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Macroscopic bottom fauna in the slack water and rapids of Pitkäkoski in the river Vantaanjoki (Southern Finland)

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Changes in the macroscopic bottom fauna of the polluted river Vantaanjoki were observed over the years 1982–1991. Sites were the Pitkäkoski rapids and the slack water above them near Helsinki. Differences between the biotopes studied are given as saprobic indices and Shannon diversities. The difference between the communities of the slack water (alpha-mesosaprobity) and the rapids (beta-mesosaprobity) was approximately one saprobity class. In the slack water the saprobic classes found were roughly comparable with the Finnish water authorities water quality classification (1–5/6 degrees) of 4th degree at the same site. The conditions should, however, also be re-examined from the point of view of a transsprobic (antisaprobic, toxic) biotope. A total of ca. 130 taxa of aquatic invertebrates were collected, among them *Krendowskia latissima* Piersing and *Heptagenia flava* (Rostock), which are new to the fauna of Finland.

1. Introduction

Optimistic newspaper articles appeared in the 1980s on the possibility of restoring the River Vantaanjoki to its former condition as a breeding place for salmon. These were perhaps based on the results of monitoring, that showed that the loading had decreased from the maximum in the beginning of the 1970s. These news motivated the small study reported here.

The Finnish classification of water quality (1–5 or 6 degrees depending on the purpose; see Vesi- ja ympäristöhallitus 1988) depends on physico-chemical, bacteriological, and botanical parameters, but ignores the invertebrates. The water quality of the study area was classified by the water administrators according to the Finnish method as passable (= 4th degree; Penttilä 1992:46). Therefore, the aim of this study is not primarily to determine the water quality, but to see what kind of bottom fauna can tolerate the well known, quite strongly polluted conditions. For comparison there is in Finland relatively little published, especially at the species level, about the communities of the whole macrobenthon (for the terminology – 'benthon' instead of 'benthos' etc. — see Steffan 1965, Fittkau 1976, 1977).

2. Study area

The river Vantaanjoki (Fig. 1) has its sources in lakes near the town of Riihimäki, about 100 km north of Helsinki, from where it flows to the Gulf of Finland. The 20–30 m broad Pitkäkoski rapids are located at a distance of 12 km from the estuary. Coordinates (Heikinheimo and Raatikainen 1971) of the site are 6686:383. At the time of the

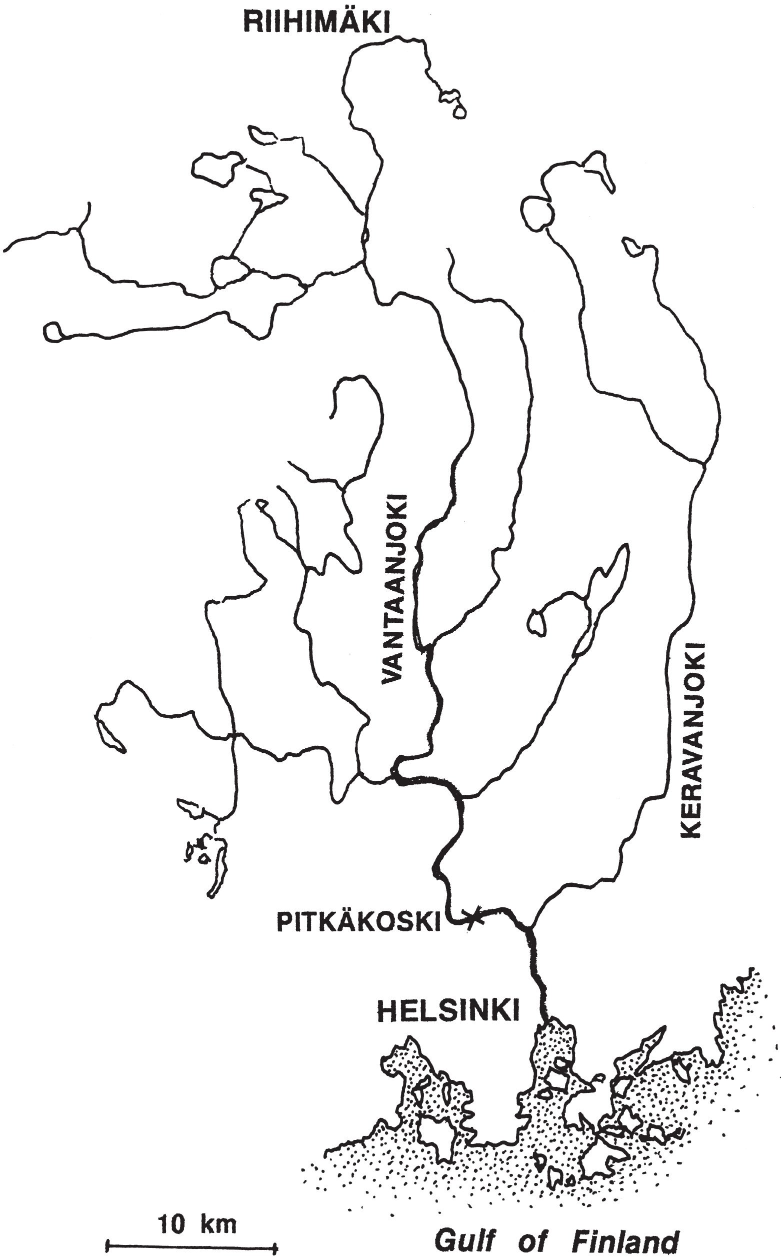

Fig. 1. The river Vantaanjoki with its tributaries. The site of the study area of Pitkäkoski is marked with a cross.

present observations the river was above Pitkäkoski loaded with the wastewaters of 13 sewage-processing plants. In the study area the slack water (<10 cm/sec) and the Pitkäkoski rapids are abruptly separated from one another by a weir. In the rapids different velocities from very slow (at the shore line) up to 155 cm/sec (mostly 45–70 cm/sec) were measured at the sampling sites.

The annual water temperature amplitude of the Vantaanjoki is more than 20 C (–0.1 to +23 C, in 1991 according to Penttilä 1992: 35–36). The study area belongs to the epipotamal zone sensu Illies (1961:209; see also Illies 1958, Illies & Botosaneanu 1963). Suortti (1966) studied the Coleoptera in the whole Vantaanjoki, but already by then the original water quality had been destroyed by waste effluents.

The chemistry parameters are available in the papers of the local water protection association, from which (Anon. 1987; Penttilä 1992) some selected values are combined in Table 1 to give a rough idea of the situation. The water protection association has a monitoring station (V 12) at the slack water site of the present study. The results of the present study on the benthon are thus to a certain extent also comparable with those of the benthological monitoring (V12, depths 2 m and 4.1 m) done for the water authorities by Kosonen (1985) and Vaajakorpi (1988).

3. Material and methods

Because of the work limitations, on each visit only one sample was collected from the habitats selected. About 1.5–2 dm^3 of the substratum, was scooped up with a hand net (mesh 0.4 mm) from the shore (depth < 1 m) of the first 200 m of the Pitkäkoski rapids and of the slack water above the weir before the rapids. Each sample was slightly sieved in the same net only. Tables 2 and 3 give the sample dates.

Above the weir the substratum was clay gyttja; in the rapids it was of stones bearing *Fontinalis antipyretica* or of gravel to silt. All readily identifiable individuals were removed from the sample in the Petri dishes under the preparation microscope as soon as possible. The rest of the sample (about 1–1.5 dm^3) was kept in an aerated vessel for some weeks at room temperature (mostly at home; about 20 C). The vessel was placed in a cage from which the emerging insects were collected; the pupal exuviae were collected from the water surface of the vessel. The emergence took place usually in 2–4 weeks. After the rearing period the vessel was emptied and any remaining animals were identified as far as possible.

4. Results

Altogether about 130 taxa were found in the two biotopes observed. Only 37 taxa were found in the 3 samples taken from the littoral of the slack water above the weir of Pitkäkoski (Table 2). From deeper zones (2 and 4.1 m) 20 taxa were reported by Kosonen (1985) and 6 by Vaajakorpi (1988). From the rapids, (6 samples 1982–1991, Table 3) 111 taxa were identified, though each yearly sample contained 23–54 taxa only. The total number of species captured in the Pitkäkoski rapids may be quite representative for this biotope.(Kuusela (1979) in his much more comprehensive studies recorded 105 macrobenthal taxa from the Jäväjänkoski rapids in Lestijoki, a river in Ostrobothnia in western Finland.)

5. Discussion

5.1. Species dominance

The samples from the Pitkäkoski rapids show that the benthic communities were unstable: species dominance varies from one sample to another (Table 3). The Jaccards (1902) coefficient of community (CC) or percentage similarity of community (PSc) gave values of less than 23% in a com-

Table 1. Selected parameters of water quality in slack water (V 12) in Pitkäkoski (applied from Anon. 1987, Penttilä 1992).

Summer months	1979-85	1991
Conductivity mS/m (γ_{25})	19.3 (11.7–26.8)	16.1–27.0
O_2 mg/l	9.0 (7.7–11.3)	7.2–11.0
O_2 saturation %	94.9 (75–120)	83.0–121.0
BOD_7 mg/l	5.0 (2.3–33.0)	1.0–3.0
pH	7.4 (6.7–8.1)	6.8–9.0
P_{tot} mg/l	0.155 (0.010–0.180)	0.056–0.150
NH_4^+ mg/l	0.776 (0.001–1.500)	0.004–0.200
NO_3^- mg/l	1.3 (0.001–6.0)	1.1–3.2
Chlorophyll$^{\alpha}$ mg/l(1982-85)	0.030 (0.008–0.132)	0.009–0.030
Turbidity FTU	26.5 (8.2–100.0)	5.6–80

Table 2. Proportional abundance of captured individuals in slack water (V12, depth <1m) above Pitkäkoski rapids in the Vantaanjoki. Below see values of diversity (*H´*) and saprobity (*S*), which are compared to the results calculated from the materials of Kosonen (1985) and Vaajakorpi (1988) from the depths 2 m and 4.1 m.

	Study year Date	1986 9.6 %	1988 24.9 %	1991 2.10 %
Oligochaeta				
Nais barbata (Müller)		?	-	1.3
Ophidonais serpentina (Müller)		?	-	3.3
Stylaria lacustris (Linnaeus)		?	1.6	-
Limnodrilus hoffmeisteri Claparede		?	**14.1**	-
Tubifex tubifex (Müller)		?	6.7	1.3
Eiseniella tetraedra (Savigny)		?	-	1.3
Hirudinea				
Glossiphonia complanata (Linnaeus)		?	1.6	-
Erpobdella octoculata (Linnaeus)		?	-	0.7
Helobdella stagnalis (Linnaeus)		?	1.6	-
Mollusca				
Bithynia tentaculata Linnaeus		?	1.0	4.6
Gyraulus albus Müller		?	2.1	-
Valvata (Atropidina) pulchella Studer		?	-	0.7
Lymnaea auricularia Linnaeus		?	0.5	-
L. peregra Müller		?	0.5	0.7
Anodonta anatina Linnaeus		?	2.6	-
Unio tumidus Philipsson		?	6.2	2.6
U. pictorum Linnaeus		?	1.0	-
Pisidium (Cyclodina) casertanum Poli		?	-	1.3
P. (C.) subtruncatum Malm		?	-	1.3
Sphaerium (S.) corneum Linneanus		?	0.5	2.2
S. (Musculium) lacustre Müller		?	-	5.9
Crustacea				
Asellus aquaticus Linnaeus		?	-	3.6
Gammarus pulex Linnaeus		?	1.0	-
Cyclops sp.		?	-	0.7
Eucyclops serrulatus (Fischer)		?	-	1.3
Macrocyclops albidus (Jurine)		?	-	7.8
Paracyclops fimbriatus (Fischer)		?	-	0.7
Acari, Hydrachnidia				
Hygrobates fluviatilis (Ström)		?	-	0.7
Insecta				
E p h e m e r o p t e r a				
Caenis horaria (Linnaeus)		3.6	2.6	-
Centroptilum luteolum (Müller)		-	-	1.3
Ephemera vulgata Linnaeus.		3.6	2.1	-
Paraleptophlebia cincta (Rezius)		-	-	0.7
O d o n a t a				
Agrion virgo (Linnaeus)		-	1.0	-
Platycnemis pennipes (Pallas)		-	-	0.7
H e m i p t e r a				
Callicorixa praeusta (Fieber)		-	-	0.7
Sigara nigrolineata (Fieber)		-	-	0.7
Corixidae, larv., 1st instar		-	-	**22.0**

(Continues ...)

Table 2. Continued

	Study year	1986	1988	1991
	Date	9.6	24.9	2.10
		%	%	%
M e g a l o p t e r a				
Sialis lutaria (Linnaeus)		-	4.2	1.3
T r i c h o p t e r a				
Athripsodes cinereus (Curtis)		-	1.5	-
Ceraclea annulicornis (Stephens)		-	1.5	-
Limnephilus fuscicornis (Rambur)		-	-	2.0
L. rhombicus (Linnaeus)		-	0.5	2.6
Molanna angustata Curtis		-	-	0.7
Phryganea grandis Linnaeus		-	1.5	2.0
C o l e o p t e r a				
Platambus maculatus (Linnaeus)		-	1.5	-
D i p t e r a				
Ceratopogonidae				
Probezzia sp.		3.6	-	-
Chironomidae				
Clinotanypus sp.		-	-	0.7
Paramerina cingulata (Walker)		-	-	0.7
Procladius pr. *cinereus* Goetghebuer		**21.4**	0.5	-
Thienemanniella majuscula (Edwards)		-	0.5	-
Demicryptochironomus vulneratus (Zetterstedt)		3.6	-	2.6
Dicrotendipes nervosus (Staeger)		-	1.5	-
Microtendipes pedellus (de Geer)		-	2.1	3.2
Paralauterborniella nigrohalteralis (Malloch)		7.1	-	-
Paratendipes albimanus (Meigen)		**42.8**	1.0	-
Phaenopsectra flavipes (Meigen)		-	4.2	-
Polypedilum nubeculosum (Meigen)		3.6	**32.3**	**12.5**
P. pedestre (Meigen)		-	-	0.7
P. scalaenum (Schrank)		10.7	-	-
Tanytarsus brundini Lindeberg		-	0.5	2.1
Cyclorrhapha, larv. sp.		-	-	0.7
	Index H’	(1.72)	3.71	3.09
	S index	(2.3)	2.6	2.7
Kosonen (1985), 23.11.1984:	depth	2 m	4.1 m	
	Index *H*'	2.22	2.44	
	Index *S*	2.9	3.2	
Vaajakorpi (1988), 26.9-6.10.1988:				
	Index *H*'	1.61	2.14	
	Index *S*	3.6	3.1	

parison between the communities from different years. Differences between the samples from different years here result partly from the voltinism, because the material was usually taken only in the spring or in the autumn. Errors can also arise because of changes in water quality or the fluctuation of the water level (Caspers & Jaeger 1988:34). That probably explains the unexpected results from the rapids after the warm and dry summer of 1988, because only the shores were sampled (QM: July 1.5–5.5 m^3/sec, August 4.5–12.8 m^3/sec, Ahola personal communication).

Because of the weir, the water level is more stable in the slack water area (station V12 of the

Table 3. Proportional abundance of captured individuals, Pitkäkoski rapids (depth < 1 m)in the Vantaanjoki. Below see values of diversity (*H´*) and saprobity (*S*).

Study year Date	1982 16.5 %	1985 20.5 %	1985 3.10 %	1987 1.10 %	1988 24.9 %	1991 2.10 %
Turbellaria	-	-	-	-	-	0.4
Dendrocoelum lacteum (Müller)	-	-	-	-	-	0.4
Oligochaeta						
Homochaeta naidina Bretscher	-	-	-	-	0.7	-
Nais simplex Piguet	-	-	-	-	-	0.4
Ophidonais serpentina (Müller)	-	-	-	-	-	-
Pristina longiseta Ehrenberg	-	-	-	0.3	-	-
Ripistes parasita (Schmidt)	-	-	-	0.3	-	-
Stylaria lacustris (Linnaeus)	-	-	-	0.3	-	-
Limnodrilus claparedeianus Ratzel	-	-	-	-	-	0.4
L. hoffmeisteri Claparède	2.1	-	-	-	-	-
Psammoryctides barbatus (Grube)	1.0	-	-	-	-	-
Tubifex tubifex (Müller)	2.1	-	-	-	-	-
Lumbriculus variegatus (Müller)	1.0	-	-	-	-	0.4
Eiseniella tetraedra (Savigny)	1.0	3.7	-	**20.3**	0.7	-
Enchytraeidae sp.	1.0	-	-	-	-	-
Hirudinea						
Glossiphonia complanata (Linnaeus)	-	-	-	-	-	0.9
Helobdella stagnalis (Linnaeus)	-	-	-	0.3	-	-
Piscicola geometra (Linnaeus)	-	-	-	0.3	-	-
Mollusca						
Ancylus fluviatilis Müller	1.0	-	-	0.3	2.8	3.1
Bithynia tentaculata Linnaeus	4.1	0.9	1.3	0.6	3.5	1.8
Gyraulus albus Müller	-	-	-	-	2.8	-
Lymnaea (Radix) peregra Müller	-	-	-	-	3.5	0.9
Anodonta anatina (Linnaeus)	-	-	1.3	0.6	-	0.4
Pseudanodonta complanata Ross.	-	-	1.3	-	-	-
Pisidium (Cyclodina) henslowanum Sheppard	-	0.9	-	-	-	1.3
Sphaerium (S.)corneum Linnaeus	-	-	-	2.6	-	1.3
S. (Musculium) lacustre Müller	1.0	**8.3**	1.3	4.6	7.0	3.6
Crustacea						
Asellus aquaticus Linnaeus	9.5	-	1.3	0.3	2.1	4.0
Gammarus pulex Linnaeus	1.0	1.9	5.2	-	5.6	4.0
Acari, Hydrachnidia						
Hygrobates fluviatilis (Ström)	-	-	-	-	-	0.4
* *Krendowskia latissima* Piersig	-	-	-	0.3	-	-
Lebertia porosa Thor	-	-	-	-	0.7	-
Insecta						
E p h e m e r o p t e r a						
Baetis niger (Linnaeus)	-	0.9	-	-	0.7	-
B. rhodani (Pictet)	**17.5**	0.9	-	-	-	-
Caenis horaria (Linnaeus)	-	**24.3**	-	0.6	0.7	0.4
Centroptilum luteolum (Müller)	4.1	2.8	1.3	2.0	-	1.3
Ephemera vulgata Linnaeus	3.1	-	**6.5**	-	-	1.3
Ephemerella mucronata (Bengtsson)	3.1	-	-	-	-	-
* *Heptagenia flava* (Rostoc)	-	-	-	-	-	0.4

(Continues ...)

Table 3. Continued

Study year Date	1982 16.5 %	1985 20.5 %	1985 3.10 %	1987 1.10 %	1988 24.9 %	1991 2.10 %
H. fuscogrisea (Retzius)	2.1	3.7	-	-	-	0.9
H. sulphurea (Müller)	1.0	-	2.6	0.3	-	1.3
Leptophlebia marginata (Linnaeus)	3.1	-	2.6	-	-	-
Paraleptophlebia cincta (Retzius)	-	-	-	0.6	-	-
O d o n a t a						
Platycnemis pennipes (Pallas)	-	-	-	-	-	0.4
P l e c o p t e r a						
Nemoura flexuosa Aubert	1.0	-	3.9	0.3	-	-
H e m i p t e r a						
Aphelocheirus aestivalis (Fabricius)	1.0	1.9	-	-	-	0.4
Callicorixa praeusta (Fieber)	-	-	-	0.6	2.1	-
Sigara nigrolineata (Fieber)	-	-	-	-	-	0.4
Corixidae, larv., 1st instar	-	-	-	-	-	**7.6**
T r i c h o p t e r a						
Anabolia laevis (Zetterstedt)	1.0	-	-	-	-	-
Athripsodes cinereus (Curtis)	-	-	1.3	0.6	8.4	0.9
Ceraclea annulicornis (Stephens)	1.0	**8.3**	3.9	1.8	**16.1**	0.9
Cheumatopsyche lepida (Pictet)	-	-	-	-	-	0.9
Micropterna lateralis (Stephens)	-	-	-	0.3	-	-
Goera pilosa (Fabricius)	-	-	-	-	-	0.4
Halesus radiatus (Curtis)	3.1	0.9	-	-	-	-
Hydropsyche pellucidula (Curtis)	1.0	5.1	**25.9**	0.6	2.1	**23.6**
H. siltalai Döhler	-	-	-	-	-	**7.6**
Limnephilus rhombicus (Linnaeus)	-	1.9	2.9	0.6	**32.1**	0.9
L. fuscicornis (Rambur)	-	-	-	2.9	-	0.4
Lype reducta (Hagen)	-	-	-	-	-	1.8
Molanna angustata Curtis	1.0	-	-	-	0.7	0.4
Mystacides longicornis (Linnaeus)	-	-	1.3	-	-	-
Polycentropus flavomaculatus (Pictet)	3.1	1.9	**6.5**	-	0.7	5.8
Rhyacophila nubila (Zetterstedt)	1.0	-	-	-	-	2.2
Stenophylax permistus McLachlan	-	-	-	-	-	0.9
C o l e o p t e r a						
Limnius volkmari (Panzer)	-	-	-	-	0.7	0.4
Oulimnius tuberculatus (Müller)	-	-	3.9	-	0.7	0.4
D i p t e r a						
Tipulidae	-	-	-	1.1	0.7	0.4
Ceratopogonidae						
Ceratopogonidae larv. spp.	-	-	-	0.6	-	0.4
Sphaeromyia sp.	-	1.9	-	-	-	-
Chironomidae						
Ablabesmyia longistyla Fittkau	-	-	-	2.3	-	-
Arctopelopia barbitarsis (Zetterstedt)	2.1	-	-	-	-	-
Conchapelopia melanops (Meigen)	-	6.5	-	-	-	-
C. pallidula (Meigen)	-	0.9	-	-	-	0.4
Paramerina divisa (Walker)	-	-	-	-	-	0.4
Thienemannimyia pseudocarnea Murray	2.1	0.9	-	4.9	2.8	-
T. (?) woodi Edwards	-	-	-	-	-	0.4
Natarsia punctata (Fabricius)	-	-	1.3	-	-	-
Brillia sp.	-	-	-	0.3	-	-
Diplocladius cultiger Kieffer	-	-	-	0.6	-	-

(Continues ...)

Table 3. Continued

Study year	1982	1985	1985	1987	1988	1991
Date	16.5	20.5	3.10	1.10	24.9	2.10
	%	%	%	%	%	%
Eukiefferiella ?claripennis (Lundbeck)	2.1	-	-	-	-	-
E. brevicalcar (Kieffer)	1.0	-	-	-	-	-
Cricotopus annulator Goetghebuer	-	0.9	-	1.4	-	-
C. bicinctus (Meigen)	-	0.9	-	-	-	-
Limnophyes gurgicola (Edwards)	-	-	-	-	-	0.4
Nanocladius parvulus (Kieffer)	-	-	-	1.7	-	-
N. rectinervis (Kieffer)	-	-	-	-	-	0.4
Orthocladius spp.	5.2	-	-	-	-	0.4
Parametriocnemus stylatus (Kieffer)	-	-	-	-	0.7	-
Synorthocladius semivirens (Kieffer)	-	-	1.3	-	-	-
Thienemanniella majuscula (Edwards)	-	-	-	-	-	0.4
T. vittata (Edwards)	-	-	1.3	0.3	-	-
Tvetenia calvescens (Edwards)	-	-	-	-	-	0.4
Demicryptochironomus vulneratus (Zetterstedt)	-	-	1.3	-	-	-
Dicrotendipes nervosus (Staeger)	-	-	-	0.6	-	-
Microtendipes pedellus (de Geer)	-	-	**6.5**	2.3	-	-
Parachironomus digitalis (Edwards)	-	-	-	0.3	-	-
Paratendipes albimanus (Meigen)	-	-	-	-	-	1.3
Phaenopsectra flavipes (Meigen)	-	1.9	1.3	1.7	-	0.4
Polypedilum cultellatum Goetghebuer	**10.3**	6.5	-	0.3	-	0.4
P. nubeculosum (Meigen)	-	0.9	-	0.3	-	-
P. pedestre (Meigen)	-	-	-	0.3	-	-
P. pullum (Zetterstedt)	-	-	**6.5**	-	-	-
P. scalaenum (Schrank)	5.2	-	-	-	-	-
Stictochironomus sp.	-	-	1.3	-	-	-
Micropsectra notescens (Walker)	-	-	-	0.6	-	-
Tanytarsus brundini Lindeberg	-	5.6	2.3	**33.5**	-	6.3
T. eminulus (Walker)	-	-	-	-	-	1.3
T. lestagei Goetghebuer	-	-	-	1.1	-	0.4
T. medius Reiss & Fittkau	-	-	-	1.4	-	-
Paratanytarsus confusus Palmén	-	0.9	-	-	-	-
Rheotanytarsus sp.	-	-	-	-	-	0.4
Simulidae						
Simulium tuberosum (Lundström)	-	3.9	-	-	-	-
Tabanidae spp.	-	-	-	0.9	-	-
?Sciomyzidae spp.	-	-	-	0.6	-	-
Cyclorrapha spp.	-	-	-	0.6	-	0.4
Pisces						
Cottus gobio Linnaeus	-	-	1.3	-	0.7	-
Leuciscus cephalus (Linnaeus)	-	-	1.3	-	-	-
Phoxinus phoxinus (Linnaeus)	-	-	-	-	0.7	-
Index *H'*	3.09	2.81	2.88	2.63	2.44	3.20
Index *S*	1.9	1.9	1.8	2.1	1.6	1.9

water administrators). Some annual differences are reported in water chemistry. For instance the conductivity of water was a bit lower in the years 1980–1982 than before or later. The parameters of the water chemistry can, however, change within a few hours period by an amount more than the mean yearly differences (Anon. 1987: 154–173). The passing maximal loadings may be of importance to the structure of the community. Among some long-lived animals such as the molluscs (*Unio*, *Anodonta*), only small individuals and larger empty shells have often been present in the samples and for instance only old empty large shells of *U. crassus* Philipsson were found from the rapids.

A distinct alteration of dominant taxa was observed in the littoral of the slack water between the years 1986 and 1988 (Table 2). *Paratendipes albimanus* (Diptera, Chironomidae) with genus *Procladius* dominant in 1986 but in 1988 and 1991 the most abundant chironomid was *Polypedilum nubeculosum*. In addition, in 1991 the oligochaete pollution indicator *Limnodrilus hoffmeisteri* was absent and *Tubifex tubifex* (Oligochaeta) decreased from the (littoral) sample. These changes might reflect the continuing decrease in the mean winter and summer values for ammonia (in 1986–87: 464–52, 1988: 239–17, 1989: 215–45, 1990: 153–20 mg/l; Anon. 1991). According to studies of Kosonen (1985), *Paratendipes* coexisted with *P. nubeculosum* and *Limnodrilus* in 1984 at a depth of 2 m but not at 4.1 m. In 1988, *Paratendipes* was found at 4.1 m, as well (Vaajakorpi 1988).

Except for O_2 saturation and its influence, the water chemistry in the slack water before the weir and in the rapids of Pitkäkoski should be much the same for both biotopes. The species similarity between these two habitats is low (eg. CC and PSc in autumn 1988 c.32 and 16%), but can be explained by differences in the velocity of the current, which certain species can utilize (Ambühl 1961).

5.2. The indices

Shannon & Weaver's (1963) diversity index

$$H' = -\sum_{i=1}^{s} p_i \log_2 p_i$$

(p_i = proportions of the abundance of species i, s = number of species) given in Tables 2 and 3 is quite low in the sites observed; the lowest shows the 1986 material from the slack water, when only the insects were observed (Table 2).

The saprobic indices S, which are justified according to Sládeček (1973) with the BOD values, have here been calculated in the simplest manner from the formula

$$S = \frac{\sum (s \times h)}{\sum h}$$

species from the tables of Sládeček (1973) and h the relative abundance. Because individual saprobic indices (s_i) for the majority of benthal macrofauna have up to now not been determined, unorthodoxically all possible species, also those with low G (weight value) have been considered here (see more about the methodology in Schwoerbel 1980 or Uhlmann 1982: 97 for instance). Species evaluated by Braasch & Jacob (1976), Russev & al. (1976) and Uzunov & al. (1988), which have been published after the paper of Sládecek (1973), have also been incorporated here if possible.

In the slack water littoral zone (Table 2) the S index was 2.6–2.7, whereas, calculating from the papers of Kosonen (1985) and Vaajakorpi (1989), it changed from 3.1 to 3.7 in the deepest (<4.1 m) parts of the same locality, thus indicating a worse alpha-mesosaprobity level. In the same water the S index for the Pitkäkoski rapids (Table 3) shows values near 2 (1.6–2.2), indicating the beta-mesosaprobity level. The phytoplankton (calculated from the data in Anon. 1987: 190) taken from the slack water of Pitkäkoski (origin: surface water?) showed approximately similar saprobic indices (1.5–2.0) than did the bottom fauna of the rapids.

Zimmermann (1961a, 1961b) reported experiments that showed that water of the same quality gives a difference of one saprobity class between a current-flow of 5 cm/sec and of 80 cm/sec. According to Braukmann (1987) in the absence of sewage pollution saprobity lies about one index degree lower in high mountain brooks than in flatland brooks.

Roughly the same fact was evident between the biotopes in Pitkäkoski, 2.6–2.7 in the littoral and 3.1–3.7 in the depth of 4.1 m of the slack water (indicating grades of alfa-mesosaprobity = 4th degree, if the system begins from the xenosaprobity), but 1.6–2.1 (mesosaprobity) in the rapids, so conforming with the results of both Zimmermann and Braukmann. Thus all these are encompassed in water quality of the 4th degree (passable) of the Finnish method as mentioned in the introduction.

To show degrees of (undefined?) pollution also 'Trent index' (Woodiwiss 1964) and BMWP or ASPT (Armitage *et al.* 1983) have been developed; these are based fundamentally on the same idea than the saprobic index. According to Uhlmann (1982: 98) the 'Trent index' corresponds to water qualities from beta-mesosaprobity to polysaprobity. The 'Chironomid index' (Bazerque *et al.* 1989) does give important tips, but is not easily applicable, because in the communities studied the given few indicator species for this system are generally absent.

5.3. The fauna

The news about the recovery of the water quality expressed in the newspapers was not reflected in the benthal fauna of Pitkäkoski as here revealed by the author (see also Penttilä 1992: 31). The decreasing abundance of Ephemeroptera and continued sparse fauna of plecopteran fauna in the rapids, on the contrary, were among other less obvious examples, observable signs of an opposite development. The changes in the total fauna (Tables 2 and 3) also do not give an impression of improvement, but vice versa. The combination of species and especially the absences from the fauna are confusing to everybody who is familiar with that in 'normal' running waters.

Among the frequently ignored chironomid midges typical genera for running waters were absent or rare during the whole observation period (cf. Lehmann 1971, Lindegaard-Petersen 1972, Ringe 1974, Caspers 1980a, 1980b, Lindegaard and Mortensen 1988, Mölleken and Steffan 1994). No species of the genus *Chironomus* was found in the slack water of the study area by the author nor by the water authority's consultants. Even *C. riparius* (Meigen), a typical of polluted streams (Gower and Buckland 1978), was absent.

The ecological valency of chironomids is, as well as other invertebrates, somewhat unknown, but without the chironomids the results of the studies would often be defective (compare also the opinions of Ruse et al. 2000). Chironomids are mostly very easily determinable at least in the pupal and/or adult stage. It is important, that determinations are carried out at the species level. As mentioned among others by Kownacki (1989), the number of individuals of some local species first increases during increasing pollution (eutrophication). After the breakdown of their dominance several other, more tolerant species may repeat the pattern.

As an example of this succession some studies on the rivulet Punkanjoki (or Punkanoja) in southern Finland, studied in 1953–1962 by Hirvenoja (in part published 1960a, 1960c, 1960d, 1964) can also be discussed here. The site is a hyporhithral slow-flowing clay-bottomed variant surrounded by fields, the temperature being < 18 C and current of flow < 10 cm/sec; it is comparable with the slack water site in Pitkäkoski. An analysis of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) sampled in 1953 gave an S index = 1.6–1.7, indicating approximately beta-mesosaprobity (in a low current flow!). At that time (1953) the dominant chironomid species in emergence traps was an univoltine *Micropsectra apposita* (Walker) (about 30 000 indiv./m^2).

The community structure in 1953 mentioned above had already changed in 1955. The changes continued during the following years probably because of the increasing waste waters from the scattered settlements. No radical changes was observed in the agriculture. In 1961 high oxygen demands (BOD5 7.2–11.2 mg O_2/l) were measured, which, according to Sládeček (1973), indicated alpha-mesosaprobity. Most species of caddisflies as well as the mayflies *Baetis vernus* Curtis, *Centroptilum luteolum* (Müller) and *Leptophlebia vespertina* (Linnaeus) were not found after 1953. For instance the gradual species richness of *Cricotopus* spp. took place within approximately one saprobity class as is shown in Table 4.

Kownacki (1989:230) has shown that *C. bicinctus* (Chironomidae) can exist in a faster flow of current in BOD5 of 20 mg O_2/l. Because *C. bicinctus* is a quite constant species in the streams of Finland, its scarcity in the Pitkäkoski rapids (cf. Table 3) is perhaps dependent on factors other than BOD; one reason might be the dissolved iron.

Paratendipes albimanus, a common chironomid species for instance in oligotrophic, unpolluted lakes in Lapland (according to the author's unpublished material), coexisted with *Limnodrilus* and *Tubifex*, especially in the slack water of Pitkäkoski. These species were known to the author also from some other communities (in prep.) with a reduced number of species in waters with high iron and sewage contents. Until 1982 the water of the river Vantaa was used for the Helsinki drinking-water purification plant. According to its limnologist, Tapani Vakkuri, values of 2.3 (0.2–6.4) mg Fe_{tot}/l during 1981 and 3.0 (1.6–6.5) mg Fe_{tot}/l were measured during the first half of 1982. Most of the iron obviously comes from the (13) sewage processing plants.

A very interesting point of view has been expressed and discussed in the paper of Rasmussen & Lindegaard (1988), involving the relation between increasing iron content and reduction of the benthal fauna; the lethal influence seems to begin for some species well below 1 mg Fe/l. One can ask: how strong is the cumulative negative effect of the iron for the ecosystem in comparison to its advantages in the purification process? Because of the iron, perhaps great numbers of plant and animal organisms will be prevented from participation in the natural self-purification of the waters. The agriculture has been found to be quality in the public opinion of dumping nutrients in the waters, but are there studies about the effect of its lethal influence to the aquatic animal communities?

Kosonen (1985) would like to interpret the sparse benthal communities above the estuary of the river Vantaanjoki as mesotrophic. One could ask if this is a suitable definition to characterize the waters in question, which obviously should be seen from the point of view of the benthon as transsabrobic (antisabrobic, toxic)?

Occasionally some fish were captured in the present study from the Pitkäkoski rapids (Table 3). According to the saprobity tables of Sládeček (1973:218), the occurrence of *Phoxinus phoxinus*, *Leuciscus cephalus* or *Cottus gobio* is not unexpected in the found saprobity class determined. Fishery biologists have also tried to stock salmonids in the Vantaanjoki and these fishes have been observed in the rapids later on. In light of the tables of saprobity, such attempts are unlikely to be very succesfull.

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References

Anon. 1987: Vantaanjoen ja sen sivujokien tilan kehitys 1975–85. — Vantaanjoen ja Helsingin seudun vesiensuojeluyhdistys ry, Julkaisu n:o 22: 1–191.

Ambühl, H. 1961: Die Strömung als physiologischer und ökologischer Faktor. Experimentelle Untersuchungen an Bachtieren. — Verh. Internat. Verein. Limnol. 14: 390–395.

Armitage, P. D., Moss, D., Wright, J. F. & Furse, M. T. 1983: The performance of a new biological water quality score system based on macroinvertebrates, ower wide range of unpolluted running-water sites. — Water Res. 17: 333–347.

Bazerque, M. F., Laville, H. & Brouquet, Y. 1989: Biological quality assesment in two rivers of the northern plain of France (Picardie) with special reference to Chironomid and Diatom indices. — Acta Biol. Debr.

Table 4. Decrease in species of *Cricotopus* (indiv./m^2; cage trap method) in Punkanjoki during increasing pollution from beta-mesosaprobity to alpha-mesosaprobity.

Year	1953	1955	1956	1962
	(beta-meso	....	......alpha-meso)	
Cricotopus tricinctus (Meigen)	124	-	-	-
C. polychaetus Hirvenoja	4	-	-	-
C. bicinctus (Meigen)	138	40	84	-
C.sylvestris (Fabricius)	78	42	604	4

Oecol. Hung. 3: 29–39.

Braasch, D. & Jacob, U. 1976: Die Verwendung von Ephemeropteren (Insecta) der DDR als Indikatoren für die Wassergüte. — Ent. Nachrichten 20:101–111.

Braukmann, U. 1987: Zoozönologische und saprobiologische Beiträge zu einer allgemeinen regionalen Bachtypologie. — Arch. Hydrobiol. Beih. Ergebn. Limnol. 26: 1–355.

Caspers, N. 1980a: Die Emergenz eines kleinen Waldbaches bei Bonn. — Decheniana, Beiheft 23: 1–175.

Caspers, N. 1980b: 1980b: Die Makrozoobenthos-Gesellschaften des Rheins bei Bonn. — Decheniana 133: 93–106.

Caspers, N. & Jaeger, D. 1988: Der ökologisch-saprobiologische Zustand des Rheins. — Z. Wasser-Abwasser-Forsch. 21: 31–35.

Fittkau, E. J. 1976: Kinal und Kinon, Lebensraum und Lebens- gemeinschaft der Obenflächendrift am Beispiel amazonischer Fliegewässer. — Biogeographica 7: 101–113.

Fittkau, E. J. 1977: Kinal and kinon, habitat and coenosis of the surface drift as seen in Amazonian running waters. — Geo-Eco-Trop 1: 9–21.

Gower, A. M. & Buckland, P. J. 1978: Water quality and the occurrence of Chironomus riparius Meigen (Diptera: Chironomidae) in a stream receiving sewage effluent. — Freshwater Biology 8: 153–164.

Heikinheimo, O. & Raatikainen, M. 1971: Paikan ilmoittaminen Suomesta talletetuissa biologisissa aineistoissa (The recording of localities of biological finds in Finland). — Ann. Entomol. Fenn. 37 (1a): 1–27.

Hirvenoja, M. 1960a: Ökologische Studien Über die Wasserinsekten in Riihimäki (Südfinnland). Chaoborinae (Dipt., Culicidae). — Ann. Ent. Fenn. 26: 31–44.

Hirvenoja, M. 1960c: Ökologische Studien Über die Wasserinsekten in Riihimäki (Südfinnland). II. Plecoptera. — Ann. Ent. Fenn. 26: 199–201.

Hirvenoja, M. 1960d: Ökologische Studien Über die Wasserinsekten in Riihimäki (Südfinnland). III. Trichoptera. — Ann. Ent. Fenn. 26: 201–221.

Hirvenoja, M. 1964: Studien ber die Wasserinsekten in Riihimäki (Südfinnland). IV. Ephemeroptera, Odonata, Hemiptera, Lepidoptera und Coleoptera. — Ann. Ent. Fenn. 30: 65–93.

Illies, J. 1958: Die Barbenregion mitteleuropäischer Fliessgewässer. — Verh. int. Ver. Limnol. 13: 834–844.

Illies, J. 1961: Versuch einer allgemeinen biozönotischen Gliederung der Flissgewässer. — Internat. Rev. ges. Hydrobiol. 46: 205–213.

Illies, J. & Botosaneanu, L. 1963: Problèmes et méthodes de la classification et de la zonation écologique des eaux courantes, considérées surtout du point de vue faunistique. — Mitt. Int. Ver. Limnol. 12: 1–57.

Jaccard, P. 1902: Gesetze der Pflanzenverteilung in der alpinen Region. — Flora 90: 349–377.

Kuusela, K. 1979: Early summer ecology and community structure of the macrozoobenthos on stones in the Jäväjänkoski rapids on the river Lestijoki, Finland. — Acta Univ. Ouluensis, Ser. A, Sci. Rer. Nat. 87, Biologica 6: 1–123.

Kosonen, L. 1985: Vantaanjoen ja sivuhaarojen pohjaeläimistö v. 1984. — Report. Manuscript in the archive of Vantaanjoen- ja Helsingin seudun vesiensuojelu yhdistys ry., 36 pp.

Kownacki, A. 1989: Taxocenes of Chironomidae as an indicator for assessing the pollution of rivers and streams. — Acta Biol. Debr. Oecol. Hung. 3: 219–213.

Lehmann, J. 1971: Die Chironomiden der Fulda (Systematische, ökologische und faunistische Untersuchungen). — Arch. Hydrobiol. Suppl. 37: 466–555.

Lindegaard-Petersen, X. 1972: An ecological investigation of the Chironomidae (Diptera) from a Danish lowland stream (Linding Å). — Arch. Hydrobiol. 69: 465–507.

Lindegaard, C. & Mortensen, E. 1988: Abundance, life history and production of Chironomidae (Diptera) in a Danish lowland stream. — Arch. Hydrobiol. Suppl. 81: 563–587.

Mölleken, H.M. & Steffan, A.W. 1994: Vergleich der Zuckmücken-Besiedlung bodenwasser-gespeister und straßenabwasser-belasteter Bachläufe (Diptera: Chironomidae). — Entomol. Generalis 19: 79–112.

Penttilä, S. 1992: Vantaanjoen vesistön yleistarkkailu. — Vantaanjoki-vuosikirja 1991. Vantaanjoen ja Helsingin seudun vesiensuojeluyhdistys ry, Julkaisu n:o 29: 9–31 + 13 app.

Rasmussen, K. & Lindegaard, C. 1988: Effects on iron compounds on macroinvertebrate communities in a Danish Lowland river system. — Wat. Res. 22(9): 1101–1108.

Ringe, F. 1974: Chironomiden-Emergenz 1970 in Beitenbach und Rohrwiesenbach. Schlizer Produktionsbiologische Studien (10). — Arch. Hydrobiol. Suppl. 45: 212–304.

Ruse, L. P., Herrmann, S. J. & Sublette, J. E. 2000: Chironomidae (Diptera) species distribution related to environmental characteristics of the metal-polluted Arkansas River, Colorado. — Western North American Naturalist 60: 34–56.

Russev, B., Kovatschev, S. Ivanka, J., Karapetkowa, M., Uzunov, J. & Detschewa, R. 1976: Vertreter der bulgarischen Flussfauna als limnosaprobe Bioindikatoren. — Hydrobiology 4: 60–66.

Schwoerbel, J. 1980: Methoden der Hydrobiologie SÜßwasserbiologie. — Uni-Taschenbücher 979, 261 pp., Stuttgart.

Shannon, C. E. & Weawer, W. 1963: The mathematical theory of communication. — Illin. Univ. Press, 117 pp., Urbana.

Sládeček, V. 1973: System of water quality from the biological point of view. — Erg. Limnol. 7: 1–208.

Steffan, A. W. 1965: Zur Statik und Dynamik der Fließgewässer und zu den Möglichkeiten ihrer Klassifizierung. — In: R. Tüxen (ed.), Biosoziologie: 65–110. Junk, Den Haag.

Suortti, M. 1966: Vantaanjoen vesikovakuoriaisten ekologiaa. — Manuscript (pro gradu) in the library of Zool. Inst. Univ. Helsinki, 98 pp.

Uhlmann, D. 1982: Hydrobiologie. Ein Grundriß fÜr Ingenieure und Naturwissenschaftler. Zweite Aufl., 315 pp., Stuttgart.

Uzunov, J., Kosel, W. & Sládecek, V. 1988: Indicator value of freshwater Oligochaeta. — Acta hydrochim. hydrobiol. 16: 173–186.

Vaajakorpi, H. 1988: Vantaanjoen ja sen sivuhaarojen tutkimus v.1988. — Report. Manuscript in the archives of Vantaanjoen ja Helsingin seudun Vesiensuojeluyhdistys ry. 14 pp. + 6 app.

Vesi- ja ympäristöhallitus 1988: Vesistöjen laadullisen käyttökelpoisuuden luokittaminen. — Vesi- ja ympäristöhallinnon julkaisuja 20: 1–48.

Woodiwiss, F. S. 1964: The biological system of stream classification used by the Trent River Board. — Chemistry and Industry 11: 443–447.

Zimmermann, P. 1961a: Experimentelle Untersuchungen Über den Einfluss der Strömungsgeschwindigkeit auf die Fliesswasserbiozönose. — Verh. Internat. Verein. Limnol. 14: 396–399.

Zimmermann, P. 1961b: Experimentelle Untersuchungen über die ökologische Wirkung der Strömungsgeschwindigkeit auf die Lebensgemeinschaften des fliessenden Wassers. — Schweiz. Zeitschr. Hydrol. 23: 1–81