobity) (Hirvenoja 2000).

Rhynchelmis limosella Hoffmeister. The ecological requirements of this species have not been evaluated in the literature. Species of *Rhynchelmis* also occur in some brooks in the study area in

Riihimäki, but taxonomical problems have appeared in the determination of the species. (Sládeček (1973) reports *Rhynchelmis vagensis* Hrabé in his list from the xeno- and oligosabrobic waters.)

Crustacea, Copepoda

Eucyclops serrulatus (Fischer). One of the most common cyclopids; occurs in all kinds of water habitats (Enckell 1980). According to Sládeček (1973) the species most likely indicates beta-mesosaprobity.

Isopoda

Asellus aquaticus Linnaeus. The species is quite ubiquitous. Its distribution in Finland is not very well known; obviously it includes the whole country, but it may be worth mentioning, that it was not found by the author in shallow lakes or in other aquatic habitats of the Sompio area (Sodankylä) in northern Finland during studies in 1959-1961, where for instance *Lumbriculus variegatus* was abundant. One individual was, however, caught in 1984 in the Lokka Reservoir 1984 which has existed in the same area since the early 1970´s (Hirvenoja 1998: 61). According to Sládeček (1973) the species most likely indicates alfa-mesosaprobity.

Insecta

The occurrence of Plecoptera, Trichoptera and Coleoptera caught in the limnocrene studied in 1956-1957 has been reported earlier (Hirvenoja 1960b, 1960c, 1964). It could be added that, according to Sládeček (1973) *Nemurella picteti* Klapálek characterizes xenosaprobity (index S = 0.2), whereas *Nemoura cinerea* Retzius chacterizes oligosaprobity or beta-mesosaprobity (S = 1.8). He (Sládeček 1973) does not mention the latter species from xenosaprobity.

Heteroptera, Gerridae

Gerris lateralis Schummel. Vepsäläinen (1973) reports that this species occurs in different kinds of pits, roadside ditches and springs, and mentions further that in northern Finland it is most often dominant among the species of *Gerris*. In 1956 it was often caught on the frames of the floating trap in the limnocrene.

Neuroptera, Megaloptera, Sialidae

Sialis lutaria (Linnaeus). Kaiser´s (1977) key has been used in the determination of the larva. Sládeček (1973) considers this species primarily as an indicator of the beta-alfa-mesosaprobity. Distribution in Finland: Lammes (2000).

Sisyridae

One female specimen of *Sisyra fuscata* Fabricius, emerged on July 5, 1956. According to Meinander (1962: 28) this species is quite common in southern Finland and has been found near flowing waters and lakes. Distribution in Finland: Lammes (2000).

Diptera

Tipulidae and Limonidae

In the summer of 1987 one undeterminable tipulid larva (Tipulinae) was found by mere chance in the limnocrene discussed here. Some mud and remains of vegetables were found in the gut content. Adults of nearly 100 species of Tipulinae are known in Finland (Hackman 1980).

In 1956 one large larva of *Pedicia rivosa* (Linnaeus) (Limonidae) was found and the gut content was observed under a microscope. The remains of a adult large adult fly with large pulvillae, probably a tabanid, were all that was found in the gut. *P.rivosa* is obviously an eucoen crenal species; it was reported already by Bornhauser (1912) to inhabit the springs.

Dixidae

Dixella aestivalis (Meigen). According to Disney (1975: 70) *D.aestivalis* is found in beds of emergent vegetation in a wide range of habitats from acid oligotrophic peat pools to alkaline eutrophic canals.

Dixella naevia (Peus). According to Wagner (1978) *D. naevia* is known in northern Sweden, Baltia, Germany and Kaukasus. In 1990 one male specimen was reared from the larva sampled in the limnocrene discussed here. Peus (1934) described *D. naevia* originally from a male which was reared from a larva collected in Latvia together with *D.hyperborea* Bergroth (Peus, 1934: 71-72). He describes the biotope as follows: :"Der Fundort ist ein Erlenmorast mit üppiger *Calla palustris* und eingestreuten *Betula*, *Picea* und *Juniperus*, viel Farnkräutern und Gräsern, am Rande des Weges von Kemmern nach Anting dort, wo dieser kurz von Anting das Hochmoor verlässt."

Chironomidae

Protanypus caudatus Edwards. The species is defined by Sæther (1975: 386) as a boreal palearctic species, which has been found from more or less oligotrophic lakes. The species has also been found in a spring (akratopeg) in northern Finland (Fig.12 in Hirvenoja 1973).

Tanypus punctipennis Meigen. According to Brundin (1949: 694) the species prefers eutrophic conditions and can tolerate low oxygen content of the water. Sandberg (1969) found this species in Lake Erken, Sweden, in zones outside the vegetation. The species is also found in running waters and temporary small waters (see the literature cited in Becker 1995).

Macropelopia notata (Meigen). The species belongs according to Fittkau (1962: 124) to the ground stock of the Central European springs, being limno-helo-crenobiontic; the important prey taxa mentioned by him belong to the genus *Micropsectra*.

The occurrence of *Zavrelimyia melanura* (Meigen) and *Z. barbatipes* (Kieffer) is restricted to springs and spring brooks or to the upper courses of brooks (Fittkau 1962). In the study area the latter species also emerged in a polluted brook.

Conchapelopia melanops (Meigen). Lindegaard (1995) lists it as a ubiquitous species. It occurred in beta-mesosaprobity in the rapids, but not in the alpha-mesosaprobic slack water of Pitkäkoski, Finland (Hirvenoja 2000); common in some shallow lakes studied in northern Finland (unpubl. materials).

Pseudodiamesa branickii (Nowicki) has been reported from the crenal and upper courses of running waters (epirhithral) by Thienemann (1941), Zavrel & Pax (1951) and Lehmann (1971). Brundin (1949: 591, 662) discusses the possible importance of this species as a member of the littoral fauna of the arctic and alpine lakes.

Prodiamesa olivacea (Meigen). It has been found by Brundin (1949: 718) and Reiss (1968: 230) in lakes, by Lehmann (1971: 488) from the crenal to the (epi-)potamal zone in the running water habitats of Fulda, Germany; studies on the occurrence of this species in the Rhine are listed in Becker (1995:95). Nadig (1942) reports *P. olivacea* in a spring with high total and sulphate hardness with a clear smell of H_2S, but not in those with low hardness or H_2S.

According to Thienemann (1954:650). *P. olivacea* incidentally occurs up to the limits of the polysaprobic zone. In the tables of the European system of saprobity Sládeček (1973, sub *Prodiamesa praecox* Kieffer, cf. also Mauch 1976) classified it as a beta-alfa-mesosabrobic species. He does not record *P. olivacea* in xenosabrobic or polysaprobic habitats. According to the German literature cited in Becker (1995:95) this species is very euryoecious. The occurrence of *P. olivacea* may perhaps be connected to the biology of its nourishment. In Finland *P. olivacea* is found — if not in xenosaprobic waters, but in at least not polluted, variable humous (chthoniotrophic, dystrophic) springs and brooks. The water in the limnocrene studied in Riihimäki (usually oligohumous) has been (up to the 1950's) considered as a very good trinking water in spite of the pure organic substrate. *P.olivacea*, on the contrary, was not found during a ten year period study in slack water or in the rapids of Pitkäkoski in the river Vantaanjoki (Hirvenoja 2000). This river is loaded by the waste waters of several purification plants and during these studies the water quality according to the Finnish classification (1-5 or 6 degrees) was classified by the local water administrators in the slack water as passable (=4th degree; Anon. 1987, Anon. 1992), which seems to correspond to alpha-mesosaprobity.

Trissocladius brevipalpis Kieffer. The single male of *T. brevipalpis* Kieffer, which emerged in August from the limnocrene observed, is perhaps a result of vernal egg laying. The species is common in the temporary vernal pools in the vicinity of the limnocrene studied. Living in the permanent water at the low temperature of the spring the larvae did not have a summer quiescencent period in the summer but grew and emerged. In springs *T.brevipalpis* is probably a xenocoen species.

Heterotrissocladius marcidus (Walker) is known in the Fulda river system, in Germany, from the crenal to the epirhithral zone (Lehmann 1971). Zavrel and Pax (1951:660) report its coexistence with *Pseudodiamesa branickii* in a spring. Lindegaard and Thorup (1975:130) list *H. marcidus* as a member of the detritus zone of the spring Ravnkilde in Denmark. Brundin (1949, Reiss 1968, Sandberg 1969, Hirvenoja 1998: 11-12) discuss the occurrence in the littoral of lakes. Mauch (1976) knows this species at most from mesosaprobic conditions.

Chaetocladius cinereipennis (Lundström; syn. *C.pige*r Goetghebuer) is obviously eucoen in the springs. According to Zavrel & Pax (1951:661-663, sub *Dyscamptocladius*; Brundin 1956: 121) the genus *Chaetocladius* is the most important genus among Orthocladiinae in Central European springs, where it was also found in the sulphur akratopegs or sulphur therms.

Metriocnemus obscuripes (Holmgren) is, according to Thienemann (1954: 335, *sub M. hygropetricus* Kieffer), a characteristic species of the hygropetric fauna ("Fauna Hygropetrica"), a species which may also occur in springs. Near the limnocrene studied some few individuals have emerged also from a vernal pool and a pool (unpublished materials of the author). According to a revised list of synonyms (Sæther 1989: 410) *M. obscuripes* is a Holarctic species, which occurs from Spitzbergen to Central Europe.

Cricotopus tibialis (Meigen) is a Holarctic, northern, somewhat psychrophilous species, which has been found in different kinds of habitats, among others in limnocrenes and streams in Central Europe. Lehmann (1971) reports *C.tibialis* in Fulda Germany from the crenal and epirhithral zones. In the River Punkanoja Riihimäki, Finland it emerged even in the beta-mesosaprobic, hyporhithral conditions.

Cricotopus fuscus (Kieffer), obviously inhabits a wide range of biotopes, including springs (Hirvenoja 1973).

Psectrocladius limbatellus (Holmgren). A very common species in the lakes of Finland. Lindegaard (1995) lists it as a lentic species, which also occurs in the limnocrenes.

Nanocladius balticus Palmén. This species was originally found in Finland in brackish water (Palmén 1959), but has also been reported to inhabit lakes in Europe (Sandberg 1969: Fittkau and Lehmann 1970: 397).

Parakiefferiella bathophila Kieffer is known as a common species in lakes, running waters and springs (Brundin 1949; Grimås 1961, Sandberg 1969, Lindegaard et.al. 1975, Lindegaard 1995, Siebert 1980, Tuiskunen 1986, Becker 1995).

Orthocladius sp. Lindegaard (1995) lists several species of *Orthocladius* found in springs. Because the pupal exuviae are not available, the determination seems to be impossible.

Phaenopsectra flavipes (Meigen). Obviously quite a ubiquitous species according to the records mentioned in Becker (1995). It occurred in beta-mesosaprobity in the rapids, but not in the alpha-mesosaprobic slack water of Pitkäkoski, Finland (Hirvenoja 2000); common in some shallow lakes observed in northern Finland (unpubl. materials).

Micropsectra (Lundstroemia) fusca (Meigen) occurs throughout Finland (Lindeberg 1970). Lindegaard (1995) lists it as a lotic ubiquitous species. As mentioned above, in the limnocrene treated here, marks of occasional sparse oxygen content were observed, which may be a limiting factor for species combination in this biotope. The species of *Micropsectra* are among the quite frequent inhabitants of the springs, but only *M.fusca* was found abundantly in this limnocrene. It also tolerates very modest environments, like those described below.

Adults of *M.fusca* emerged on August 30, 1988 in a rain water barrel made of iron at the summerhouse of Dr. B. Lindeberg in Punkasalmi, in eastern Finland. The barrel usually contained standing water; it was treated with an anti-rust agent, which contains mercury, pieces of which were abundantly present in the sediment; larvae of *M. fusca* coexisted in the barrel with *Chironomus luridus* Strenzke.(For the determination of *C.luridus* adults and pupae from Punkasalmi are available; the occurrence in Finland has been confirmed also karyologically by prof. P.Michailova)

The larva of *M. fusca* is obviously hitherto unknown, and is briefly described below (Fig.7):

Length about 7.5 mm, the brownish head capsule 370 µm long. Abdominal segments 1.-6. anallateral with hairy, asymmetric biramous setae. Segment 8. with a dorsal hump. Claws of all parapods smooth. Antennal pedestal without spur, but the antennae are otherwise typical to *Micropsectra*. In the labro-epipharyngeal region the bases of S_I twice as long as broad, those of S_{II} not longer than broad; the labral setae and chaetae roughly serrated. Premandibles with two apical teeth and with a premandibular brush. The mandibles, hypochilum and paralabials as usual in *Micropsectra*. There are differences between the species of *Micropsectra* in the ventral sclerotization behind the foramen occipitale, which is why that of *M. fusca* is illustrated.

Comments to the morphological nomenclature used here: The hypochilum is in Orthocladiinae s.lat. and Chironominae a new complex organ, arising

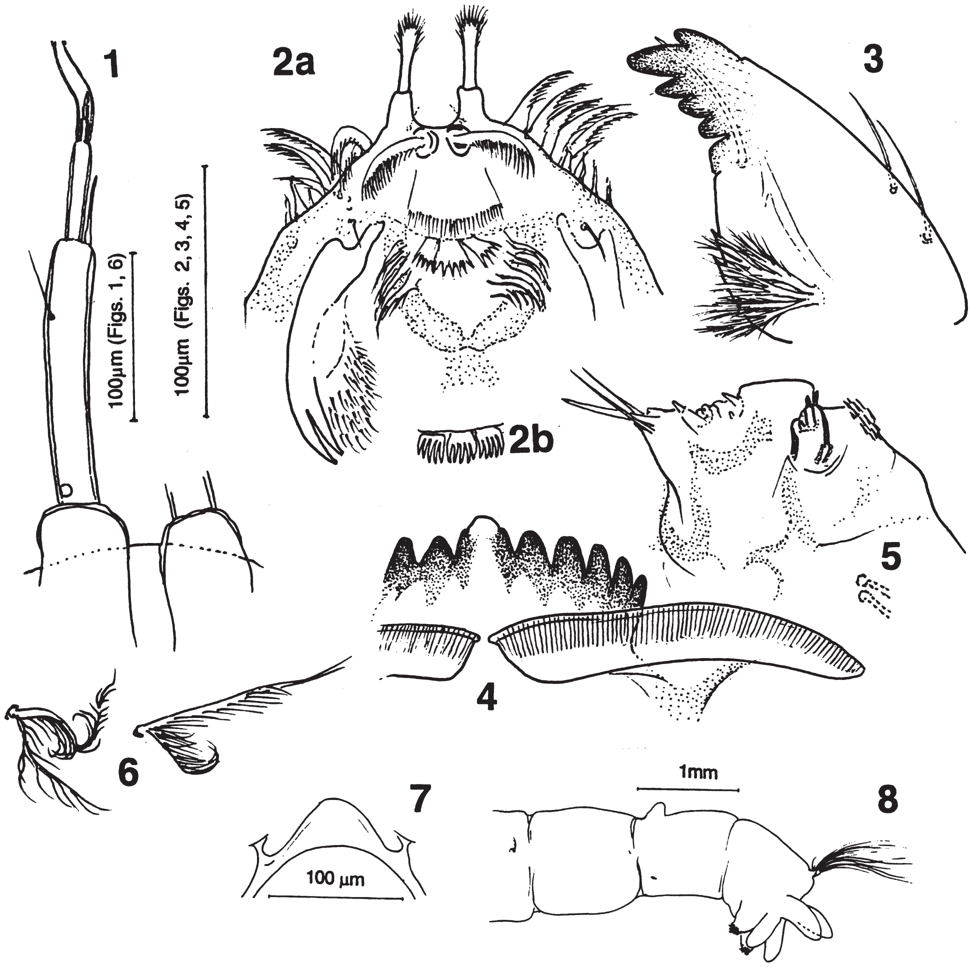

Fig. 7. *Micropsectra (Lundstroemia) fusca* (Meigen). Larva. Antenna (1), labro-epipharyngeal region (2a), pecten epipharyngis seen in a different position (2b), mandible (3), hypochilum and paralabials (4), maxille (5), lateral setae of the abdominalsegments 1.-6. (6), area of foramen occipitale between the posterior tentorial pits (7), abdominalsegments 6.-9. (8).

from the fusion of the submentum and the front border of the ventral wall of the secondary sclerotized head capsule. The paralabials are understood here also as the secondary new complex organs, arising in Chironominae from the fusion of the hairy parts of the maxillar cardo (basipodite) and the front border of the ventral wall of the head capsule. — Submentum and mentum (in the literature: "paralabial kamm", "dorsomentum", "glossa", "ligula") as the free sclerites before the hypostoma of the head capsule are still present in Tanypodinae. A free sclerite mentum, as broad as the whole hypochilum and provided with long teeth, is present in Orthocladiinae in *Halocladius (Psammocladius) braunsi* (Fig. 59.9 in Hirvenoja 1973) between the hypochilum and the prementum. The labial segment of the last mentioned species resembles the labial segment in *Anopheles* (Anophelini), where the free sclerites of a toothed mentum, but also a toothed submentum are present, forming a compact "paquet" opposite to the other Culicini (*Aedes*, *Culiseta* etc.).

M. notescens (Walker) is, according to Säwedal (1976: 124), "a coldstenothermous, polyoxybiont species known from springs and the epirhithral zone of streams, where it inhabits lentic places". The present study shows that also a stronger flow of current can be tolerated by this species as well as by *Micropsectra (M.) recurvata* (Goetghebuer).

Säwedal (1976: 131) reports *M. apposita* (Walker) coexisting with *M. notescens* at epirhithral lentic places in a brook in southern Sweden. A mass emergence of *M. apposita* (about 30,000 indiv./m^2) was observed at the hyporhithral, in the lentic zone of the river Punkanjoki, (the water quality here near beta-mesosaprobity), in southern Finland in July-August 1953 (Hirvenoja 2000). Reiss (1965, 1968 sub *M. contracta* Reiss; see Cranston 1974:92) describes the occurrence of *M. apposita* in Lake Bodensee, Germany, where he found it at depths between 5 and 210 m. *M. apposita* is, according to Lindegaard (1995), a lotic species. In Lapland it seems to be (unpubl. material of the author) very abundant in the limnocrenes observed.

Paratanytarsus austriacus Kieffer occurs abundantly in the study area in Riihimäki also in some temporary waters. According to Reiss and Säwedal (1981: 96) and to the literature mentioned in Becker (1995) *P. austriacus* inhabit lakes, ditches, small standing waters and small streams arising from the springs. According to the author´s materials it tolerates freezing and may emerge in some vernal snow melting pools (unpubl.). Hirvenoja & Michailova (1991: 95) report it in a pool, where BOD_5 9.3 mg O_2/l was measured, corresponding to alpha-mesosaprobity.

Tanytarsus palettaris Verneaux. It has been found in European springs and brooks. *T. palettaris* is hitherto known from French Jura, to Roumania and Finland (Verneaux 1969; Reiss & Fittkau 1971, Ilmonen and Paasivirta 2000). The waters in the biotopes described by Verneaux (1969: 8) contain more dissolved minerals and there is obviously less organic matter in the sediment, but the flow of current or the temperature conditions in Riihimäki correspond to the French habitats.

Brachycera, Sphaeroceridae

Opacifrons humida Haliday (Syn. *Spinotarsella humida*). From the 28th of June to the 24th of September 1956 six females of this semiaquatic species were found in a trap (kindly determined by Prof. W.Hackman). Because only single females were occasionally found, the occurrence in the trap perhaps does not indicate the growing site of the larvae with certainty.

Hydracarina

Arrenurus sp. Female specimen were captured in June 26,1956 (kindly determined by Prof.Dr. P.Bagge).

Araneae

Terrestric species were sampled in June 21,1956 from the cage trap too (kindly determined by Dr. J. Terhivuo): 1 ad. male and 1 ad. female *Tetragnatha extensa* (L.) and 1 ad. *Larinioides* (=*Araneus*) *patagiatus* (Clerck). These are common species in Finland and not unexpected near an aquatic biotope (Palmgren 1974).

Discussion

Bornhauser (1912) listed 147 genera within 287 animal species from European springs. The fauna known at that time consisted, among others, of 60 taxa belonging to the Protozoa, but only of 3 taxa of the Chironomids. Lindegaard (1995) compiled lists of more than 200 chironomid species, which were recorded from European cold springs during the nineteenth century.

The spring species have ecological connections, especially to the rhithral of running waters, to the arctic or mountain regions and to the profundal of the lakes. The cold crenal waters in Finland should sometimes be even katharob and among natural waters of the highest quality. It should be possible to list many of the organisms found in them, especially the numerous chironomid species in clear spring water conditions, as inhabitats of the xenosaprobic or at least oligosaprobic sites. Exceptions are for instance spring waters which occasionally or continuously contain humic substances. Unfortunately, the chironomid species have rarely been evaluated in this respect in the literature (Sládeček 1973, Mauch 1976).

A state of near xenosaprobity may prevail constantly in the rheocrene dealt with in the present paper (Table 6), but the fauna of the epirhithral pool (Table 7) studied indicates worse conditions, however, perhaps still remaining within the limits of oligosaprobity. An attempt to calculate the saprobic index (about the methodology see Sládeček 1973, Schwoerbel 1980, Uhlmann 1982) for the limnocrene (Table 3) on the basis of the few species with a known specific index indicates a slight beta-mesosaprobity. The estimated result obtained from the presence (or lack) of certain species may obviously not indicate the water quality during the period of study only, but rather unobserved conditions in winter and possible occasional low ground water lewel periods, all of which may cause depletion in the oxygen standard and/or may restrict the occurrence of many typical, more oxyphilous organisms.

Information about the conditions in the springs studied here has also been obtained by calculating the Shannon & Weaver´s (1963) diversity index (*H´*) In the limnocrene studied the material caught with a cage trap in 1956-1957 (Table 3) or that taken by means of a hand net (Table 5) give a value of *H´*= 2.20. The value *H´* = 2.23 was obtained from the epirhithral pool, but the lowest *H´*= 1.42 is from the rheocrene. The low values here cannot have anything to do with the water quality, but perhaps indicate only the low number of niches (or merotopes) in the biotopes studied; this situation can be seen without calculations. Variable, also very low indices were found in the Danish springs by Lindegaard et al. (1998).

The three sites studied have explicable differences between their faunas. They have a certain cohesion with the known European spring faunas. The majority of the species listed above, on the contrary, were not found in the very polluted river Vantaanjoki in the area of Pitkäkoski (Hirvenoja 2000). Exceptions were *Lumbriculus variegatus*, *Eucyclops serrulatus*, *Asellus aquaticus*, *Sialis lutaria*, *Centroptilum luteolum*, *Conchapelopia melanops* and *Phaenopsectra flavipes*, all of which are probably not precisely ubiquitous, but may indicate certain various negative conditions in the crenal cicumstances studied. The bottom fauna indicates the situation over a much longer period during the year than a chemical analysis does.

Conclusions

A basic feature in the observation of aquatic communities is the stability of the species combination, which can last as long as several thousand years without the interference of human activities (see for instance Fig. 1 in Hirvenoja 1998 and the literature cited in it); climate, however, is always of great importance. Minor examples of the grade of stability over successive years are for instance in Hirvenoja (1960a, 1960c, 1964); this author collected larvae of *Chaoborus nyblaei* (Zetterstedt) in a pool in Utsjoki, Lapland in 1960; unknown larvae were collected for the first time in 1894 in the same site (Hirvenoja 1961). The reasons for the possible changes observed in a fauna are always worth of studying.

Small, not negative differences were found in the animal communities of the limnocrene treated here between 1956-57 and 1990 (Tables 3 and 5) in spite of the felling of timber and one very large digg, and in spite of the marked changes in the visible environment described earlier in this article. This indicates that the most important activity in the conservation of the spring animal communities is to keep the springs and their outlets open or — sometimes — to try to prevent a total drying (lowering of the ground water level) of the area if it is possible. There are no apparent reasons to avoid for instance to fell the timber in such sites.

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Selostus

Kylmät pysyvävetiset lähteet ovat 1900-luvun kuluessa maankäytön tehostuessa harvinaistuneet tarkastellulla alueella Riihimäen pohjoispuolella. Kirjoituksessa kuvataan yhden vielä nykyisin säilyneen, orgaanisella alustalla sijaitsevan, hieman epävakaaksi muuttuneen allikkolähteen (limnokreenin) ympäristön kehitystä ja siitä vuosina 1956-57 ja 1990 tavattua eläimistöä. Lähteet kuuluvat virtaavien vesien ekosysteemiin niiden ylimpinä ja kylmävetisimpinä osina. Maan uumenista virtaava pohjavesi hapettuu nopeasti saadessaan ilmakosketuksen.

Kirjoituksessa on kuvattu myös samalla seudulla sijaitsevan, maan sisältä suoraan purkautuvan pysyvän puron (purolähde, rheokreeni) lajistoa. Purolähde eroaa allikkolähteestä m.m.paljon voimakkaampaan virtaukseen liittyvien tekijöiden vuoksi. Lämpötila ei ehdi paikallisesti nousta 4-5 asteesta kuten allikkolähteiden pintakerroksissa tapahtuu lähes kymmeneen asteeseen tai hyvin paikallisesti korkeampiinkin lämpötiloihin.

Tarkastellun purolähteen vesi päätyy epirhithraalissa (= puron ylimmällä juoksulla), tässä tapauksessa erittäin lähellä lähdettä olevaan padottuun lammikkoon. Sen eläinlajisto on äkillisesti erittäin hitaaksi muuttuneessa virtauksessa sekoitus virtaavien ja seisovien vesien faunaa. Epirhithraalissakin veden lämpötila on vielä 10°C tienoilla. Tarkastellun lohien kasvatusallasta edeltävän ilmastuslammikon eläinlajiston koostumus osoittaa melko hyvää veden laatua. Periaatteessa itse lähteiden vesien pitäisi luonnossa kuulua laadultaan parhaimpiin, mitä ne välttämättä eivät kuitenkaan aina kaikilta ominaisuuksiltaan ole.

Lajistoltaan runsaimpina esiintyvät lähteiden ns. makrofaunassa surviaissääskien toukat kuten on laita muissakin vesistöissä (järvissä hyvin usein 90%). Niitä on pelkästään Euroopan lähteistä tavattu yli kaksisataa lajia. Eläinlajeja on kirjallisuudessa mainittu Euroopan lähteistä runsaat puolisen tuhatta, jotka eri yhdistelminä tuottavat melkoisen elinpaikkojen kirjon. Laji- tai yksilömäärät vaihtelevat lähteissä aivan samoissa suuruusluokissa kuin virtaavissa vesissä tai järvien rantavyöhykkeellä vastaavan kokoisilla pinta-aloilla. Yhden järven koko pohjan makrofauna vaihtelee sadan lajin molemmin puolin, mutta yhden rajallisen alueen lajimäärä on karkeasti ottaen tavallisesti vain neljännes siitä, jos sitäkään.

Edellä olevassa kirjoituksessa tarkasteltujen lähteiden eläinlajisto on osittain läheisten virtaavien vesien faunaa, mutta yhteisiä elementtejä on arktisten seutujen, järvien ja murtovesienkin lajiston kanssa. Osa lähteidenkin lajeista elää vain suhteellisen puhtaissa vesissä, jollaista tilaa ne ilmentävät muissakin vesissä esiintyessään.

Edellä mainitun alunperin 1956-57 katsotun limnokreenin pohjaeläinlajistoa tutkittiin uudelleen vuonna 1990 senjälkeen, kun se oli kaivettu kooltaan n. 5-10 kertaiseksi (riippuen veden pinnan tasosta). Yli 20 vuoden ajallisesta erosta, lähteen kaivuusta ja voimakkaista lähiympäristön puulajistoa vaihtaneista hakkuista huolimatta pohjaeläimistö näyttää 1990 olevan lähes entisellään vuoteen 1956 verrattuna. Vähäiset faunan muutokset osoittavat mieluumminkin olosuhteiden paranemista ilmeisesti kaivuun antaman väljyyden vuoksi. On ilmeistä, että kosteikkojen suojelun tärkeimpiin tehtäviin pitäisi kuulua paitsi pohjaveden pinnan alenemisen kohtuullinen varominen, erityisesti lähteiden pitäminen avoimina. Ei liene sensijaan mitään syytä, ellei muiden tekemin perusteellisin tutkimuksin toisin osoiteta, kieltää esimerkiksi metsän hakkuita t.m.s. toimenpiteitä niiden lähimmässäkään ympäristössä.