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Mauri Hirvenoja
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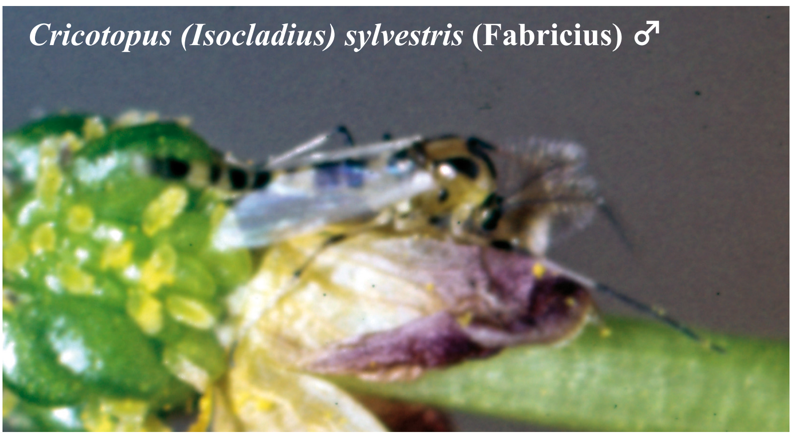
Cover picture:
A view of Lake Sompiojärvi towards northwest from the slope of the Terävänattanen fell. The narrow pale stripe along the shore of the lake (low birch wood cf. Figs. 37-39 of the following article) shows the site of the ancient village off the Lapps. Behind the lake the small mound in the middle is the Kussuolinkivaara Hill (cf. Figs. 9-10).



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The genus *Cricotopus* v.d.Wulp (Dipt., Chironomidae) in the running waters of the Sompio area, northern Finland

Mauri Hirvenoja

Hirvenoja, M. 2013: The genus *Cricotopus* v.d.Wulp (Dipt., Chironomidae) in the running waters of the Sompio area, northern Finland. – Risum teneatis 1: 3-35. (www.poronoro.fi/library)

Emerging aquatic insects were collected using floating cage or submerged funnel traps in May - September 1959 through 1961 in the running waters of Sodankylä, northern Finland. The biotopes represented areas of rather weak current in the upper Kemijoki system. They ranged from crenal to hyporhithral. Ever since 1970 the Lokka Reservoir has inundated them.

The number of individuals emerged per site ranged from 870 up to 19938 ind./m². The variation is mainly attributable to trophic level, which ranged from oligotrophy to eutrophy. Peak emergence was observed in the vicinity of ancient abodes of the Lapps as well as more recent camps of the reindeer husbandry (Tables 8, 12).There were no evident sewage outflows in the area.A majority of species started to emerge when the air temperature rose to about >8ºC. Nevertheless, spring or other cold stenothermous species were able to pupate in temperatures lower than the ones mentioned above.In the fashion of other species they used warm air at the water surface for emergence. The peak of the emergence of insects in the Sompio area was as far as it was possible to discover during the light and warm hours of the day.

The following species of *Cricotopus* were found in the running waters of the area:

C. (Cricotopus) tibialis (Meigen) is a rather constant member of crenon and hypocrenon communities.

C. (C.) cylindraceus (Kieffer), *C. (C.) festivellus* (Kieffer). *C. (Isocladius) intersectus* Fabricius, *C. (I.) pilitarsis* Edwards, *C. (C.) polaris* Kieffer, *C. (I.) reversus* Hirvenoja and *C. (I.) sylvestris* Fabricius, all of which inhabit the nearby lakes, were accidentally found in very low numbers as xenocoen species from hypocrenal to hyporhithral sites.

C.(C.) claripes Hirvenoja (cf. the text) and *C. (C.) septentrionalis* Hirvenoja were found only under metarhithral conditions.

The following species, some of which are rheophilous, emerged from variable meta- or hyporhithral sites: *C. (C.) albiforceps* (Kieffer), *C. (C.) annulator* Goetghebuer, *C. (C.) bicinctus* (Meigen), *C. (I.) suspiciosus* Hirvenoja, *C. (C.) triannulatus* (Fabricius) and *C. (C.) tristis* Hirvenoja.

Species found only in the lakes of the study area were *C. (C.) pilidorsum* Hirvenoja, *C. (C.) magus* Hirvenoja, *C. (C.) coronatus* Hirvenoja, *C. (C.) patens* Hirvenoja, *C. (I.) tricinctus* (Meigen), *C. (I.) arcuatus* Hirvenoja, C. (I.) obnixus (Walker).

The production, saprobity and phenology are discussed. A majority of the species of the genus *Cricotopus* belong to the fauna of "sound" aquatic habitats.

Mauri Hirvenoja, Sotilaskorventie 13, FI-01730 Vantaa, Finland

1. Introduction

The original aim of the study was to preserve fragments of aquatic animal life in the Sompio area in northern Finland in 1959-1961 as it was prior to the construction of massive hydroelectric power plants (a map of the area in Hirvenoja 1998c) and on the page 33 of the present work. Weighing was tentatively applied to find different kinds of biotopes and communities. The area was, however, very diverse and it proved impossible to reach a satisfactory result. The biotopes observed are examples only.

We are here dealing with biotopes, some of which were evidently influenced by culture to some extent. Nevertheless, there was no trace of municipal waste loaded with chemicals.

It has proved impossible to prepare and determine in particular the material of the running waters of the study area in its entirety. The sites are, however, described here for a future treatment of the material if it ever will become feasible.

Several ecological parameters vary irregularly along stretches of running waters. Slight differences in the maximum summer water temperature can be taken to serve as a common base. It can be used in comparing differences in the distribution of animal species along the water course. The influence of factors such as size, substrate, local velocities or trophic relations may then be compared

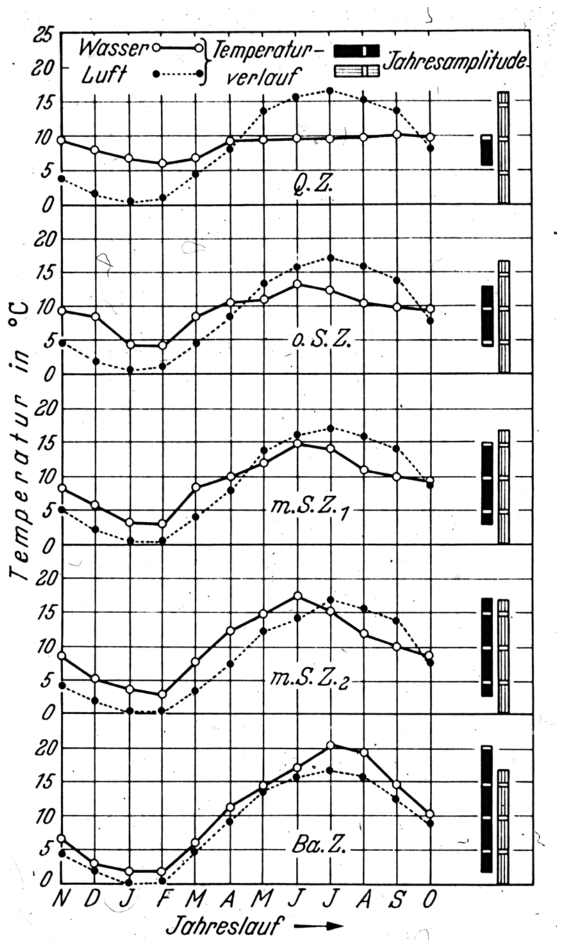


Abb. 1. Jährlicher Temperaturverlauf und Temperatur-Jahresamplituden von Wasser und Luft in den verschiedenen aufeinanderfolgenden Zonen eines Fließgewässers. *Q.Z.* Quellzone oder Krene, *o.S.Z.* Obere Salmoniden-Zone oder Epirhithron, *m.S.Z.*$_1$ oberer Abschnitt der Mittleren Salmoniden-Zone oder Metarhithron, *m.S.Z.*$_2$ unterer Abschnitt der Mittleren Salmoniden-Zone oder Metarhithron, *Ba.Z.* Barben-Zone oder Epipotamon. Aus SCHMITZ 1955, ungezeichnet und ergänzt

Fig. 1 & 2. The temperature zonation of the running waters used in the present and other papers of the present author. Accepted from Steffan (1965) abowe and from Kownacka and Kownacki (1972) right.

inside a temperature zone.

Central European biologists have differentiated running waters into springs and salmon, grayling and barbus zones (Fig. 1, cf. Steffan 1965). Early studies on the succession of invertebrates (e.g. Illies 1953) yielded a rough idea of their parallel distribution in similar zones of running waters. This, in turn, led to an attempt to construct a generalized zonation for running water by Illies and Botosaneanu (1963).

Steffan (1971) developed this classification further. The ice brooks, the metakryal and hypokryal were included in the succession of biocoenoses. The classification is often used in the European literature and also discussed more completely for instance by Kownacka and Kownacki (1972) and Braukman (1987). A zonation of rivers using this approach has not been discussed in Finland. One gets rather an impression that the highly endangered aquatic world is a terra incognita (cf. Airaksinen and Karttunen 2001, Rassi et al. 2001, Ilmonen et al. 2001).

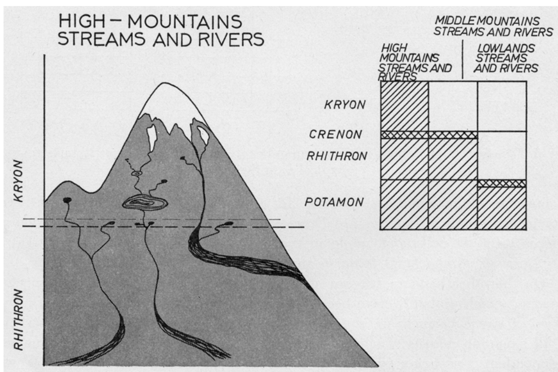
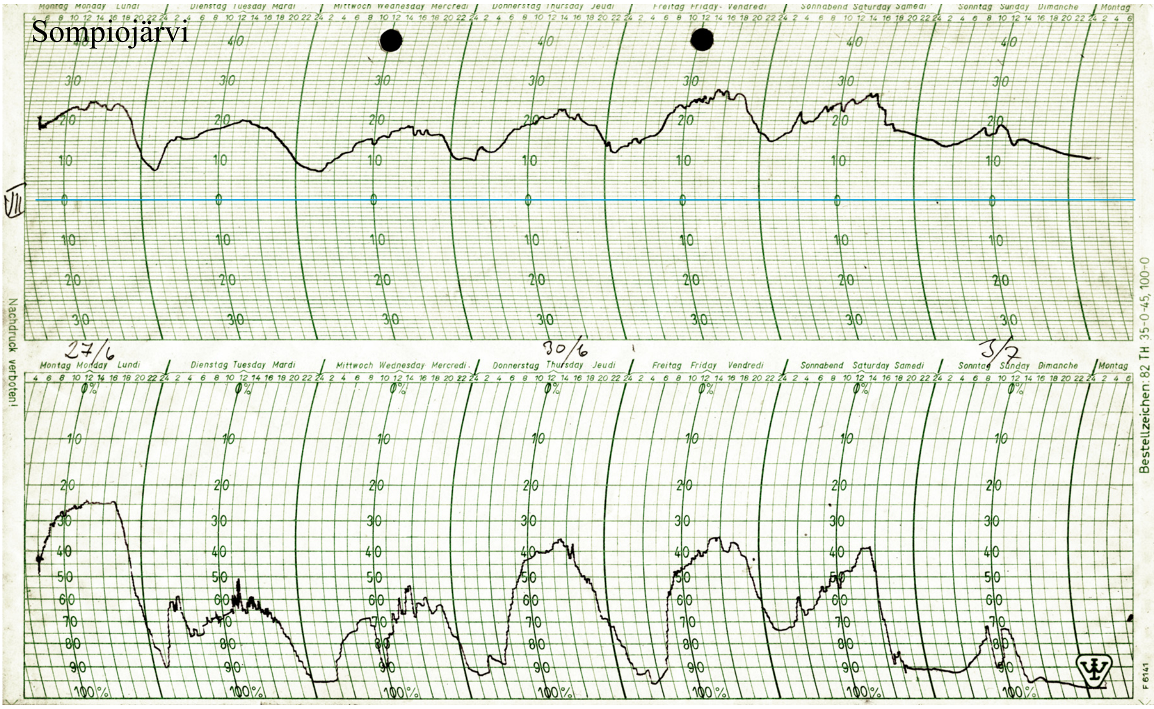


Fig. 6. Zonation of running water ecosystems with special regard to the group of high-mountain streams and rivers.

2. The study area and sampling methods

Since preliminary studies could not be done within the area, the sites were at first chosen in a rather random pattern. This made it imperative to extend the sampling at some sites into the following year (Fig. 19). The water temperature at each site was monitored daily when the traps were emptied. Maximum-minimum permanent thermometers were used whenever they were available or could be used at a site.

A number of bottom samples were taken on occasion using a hand net or an Ekman bottom sampler. A bulk of the material was collected *in situ* from May to September 1959-1961 using cage traps (Fig. 2) in shallow water or with submerged Brundin (1949) funnel traps in deeper sites. These



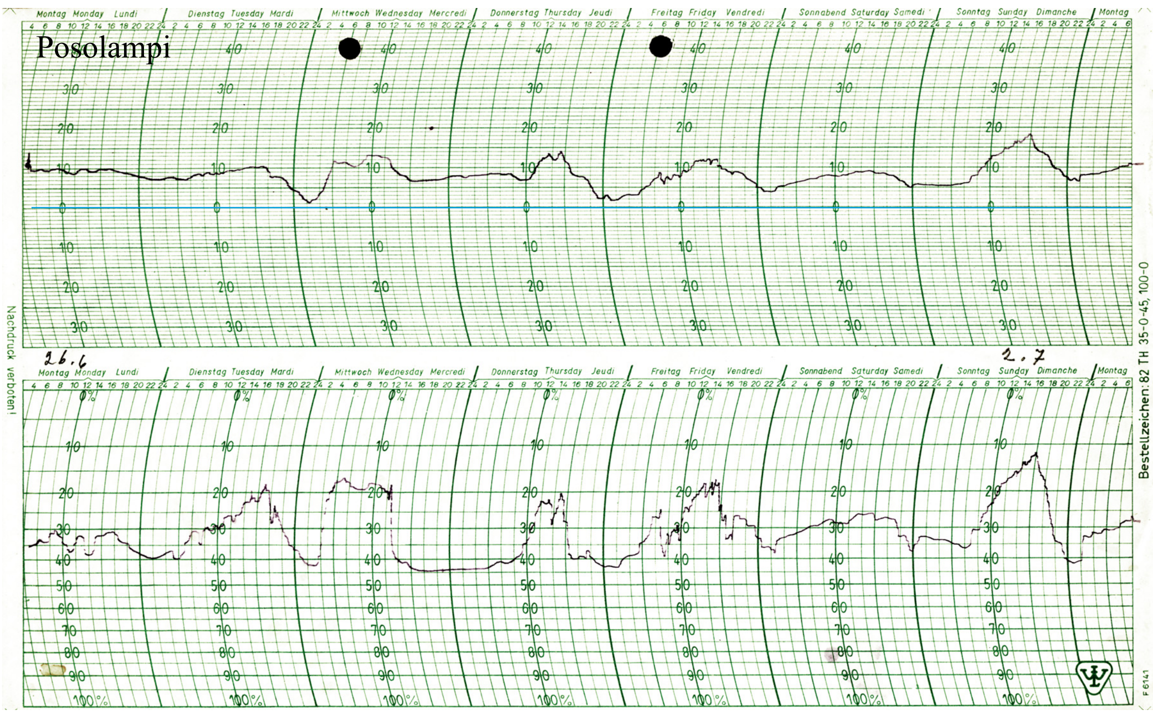


Fig. 3. Variation of the air temperature and moisture at Sompiojärvi between June 27. and July 3.1960 and at Posolampi between June 26. and July 3.1961.

devices measured 0.5 m².

Because the insects in the study area emerged gradually after sunrise, the traps were emptied afternoons every day to avoid losts of the matherial. Based on a rough evidence one might state that they emerged during the light and warm hours. In midsummer the sun was above horizon 24 hours but the air temperature fluctuated widely down to near zero.

The coldest hours were in general the ones between 24 and 04 hrs. An air ambient temperature from 8°C to 10°C set an apparent lower limit to the emergence of many species. This conclusion was supported by taking sample series with intervals of two or three hours for 3 days.

One preliminary small serie of samples was taken from southern Finland, Riihimäki, in August 9-10. 1953. 88.3% of the chironomid midge *Micropsectra apposita* (Walker) emerged as adults (394 individuals of 446) between 22 and 04 o'clock i.e. during the dark hours (Hirvenoja, M. 1954, unpublished pro gradu thesis, Helsinki University). In the same samples from the same site the number of other emerging species was at that time of the year very sparse, with a majority of species emerging between 12 and 16 o'clock.

Populations which I have determined as *Micropsectra apposita* belonged also to the fauna of the Sompio area treated here, but in Kotaoja Stat. 1/1959 in June 15-17. that species emerged between 06 and 21, the most individuals between 12 and 15 o'clock i.e. at the daytime, contrary to the observation in Riihimäki.

In the ponds observed in Riihimäki in the 1950's the chironomids, chaoborids as well as ephemerids emerged during the light hours. *Cloeon dipterum* (Linnaeus) followed the fluctuation of the temperature and emerged between 11 and 14 o'clock (Hirvenoja 1964:69, 1965). In the sparse material of other Ephemeridae the most individuals of *Caenis horaria* (Linnaeus) emerged between 19 and 23 o'clock and those of *Siphlonurus linnaeanus* Eaton in the River Punkanjoki between 08 and 20, the most between 17 and 20 o'clock. Different times in the emergence of the chironomids may depend in part also on factors which determine the rhythm of the pupation.

Palmén (1955) studied the diel periodicity of emergence in the brackish waters near the Biological Station of Tvärminne in the summer 1954. All species observed emerged around the midnight. According to Oliver (1968) in Canada the peak emergence of most arctic chironomids occurs around the warmest part of the diel cycle.

The emergence of insects is of interest as such, but it may be an important feature in the dynamics of the biocoenoses not only from the point of view of the fish biology, but also in the nourishment of birds (Nummi et al. 2013).

The contents of cage traps were secured using a suction bottle with some drops of alcohol (70-75%). Some drops of chloroform were first inserted into a bottle of funnel trap so that the contents could be emptied using a plankton net.

Aquatic insects have been collected using many different kinds of devices (e.g. Mundie 1956, 1964, Brundin 1966). Here both types of traps were used in lentic and lotic conditions, i.e. floating cages in shallow water and submerged funnel traps in sites deeper than 70-80 cm. Tentative comparisons have been made to show eventual quantitative differences in catch. A rough visual inspection the cage traps yielded catches that exceeded by a quarter or even more the ones in funnel traps (cf. Morgan et al. 1963).

Fig. 4. A tent trap on rhe rheocrene at Kotakenttä (Stat 12/1959).

Before embarking in this study the author had observed large quantitative differences, the reasons behind which were unknown, in samples from single sites taken in different years in Riihimäki, southern Finland. Only floating emergence traps were used in Riihimäki (Hirvenoja 1960a: Fig. 5, 1964: Fig. 6).

In 1959 large numbers (up to 12000 ind./m² , 2 funnel traps) of *Corynocera ambigua* (Zetterstedt) emerged within the study area in Lake Sompiojärvi (Hirvenoja 1960b). A year later, at approximately the same site, the catch of a funnel trap was only about 4000 ind./m². The difference is probable attributable to a variable aggregation of larvae.

The main emphasis of this study is to assess the relative abundance of species on the basis of pupae and adults (funnel traps) or the adults (cage traps) rather than striving to improve the quantitative aspect of results with several bottom samples of larvae for statistical analysis, but difficult to determine as species.

Kuusela (1979: 66) discusses the possibilities for obtaining reliable quantitative results using other methods.

The original names and code numbers of the stations studied in different years are used throughout this study. This is done to avoid any confusion that might arise in the handling of the material.

3. Springs and spring brooks around Lake Sompiojärvi

The Kotakenttä Spring

Stat. 12/1959, Grid 27° E, 7558:517. Fig. 4.

Stat. 12/1959 was a very small hole in the ground, a rheocrene at the border of a forest, above the level of the large limnocrene Stat. 1/1959. The water ran (<10 cm/sec) on a thin layer of dark mud. Water temperature in July 21 ranged from 3ºC to 4ºC, attaining a high 7ºC at an ambient air temperature of 29°C.

The material has only been determined in part; then genus *Micropsectra* was an important constituent. Two males and one female of *Cricotopus intersectus* Staeger emerged in June 25, 1959. This species, accidental in a spring, represents 0.07% of the total number of chironomids (Table 8) that emerged from that site. The larvae have evidently hibernated in the frozen mud layer.

The Kotaoja Spring

Stat. 1/1959, Grid 27º E, 7558:517, Fig. 6.

Stat. 1/1959 was a large limnocrene. The diameter of open water ranged from 6 to 10 m with a depth of <1.5 to 2.0 m (map Fig. 1 in Hirvenoja 1960b). The bottom was covered with quite pure gravel. In July 1959 the mean water surface temperature was +8.6ºC. It was constantly under +4ºC at the bottom. A maximum surface temperature of +11ºC was reached in July 22, 1959. In addition to water from its bottom the limnocrene was fed through the rheocrene Stat. 12/1959. Snow melt or rain water from the Pyhänattanen Fell flowed through a small brook to the limnocrene.

Not a single *Cricotopus* was seen to emerge in the funnel trap in the middle of the limnocrene (Kotaoja Stat. 1/1959). Near the shallow shore, where the bottom was, in part, covered by *Calliergon spp.* moss carpet, 8 males and 12 females of *C. tibialis* Meigen emerged in July 10. 1959 in a floating cage trap, which was tentatively kept on this site for one day only.

← Fig. 5. Stat. 2/1959 in the estuary of the Kotaoja Brook.

Fig. 6. Part of the wide ancient dwelling place of the Lapps called Kotakenttä (kota = hut of the Lapps, kenttä =field) in 1959; the boat is in the limnocrene Stat. 1/1959. The rheocrene (Stat. 12/1959) was some 30 m left of the yellow writers tent. Before the boat there are funnel traps used in the sampling of the emerging insects.

The estuary of the Kotaoja Brook

Stat. 2/1959, Grid 27º E, 7558:518. Fig.5

There was only a weak current in the brook that was 2 to 5 m broad and shallow (0.2 to 2.0 m deep). Downstream of the limnocrene Stat. 1/1959 there were several successive troughs and thresholds (>10 cm deep), which were evidently gouged by the action of ground water. The July mean temperature at a depth of 0.5 m at the Stat. 2/1959 was +10ºC. The surface water temperature rose above +13ºC in July-August of 1959. Any cold water was kept behind the last threshold at the shore line of Lake Sompiojärvi.

Waves brought in warm and turbid lake water with loose gray sediment and also some bottom fauna from Lake Sompiojärvi to Stat. 2 on the brook over the last threshold that was <0.5 m deep. It separated the lake from the brook. This may explain why the value of COD_{Mn} was rather high, namely O_2/l (Table 1), while the low conductivity reflects not only the low salt content in the brook but in the lake as well. The most humic substances came from the swampy environment. The number of bacteria was 58000/1 ml in July 24-29, 1963 (Kalataloussäätiö / T. Sormunen, mimeograph).

Stat. 2/1959 had a mixed community of insects from running cold water and the lake fauna such as e.g. *Corynocera* and *Stictochironomus* (Hirvenoja 1960b). In June 30, 1959 one male of *C. tibialis* and in July 10, 1959 one males of *C. intersectus* Staeger emerged from a funnel trap (0.5 m^2); this represents 0.1% of the total number of chironomids (Table 8) that emerged at this site.

Table 1. The water chemistry in the Kotaoja Brook, near its inlet into Lake Sompiojärvi (near Stat. Kotaoja 2 / 1959) on July 24-29.1963 (Kalataloussäätiö / T. Sormunen, mimeograph).

Temperature °C	7.9
pH	6.6
Alkalinity	0.24
Coloration Pt mg/l	125
COD_{Mn} mg/l	37.1
Conduct. mS/m(γ25)	2.09

The Kuusioja Brook

Stat. 13/1959-1960. Grid 27° E, 7558:511. Fig.5.

In its upper course near the hill Kussuolinkivaara (Fig. 8) the Brook Kuusioja was a trifle rill but it broadens before meeting Lake Sompiojärvi. In June 23 to 27, 1960 the temperature of the surface

Fig.7. The Kotaoja Brook seen from the large limnocrene Stat. 1/1959.

water at the site, some 0.5 km from the estuary, ranged from 10.7ºC to 21.5ºC while near the bottom it was between 10.7ºC and 14.5ºC. This indicates a discharge of ground water. In the July of 1959 the mean temperature of the surface water was 16.1ºC. The water flow was very slow.

Table 2 gives some values for water chemistry. The alkalinity in the Brook Kuusioja was the highest measured in the environs of Lake Sompiojärvi. The brook had 4.3 mg Ca/l in August 1959 (Finnish Geological Survey).

One male and one female *Cricotopus sylvestris* emerged in July19.1959 and one male *C. cylindraceus* (Kieffer) associated with pupal exuviae in a submerged funnel trap in August 25, 1959 at the sampling site that was about 1.5 to 2 m deep.

This was the third record of *C. cylindraceus* ever made. The associated pupal exuviae, shown also in the microscope slide of Kieffer, allowed a definite identification to be made. The redescription of this species of Kieffer in Hirvenoja (1973b) was based on a much more extensive adult material that emerged in Riihimäki in 1952 (Hirvenoja 1954. Unpublished pro gradu thesis, University of Helsinki) in an artificial clay pond with a high pH from 7.4 to 7.9. A sister species, *C. coronatus*, was found to be abundant in the alkaline water of Lake Sompiojärvi. The probably more apomorphous sister species, *C. patens* coexisted in Riihimäki with *C. cylindraceus* in an alkaline pond. It was, nevertheless, abundant in Lake Seitajärvi of the present study area.

C. sylvestris and *C. cylindraceus* represent only 0.3% of the total number of Chironomidae (Table 8) which emerged at Kuusioja Stat. 13/1959. The nearly vertical shores of this brook were not studied. This site is also the type locality of the chironomid *Tanytarsus dispar* Lindeberg (1967) which was very abundant in the bottom here.

As in the Kotaoja and in other short brooks around the lake, there was a shallow threshold about 0.5 deep between the Kuusioja and Lake Sompiojärvi. The maximum number of sediment layer found in Lake Sompiojärvi was 2.7 m (Salmi 1963, Hirvenoja 1998c). The bottom (depth <2 m) of all brooks near their estuary evidently had the depth of their original bottom. Paulaharju (1953) and Hirvenoja (1973a) tell that when Lake Sompiojärvi was about to freeze in the autumn, schools of large fish made their way to the Kuusioja brook while small fry (2-3 cm) went to the Kotaoja brook.

Table 2. The water chemistry in the Kuusioja Brook before its inlet to Lake Sompiojärvi on July 24-29.1963. (Kalataloussäätiö T. Sormunen, mimeograph)

Depth	0 m	2.0 m
Temperature °C	14.3	9.9
pH	6.9	6.7
Alkalinity	-	0.59
Coloration Pt mg/l	100	100
COD_{Mn} mg/l	-	81.7
Conduct. mS/m(γ25)	-	5.17

Other spring brooks around Lake Sompiojärvi

There were inlets of some (10 known to me) spring brooks on the shores. A relatively large, long and important brook, the Hietaoja, ran from the Nattastunturit Fells to the north of the lake. It had several rapids and a gravel bottom that was according to the local fishermen the spawning site of the whitefish. This rather large brook was not studied during the period of this study. Since most of it is above the present level of Lokka Reservoir, it can be studied even today.

With the exception of the Kuusioja, which flowed to the eastern shore of Lake Sompiojärvi, a majority of the other small brooks were short because of paludification. Most of them had a treshold (0.5 m) at the estuary against the lake. Behind the threshold they had a deep (<2 m) pond probably formed by discharging ground wate The following species of *Cricotopus* emerged between June 16 and July, 1960 from two floating cage traps (0.5 m²) in that "pond" of Pyhäleipunen

Fig, 8. A broadening of the Kuusioja Brook some 0.5 km upstream of the estuary was bordered with *Salix glauca* shrubbery.

Figs.. 9...10. A fishermen's idol on top of the Kussuolinkivaara Hill.

Fig. 11…13. "Kiiskismarkkinat" (ruff market) at the Kuusioja Brook. (Enlarged from a narrow-gauge film 6 x 8 mm,)

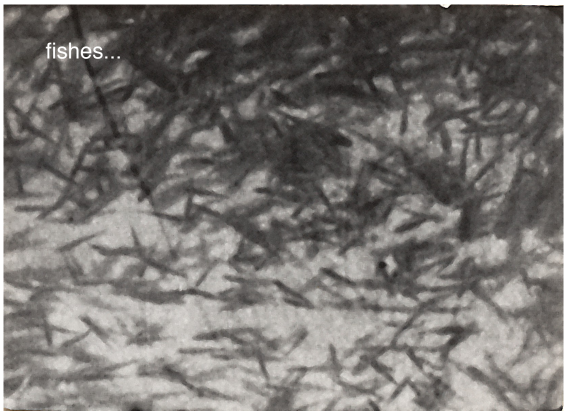


Fig. 14. The Lake Sompiojärvi seen from the outlet to the River Mutenianjoki. Behind the row of the Fells Nattaset. The outlet was bordered by a sparse *Equisetum limosum* and dense *Carex* vegetation.

Fig. 15. Occasional mass occurrences of insects took place in the slightly eutrophied lake. Here *Caenis horaria* Linnaeus (Ephemeroptera) swarm above the western (sunset) shore. Nymphs or in the traps emerging adults were sampled along shores opposite to the swarming areas.

	light trap		dark trap (covered)	
	males	females	males	females
C. sylvestris	44	32	26	9
C. intersectus	0	2	-	-
C. festivellus	3	-	-	-

This constituted a preliminary experiment that was done since it was observed that the submerged funnel traps captured few midges in comparison with the floating cage traps made of white nylon mesh. The funnel traps were made of stainless steel and consequently cast a dark shadow over the emerging insects. At that time the surface water temperature in the brooks was about the same as in Lake Sompiojärvi. Loose cold substrate made measuring the temperature near the bottom difficult. It was <13ºC, i.e. at least one degree lower than the near bottom temperature in Sompiojärvi. The difference is evidently attributable to seeping ground water.

Lake Sompiojärvi

Stations 3-11, 14, 16-19 / 1959-1960

Some details of the shallow Lake Sompiojärvi (depth <1.5-2 m, diameter about 4 km) have been published (Hirvenoja 1960b, 1961, 1962ab, 1963, 1998c). The bottom varied from fine sand to layers of gray substrate, made up of gray *Pediastrum* mud (gyttja) without silt or lehm since Boreal period (Salmi 1963, cf. Hirvenoja 1998c). Table 3 shows some details of water chemistry. Several brooks running from nearby springs probably kept the water quite well oxygenated in winter. Some fish species, including a population of *Coregonus l. lavaretus* (Linnaeus) could pass the winter in it. Other fishes were *Leuciscus idus* (Linnaeus), *Rutilus rutilus* (Linnaeus), *Perca fluvitilis* (Linnaeus), *Esox lucius* (Linnaeus), *Lota lota* (Linnaeus) and *Gymnocephalus cernuus* (Linnaeus).

Coriolis force operating in the round lake swept the northern and western shore areas clean. They had wide stretches of mineral bottom while very soft loose material accumulated in some eastern parts of the lake.

Other lakes in the study area had a pH <6.5, while Lake Sompiojärvi had a pH higher than 7. The only brook with an alkaline reaction was the (epirhithral) Brook Hietaoja (pH 7.2, 9.6°C in June 24. 1963 T. Sormunen; pH 7-8 Finnish Geological Survey,) from the north with a relatively abundant water supply with numerous rapids.Unknown small sources of lime exist on the eastern side of the lake. Probes that I took in August 1959 from the Brook Pyhäleipunen and the lake were kindly analyzed by the Finnish Geological Survey: the

Fig. 16…18 The Brook Hietaoja had apparently some importance to the quality of the water in Sompiojärvi, because it had pH 7-8. It was in August navigable only to a half distance from the inlet to Sompiojärvi to the site of a summer grave of the ancient shaman Akmeeli (small photos).

brook had 3.5 mg Ca/l while the lake had 1.89 - 1.94 mg Ca/l. In the brooks Kuusioja, Pyhäleipunen and Isokorkiste, all of which flowed to the eastern shore of Sompiojärvi, the alkalinity varied between 0.43 and 0.59 mval/l , whereas in other brooks or in the lake it varied (n = 7) between 0.19 and 0.24 mval/l (Kalatalousssäätiö / T.Sormunen, mimeograph). According to the mapping of the Finnish Geological survey in an unnamed western source the highest 11 mg Ca/l was measured.

The surroundings of the lake were videly paludified on the eastern and western sides and the pH in the brooks was consistently under 7.

I had observed a small, very cold limnocrene, a spring, without a visible outlet to the lake. The local people called it Kylmäkaltio. The surface water in July 2-5. 1960 was 3.5-4.0°C. The crene was close to the Pyhäleipunen and 3-4 m away from the lake shore. The bottom was white with lime that covered a layer of rust. From the sediment, which consisted of dark mud (dy) 2 males of crenobiont or crenophilous (Lindegaard 1995) *Diamesa incallida* (Walker), one *Parakiefferiella bathophila* (Kieffer) and a female *Micropsectra* sp. emerged in those days in a floating cage trap, which was tentatively kept on this site.

The entire Lake Sompiojärvi was a spring, a large limnocrene. As stated above, the lake was shallow, some 1.5 m deep. A trough < 2 m deep ran across it. It was called Akanvaalo and it ran diametrically from the Brook Kotaoja on the NW side of the lake towards a large boulder called Akankivi (a seita, an object of veneration of the Lapps) on the SE side of the lake.

As an oral tradition had it, the lake had been much larger before an effort to drain it was made. The springs and brooks observed in1959 had then been in the center of the former wider lake.

The chironomid *Micropsectra radialis* was found (Hirvenoja 1998c) in the earliest /first Preboreal sediment layers of 60 cm in Sompiojärvi. It then disappeared above the silt layers in the lake, but was still present obviously as a preboreal relict in the brook Kotaoja, especially in the Stat. 1 /1959. It was not known from other sites of the study area, but should exist in many other springs around the Nattastunturit Fells. It is also possible that the different intensities of *Corynocera* emergence seen in 1959 and 1960 (Chapter 2) were attributable to local differences in bottom temperature arising from the ground water. It proved namely impossible to place the traps onto precisely the same sites in two consecutive years.

Total nitrogen measured by Sormunen in 1963 near the outlet (Table 5) shows that the lake was eutrophied in the scale of Forsberg and Ryding (1980). AB Hydroconsult (1971) measured the total phosphorus in July 1969, i.e. immediately before the lake was inundated. The result P_{tot} 27 µg/l, agreed also with eutrophy in the Forsberg and Ryding scale. Sohlberg (1986, unpublished pro gradu thesis, University of Helsinki) found a slight preponderance of

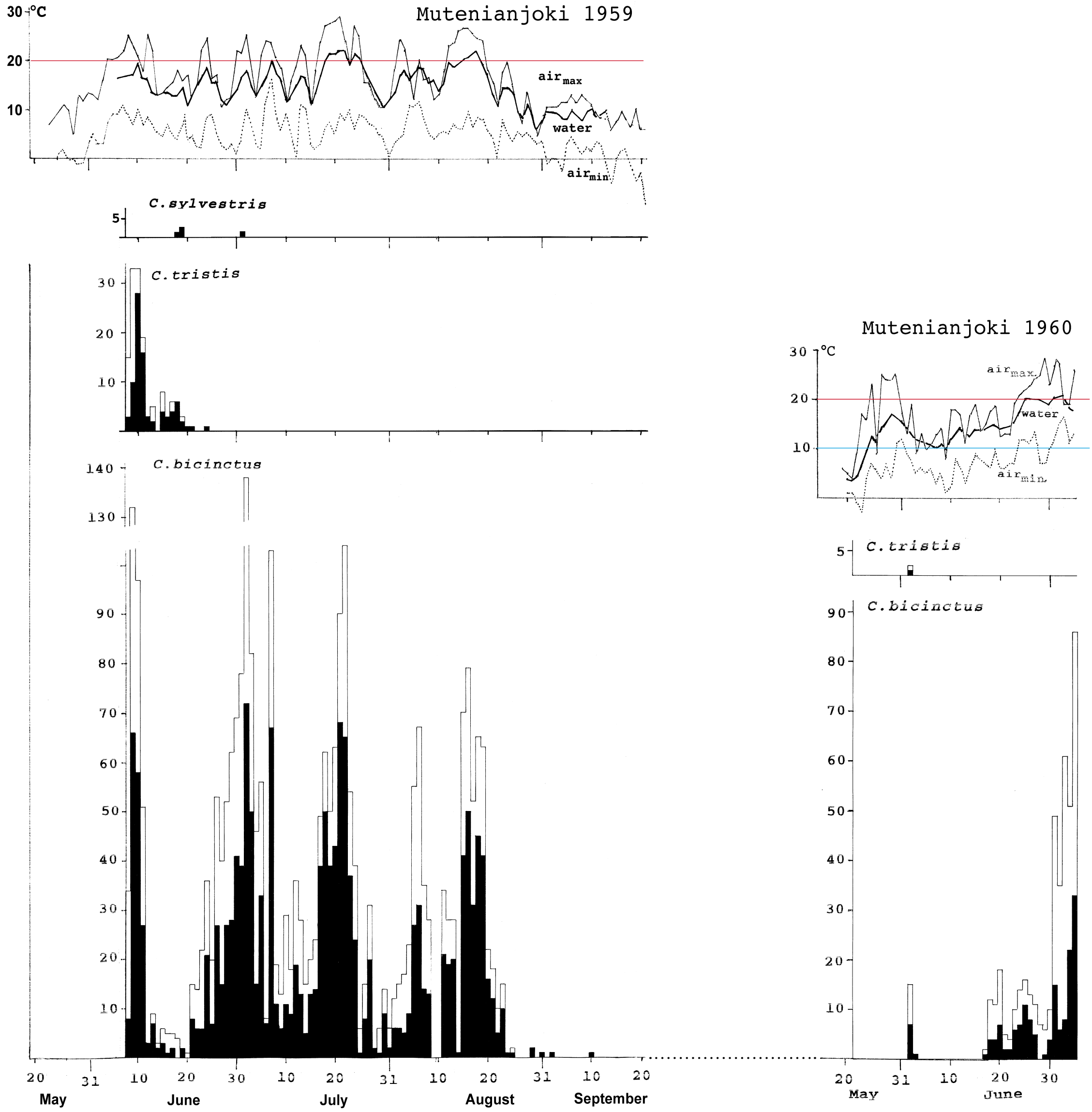


Fig. 19. The emergence of the species of *Cricotopus* in Mutenianjoki (at Juitsa) in the Stat. 15, 1959-1960 pro 0.5 m^2 Dark columns females, white columns males. The emergence of adults need apparently water temperature of more than 10°C also for the pupation (13…14 °C ?).

eutrophic zooplankton. To a certain extent the lake probable released plant nutrients. The total count of bacteria in July 24-29, 1963 in the Lake Sompiojärvi was as follows (Kalataloussäätiö / T. Sormunen, mimeograph):

near the inlet of the Hietaoja Brook from the Fells
29 000 / 1 ml,

in the middle of the lake (n=2)
2 100 000 - 2 400 000 / 1 ml,

in the outlet to Mutenianjoki
4 800 000 / 1 ml.

At present it is somewhat uncertain whether this study can be continued. A list of *Cricotopus* species is therefore given below. Most of these had a limited distribution in different specific parts of the lake.

Cricotopus pilosellus
C. pilidorsum
C. villosus
C. polaris
C. magus
C. coronatus
C.intersectus
C. festivellus
C. bicinctus
C. sylvestris
C. tricinctus
C. arcuatus

Fig 20. River Mutenianjoki, at Juitsa, Stat. 15/1959-1960.

As for this compilation in particular the species mentioned first were relatively plesiomorphous (?ecologically more plesiotypical in some features than the others) and lived on the northern shore near the Brook Hietaoja which flowed from the direction of the northern Terävänattanen and Sukunattanen Fells.Accordingly, the relatively more apomorphous species *C. magus* emerged by the mouth of the Brook Kotaoja only and *C. coronatus* in the eastern part of the lake only.

C. intersectus, an accidental species in the springs, was enormously abundant in the bottom of the lake near the inlet of a cold spring brook at the western shore. The taxonomy of this species may need some focusing.

From the rest of the species C.festivellus and C.bicintus bring to the combination a nuance of the running water.To understand the Lake Sompiojärvi as a biotope and environment of all other species some attention must be directed to the dominating chironomid to the circumboreal *Corynocera ambigua* Zetterstedt (Hirvenoja 1960b, 1961, 1998c), the larvae of which consumed the algal *(Pediastrum)* gyttja with their shovel-like mandibles. This condition had lasted at least for several thousand years up to the inundation; the Boreal layer of 1.3-1.4 m is an exception. The lake had then probably dried up, was surrounded by the steppes (cf. Salmi 1963) and became a *Chironomus* pond?

In the Lake Seitajärvi *C. ambiqua* was a recedent species only and was absent in Posolampi, the most acid lake of the study area.

Table 3. The water chemistry in different parts (N=11) of Lake Sompiojärvi and just in the outlet of the Lake to the River Mutenianjoki on July 24-29.1963. (Kalataloussäätiö / T. Sormunen)

	Sompiojärvi (N=11) depth 0-0.5 m	Mutenianjoki (N=2) inlet 0 m
Temperature °C	14.4-16.5	15.3-18.5
pH	7.1-7.6	7.5
Alkalinity	0.19-0.22	-
Color. Pt mg/l	50-90	-
COD_{Mn} mg/l	43.9-70.6	-
Conduct. mS/m(γ25)	1.76-2.86	-
N_{tot}mg/l	-	1.29

The River Mutenianjoki, the outlet of Lake Sompiojärvi

Station 15/1959-60 Grid 27° E, 7554:517. Figs. 10-11.

Station 15/1959-1960 was about 0.5 km downstream from Lake Sompiojärvi where the river was 5-10 m broad. It was located at the end of a slack water section within easy reach by motorboat. The next stretch downstream was a very shallow and stony part of the small river and had a distinctly visible water flow (about 10-15 cm/sec.). In July-August the river was only in part navigable with motorboat.

The sampling site, called the Juitsa, was at an ancient dwelling-site of the Lapps. The site was called Juikenttä or Vanhakenttä (Carpelan, C., Juikenttä. Kaivauskertomus v. 1962, julkaisematon, Museovirasto (Unpublished, in Finnish, Finland's National Board of Antiquities).

According to an oral tradition a rapid had been cleared off here. The level of Lake Sompiojärvi and the outlet to Mutenianjoki were consequently lowered down to the level before the damming of the Lokka Reservoir. Following the drop in water level fishermen built their huts at the new camp (Fig. 22) at the new outlet some 0.5 km to the north of the Juitsa. The builders were already at this time Finns from the nearest village called Mutenia. (The settlement of the Finns began officially in 1673.) It was also asserted that once the water in the lake was lowered *Sparganium angustifolium* (Fig. 2 in Salmi 1963) invaded Lake Somiojärvi and covered its surface with its long leaves. This made using a motorboat on the lake difficult and put an end to seine fishing there as well.

I trust that the water of the Mutenianjoki Stat.

Fig 21. The swarming of insects above the river carrying turbid eutrophied water from Lake Sompiojärvi attained dimensions approaching mass occurrences, The filter feeder *Neureclipsis bimaculata* (Linnaeus) (Trichoptera) is the most visible constituent of this swarm.

Fig 22. The new fishermen's camp called "Luusuan kenttä" at the new outlet to the Mutenianjoki in 1959. (Enlarged fotos from a narrow-gauge film 6 x 8 mm,)

15/1959-1960 was approximately similar to what was measured at the outlet of Lake Sompiojärvi, i.e. faintly eutrophic. In July 1959 it had a mean temperature of 16.6ºC at Stat. 15. O_2 saturation (n=7) ranged from 85% to 95% in June-September 1959.

The water in the Mutenianjoki was as turbid as in the lake at the Station but it grew gradually clearer through the action of innumerable insect larvae such as *Ephemeroptera*, *Trichoptera* (in particular the filter feeder *Neureclipsis bimaculata* (Linnaeus)) and others. The intense insect emergence in 1959-1960 at the Juitsa on the River Mutenianjoki was evidently sustained through utilization of copious suspended solids (not measured) in the water. The following species of *Cricotopus* were observed among the chironomids emerging in the floating cage traps (Figs. 3 and 4):

	Indiv./0.5 m^2
Cricotopus sylvestris	4
C. tristis	137
C. bicinctus	2734

The total number of *Cricotopus* (2881 ind./0.5 m^2) made up 43.1% of the total number of *Chronomidae* (Table 8) that emerged in 1959 in the Mutenianjoki at the Juitsa. The onset of sampling in 1959 was two weeks late (Fig. 19). The sampling was therefore continued in May-June 1960 during a period of high water using a submerged funnel trap. A comparison of the catch of 1959 to that of 1960 shows that the evident difference in sampling efficiency between floating cage (1959) and submerged funnel (1960) traps.

From 1 to 1.5 generations a year is apparently the "norm" in the lakes of the Sompio area. One is inclined to think that in favorable conditions the generations of *C. bicinctus* overlap and the pattern of emergence tracks the changes in temperature. *C. tristis* is clearly univoltine.

4. Springs and spring brooks at Lake Posolampi, Korvanen

A spring at the northern shore of Posolampi

Stat.1/1961, Grid 27° E, 7544:528. Fig. 25.

The site is a small limnocrene with a diameter of open water 1 m and a depth of <1.0 m. The hollow was surrounded with peat. The bottom was made up of sand covered with dark mud (dy). In July 1961 the mean temperature in a depth of 0.5 m was 6.2ºC; in July 16 a maximum of 8.6ºC was measured at this depth. In July 19 a high of 17.5ºC was found at a site on the surface water at an ambient air temperature of 21ºC. Humic substances and low saturation of oxygen lowered the quality of water (Table 4); the high value of total phosphorus in the table is surprising.

Measurements of the phosphorus and nitrogen concentrations were not available from the spring before the damming of the Lokka Reservoir in 1970. After that year the water of Lokka reached occasionally during the high water level the spring. Nevertheless, measurements made in June 22 1984 during a low water of Lokka indicate a hypereutrophied stretch of water in the spring in the Forsberg and Ryding (1980) scale. This may, of course, reflect poorly the situation in 1961 but the values of conductivity (2.0), P_{tot} (0.030 mg/l) and N_{tot} (0.070 mg/l) obtained from the water of Lokka Reservoir itself in the same day in1984, gave completely different readings (Table 4).

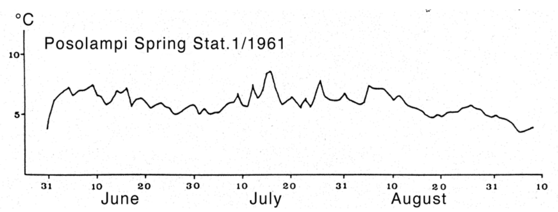


Fig. 23. Changes of the temperature in the depth of 0.5 m in the Stat.1/1961.

Fig. 24. A reindeer corral near Lake Posolampi.

There was a trifle rill on the NE side of the spring that drained into a bog not far from the limnocrene that may have influenced the hypereutrofied state of the spring. It probably also brought warmed water to the spring that had an unusually fluctuating temperature (Fig. 23). In addition, rather close to that rill one could see remains of huts associated with Finnish modern reindeer husbandry, because only one family of the Lapps inhabited the nearest area. Not far from the site there was also an enclosure used in handling reindeer (Fig. 24).

A single male of *Cricotopus tibialis*, 0.01% of the total number of chironomids (Table 8) found at the site, emerged from a submerged funnel trap (0.5 m²) on August 5, 1961. The steep banks of the limnocrene were not studied.

Table 4. The water chemistry in the limnocrene, Stat. Posolampi 1 / 1961, in June - September 1961 and in June 22,1984 (P and N have been measured by Viljavuuspalvelu Oy, Helsinki).

Date	1961	1984
O_2 mg/l	7.9 - 10.6 (N=3)	-
O_2satur.%	62.6 - 80.0 (N=3)	-
pH	5.4 - 6.0 (N=3)	7.4
Color. Pt mg/l	45 - 100 (N=2)	50
Conduct. mS/m(γ25)	5.28 (N=1)	4.40
P_{tot} mg/l	-	0.32
N_{tot} mg/l	-	1.82

Fig. 25. Posolampi Spring, Station 1/1961. Behind is seen the Lake Posolampi, the rest of the huge ice dammed lake that discharged the waters to NE at the beginning of the Holocene, The spring and lake had a relict population of *Gammarus lacustris* (L.) (Crustacea).

The Spring Brook from the Spring, Stat.1/1961

Stat.2/1961, Grid 27° E, 7544:528. Fig.25.

It was a very slowly flowing brook from the limnocrene to the Lake Posolampi, with a length of about 80 m from the limnocrene Stat.1; the Stat. 2 was a few meters away from the mouth of the brook on the shore of Posolampi with a depth of 0.7 m. Accordingly, it represented a mixed biotope made up of oligotrophic lake water and cold, hypertrophic crenal water. The surface had virtually the same temperature as the lake water (under or slightly above 20ºC). The cold ground water ran along the bottom and was difficult to observe. The following tabulation gives some temperatures (ºC) measured in this brook and in the spring.

	Brook (Stat.2) °C surface - near bottom	Spring (Stat.1) °C near bottom
June 06	8.5 - 7.2	7.0
June 07	17.5 -11.0	7.0
June 09	18.0 - 9.0	6.9
June 12	17.0 - 6.0	5.8
July 15	21.5 - 7.2	6.6

The relatively high temperature at the bottom of Stat. 1 must also be attributable to the influence of the rill, visible not far from the Stat. 1. but which then disappeared in the peat.

Three males of *Cricotopus polaris* emerged in the cage trap at this site. Four additional evidently xenocoen species that also belonged to the fauna of Lake Posolampi emerged from this brook in 1961, namely l male *C. pilitarsis* on August 7, 3 females of *C. festivellus* in July-August, 2 males and 1 female of *C. intersectus* in early August and 1 male of *C. reversus* Hirvenoja in August 8. The total number of insects that emerged in this brook (Stat. Posolampi 2/1961) was about one half of - that which emerged from the spring (Stat. Posolampi 1./1961). There was an assemblage of species, some of which are known in Finland from bog pools, some from the brackish water of the Gulf of Finland. A part belonged to the fauna of Lake Posolampi and the spring, Stat. 1/1961.

Species of *Cricotopus* made up only 0.3% of the total chironomid catch (Table 7) at this site.

Fig. 26.The Eastern Spring Brook, Station 6/1961, is coming from a large limnocrene near the forest in the eastern part of Posoaapa, the largest aapamoor in Finland, now inundated under the Lokka Reservoir.

Posolampi, an Eastern Spring Brook

Stat.6/1961, Grid 27° E, 7544:529. Fig.26.

The Stat. 6/1961 on the eastern shore of Lake Posolampi was some meters away from its eastern shore. It was probably also a spring brook but the water flow from the brook was so weak that it was a mixed biotope between the brook and the lake. The probable large limnocrene itself, about 300 m away from the lake was beyond reach because of a soggy bog overhang.

This site is also the type locality of the chironomid *Chironomus clarus* Hirvenoja (1962c) discussed on the next page. A thick layer of very loose mud made measuring the temperature at the bottom of the brook very difficult. Records of July 15, 1961 show 22.6ºC on the surface and about 16ºC at the bottom.

Cricotopus midges emerged in the funnel trap in Stat.6/1961 as follows:

	Indiv./0.5 m^2
C. tibialis	1
C. coronatus	1
C. pilosellus	5*
C. festivellus	17*
C. reversus	3*
C. obnixus	9*

Species, which were also found in Lake Posolampi are marked with an asterisk. They and *C. coronatus*, a common species in Lake Sompiojärvi that was also found in this brook, are evidently xenocoen. A total of 35 *Cricotopus* were captured at this site. They make up 9.6% of the chironomids which emerged there (Table 8).

About the taxonomy of *Chironomus clarus* Hirvenoja (1962c)

The study area, in particular the spring book Posolampi 6/1961 is the type locality of *Chironomus clarus*. It is also the only known certain breeding site of this species.

A population from Riihimäki was described on the basis of morphology and karyology as *C. clarus* by Michailova and Hirvenoja (1995). This was later corrected to be *C. obtusidens* Goetghebuer (Michailova, oral communication). The pupal exuviae of the original *C. obtusidens* or *C. obtusidens* Goetghebuer sensu Strenzke have evidently never been described.

A synapomorphous character for three species (possible sister species) *C. annularius* s.auct., *C. obtusidens* and *C. clarus* is the broadened anal point in the male hypopygium.

As a population *C. annularius* is possible to differ having the "beard" in the male fore tarsus. The pupal exuviae from Finland (Riihimäki) and Bulgaria (karyologically confirmed by P. Michailova) show differences given in the Fig.28.

The pupae of *C. obtusidens* resemble those of *C. annularius* from Bulgaria, but points of the pleural region of segment 4 have not been found (Fig. 4, sub *clarus* in Michailova and Hirvenoja (1995) and the shagreen of the sternite 2 and 3 is stronger in the first mentioned. Further the paratergite 2 of the latter is smooth.

In the pupal exuviae of *C. obtusidens* from Riihimäki and *C. clarus* type specimen the parasternite 5-7 are smooth, but in the hind corners of the abdominal segments 5-7 there is in *C.obtusidens* a patch of spinulae in each, in *C. clarus* distinct only in segment 5 (Fig. 27).

In some species of the genus *Chironomus* the patches seem to continue with the spinules along the paratergites. Their evolution, however, seems to be independent from the evolution (e.g. reduction) of the spinulation of the paratergites. This may be attributable to their different origin (? = PA) and to the homology for instance with the anal sporns on segment 8. Slight dislocations of organs are common features accompanying the process of evolution.

In *C. annularius* those patches of spinules are strong in the anal corners of segments 5-7; in *C. obtusidens* they are strong at least in the segments 5-6, but may be indistinct in segment 7.

C. annularius and the dominating *C. obtusidens* coexisted in Riihimäki in a hyporhithral (?epipotamal) hypereutrophied brook. This situation is in contrast to the ecologically apparently more plesiotypical *C. clarus* that inhabited the cold oligotrophic spring brook at least at Posolampi Stat. 6/1961..

Fig. 27. Patches of spinules in the anal corners of the abdominal segments 5-7 in the pupal exuviae of *Chironomus obtusidens* Goetgebuer (A) and *C. clarus* Hirvenoja type material (B).

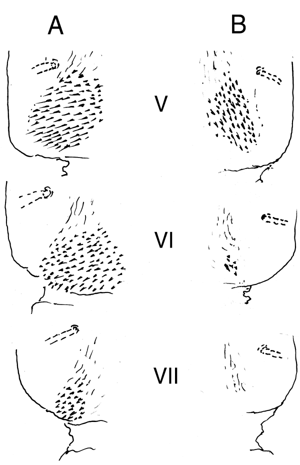
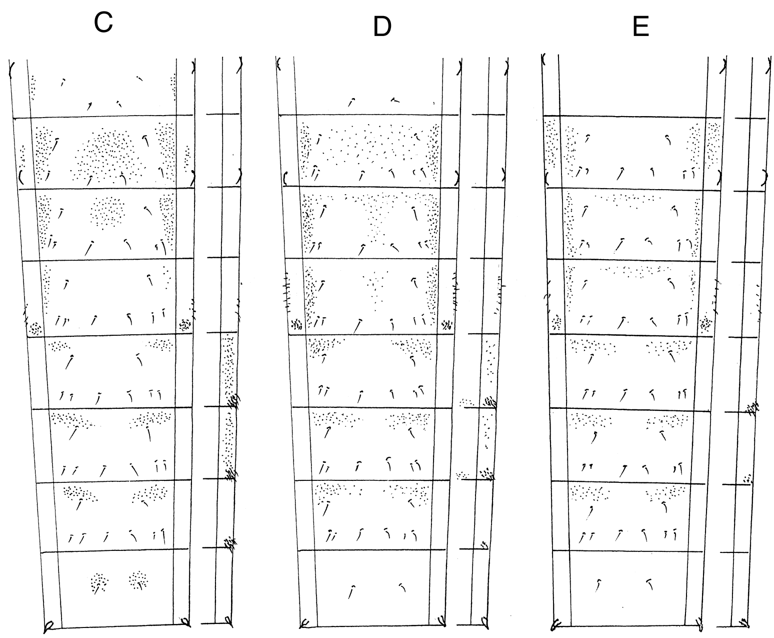


Fig 28. Sheme of the armament of the sternite, parasternite and (on the right side) paratergite in *Chironomus annularius* s.auct. from Finland (C) and from Bulgaria (D); the corresponding details of *C.clarus* type material.



5. Running waters of the Seitajärvi (Korvanen) region

The Brook Tupalehdonoja

The upper course, the outlet of Lake Seitajärvi, Stat.8/1960, Grid 27° E, 7546:536

Seitajärvi was a mixotrophic lake (Table 12). The water was flowing very slowly in the outlet (depth 0.7 m, width about 1 m), but apparently discernible enough to give rise to differences in the fauna in comparison with that of the lake. 10 individuals of Cricotopus patens, an abundant species in the lake, emerged xenocoen also here in June 20.-29. 1960 when the temperature of the water was 14.8-21.0°C. The catch from the funnel trap made up 1.9 % of the total number of Chironomidae which emerged in Stat. 8/1960 (Table 8)

The lower course after joining a spring brook, the inlet to the River Luiro, Stat.9/1960, Grid 27° E 7544:536, Fig.29.

The brook Tupalehdonoja was in general narrow (0.2 to 0.4 m wide) but the sampling site near the mouth to the River Luiro was about 1.0 m wide, <0.2 m deep with a water flow of about 15 cm/sec. In the warmest month of July the mean water temperature was 13.7 ºC, which evidently shows that it originated from springs. An occasional maximum surface temperature of 17.0 ºC was recorded in August 1, 1960 (Fig. 30). The bottom was covered with fine sand. This polyhumous brook (Table 5) had its origins in some springs on a boggy terrain so that one branch flowed from Lake Seitajärvi via a bog.

Cricotopus midges emerged into a floating cage trap at this site as follows

	Indiv./0.5 m²
C. bicinctus	19
C. septentrionalis	8
C. claripes	8
C. albiforceps	2
C. tristis	1

Cricotopus (38 ind./0.5 m ²) made up 2.7% of the total number of emerged Chironomidae (Table 8).

Some samples obtained using a hand net showed that there was on the steep bank of the brook a community that had, among other, *Procladius olivaceus* (Meigen) and *Chironomus* ?n. sp. as its constituents. The community was dissimilar to the species assemblage at the brook bottom. *Cricotopus* was not seen in the few samples netted from the steep bank.

C. claripes could be a circumpolar species and should, according to some authors, be a synonym of *C. slossonae* Malloch. This is, however, for the present not correct. The problem was allredy during the description of *C. claripes* well known. The last mentioned species has been suggested to prefer cold water while the ecological attributes of holomorfologically completely described *C. slossonae* from Illinois, USA, remain unknown. Because of this, the name *claripes* sp.n. was for the present emphatically applied in Hirvenoja (1973b), even though the adults are similar.

Fig. 29. A tent trap on the Stat. 9/1961 in the Brook Tupalehdonoja.

Fig. 30. Changes of the temperature and emergence of species of the genus Cricotopus in the Brook Tupalehdonoja Stat. 9/1960

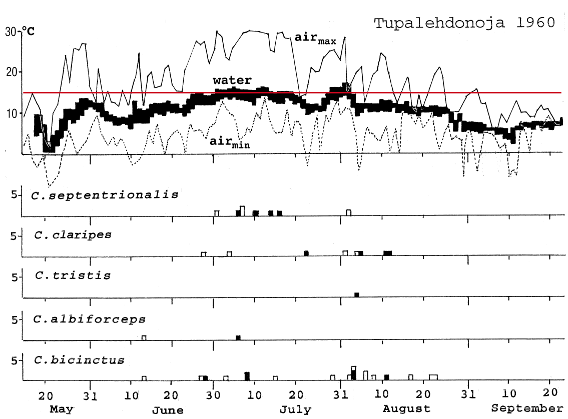
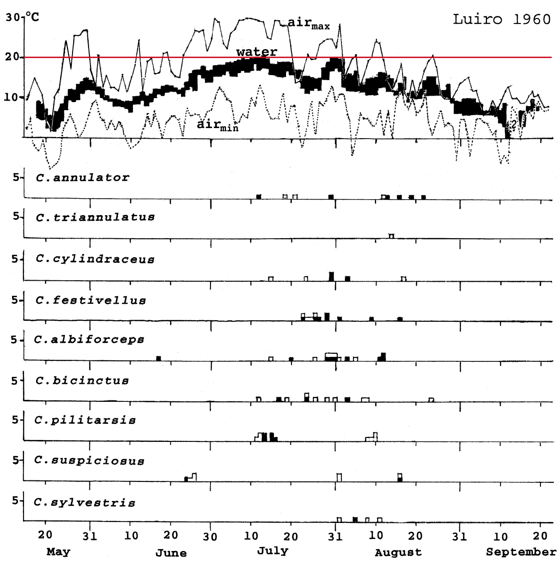


Fig. 31. The River Luiro at the estuary of Tupalehdonoja.

Table 5. The water chemistry in the Tupalehdonoja Brook, Stat.9/1960 in June - September 1960.

O_2 mg/l	9.1 - 11.3 (N=2)
O_2 satur.%	95 (N=2)
pH	5.1 - 6.9 (N=4)
Color. Pt mg/l	125 (N=1)
Conduct. mS/m(γ_{25})	2.97 (N=1)

Fig. 32. Changes of the temperature and emergence of species of the genus *Cricotopus* in the river Luiro Stat. 10/1960.



The River Luiro (upstream of the Village Korvanen)

Stat. 10/1960. Grid 27° E, 7544:536. Fig. 31.

The Luiro flows from the oligotrophic Lake Luirojärvi, more than 30 km to the north of the site. All area upstream of the Stat. 10/1960 was uninhabited, save for a lumberjack camp some hundred meters away. The site belonged to a lentic sequence (Fig. 17) from 10 to 15 m wide and mostly <1 m deep. In the warmest month of July 1960 the mean water temperature was 16.8 º. The O_2 saturation was high in the humic water as measured in 1960 (Table 6). A very low conductivity, 2.1-2.2 mS/m(γ25), was recorded in June 23, 1984.

There are records made in Tanhua (Table 6) before the damming of the Lokka Reservoir in 1970. Tanhua is some 100 km downstream of the site. Before entering Tanhua the river had passed some small villages. Nevertheless, the water quality at the nearly uninhabited site near Korvanen should not have been strongly loaded. The total phosphorus value at Tanhua was consistent with oligotrophy in the sale of Forsberg and Ryding (1980) while the total nitrogen would have indicated mesotrophic water. The N_{tot}/P_{tot} ratio showed that phosphorus is the limiting factor in the Luiro, at least in Tanhua. The river is therefore assumed to have been oligotrophic at Stat. 10/1960 in 1960.

Occasional traffic on the river made it impracticable to keep traps in the middle of the Luiro. When the water temperature rose to about 10ºC on the narrow and shallow littoral zone with a sparse vegetation, *Cricotopus* midges emerged in a floating cage trap as follows (Fig. 1&):

	Indiv./0.5 m²
C. albiforceps	15
C. annulator	9
C. bicinctus	12
C. cylindraceus	6
C. festivellus	12
C. pilitarsis	12
C. triannulatus	1
C. suspiciosus	8
C. sylvestris	4

The total number of *Cricotopus* (67 ind./0.5 m²) was 4.1% of the total number of Chironomidae that emerged in the Luiro Stat 10/1960.

Table 6. The water chemistry in the River Luiro, Stat. 10 / 1960 in June - September 1960 (author's measurements) and in the same river in Tanhua (Grid 27°E, 74930:3523) about 100 km from the study area towards the lower course in July 18, 1967 by the Database of water quality of surface waters managed by Finnish Environment Institute.

	June - Sept.1960	18.7.1967
Temperature °C	-	14.7
O_2 mg/l	11.2 - 11.8(N=2)	-
O_2 satur.%	95 - 130 (N=2)	-
pH	6.4 - 7.7 (N=3)	7.2
Color. Pt mg/l	70 (N=1)	60
CODMn mg/l	-	11.0
Conduct. mS/m(γ25)	4.29	3.1
P_{tot} µg/l	-	5
N_{tot} µg/l	-	500

Table 7. The water chemistry in the Brook Pakajoki (depth 0.5 m). Muonio (Grid 27°E, 7507691:3354074) in June 4, 1975; (Database of water quality of surface waters managed by Finnish Environment Institute)

Temperature °C	8.2
pH	6.9
Color. Pt mg/l	91
COD_{Mn} mg/l	9.9
Susp. solids mg/l	9.1
Conduct. mS/m(γ25)	2.3
P_{tot} mg/l	0.019
N_{tot} mg/l	0.310

Chironomus tupalehtoensis sp.n., stat. nov. for *Chironomus* sp. "Seitajärvi"

Hirvenoja and Michailova (1997) described and keyed material under the name *Chironomus* sp. "Seitajärvi". The material was made up of adults, pupae and larvae of a species from the material collected the Lake Seitajärvi and its surrounding . The new species has earlier also in the literature been determined as *Chironomus jonmartini* Lindeberg from this lake. The last mentioned species was in this connection also studied karyologically and redescribed morphologically. The type locality of *C. tupalehtoensis*, exactly the outlet of the Brook Tupalehdonoja is inundated to the Lokka Reservoir.

Experience has shown that the fine spinulation visible in phase contrast in the pupal exuviae together with the adult characters are in the determination very usefull (cf. above p. 17 *C. clarus*). The most important feature in the determination of the new species is in the spinulation of the sternites illustrated in the paper of Hirvenoja and Michailova (1997 Fig. 8).

The type locality was near the eastern end of the oblong Lake Seitajärvi. It was some 15 m from the shore of that lake, in its outlet to the Brook Tupalehdonoja. It was not possible to take the site of the observation (Stat. 8 / 1960) from farther away, because the brook was dammed by fishermen like the Brook Posolampi Stat. 6 /1961 (Fig. 26). The shores of the brook were paludified, and it was not possible to walk there.

The temperature of the water in the type locality of *C. tupalehtoensis* was approximately the same as in the surface of Seitajärvi, but about 1°C lower, because the brook apparently drained also the deeper waters from the lake. The temperature of the lake water exceeded 20°C in a few days in July and August. The Brook Tupalehdonoja from the Lake Seitajärvi with a relatively warm water joined a cold spring brook upstream of the site Tupalehdonoja Stat. 9 / 1960.

The lake was dominated (about 60% of the chironomids) by *Microtendipes nigellus* Hirven-oja, but only 2 individuals of this species were found in its outlet to the Tupalehdonoja (Tuiskunen 1982. Unpublished pro gradu thesis, University of Helsinki). In the outlet, on the contrary, among others *Microtendipes lugubris* Kieffer coexisted with the new species *C. tupalehtoensis*. Both were abundant and emerged at the same time 28.5. - 3.6. 1960 when the temperature of the water had for about three days exceeded 10°C. Both *M. lugubris* and *C. tupalehtoensis* had one generation in Tupalehdonoja.

Types: Holotype, 1 male in euparal in a microscopical slide, paratypes 2 pupal exuviae, Tupalehdonoja May 29. 1960, M. Hirvenoja.

6. Classification and comparison of the sites

The total emergence of insects

Hirvenoja (1973b) gives a short description of the habitat preference and geographic distribution of *Cricotopus* treated here.

Table 8 lists the total catches from the emergence traps at each site. This will serve as a background against which the importance of *Cricotopus* examined here can be evaluated. They are quantitatively often of minor importance, but the genus belongs quite constantly to the fauna of "normal" non or slightly polluted waters. With the exception of Lake Sompiojärvi the sites studied here represent the upper courses (crenal, hypocrenal, epi-, meta- and hyporhithral) of running waters.

Crenal, hypocrenal and epirhithral; the mean water temperature in July is below or near 10ºC.

Kotakenttä Stat. 12/1959, Kotaoja Stat. 1/1959 and Poslampi Stat. 1/1961 represent crenal habitats covered here.

The hypocrenal sites Kotaoja Stat. 2/1959, Kuusioja Stat.13/1959 and Posolampi Stations 2 and 6/1961 must be regarded as exceptions from "normal" epirhithral biotopes since they have a low bottom temperature but warm water at the surface.

C. tibialis, which has also been found in the Arctic, was present at least in small numbers in most sites. Lehmann (1971) records *C. tibialis* from crenal to metarhithral zones in Fulda, Germany. It has also found in a spring at Riihimäki, southern Finland (Hirvenoja 2002), in a pond on a bog, in a pool of melting snow (unpublished) but also in the hyporhithral zone during increasing pollution of the small River Punkanjoki in the 1950's. Up to now taxonomic differences have not been found in the midges of the latter population, even though they differed considerably in coloration. There is, however, a very small possibility that the larvae had drifted down from the upper and colder course of this small river, which was a spring brook.

Metarhithral; the mean temperature in July <15ºC.

Lehmann (1971:528) was not able to distinguish separate chironomid species characteristic to metarhithral. He tentatively attributed this failure to continuing pollution of the River Fulda. The site on the Tupalehdonoja Brook can be considered to represent metarhitrhal or Salmonid middle zone: the brook trout Salmo trutta fario Linnaeus lived in it.

A striking feature was the absence of *C. septentrionalis* and *C. clarus* from the material taken from the River Luiro Stat. 10/1960. The sites Tupalehdonoja and Luiro (see below) were less than 50 meter apart from each other. *C. tristis* seems to be rare in oligotrophic water. *C. albiforceps* (Kieffer) and *C. bicinctus* (Meigen) were found both in the Tupalehdonoja and the Luiro. Lehmann (1971:479) reports that the latter lives in crenal through epipotamal zones at Fulda.

Ilmonen and Kuusela (2001) have recorded *Simulium (Hellichiella) baffinense* Twin in the Tupalehdonoja. It seems to prefer temperature conditions similar to the former species.

Interestingly, G. Mothes recorded in August 10. 1967 *C. septentrionalis* in the small river Pakajoki, Muonio, Finland. He caught a midge flying above the river. It was the second record ever made. Apparently *C. septentrionalis* is a constituent of the fauna of this small river. The Pakajoki is a tributary of the Muonionjoki, a rather large river that is also the border of Finland and Sweden. The Pakajoki is much larger than the Tupalehdonoja but it is also polyhumous and lies at the same latitude north (Table 7).

Ringe (1974; cf. Scheibe 2002) classifies the Brook Breitenbach in Germany as epirhithral. It has a temperature resembling that of the Tupalehdonoja and at least one third of the chironomid species found there is also found in Tupalehdonoja. The number of species shared by these sites may well be higher since the material from both does not include pupae. Accordingly, the taxonomy of *Micropsectra* was uncertain. There were, however, differences as well. For instance, *Diamesinae* were more common in the Breitenbach than in the Tupalehdonoja.

The species hardly inhabit one ecological zone only. The structure of a community which prefers certain circumstances weakens gradually along one zone or zones. Several European studies have shown such an effect. As a good example it may be illustrated by a figure taken from Guy (1982) on the development of the communities in the River l'Eau d'Olle in the French Alps.

The community structure of a site may also change for some longer period. I (Hirvenoja 1998c) have separated such periods, the original or new ones, from another as phases.

Hyporhithral; the temperature in July near +17-18°C<+20°C.

The sampling stations Luiro Stat. 10/1960 and Mutenanjoki Stat. 15/1959-60 are considered to represent the hyporhithral or grayling zone so that the oligotrophic river Luiro upstream of the Village of Korvanen can perhaps be thought to serve as a representative of the hyporhithral (or grayling) zone with a grayling (*Thymallus vulgaris*) Linnaeus population living there. In the eutrophic but also hyporhithral Mutenianjoki the whitefish (*Lavaretus lavaretus*) the pike (*Esox lucius*), the perch (*Perca fluviatilis*) and the common dace (*Leuciscus leuciscus*) are more important than the grayling.

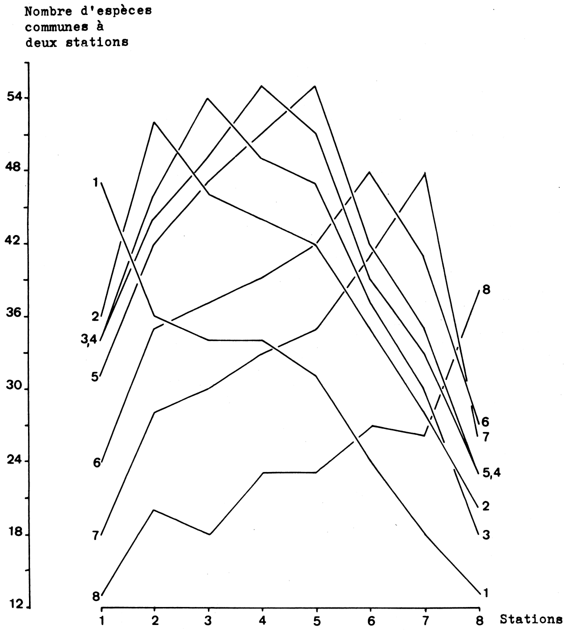


FIGURE 4 : Structure des communautés de macroinvertébrés benthiques de l'Eau d'Olle.

Fig. 33. An example: The development of the communities along the River l'Eau d'Olle in the studies of Guy (1982).

Table 8. The annual emergence of insects in the traps (individuals /0.5 m^2) in the running water sites discussed in the present paper. The total numbers with an asterisk (*) have been obtained with the submerged funnel traps.

Biotope	Ephemeroptera	Plecoptera	Trichoptera	Ceratopogoniidae	Chironomidae	Simuliidae	Total
Kotaoja							
spring (Stat.12)	1	110	86	16	4477	10	4700
spring (Stat.1)	1	1	14	0	2979	0	2994*
brook (Stat.2)	19	2	1	1	1691	0	1714*
Kuusioja (Stat.13)	0	0	28	0	983	0	1011*
Mutenianjoki (Stat. 15, 1959)	2234	2	675	78	6681	299	9969
Tupalehdonoja							
(Stat. 8)	14	0	0	0	529	0	543*
(Stat. 9)	21	24	128	11	1417	34	1635
Luiro	120	57	128	31	1631	27	1994
Posolampi							
spring (Stat.1)	0	0	0	1	9852	0	9853*
brook (Stat.2)	14	14	21	245	3888	40	4222*
brook (Stat.6)	68	-	1	2	364	-	435*

The following species of *Cricotopus* were recorded as the inhabitats of the community hyporhithron in the Sompio area:

C. albiforceps	*C. suspiciosus*
C. annularius	*C. sylvestris**
*C. bicinctus**	*C. triannulatus**
C. cylindraceus	*C. tristis*
*C. pilitarsis**	

The species which may also occur in lakes or brackish waters (Hirvenoja 1973) are marked with an asterisk (*). Lehmann (1971) records them from both hyporhithral and potamal zones of the river Fulda in Germany. Only *C. bicinctus*, *C. tristis* and *C. sylvestris* (the latter is a common inhabitant of even ponds and pools) tolerated the conditions of the eutrophic River Mutenianjoki, *C.bicinctus*, *C. albiforceps* and *C.tristis* were also in metarhithral present.

Simuliidae dominate, in particular, the eutrophic Jäväjänkoski Rapids in Central Finland. Kuusela (1979) recorded at this locality *C. albiforceps*, *C. bicinctus*, *C. triannulatus* and *C. trifascia* Edwrds and two undetermined species of *Cricotopus*. Lehmann (1971) reports *C. trifascia* from metarhithral to epipotamal zone in the Fulda, Germany. Ringe (1974) captured only *C. curtus* Hirvenoja in the Rohrwiesenbach, Germany. According to him the site "lies in a transition reach between epi- and hyporhithral".

7. Comparisons with some other running water biotopes observed by the author in Finland

A short sampling period using cage and funnel traps in August 10 through 16 at the River Oulanka near the Biological Station of the University of Oulu (Grid 27º E, 736:60), Kuusamo, northern Finland yielded the following *Cricotopus*: *C. annulator*, *C. triannulatus*, *C. albiforceps*, *C. bicinctus* and *C. suspiciosus*. This assemblage of species is very similar to the one found in the River Luiro. The long-term mean July water temperature in the Oulankajoki is 18.8 ºC (the yearly maximum temperatures 15.4 ºC on July 7, 1992, 23.5ºC on May 23, 1972; K. Kuusela in litt.).

Table 9. Water chemistry in River Oulankajoki (depth 1 m) in the upper course of the study area upstream of the Biological Station, Kuusamo (Grid 27° E, 7366051:603602); (Database of water quality of surface waters managed by Finnish Environment Institute).

Date	3.7.1968	18.8.1969
Temperature °C	15.4	16.5
pH	7.2	7.3
Alkalinity mval/l	0.17	0.40
Color. Pt mg/l	40	28
CODMn mg/l	9.1	5.6
Susp. solids mg/l	1.6	2.0
Na mg/l	1.2	1.3
K mg/l	1.0	0.8
Ca mg/l	0.13	0.25
Mn mg/l	0	0
Cl mg/l	1.7	1.4
SiO_2 mg/l	2.7	3.7
Fe mg/l	0.4	0.18
Conduct. mS/m(γ25)	3.4	5.7
P_{tot} µg/l	0	0
N_{tot} µg/l	300	400

The river bed is variable at Oulanka. It was made up of coarse gravel, stones with rapids but also of fine sediments in pond like lentic areas. Table 9 shows that the site is oligotrophic. *C. bicinctus* and *C. albiforceps* emerged in the traps at sites with at least a slight flow of current. *C. suspiciosus* was found on *Potamogeton* in manifestly lentic sites only. In the River Luiro *C. suspiciosus* emerged from the river littoral some 20-30 cm deep with sparse vegetation and very weak current together with its sister species *C. sylvestris*. Lehmann (1971:530) differentiates a potamal group of species, including *C. sylvestris*, in the choriotope with vegetation.

Table 10. Variation of the water chemistry (N=18) in the Karikoski Rapids, below the fish farm of Siikakoski, Grid 27°E, 6945020:3465170 in June - September 1996 - 2000 (Database of water quality of surface waters managed by Finnish Environment Institute).

Temperature °C	10.4 - 22.4
O_2 mg/l	8.5 - 11.2
O_2 satur.%	88 - 100
COD_{Mn} mg/l	5.2 - 5.8
Color. Pt mg/l	15 - 25
P_{tot} µg/l	6 - 11
N_{tot} µg/l	270 - 360

In addition to the two sites mentioned above *C. suspiciosus* has been found in Konnevesi, Central Finland, downstream of the Siikakoski Rapids and above the Karikoski Rapids. Even through *C. suspiciosus* very much resembles *C. sylvestris* this record is taken up here in spite of the circumstance that the high water temperature at this site does not warrant an inclusion into hyporhithral but to epipotamal rapids.

The velocity of current in the surface water was estimated in the last week of June in 1999 to be 20cm/sec. but a corresponding record could not be taken with an Ott flow meter at the bottom within the vegetation (in particular Sparganium). The water comes from the oligotrophic lake Konnevesi but the site is exposed to an outlet from a fish farm. Downstream of the fish farm the water is still oligotrophic in the Forsberg and Ryding (1980) scale (Table 11).

The following rheophilous species of *Cricotopus* emerged in funnel traps laid out there during a sampling in the last week of June in 1999: *C. bicinctus* (83%), *C. suspiciosus* (16%) and *C. albiforceps* (1%). The relative abundance of *C. bicinctus* is attributable to the influence of organic matter from the fish farm.

8. The influence of the trophic level

A straightforward way to explain the quality of Lake Sompiojärvi to the general public is to point out fish grew up there at a rate that was one of the best in Lapland (Salojärvi, K. 1972, unpublished pro gradu thesis, University of Helsinki).

The same reasoning can be extended also to the mixotrophic, very paludified Lake Seitajärvi near the village Korvanen. In the latter both the number of fish species as well as individuals caught was sparse at least in 1960 probably because of the low oxygen status in winter. (In Jyly 10. the saturationvaried in the most sites between 80-90%). The name of the lake may, however, indicate that conditions there may have been more favorable there in ancient times. According to Paulaharju (1953: 123-124) also the whitefish exited in the lake.

Salmi (1963: 106) mentions the numerous springs in the surroundings and on the lake floor with water ladden with oxygen the year round. He suggest the abundant plankton being important to the growth rate.

Plankton was in fact abundant in Lake Sompiojärvi (Sohlberg, T. 1986, unpublished pro gadu thesis, University of Helsinki), but did not encoutter its most important constituent, the small cladoceran *Bosmina longirostris* (O.F.Müller) when analyzing the contents of fish stomachs. There may have been other crustaceans, but they were then larger sessile species living on the bottom or within the vegetation, not in the plankton.

Chironomids and other insects were, by far, the most important food items of fish. In September e.g. whitefisch fed on *Pisidium* clams. In Sompiojärvi the most important prey was the flightless chironomid *Corynocera ambiqua* which swarmed on the surface of the water. Fish stomachs were chock full of those midges for nearly a month.

Relatively high numbers of the dominating chironomid *Microtendipes nigellus* Hirvenoja emerged in Seitajärvi. The most important constituents of plankton, *Daphnia galeata* Sars, *Holopedium gibberum* Zaddach and *Sida chrystallina* (O.F.Müller) were large ones (Snellman, M-L. 1987, unpublished pro gradu thesis, University of Helsinki).

While the bottom of Sompiojärvi was coverede with *Pediastrum* gyttja and the water pH exceeded 7.0, the bottom of Seitajärvi was made up of dark mud and the pH was near 6.5. A map of the Finnish Geological Survey gives sources of water with pH exceeding 8.0. There both the northern side of Seitajärvi as well as waters from the NW side of Sompiojärvi are mentioned.

Järnefelt (1924, 1926) had shown that plant nutrients affect the numbers of chironomids. Such an effect was also seen here. According to Kownacki (1989) even very low levels of pollution increase total chironomid numbers but do not affect the dominance structure.

Bagge and Salmela (1978) studied the effect of trophic level on populations of Plecoptera and Trichoptera in the River Tourunjoki in Central Finland. They regarded waters as oligotrophic if $P_{tot}/mg/m^3$ was <30 and did not find differences in the qualitative combinations of species between putative oligo- and mesotrophic sites. Following Forsberg and Ryding (1980) the phosphorus level of their study area fell

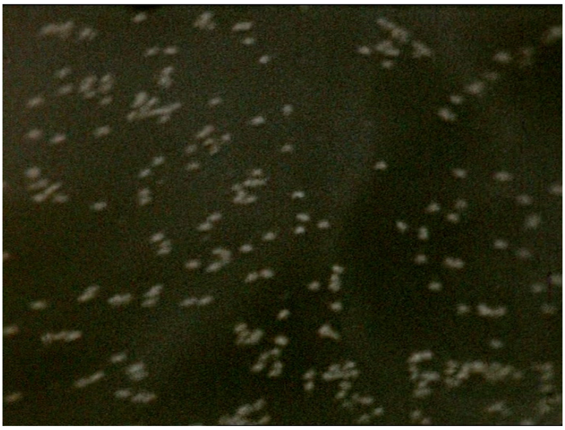


Fig. 33...35. Swarming *Corynocera ambiqua* (Zetterstedt) on the water surface (left) over the whole lake. Above a normal copulation (right) and (in the middle) a tandem of three individuals, where a second male has. fastened to the head of the female. Sompiojärvi was famous for its whitefish (below left).

within the range of eutrophic waters.

The water chemistry of the sites in the Sompio area is poorly known. The available records show an increase in emergence from oligotrophic to eutrophic sites (Table 11). In Riihimäki, southern Finland, I (Hirvenoja 2002) counted 2300 midges emerging in a cage trap in a spring approaching oligotrophic conditions and nearly 4500 ind./m^2 in an artificial cold water pool with considerable amounts of plant nutrients on a field. These numbers are comparable to the level of low numbers in the Sompio area.

Ringe (1974) used greenhouses above brooks as traps. He captured in the Breitenbach Brook, Germany (mean pH 6.98) 27355 ind./m^2 but in the Rohrwiesenbach Brook (mean pH 7.71) he only captured 5476 ind./m^2. The nitrogen level was variable in the latter case and amounts of phosphorus in these brooks were not known. Accordingly, it is difficult to compare these brooks with each other or the ones studied in Finland as well. According to Ringe (1974:281) the station on the Breitenbach is epirhithral but the site on the Rohrwiesenbach “lies in a transition reach between epi- and hyporhithral” (see also Section 6 above).

C. bicinctus and evidently also *C. tristis* are able to benefit from the relatively high trophic grade in the small River Mutenianjoki. Out of species mentioned above, only *C. albiforceps* was captured in the oligotrophic River Oulanka in August 1968 (see Section 7 above) at a site where the velocity of the water flow (about 20-30 cm/sec.) precariously allowed using a funnel trap. Kuusela (1979:42) mentions *C. albiforceps*, *C. triannulatus* and *C. bicinctus* from the Jäväjänkoski Rapids (see Section 6 above).

The evolution of the apneustic respiratory system of chironomid larvae began arguably in cold mountain brooks (Brundin 1966). The adaptive radiation differentiated thereafter apotypically towards conditions more demanding than the origin. Such a trend continues in many specie groups including the genus *Cricotopus*. To mention an example, instead of the eutrophilous *C. tristis* its more plesiomorphous sister species *C.clarus* and *C. septentrionalis* prevail over *C. tristis* in the oligotrophic and cold Tupalehdonoja. As for *C. sylvestris*, its plesiotypical sister species *C. suspiciosus* and *C. pilitarsis* replace it in less loaded conditions.

The intense insect emergence seen in the europhied Mutenianjoki Stat. 15/1959 is evidently attributable to the utilization (not measured) of vast amounts of suspended solids in the water which flowed from the shallow, constantly turbid and gray (eutrophic) Sompiojärvi. In the limnocrene Posolampi Stat. 1/1961 the large numbers of emerged insects (Table 8) are, however, evidently based on the dissolved nutrients and in local primary production. The differences between the lakes Sompiojärvi and Seitajärvi

The materials which I collected through the years

Fig. 36. In 1959 around Sompiojärvi there were summer shelters of the fishers and /or their families 6 made of wood (Fig. 22) and 3 of peat like the one above.

1953 and 2012 show roughly about 20000 to 30000 ind./m² in temperate waters unaffected by municipal pollution.

The total emergence of insects at Kotaoja Stat. 1/1959 was also relatively large with lower numbers emerging downstream at Kotaoja Stat. 2/1959. The numbers were still lower in the uninhabited Kuusioja Brook on the opposite shore of the lake. Unfortunately there are no data for phosphorus or nitrogen from these sites. They and the adjacent sites had in general quite low values for conductivity.As for midges, *Micropsectra (Lauterbornia) radialis* Goetghebuer (syn. *Lauterbornia coracina* Kieffer), *M. recurvata* and *M. apposite* (Walker) were abundantly present at Kotaoja Stat.1/1959. *M. radialis* is a classical indicator of Central European oligotrophic and stratified "Tanytarsus" lakes. An abundance of chironomids there could be taken to indicate relatively abundant plant nutrients within an oligosaprobic level (Table 8).

The limnocrene Kotaoja Stat. 1/1959 is at the foot of an uninhabited mountain. The abundance of insects there in comparison to the other biotopes studied in the Sompio area indicates relatively favorable conditions with nutrients allowing an oligo- or mesotrophic site classification. The brook Kotaoja discharged into the shallow and eutrophied Lake Sompiojärvi.

Kotaoja Stat. 1/1959 was adjacent to nearly aban-

Table 12. Selected values of the water chemistry (from the Tables 1-9) compared with the numbers of the individuals emerged annually pro one quadratmeter in the sites studied in the Sompio area 1959-1961 or discussed in the present paper. (In Lake Sompiojärvi the emergence given shows variation within the limits of 11 different stations in 1959-1961, in Seitajärvi of 7 different stations in 1960 and in Posolampi of.4 different stations in 1961).

	N_{tot} mg/l	P_{tot} mg/l	Cond. mS/m	Color. Pt mg/l	COD_{Mn} mg/l	Indiv. emerg./m²
Oligotrophic						
Oulankajoki	<0.400	0.000	<5.7	28-40	9.1	partl.stud.
Luiro	0.500	0.005	<4.29	<70	11.0	3988
Karikoski(Konnevesi)	<0.360	<0.011	(?4.4)	<25	5.8	partl.stud.
Mesotrophic, more or less eutrophied						
Seitajärvi l960	<1.900	<0.094	<5.0	60	<115.0	1252…7926
Tupalehdonoja Stat. 8/1960, the water from Seitajärvi						1086
Sompiojärvi (1959)	1.290	0.027	<2.86	90	<70.6	3278…16526
Mutenianjoki 1959, the water from Sompiojärvi						19938
Posolampi Stat.1	1.820	0.032	5.28	<100	-	19706
?Oligotrophic						
Posolampi 1961	-	-	<5.5	<48	<38	286…2694
Posolampi Stat.6	-	-	-	-	-	738
Kuusioja	-	-	5.17	100	81.7	2022
Tupalehdonoja Stat. 9/1960	-	-	2.97	125	-	3270
Kotaoja Stat.2	-	-	2.09	25	37.1	3428
?Mesotrophic						
Kotaoja Stat.1	-	-	-	-	-	5988
Posolampi Stat.2	-	-	-	-	-	8416
Kotakenttä Stat.12	-	-	-	-	-	9400

doned (from 1 to 3 fishermen in 1959) camp sites called Kotakenttä and Kenttäharju (kota = a Lapp hut, kenttä = field, harju = esker) some 1 km along the Kotaoja Brook and on the NW shore of Lake Sompiojärvi. A relatively young birch wood was growing on the site in 1959.

As mentioned in the original description of the site above the site had been inhabited by Lapps for thousands of years at least since the neolithic era up to the beginning of the 20'th century (Carpelan, C, Lappalaisperäisten muinaisjäännösten inventointi ja tutkimus Sompion Lapissa kesällä 1964. Julkaisematon käsikirjoitus, Museovirasto. (Unpublished manuscript in Finnish, Finlands National Board of Antiquities). It had also been visited by people who went from the Sompio area to the Arctic Sea (Figs. 37-39). Folks from the south went up the rivers Kemijoki, Luiro and Mutenianjoki. They left apparently their boats on the shore of Lake Sompiojärvi and continued on foot some 250 - 300 km.

It is possible that the soil of Kotakenttä or the entire northern shore had become eutrophied over the centuries through human activity including reindeer husbandry so that as late as in 1959 nutrients still seeped into the springs and even to Lake Sompiojärvi.

Large numbers of insects emerged in the small rheocrene (Table 12) in the already then abandoned former abode site Kotakenttä Stat. 12/1959. In the summer of 1959 the Brook Hietaoja on the northern shore of Lake Sompiojärvi was only in August visited by fishermen. A conductivity recording of 2.20 mS/m (cf. Table 1) was in July taken. The conductivity of the lake water close to the mouth of a small spring brook on the western shore was as low as 1.76 mS/m.

The water quality and relatively high productivity in Sompiojärvi may serve as an example of a positive influence of eutrophication on fish populations. Before its inundation the lake was the site of a historically important fishery (Paulaharju 1953) famous for e.g. the large whitefish (*Coregonus l. lavaretus*).

Eutrophication through plant nutrients in connection with a favorable oxygen level differs dramatically from the effect of pollution through harmful substances associated with technology. Numerous species of *Cricotopus*, some quite abundant, lived in Lake Sompiojärvi while they are completely lacking from the extensive lentic stretch of the River Vantaanjoki in southern Finland. The latter is polluted with municipal waste (Hirvenoja 2000, Table 2).

Stat. 1/1961 at Posolampi was a site somewhat similar to the mentioned above. When the material was collected in 1961the acid and oligotrophic (?<mesoligotrophic) Lake Posolampi was also uninhabited. The eutrophic (?hypereutrophic) grade and the intensive emergence in the limnocrene (Table 8) near the shore line of the lake were exceptional.

As mentioned in context earlier in 1961 one could still discern wooden remains of Lapp huts near the very eutrophic Posolampi Spring Stat. 1/1961. They, however, have been erected by Finns and not Lapps.

The other putative spring brook site, Posolampi Stat. 6/1961 did not have this feature (Table 8) but rather few insects emerged there.

Figs. 37...39. On the eastern part of Kotakenttä there were perhaps thousend of years old columns of stones (below the first) to show the path to the Arctic Ocean.

9. The saprobiological aspect

Salmi (1963) records the occurrence of *Pediastrum* algae in the sedimentary series of Lake Sompiojärvi. He identified seven species, most of which are oligosaprobic. *P. Boryanum* is, however, according to him weakly mesosaprobic. It is very abundant, but has its deepest regression in the layers 2.3 m, 0.9 m and 0.1 m, i.e. during the coldest, rainy and recent times.

Classes of saprobity should show at least the organic loading. In the classification of the Finnish Water Authorities (Vesi- ja Ympäristöhallitus 1988) COD_{Mn} values of 18-23 mg O_2/l or BOD_7 values of 2 mg O_2/l stand for the limit between classes II/III in the Finnish water quality system of five grades. In the Sompio area natural waters of which analyses of water quality have been made available belong at last to class II or they are somewhat worse off.

The running waters of northern Finland are in general less loaded than the waters in the southern part of the country (Laaksonen 1970). Laaksonen (1969) gives a mean value of BOD_5 1.517 ± 0.6055 mg O_2/l. It should still indicate approximately a state of oligosaprobity or the beginning of beta-mesosaprobity (Sládeçek 1973:109).

An attempt was made to calculate the local saprobic index S (for the method the reader is advised to consult e.g. Schwoerbel 1980 or Uhlman 1982) using what was known of the fauna (unpublished observations) of the oligotrophic and lentic site in the Luiro Stat. 10/1960. The results are as follows: Ephemeroptera, Plecoptera and Trichoptera together give a mean index S = 1.4, Oligochaeta S = 2.2 and the entire macrofauna S = 1.8, which indicates the beginning of beta-metasaprobity. The corresponding indices in 1960 are for the Tupalehdonoja Brook as follows: the Ephemeroptera and Plecoptera index S = 1.4, Oligochaeta S = 2.2 and the total value for the macrofauna so far known S = 1.6.

The Tupalehdonoja shows, in spite of its relatively high content of humic substances a little lower Index S than that of the Luiro. This may be attributable to a faster current in the former site (Zimmermann 1961a, 1961b; Braukmann 1987; Kownacki 1989; Hirvenoja 2000). These calculations for the fauna give roughly the same levels of saprobity as the measures made on the basis of water chemistry by Laaksonen (1969).

According to Kuusela (1979) the quality of water in the Jäväjänkoski rapids (discussed also in sections 6 and 8 here) varies between xeno- and oligosaprobity, i.e. about one class above the lentic section of the Luiro if to figures are converted to correspond to the different velocities.

The limnocrene Kotaoja Stat. 1/1959 was in a subjective scale regarded as the best drinking water in the area studied here and this in spite of the large numbers of insects emerging in it. As mentioned earlier the local water chemistry was never studied; in particular a BOD value would have been an important parameter to know. Species of the genus *Micropsectra* were the conspicuous chironomids here. The only plecopteran, even though not in the funnel trap, was *Diura bicaudata* (Linnaeus). According to Sládeçek (1973: 216) it is known only from xenosaprobic sites (Si = 0.1). In contrast to Stat. 1 fewer insects emerged at Kotaoja Stat. 2/1959 down the brook. Here waves carried turbid lake water with loose gray sediment into the mouth of the brook. Relatively low values are seen in Table 1 for water chemistry near Stat. 2/1959. Here *Isoperla grammatica* Poda emerged in the funnel trap; Sládeçek (1973) characterizes it as a beta-mesosaprobic (Si=1.75) species. The only oligochaete seen in an accidental bottom sample near Stat. 2/1959 was *Stylodrilus heringianus* Claparede (Si=1.75).

Micropsectra radialis was not present in the clearly eutrophied spring Posolampi Stat. 1/1961 but four other species of *Micropsectra predominated* there. One of them, *M. apposita*, had a mass occurrence in 1953 in the Punkanjoki at Riihimäki, southern Finland. There were then about 30000 indiv./ m^2 together with other midges including *Cricotopus* (Hirvenoja, M. 1954, pro gradu study, Helsinki University, unpublished, cf. Hirvenoja 2000:37). The phase was interpreted to be beta-mesosaprobic and took place immediately before a sudden collapse in the density of *Micropsectra apposita*. Unfortunately one may not compare exactly the two situations since values of P_{tot} and N_{tot} are not available for Riihimäki 1953. The environs of the spring Posolampi Stat. 1/1961 were uninhabited and there certainly was not communal waste while pollution of that kind evidently increased at Riihimäki in the 1950's.

Mauch (1976) gives the following relative occurrences for *Cricotopus bicinctus*: 5os, 4bms, 1ams and for *C. triannulatus* 4os, 4bms and 2ams. I found *C. tricinctus* and *C. maurii* Spies and Saether still in a beta-mesosaprobic phase in a lentic and with municipal waste waters polluted water of the small river Punkanjoki at Riihimäki. When BOD_5 increased up to 7.2-11.2 mg O_2 only *C. sylvestris* was found in low numbers (Hirvenoja 2000:36-37).

According to Kownacki (1989:230) *C. bicinctus* can live in a swift flow even in BOD_5 values of 20 mg O_2/l, i.e. at the onset of polysaprobity in the scale of Sládeçek (1973). In lentic conditions this should represent the onset of alpha-mesosaprobity.

At least to a certain extent one may view trophic and saprobic levels to stand for different and independent concepts. As stated earlier here one gets an impression that the direct effect of plant nutrients is less detrimental for animal life than municipal waste water (Hirvenoja 2001).

A problem arises with easily recognizable chironomids like *Prodiamesa olivacea* (Meigen) with (Si=2.25 in Sládeçek 1973, sub *P. praecox* Kieffer). They are often abundant in spring and brooks (like the Tupalehdonoja) with some mud, yet *P. olivacea* is found in certain polluted areas as well and it also tolerates high concentrations of H_2S (Nadig 1942).

Nyman et al. (1986:7) argue that there are no biological indicator systems that could be used to monitor flowing waters in Finland. My observations (Hirvenoja 2000) show that saprobity is as useful or useless in Finland as it is in Central Europe because we share the same organism. The low number of Chironomidae is a major shortcoming in the saprobity tables. As a mere thought the idea of knowing the environment using a few indicator species appears to be enormously optimistical.

Evidently there is not a single way to classify waters correctly. Plant nutrients, saprobity and toxic chemicals etc. are very different things (cf. Sládeçek 1973, Hirvenoja 2000:36, 2006:379). Nyman et al. (1986) think that chironomids can not be so reliably determined (sic!) that they would be of use here. It will, however, be the task of hydrobiologists to correct any possible defects (an example for instance: Hirvenoja 1973b). Other scientists can not be expected to do this work. Changes in communities that are monitored to a sufficient taxonomic level can show eventual alterations. This can be done with or without indices. The reasons for the changes can then be investigated further.

10. The distinct influence of humic substances?

Humic waters flowing from e.g. drained peatlands are often seen as a concern. There is evidently but a single reason, an eventual fall in the oxygen level and an accumulation of mud in the receiving waters.

We do not know much of the direct influence of humic substances on animal communities even though many species can live in humic waters. To give an example, Hirvenoja (1960a, 1964) showed that humic and polluted waters in combination gave rise to a mass occurrence of Volvocales (*Eudorina elegans* and *Pandorina morum*), planctic crustaceans (*Daphnia* and *Cyclops*) and an abundance of chaoborids in some *Cloeon – Chaoborus – Chironomus* ponds in Riihimäki. This did not, however, interfere with a parallel phenomenon in ephemerids and chironomid midges. This example may serve to illustrate the point that perhaps the plant nutrients (conductivity about 20-30 mS/m) which flowed into the site of the outbreak were responsible for the high productivity. Poisonous chemicals like ferrosulfate seen in waste waters today were then absent. A high concentration of humic substances (up to 800 mg Pt/l) did not prevent the above phenomenon from taking place.

In the classification with a scale of five, evidently values for potable water of the Finnish Water Authorities (Vesi ja ympäristöhallitus 1988) the values used to demarcate degrees III and IV are as follows: coloration 100 mg Pt/l, COD_{Mn} 33-50 mg O_2/l and BOD_7 5 mg O_2/l (=BOD_5 4.3 mg O_2/l). According to Sládeçek (1973:67) the latter would indicate low mesosaprobity. We may take the Tupalehdonoja as an example here. It was a site with e.g. brook trout. It had a color value of Pt mg/l of 125. This value would place it in the fourth class out of five in classification of drinking water but apparently not for many animal species. Genuine industrial pollution will selectively kill organisms at an affected site but apparently water administrators are either unwilling or unable to monitor that kind of a process.

11. Phenology

Knowing the phenology of insects species is a prerequisite in appraising single bottom samples.

Upon arrival in the study area on the 10th of May in 1960 the camp was put up in deep snow. The River Luiro was navigable then but the Lake Seitajärvi shed its ice in May 15 so that traps could be set out on May 16. The first midges emerged quite soon in the Luiro on May 18 and in Lake Seitajärvi on May 20.

Oliver (1968) describes a somewhat similar fast sequence of events in the Arctic. Entire populations of successive species started emerging en masse e.g. in Lake Seitajärvi took place about one week thereafter in the last week of May and the running water species treated here after that, i.e. not immediately after snow melt as in Arctic Canada (Oliver 1968).

Many chironomid species do not emerge in water temperatures below about 10ºC. The numbers of *C. bicinctus* were large enough to allow for a rather precise assessment of emergence. Fig. 19 shows that continuous emergence ceased on about August 24, 1959 when the water temperature fell below 14ºC. Further that figure shows the onset of continuous emergence on June 17, 1960 when the water temperature again reached 13-14ºC. Pupation may evidently take place some days earlier at a slightly lower temperature.

Cricotopus were not seen to emerge in the deepest part of the limnocrene Kotaoja Stat. 1/1959. The dominating chironomids there belonged to the genus *Micropsectra*. They were able to pupate in water at least as cold as <4ºC and swim e.g. into the bottle of the funnel trap. They could not, however, hatch as adults in the cold water and air of the bottle before it was pried open above the water surface so that warm air entered the bottle. Different species have characteristic pupation temperatures and they hatch as adults on the surface aided with an air temperature warmer than that of the water. The annual variation in temperature of Lake Nettilling and Lake Hazen in arctic Canada is between 0.5ºC and 4ºC. Nevertheless, the entire life cycle of chironomids such as *Heterotrissocladius subpilosus* takes place within this narrow temperature range (Oliver 1964, 1967). This is why some subfossil chironomid midges can be used to indicate changes in climate (Hirvenoja 1998). We may here note that *Micropsectra* adults hatched immediately when the bottle was opened. A reverse process, from warm water to cold air can be followed in the laboratory. For instance, an emerging adult cannot free itself from the pupal exuviae or it does it only in part and dies on the surface of water.

Table 13 lists the dates of emergence for three earliest chironomid species in the Sompiojärvi area.

Table 13. The emergences of 3 earliest species in the Lake Sompiojärvi area in 1959 when in the lake the ice had just disappeared. The temperatures given are the highest surface temperatures measured. It was impossible to measure the fluctuating temperature in the bottom of the lake with certainty. In the brook the bulk of the evenly running water is more stable and shows more correctly the temperature in which the pupation has happened. The brook station Kotaoja 2 and the lake stations 3 and 4 near the shore of Sompiojärvi were all near (roughly 50-150 m) another. (See the total emergence of *Corynocera* in Hirvenoja 1960b:159.)

Date May	air max °C	Lake, water °C	Lake, Stat.3-4 number of ind. *Pogon*ocladius	Lake, Stat.3-4 number of ind. *Trissocladius*	Brook, water °C	Brook Kotaoja Stat.2 number of ind. *Pogonocladius*	Brook Kotaoja Stat.2 number of ind. *Trissocladius*
23.	7.0	6.0	-	3	**3.5**	-	-
24.	8.0	6.0	13	5	**3.5**	-	-
25.	10.0	6.0	326	1	**4.0**	-	-
26.	11.0	7.0	-	11	**5.0**	315	-
			Corynocera			*Corynocera*	
27.	10.0	7.0	5	-	**5.0**	-	-
28.	5.0	5.0	?	11	**3.0**	-	-
29.	13.0	8.0	313	-	**5.0**	-	2
30.	12.0	9.0	2217	1	**5.0**	-	3
31.	13.5	9.0	8379	-	**6.0**	5	2

They are *Pogonocladius consobrinus* Holmgren (Orthocladiinae). It needs about 3.5° for pupation. Two others are *Trissocladius tornetraskensis* Edwards (Orthocladiinae) and *Corynocera ambiqua* Zetterstedt (Chironominae, Tanytarsini), which apparently need about 5°C for the pupation. If the water temperature does not reach a threshold value required for a species, it is unable to live there. Among other factors, this makes it possible to obtain a rough idea of past temperatures (Fig. 40).

In southern Finland many chironomid species have two emergence periods, the first in June and a second one in July-August. Several species have one generation the peak of which may even glide over the season in different years. The number of generations may be even higher (e.g. *Corynoneura*).

In the lakes of northern Finland studied here many species clearly have a single emergence period and, accordingly, a single generation, but many species had near the end of the summer another emergence period, weaker than the first one. It ceases at the approach of cold weather. Similar life cycle may occur also in southern Finland in different insect groups.

In the Mutenianjoki *C. tristis* has one generation a year associated probably with diapause (perhaps between the second and third larval instars seen in rearing *Trissocladius brevipalpis* Kieffer in the laboratory, cf. Hirvenoja 2002:12-14). This will be broken through the low winter temperature. We may, therefore, be justified in assuming that *C. bicinctus* has in the Mutenianjoki (Figs. 6-7) one main generation without diapause. The peaks seen in the emergence curves arose because of variation in temperature. The temperature sum may have allowed the emergence of a partial second generation in the same summer but it is not seen in the emergence curve because of the dense population. Such a scenario would spread out the emergence over the summer months mixing eventual different generations. The phenomenon can be seen also when sampling flying midges (Hirvenoja 1975, Fig. 1). Further examples illustrating some sites and species in southern Finland can be seen in Hirvenoja (1960a, Fig. 5; 1964, Figs. 5-6).

In the Luiro and the Tupalehdonoja sites (Figs. 29-32 with a low productivity the emergence period of each species of *Cricotopus* lasts about two months. One may see that the days of emergence coincide with or take place after the warmest days.

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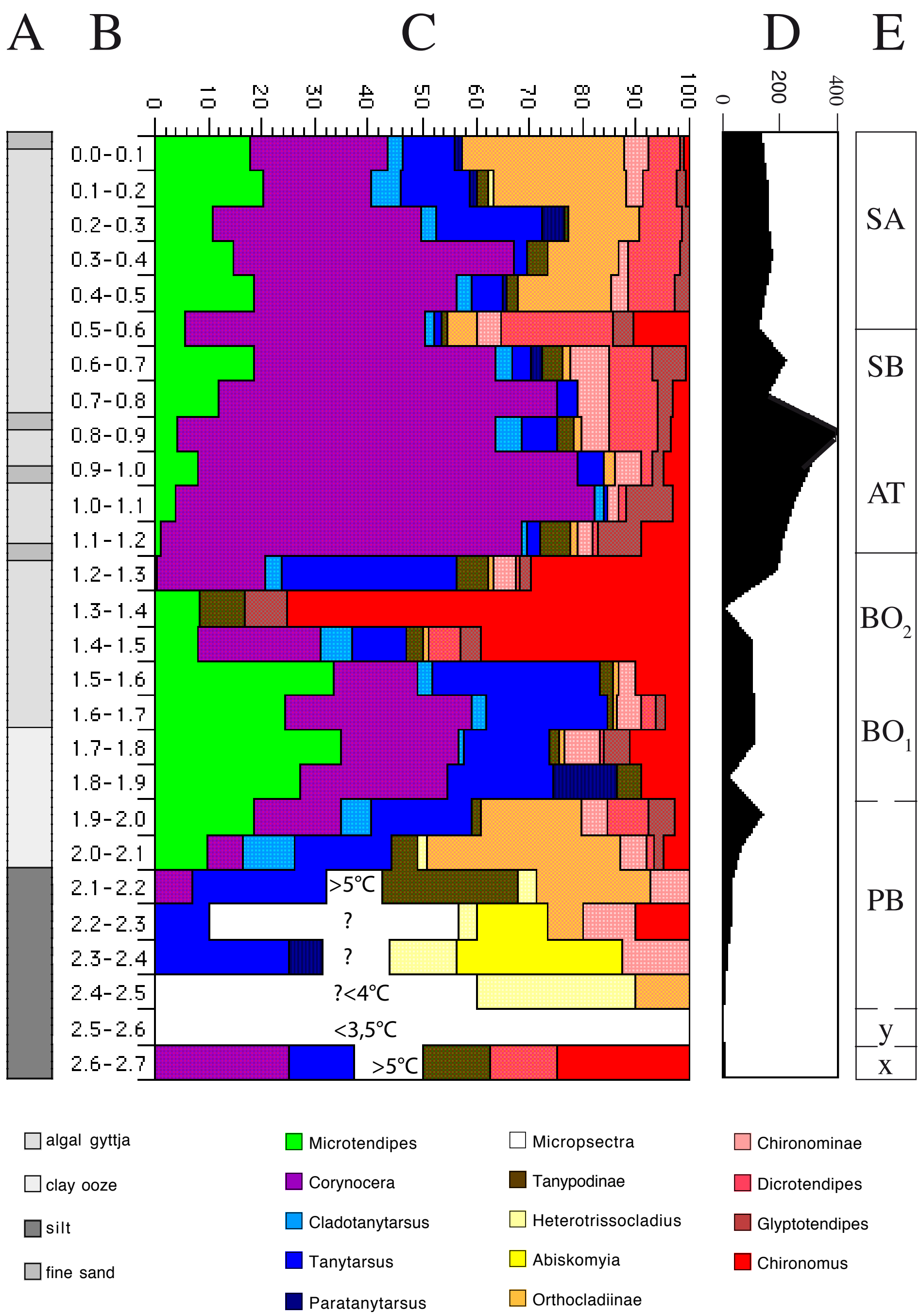

Fig. 2. Development of chironomid taxocoenoses in Sompiojärvi.
A. Sediments (redrawn from Salmi 1963); B. Depth in m; C. Relative abudance of the most abudant taxa; D. Number of head capsules found per about 20 ml dry sediment (exception: depth 0.8-0.9 m); E. Suggested chronozones (in this column x = first relatively warm period, y = includes obviously also the period of the extinction of all chironomids).

Fig. 40. The chironomid taxocoenoses in the sediments in Sompiojärvi (adapted from Hirvenoja 1998c). Some early layers have been provided with the suggested past temperatures..

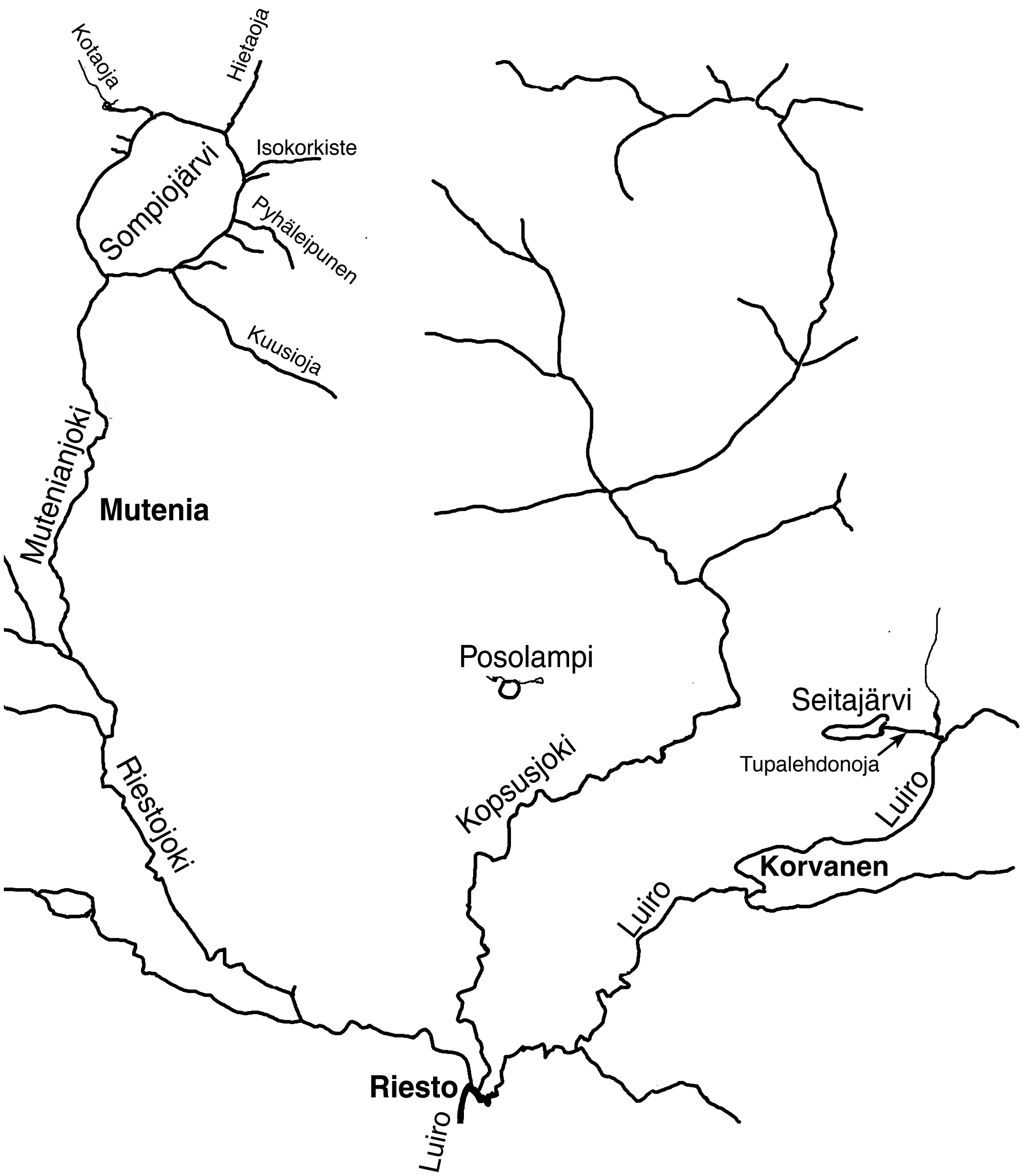

Fig. 41. A simplified map about the waters of the study area.

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