Lynni sillisaintu

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Factors affecting on parr and smolt production of salmonid fish in the Utsjoki and Simojoki revers Northern Finland, and in the Säpsä and Lizma rivers, bastern Karelia in USSR

2. Study area.

2.1. Leographic location.

The Lisma and Säpsä Rivers are situated in the taiga zone of sonth Karelia. Both belong to bosin of Onega lake.Säpsä River begins from the Sämozero Lake (270 km^2) and discharges in to the Vagatozero Lake, through uhich Suoju River flous. The Suoja River discharges further into the Onega Lake. The Lisma Rever begia from the lake uithont name and flous into the Chorga Gult of Onega Lake. River flous through three lakes - Lismozero Lake (104 km^2), Kedrozero Lake (24,9 km^2) and Tarasmozero Lake (1,1 km^2). Upper course of the river is called Verchnjaja Lisma. Middle course from the Lismozero Lake to Lake Kedrozero is called Srednjaja Lisma. The lover course dounstream the Lake Tarasmozero is named Niznjaja Lisma. The river between Kedrozero Lake and Tarasmozero Lake is called Kedra-river.

2.2. Hydrology and main features of the waterconrse

The main hydrological characteristics of the Rivers Lisma and Säpsä are in the table 1 (Bersonov,1960; Grigor'ev,Gricevskaja,1959).

Table 1

Hydrological characteristic of the Rivers Lisma and Säpsä

Name	Length km	total fall m	Drainage area km^2	Lake percentage, %	Mean flon rate m^3/s
Lisma	68,3	114	717,6	19,4	7,6
Säpsä	34,0	17,0	1803	20,4	15,7

The flou rates vary during the year (table 2,3; fig. 1). In both of the rivers the flou rate is highest in May and Iune. Whereas the minimum is achieved in March-april in Lisma river and in February - March in Säpsä river. In Lisma river the water level slighily rise in October- November. At whole the discharge varies insignificantly, because there are large lakes, which basin for staraging wafer and leveling flow rafes in the waterconrse.

Table 2

Mean monthly discharges

R[illegible]er	Jan	Feb	March	Apr[illegible]	May	Jun	Jul	Ang	Sept	Oct	Nov	Dec
Lisma	4,35	3,74	3,32	3,25	7,22	7,84	5,96	5,45	4,38	4,85	5,28	4,0[illegible]
Säpsä	11,1	10,4	10,8	11,6	19,4	20,8	17,4	14,6	13,0	12,7	12,4	12,[illegible]

There are 9 rapids in the River Säpsä. The most important rapids are situated in upper part of the river the largest rapids are :

" Tukka " - 1 0000 m^2

"Leppiakoski" - 3000 m^2

" Krakul'skij" - 12000 m^2

" Kovera " - 6000 m^2

" Säpsä-losma" - 8000 m^2

The total area of the rapids is 4, 4 ha. The lower covrse of the Säpsä River is gently sloping with numerous reaches. The length of the upper part of the Lisma River up to Lake Lismozero is abont 12 km. The total length of rapids in this part is 3,4 km. Most of them are sitnated in the beginning of the river. The fall of Verhnjaja Lisma River is 35 m.

The River Srednjaja Lisma rises in the Lake Lismozero and disscharges into the Lake Kedrozero. This part is 12,2 km long. At hole it is gently sloping. The total fall is 5 m.

Table 5

Mean tendays discharfe and temperature in River Sjapsja and Lizhma (data of GMS)

Дата		р. Лижма								р. Сяпся							
		T°C				D, м³·с⁻¹				T°C				D, м³·с⁻¹			
		1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986
J	1	0.2	0.1	0.2	0.3	4.3	4.7	4.3	3.8	0.2	0.1	0.1	0.1	14.7	11.1	13.6	10.2
	2	0.1	0.1	0.2	0.3	4.2	4.5	4.0	3.7	0.2	0.1	0.1	0.1	13.6	11.9	11.6	9.7
	3	0.2	0.1	0.2	0.7	4.2	4.4	3.8	3.5	0.2	0.1	0.1	0.1	13.9	12.3	11.1	9.3
F	1	0.1	0.1	0.2	0.6	4.0	4.3	3.5	3.3	0.1	0.1	0.1	0.1	14.5	11.9	10.7	9.8
	2	0.1	0.1	0.2	0.4	3.8	4.1	3.3	3.1	0.1	0.2	0.1	0.1	13.5	13.4	10.3	9.2
	3	0.2	0.1	0.2	0.3	3.6	3.9	3.2	3.0	0.1	0.1	0.1	0.1	14.2	13.3	10.9	8.0
M	1	0.1	0.2	0.4	0.7	3.5	3.7	3.0	2.8	0.1	0.2	0.1	0.1	13.8	13.0	11.1	8.0
	2	0.3	0.6	0.9	1.2	3.4	3.5	2.8	2.6	0.2	0.1	0.2	0.1	14.3	13.5	11.3	8.9
	3	0.8	0.9	1.5	1.5	3.3	3.4	2.7	2.4	0.4	0.2	0.5	0.3	15.9	12.3	10.4	9.3
A	1	1.5	1.4	2.0	1.7	3.5	3.0	2.6	2.3	0.7	0.5	0.6	0.8	17.6	12.3	10.4	9.9
	2	2.9	1.9	2.5	2.1	5.2	3.4	2.5	2.4	1.2	1.2	1.0	1.2	22.3	13.3	10.0	10.4
	3	4.7	2.8	3.3	3.9	7.7	4.5	2.4	2.8	2.5	3.0	1.9	2.9	25.2	19.1	9.9	11.6
M	1	6.6	4.9	4.3	4.8	9.1	7.1	3.7	4.9	4.5	5.5	3.7	4.4	26.7	24.2	12.8	15.8
	2	11.0	9.8	4.9	8.7	9.6	8.2	6.5	5.7	7.9	10.3	4.2	6.5	26.8	25.3	16.2	17.7
	3	13.0	15.6	6.5	12.3	9.3	7.8	6.8	6.1	11.3	11.3	7.1	10.6	26.2	25.0	17.7	18.2
J	1	14.8	17.6	12.5	16.6	8.4	6.2	6.9	5.9	14.3	14.2	9.8	13.7	24.6	22.4	17.6	17.6
	2	17.0	15.8	15.4	17.8	7.2	5.1	6.6	5.2	17.6	15.2	13.0	19.5	21.7	18.8	16.9	16.1
	3	14.0	19.0	15.4	17.3	5.9	4.4	6.0	4.2	14.7	18.0	12.8	17.3	18.4	16.5	16.3	13.2
J	1	18.1	17.6	13.4	17.3	5.0	3.7	5.2	3.5	18.5	17.9	13.8	16.7	16.4	14.6	16.0	11.5
	2	19.6	19.0	17.6	18.0	4.3	3.1	4.6	3.4	20.3	20.2	17.5	18.6	13.8	12.7	14.4	12.1
	3	20.4	19.7	18.4	20.3	3.8	3.1	4.1	3.0	19.7	19.4	17.6	21.6	11.5	12.7	12.5	10.9
A	1	18.6	20.6	19.4	20.5	3.4	2.8	3.7	2.5	19.7	21.3	18.5	20.5	9.4	11.6	11.9	9.2
	2	16.2	19.7	19.3	14.3	3.0	2.5	3.4	2.2	17.8	16.5	19.4	16.3	8.1	10.4	11.1	8.3
	3	13.8	13.7	16.7	10.6	2.7	2.4	3.2	2.2	14.9	14.4	17.4	12.3	6.8	8.9	9.6	8.6
S	1	12.5	11.2	14.7	10.8	2.4	2.4	3.2	2.3	13.9	12.2	14.9	11.2	5.6	8.4	8.6	8.8
	2	12.1	10.4	12.0	9.5	2.3	2.3	3.2	2.5	12.9	11.6	12.9	9.6	5.6	7.5	8.2	11.2
	3	9.8	8.1	7.7	6.6	2.5	2.3	3.4	2.8	10.5	9.2	9.1	6.6	6.9	8.1	8.4	12.0
O	1	5.0	8.2	7.3	3.5	2.8	2.7	3.4	3.0	6.1	8.7	8.4	4.4	6.6	9.9	8.6	12.9
	2	5.0	5.0	5.9	3.0	3.4	3.5	3.6	3.3	6.0	6.0	6.8	3.1	7.1	12.6	9.7	13.5
	3	3.5	3.5	2.5	2.8	4.0	4.4	4.0	3.4	4.0	4.6	3.2	3.1	8.4	15.5	10.3	13.5
N	1	0.4	2.0	0.5	1.1	4.3	5.0	4.1	3.5	1.9	3.8	0.3	1.8	9.7	18.2	9.6	13.9
	2	0.1	1.1	0.6	0.2	4.5	5.2	4.1	3.6	0.4	1.0	0.1	0.9	6.4	17.8	10.4	14.8
	3	0.1	0.6	0.2	0.6	4.7	5.1	4.1	3.8	0.3	0.2	0.1	1.3	7.7	14.6	11.0	15.9
D	1	0.1	0.4	0.3	0.2	4.8	5.1	4.0	3.4	0.3	0.1	0.1	0.2	8.3	14.6	10.0	11.4
	2	0.1	0.4	0.5	0.1	4.8	4.9	4.0	3.2	0.1	0.1	0.1	0.1	9.0	15.8	9.9	5.5
	3	0.1	0.3	0.4	0.2	4.7	4.6	3.9	3.2	0.1	0.1	0.1	0.1	9.9	15.3	10.0	6.2

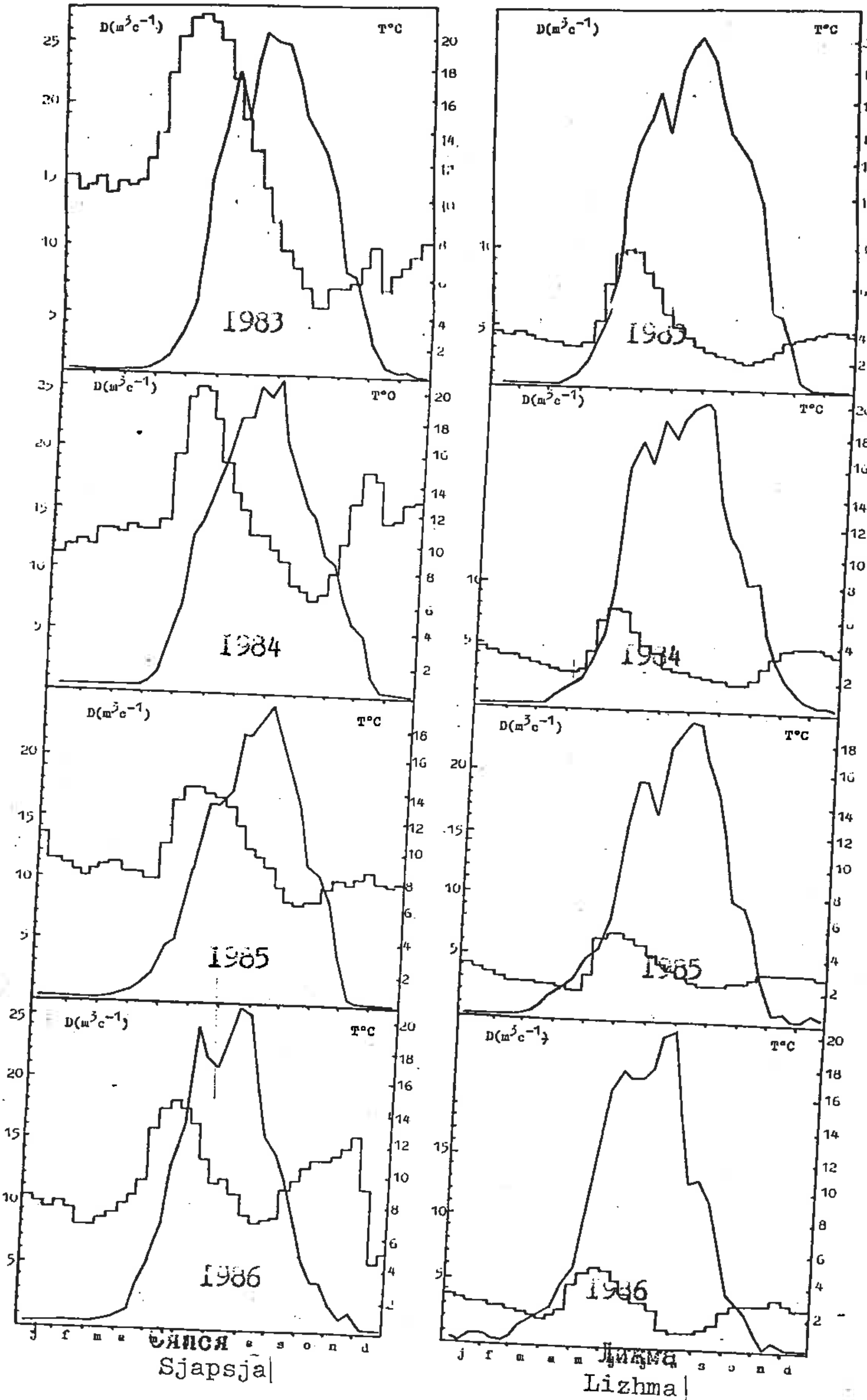

Fig.I. The Seasonal dynamics of discharge and temperature in the Rivers Sjapsja and Lizhma in I983-I986

There are found a few rapids theiz total area is about 4000 m^2.

The River Niznjaja Lisma is about 4 km long and total fall is 29,5 m. Between the Lake Kedrozero and Lake Tarasmozero there is a rapid 0,8 km long.

Downstream Lake Tarasmozero 3 stretchas of rapids lie total area 5 ha.

2.3. Water quality

The River Lizhma is oligotrophic river. The water is clear. rich in oxigen and contains only slightly organic watter (table 4).The content of mineral nitrogen (0-0,03 mg/l) and phosphorus (0,0015-0,0064 mg/l) is low. The water is mostly neutral or slightly alkaline.There are no enterprises and agricultural farms. Only village is situated in the river month.

The river Sjapsja is similar nith Lizhma River on their chemical characteristics. The content of iron and nitrogen is slightly acid (table 4). The water quality in Sjapsja River is dependent on state of the Lake Sjamozero,where the process of eutrophication has began in reant years (Sterligova et al.,1988). Besides, the lower part of the river is under the enfluence of agricultural reclamation. Up to 800 tons of suspended soil and 700 tons of organic matter get into the river from reclamation area. There is only rather little village in the source of the river.

2.4. Geology and geomorphology

The relief of the Lizhma river is characterized by broken ground and complicated structure. It is in the Onego-Ladoga watershed representing a plateau with absolute marks of 150-200 m.

The glacial-accumulative type of relier prevails in the region of the Verhnjaja Lizhma river - these are ridge-hilly and wav wavy plains of the main moraine.

Below the Lizhmozero lake the type of relief changes to denudation-tectonic (ridge-hilly relief).The area of the Lizhma river basin is covered by quaternary sediments. Thay are glacial (boulder sand,Loamy sand,clay) and lake-glacial (varved clay, loam and sand) sediments.Only in the region of the Nizhnjaja Lizhma river there are exposures of prequaternary rocks: granite,

Table 4

Values of the water quality in the Lizhma River Sjapsja River (Solov'eva i dr., I973; Martynova i dr., I982)

River	O_2, mg/l	Susp. solids mg/l	pH	Colour; degrees	CODMn mg, O_2/l	tot. ions mg/l	Fe mg/l	N. mg/l		P mg/l	
								tot.	Nitr.	tot.	Miner
Lizhma	-	-	7,0--7,2	3I-33	6,6-8,8	35,8-38,8	0,I2	-	0-0,03	-	0,00[illegible]-0,006
Sjapsja	8,8-II,9	I,0-5,2	6,4--7,0	3I	8,3	I2,3-27,2	0,09-0,42	0,I3--0,39	0,0I--0,17	0,029--0,035	0,00[illegible]

diabase and quartzite.

In the Lizhma river basin podzolized, soddy sand bog-peaty solis are dominant.

The basin of the Lizhma river falls within the green moss coniferous forests. Timber felling activities are being continued in the region. At the cleared sites deciduous forests are being formed. The ratio of the species composition of the forests is as follows: 37% of deciduous (birch,aspen and others),spruce - 31%, pine - 32%.

Mires occupy a large part (10%) of the Lizhma water catchment area. They are dominant in the upper part of the basin.

The relief of the Sjapsja river basin is also represented by several types. In the head river the glacial-accumulative type of relief is dominant. These are ridge-hilly plains of the main moraine. The largest part of the river basin is occupied by the water-accumulative type of relief,i.e.mire and lake-glacial plains.

The area of the basin is covered by quaternary sediments.Thay are mainly sand, pebble sand,peat,varved clay and loam.

In the Sjapsja river basin the predominating solls are podzolized,bog-peaty and soddy-podzolized. The vegetation of the basin, referred to the taiga zone,is represented by subarctic forms with prevailing coniferous species (pine,spruce).

Paludified sites and river banks are covered by spruce and spruce-birch forests. Some 20% of the basin area are occupied by mires and laludified sites.

2.5. Climate

The rivers Lizhma and Sjapsja are situated in the same climate area. The mean annual temperature is about +2°C. The coldest month is Ganuary (mean temperature -10,5°) and the warmest Guly (+15,9°).The main characteristics of climate area is in the table 5 and fig.2.

Table 5

Characteristics of climate area of South Karelia

Number of days with temperature: below -5°	higher :0°	+5°	+10°	+15°	Period without frost days	Thermal sum in vegetation period °C, higher +5°	+10°	Precipitation, mm: annual	vegetation period	Snow period
II5--I25	200--205	I53--I58	I00--II0	40-45	I05-II5	I700--I850	I400--I450	650--725	200--225	I45--I55

The pool lakes in the Lizhma and Sjapsja River basin freeze up an average in November-December, and the ice breaks up in April--May (Table 6).

Table 6

Ice regime in the basin of rivers Sjapsja and Lizhma

yhdellä lauseella =>

Years	I983	I984	I985	I986
freeze-up	I8 of November	7 of December	I3 of November	4 of January
Breaking the ice	24 of April	I7 of April	I8 of ~~November~~ April	I6 of May

Temperature regime in the River Sjapsja and Lizhma is in table 3 and 7.

Table 7

Meam monthly temperature of water in the rivers Lizhma and Sjapsja

River	Month I	2	3	4	5	6	7	8	9	I0	II	I
Sjapsja	0,I	0,I	0,2	I,I	5,6	I4,5	I7,9	I7,0	II,6	5,0	0,7	0,
Lizhma	0,2	0,2	0,9	2,2	7,5	I5,5	I8,5	I7,0	II,0	4,2	I,0	0,

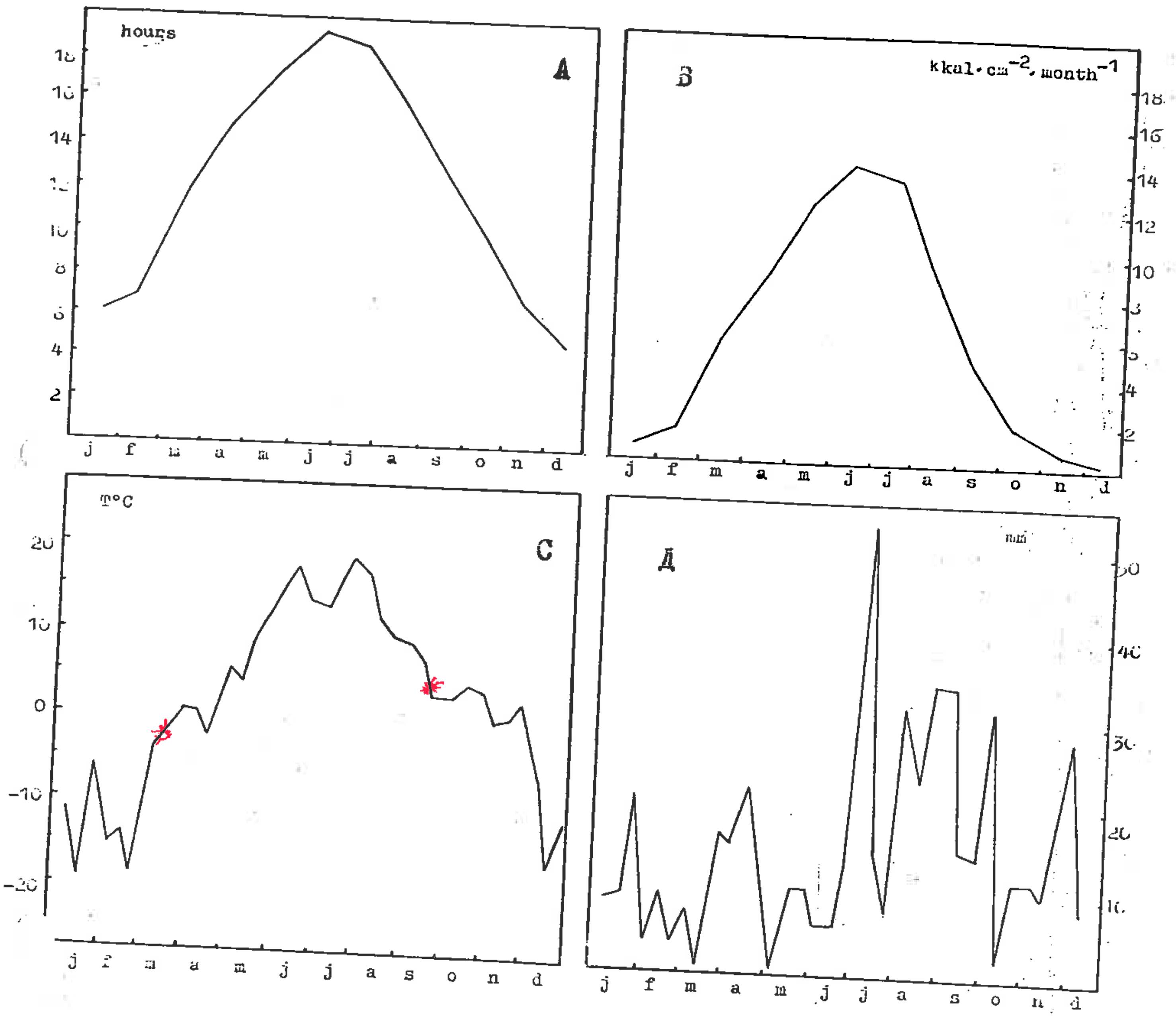

Fig.2. Characteristics of climate in Lizhma district

A - length of bright day

B - Total solar rediation

C - temperature of air

D - precipitation

* 1983 - 1986

The period of midnight sun in the Lizhma distruct begins in mid--May and lasts till the end of Jily.The largest lendth of summer day is about 20 hours, and the shortest - 5 hours (table 8).

Table 8

The length of the bright day (hours-minute)

Month	I	2	3	4	5	6	7	8	9	I0	II	I2
	6^{08}	8^{54}	II^{40}	$I4^{42}$	$I7^{32}$	$I9^{36}$	$I8^{46}$	$I6^{04}$	$I3^{02}$	$I0^{08}$	7^{I2}	5^{I8}

Temperature of water in I983-I986 is shown on fig.I.

Shliseinti

2.6 Dredging and restanration of the rivers

The river Lizhma was used for timber-rafting since the end of the 18th century.Dams were constructed at the upper, midle and lower sites of the river.The banks of fastest rapids and the river branches were fenced off with stony and wooden walls. A part of pebbles and stones were removed from the rapids. All those constructions exerted a negative effect on the spawning conditions of salmon producers and young salmon habitats. In 1957 timber-rafting was ceased on the Lizhma river. The dams are now being destroyed, and they do not hamper salmon migration. Along the rapids one can find the remains of wooden walls. There is practically no submerged timber in the rapids.

As compared to the Lizhma river the Sjapsja river was under much stronger effect of timber-rafting. The river was thoughroughly prepared for timber-rafting. The mouth sites of the rapids were straightened, made deeper and practically changed into canals: the branches and arms were separated by wooden walls and dams; boulders and pebbles were removed from the rapids. Timber-rafting was ceased in 1963, then the river was cleared off theesubmerged timber. Nevertheless one can still find a large number of submerged timber in the river. The bottom of most rapids is bedded with tree bark. The remains of wooden walls and dams are still observed in the river. All this together with a number of other factors resulted in disappearing of salmon from the Sjapsja river.

In order to reconstruct the salmon stock in the Sjapsja river the Institute of Biology, USSR Academy of Sciences has developed a project for river recultivation.

3. Fish and Fisheries regulation

3.1. Fish species

In the Lisma Rever following fish species have been observed:

river lamprey (L a m p e t r a f l u v i a t i l i s L.),salmon (S a l m o s a l a r m. s e b a g o), trout (S a l m o t r u t t a m. l a c u s t r i s) brown trout (S a l m o t r u t t a m. f a r i o), vendace (C o r e g o n u s a l- b u l a L.), whitefish (C o r e g o n u s l a v a r e t u s l a v a r e t o i d e s) grayling (T h y m a l l u s t h y- m a l l u s L.), smelt (O s m e r u s e p e r l a n u s L.), pike (E s o x l u c i u s L.), roach (Rutilus rutilus L.), minnow (Phoxinus phoxinus L.), bleak (Alburnus alburnus L.), bream (Abramus brama L.), stone loach (Nemachilus barbatulus L.), burbot (Lota lota L.), perch (Perca fluviatilis L.),ruft (Acerina cernua), bullhead (Cottus gobio L.).

In the Säpsä River following fish species have been observed :

salmon (Salmo salar m. sebago), vendace (Coregonus albula),whitefish (Coregonus lavaretus lavaretoides) grayling (Thymallus thymallus L.), smelt (Osmerus eperlanus), pike (Esox lucius), roach (Rutilus rutilus), dace (Leuciscus leuciscus), bleak (Alburnus alburnus), brem (Abramus brama), stone loach (Nemachilus barbatulus), burbot (Lota lota), perch (Perca fluviatilis), bullhead (Cottus gobio).

3.2. Fishing

3.3. Fisheries regulation

Since 1956 all kind of fishing are prohibited in all salmon rivers. This prohibition is in action in Lisma River up to-day. Since 1988 in the River Säpsä some kind of fishing nas alloned, - bisides salmon.

4 2 8 Food supply and feeding

Fish feeding was studied using methods generally accepted in Soviet hydrobiology (Methods for the study of feeding - and food relations of fish under natural conditions, 1974).

The materials obtained on feeding have been generalized and are represented in a stsndard Table. The organisms seldom encountered in fish food (pupae of Sumiliidae and larvae of Odonata, Coleoptera, Nematoda Oligochaeta, Hydracarina and Hemiptera) are referred to as "Others" for simplification. Similarly, all the aerial, terrestrial, subimaginal and imaginal stages of aquatic are collectively referred to as " Insecta," Imago and Subimago".

Naturally, the most complete material on the nutrition of salmon juveniles has been collected from the River Lizhma which has been the target of various investigations for a long time.

4.2.9. Genetic studies *poistekaan*

To reveal some population characteristics of the salmon in Lake Onega at the cytogenetic level, relevant karyotypes were studied. The experimental material was represented by the parr and parr males of the Athlantic salmon populations from the rivers Lizhma and Shuya (including the salmon from the River Syapsya) as well as their embryos formed during the initial period of embryonic development, mainly those at the blastula stage. The embryos were studied in both normal and C - mitosis, whereas the fish were only investigated by colchicine injection. The tissues of the colchicinated fish, mainly the head kidney and gill epithelium, were used making permanent preparations to be stained with either acetoorcein or Gimsa stain. Besides, both mitosis and meiosis were studied in parr male gonaads. The metaphases that meet the demands of karyotypical analysis were either drawn or photographed on an Amplival microscope at magnifications of 100 x 15 and 100 x 16. For a more detailed analysis of the morphology of individual chromosomes, attempts were made to differentially stain the heterochromatic blocks localized in the near-centromeric areas (C - stain -ing) using Sumner's methods (Summer, 1972).

4.2.10. Hydrobiological studies

Zooplankton. In order to more fully characterize zooplankton, sampes were taken in two replications: in the main stream of the river flow and in the nearshore zone by sieving 100 l water through a plankton net (gas Nos..49, 58 and 61). The material collected was fixed with 4% formalin solution. Chamber treatment was made using conventional methods (Kiselyov, 1956, 1969). 1. As a rule, the total number of zooplanktonic organisms was estimated and then the number per unit volume (individuals per cubic metre) was recalculated. 2. The biomass of planktonic fauna was determined by recalculating the individual mass of each organism given in the literature (Kiselyov, 1956) relative to its quantity. A few manuals were employed in assessing the species ckmposition of small cructaceans and rotifers (Rylov, 1948; Manuilova, 1964; Kutikova, 1970. smirnov, 1971).

Macrophytes. The study of macroflora included determunation of species composition, stratigication and the closed pattern of of phytocenoses. Folding frames 0.25 m2 in area were used for quantitative estimation of vegetation.

The amount of phytomass was calculated from the data on plant height and absolutely dry average weight per unit length.

Annual production was estimated using the following formulas: for aerial-aquatic and submerged plants

$$P = 1.2 \ B_{max};$$

for plants with floating leaves

$$P = 1.2 \ B_{max} + M \cdot n,$$

where M is the main mass of a species n is the number of leafless whorls, and for mosses

$$P = 0.3 \ B_{max}$$

Periphyton. Periphyton samples were taken ~~in minor rivers~~, by extracting periphyton - bearing substrate at a certain place. Because part of the material can be washed away and lost the periphyton -bearing substrate was placed in a bottle or a polythene bag under the water, or otherwise the periphyton alone was collected without extracting the substrate. To provide a better understanding of algal flora, trapped benthos samples were examoned ($S = 400 \ cm^2$).

Samples were taken from the substrate either by washing or with a scalpel a toothbrush. ~~Also,~~ the stalks of soft aquatic plants were squeezed to provide additional evidence for in algal flora.

In some instances, notably when periphyton is represented by diatomaceous aldae, specimens are taken by shaking the substrate in a polythene bag for a short time (up to 3 min.). The same method proposed earlier by some scholars (Gough and Woelkerling, 1976; Bowker, 1986) was employed to asssess the settled to attached fotm ratio in the aldal cenoses of periphyton, but in this case the substrate was shaken less vigorously and for a shorter time.

The formation of periphyton was studied using various substrates such as glass plates (77 x 25 mm) and rods, preliminarily washed gravel, bricks, wood, ahd macrophytes (Carex sp.) growing on the bank.

The biomass of periphyton clusters was determined by calculated and direct weighing.

The oxygen modification of the bottle method was employed to assess primary production various appliances were used for exposing production vessels.

Zoobenthos. When studying the benthic fauna of minor rivers we prefer a Surber-type quantitative frame with a trapping area of 0.04 m^2 (0.16 x 0.25). The advantage of the frame is that samples can be taken fairly rapidly from soils of different particle size (up to small boulders) without any considerable loss of inverte-brate fauna.

The quantitative frame consists of a metal loop with a bag 70 cm in length attached to it for collecting fauna and a limiter to control sampling area. The frame can be folded which is very convenient in the field. The limiting loop is fastened by hinges. The lower part is made of thick cloth and the remaining two-thirds are made of gas n. 23.

In the couse of sampling the frame is placed on the ground against the current, and the limiting loop, which indicates sampling area, is unfolded. The ground samples taken from this area are rapidly placed in the bag. To avoid losses of invertebrates, the ground which and then samples are taken near the loop boundary. The researches can control the transfer of ground samples to the bag by putting on a diver's mask.

The ground taken with the frame is then placed in a plastic bucket or any other container. The organisms, present on the inner side of the appliance, are washed down into the container. The water in the bucket is then agitated in a circular manner for a better separatii on of bottom animals from the ground. Before the organisms have settled down the water is poured through a net.

The ground is washed with a net which consists of a metal hoop 25=30 cm in diameter and 35=40 cm in length. A cone-shaped sack made of nylon net Nos. 23-35 is attached to the hoop. Washing is repeated until the invertebrates are separated from the ground and the water is no longer turbid. After repeated washing the ground is examined once more to collect mollusks and other organisms that have not come up to the surface. Mossy and nostoc periphytons, whech may host invertebrate larvae, are scraped from individual stones, and attached shelters of caddis flies, black fly pupae and other organisms are removed. The entire contents of the sample are transferred from the washing net into a jar, fixed with 4 % formalin or alcohol and labelled.

Chamber treatment is made in the laboratory. A sample is placed in a small cuvette. or a Petri dish where both macro - and megobenthos are preliminarily collected. The sample is then examined under the binocular microscope, and each group of invertebrates is removed separately. Modified Bogorov's chamber with a groove width of 10-12 mm is suited for this purpose. While treating the sample, the organisms of each group are counted separately, dried on filter paper and weighed on torgion scales to an accuracy of 0.1 mg. Hydrobiont species are then determined and their number, N,(individuals per sq.metre) and biomass, B, (individuals per sq. metre) are calculated using the following formulas:

$$N = \frac{n}{s} \qquad B = \frac{b}{s}$$

where n and b are the number (individuals) and biomass (g) of organisms in a sample, respectively, and S is frame area (m^2).

Drift. Traps were employed in the field to collect drifting invertebrates for quantification. The trap is a frame 0.5 x 0.2 m in size with a sack 1.2 m long, one - third of it consisting of thick cotton cloth and two -thirds of nylon net No. 19. The trap is installed in the river with the held of metal pintles or wooden stakes driven into the ground in such a way that the upper edge of the trap is 1 cm above the water surface. Organisms migrating at depth and those drifting along the surface can, therefore, be detected.

In deep rivers, traps can be installed in both surface and bottom layers. Flow rate is measured with a hydrological current meter. The river depth at a sampling site, ground pattern and the presence of periphyton are also taken into account. When drifting organisms are sampled, exposition generally varies from a few minutes to a few hours. If net No.14 is used for sampling drifting invertebrates, then samples exposed for 30 minutes to one hour are preferred (Shustov and Shirokov, 1980). If the trap is made of net No.19, then 15 to 30 min exposition is optimum.

The samples are transferred to a washing net made of net No.23-25 and then into a jar. They are fixed with 4% formalin and subsequently treated in the laboratory.

Such a sample represents closely packed stuff composed of bottom invertebrates, zooplenktonic organisms, aerial and terrestrial insects, fish larvae, filamentous aldae, pieces of aquatic vegetation, fallen tree leaves, etc. Unlike zooplanktonic and zoobenthic samples, such a sample is thoroughly examined regardless of its size (Kiselyov, 1956, 1969; Yashnov, 1969).

Modified Bogorov's chamber, very convenient for working with a binocular mocroscope at a magnification of 1 x 8 (105 x 130 mm in size, groove width 14 mm and groove depth 8 mm), is used for examining samples, Each sample is examined twice. All organisms are classified up to the order level, each group is counted and weighed on torsional scales to an accuracy of 0.1 mg and the size of each organism is measured, Their species are then determined, if possible.

The amount of plant remains in each sample is estimated. The Tables for drifting organisms were made by analogy with those for fish nutrition. The organisms seldom involved in drift such as Oligochaeta, Hydracarina, Coleoptera (L.), Simuliidae (P.), and Diptera (L.) are collectively referred to as " Others". Similarly, all the aerial, terrestrial and subimaginal stages of aquatic insects are referred to as "Insecta (imago, subimago)". The number, N, (individuals per m^2) and calculated using the formulas:

$$N = \frac{n}{s \cdot t} \qquad B = \frac{b}{s \cdot t}$$

where n and B are the number (individuals) and biomass (g) of organisms in a sample, respectively, S is frame area (m^2) and t is exposition time (hr).

RESULTS

5.2. Hydrobiological regime of the rivers.

Macrophytic vegetation. A total of 54 macrophytes were recorded (tabl. 9), The macrophytic flora includes vascular plants, bryophytes and members of the Charophyta and Rhodophyta.They comprise hemicryptophytes and helophytes or marsh plants and, mainly, hydrophytes.

Of 48 vascular plants recorded, 39 are restricted to hydrophytes, among them 7 are floating, 16 - submergent, 16 -emergent. The aquatic flora includes species of 28 families, excluding bryophytes ahd macroalgae. The main ~~families~~ are Cyperaceae (7 species) and Potamogetonceae (5).

Table 9

Macrophytes in rivers Lizhma and Säpsä

№№	Species of macrophytea	Position of the species in phytocenoses	Most typical associations
I	2	3	4
I	Lemanea sp.	ed	p
2	Chara sp.	ed	ps
3	Fontinalis antipyretica L.	ed	ps
4	F.gothica Card. et Arn.	+	
5	F.hypnoides Henrii	+	
6.	Hydrophypnum smithii(Sm.)Broth	d	
7	Equisetum fluviatile L.	ed	psa
8	Isoetes lacustris L.	+	
9	Typha latifolia L.	+	
I0	Sparganium emersum Rehn.	e	
II	Potamogeton lucens L.	+	
I2	P.perfoliatus L.	* ed	psa
I3	P.gramineus L.	* ed	psa
I4	P.natans L.	+	
I5	Zannichellia palustris L.	e	
I6	Alisma plantago-aquatica L.	+	
I7	Sagittaria sagittifolia L.	+	
I8	S.natans Pall.	+	
I9	Butomus umbellatus L.	+	
20	Elodea canadensis Michaux.	* d	
2I	Calamagrostis canenscens Roth.	+	
22	Phragmithes australis(Cav.) Frin.ex Stend	ed	psa
23	Catabrosa aquatica (L.)Beauv.	+	
24	Scirpus silvaticus L.	+	
25	S.lacustris L.	ed	psa
26	Eleocharis acicularis(L.)Roem. et Schult	+	

Table 9 (continued)

1	2	3	4
28	Carex acuta L.	ed	a
29	C.nigra(L.)Reichard.	ed	a
30	C.vesicaria L.	ed	a
31	Lemna minor L.	+	
32	Juncus compressus Jacg.	+	
33	Iris pseudocorus L.	+	
34	Polygonium amphibium L.	+	
35	Nymphea candida L. et C.Presl.	+	
36	Nuphar lutea(L.)Smith.	ed	ps
37	Ceratophyllum demersum L.	+	
38	Caltha palustris L.	+	
39	Batrachium circinatum(Sibth.) Spach.	ed	ps
40	B.kaufmanii(Clerc.)V.Kraz.	* ed	ps
41	Comarum palustre L.	+	
42	Callitriche palustris L.	+	
43	Epilobium palustre L.	+	
44	Myriophyllum spicatum L.	* ed	psa
45	M.verticillatum L.	+	
46	Hippuris vulgaris L.	+	
47	Cicuta virosa L.	+	
48	Sium latifolium L.	+	
49	Naumburgia thyrsiflora(L.)Rich.	+	
50	Menyanthes trifoliata L.	ed	psa
51	Myosotis scorioides L.	+	
52	Utricularia vulgaris L.	+	
53	U.intermedia Heyne.	+	
54	Lobelia dortmanna L.	d	

Notes* - in some places plants cover the river from bank to bank; "+" - the plant is found in the river; "e" - edificator; "d" - - the plant dominales in one layer; "p" - the plant forma associations; "purum","s" - subpurum; "a" - aquiherbosum.

The macrophytic vegetation in the upper and riffle zone consisted almost entirely of bryophytes, the most abundant of whech was Fontinalis antipyretica, ~~with average biomass~~ of ~~about~~ 155 gm^{-2} Aedw. ~~Some others have~~ the maximum biomass not more than 60 gm^{-2}. Only submergent angiospermus ~~from genus~~ Batrachium and Myriophyllum were rare occured in this zone. Macrophytic algae Lemanea fluviatile ~~were also wide-spread at those sites~~.

In pools angiospermus were the predominant group of macrophytes, ~~among them~~ the lar[t]gest standing crop was ~~esti-mated for~~: Carex spp. 450, Sparganium emersum 370, Saggittaria saggitipholia 335, Menyanthes trifoliata 310 gm^{-2}. The biomass of Phragmites australis, the most widespread species in all types of bassins ~~in the study area~~ was 180 gm^{-2}.

Periphyton. 152 species ~~were~~ collected and enumerated ~~from different substrates in studied rivers including~~: 34- Cyanophyta, 2- Chrysophyta, 93- Bacillariophyta, 20 - Chlorophyta, 3- Rhodophyta. The euperiphytic forms were most variable in all sites and ~~had the greatest abundance of~~ taxa (64 % of total population), while the others were planctonic (20%) and benthic (16%). Similar proportions of taxonomic and ecological groups were observed in each river(Fig.3). Most of the common for all rivers species are cosmopolites. ~~The abundance of~~ arcto-alpine and boreal forms was the largest in Teno River).

Twenty five algae were recorded as numerical dominants, i.e. about 16% of total (Tabl.10), Of these, only four were

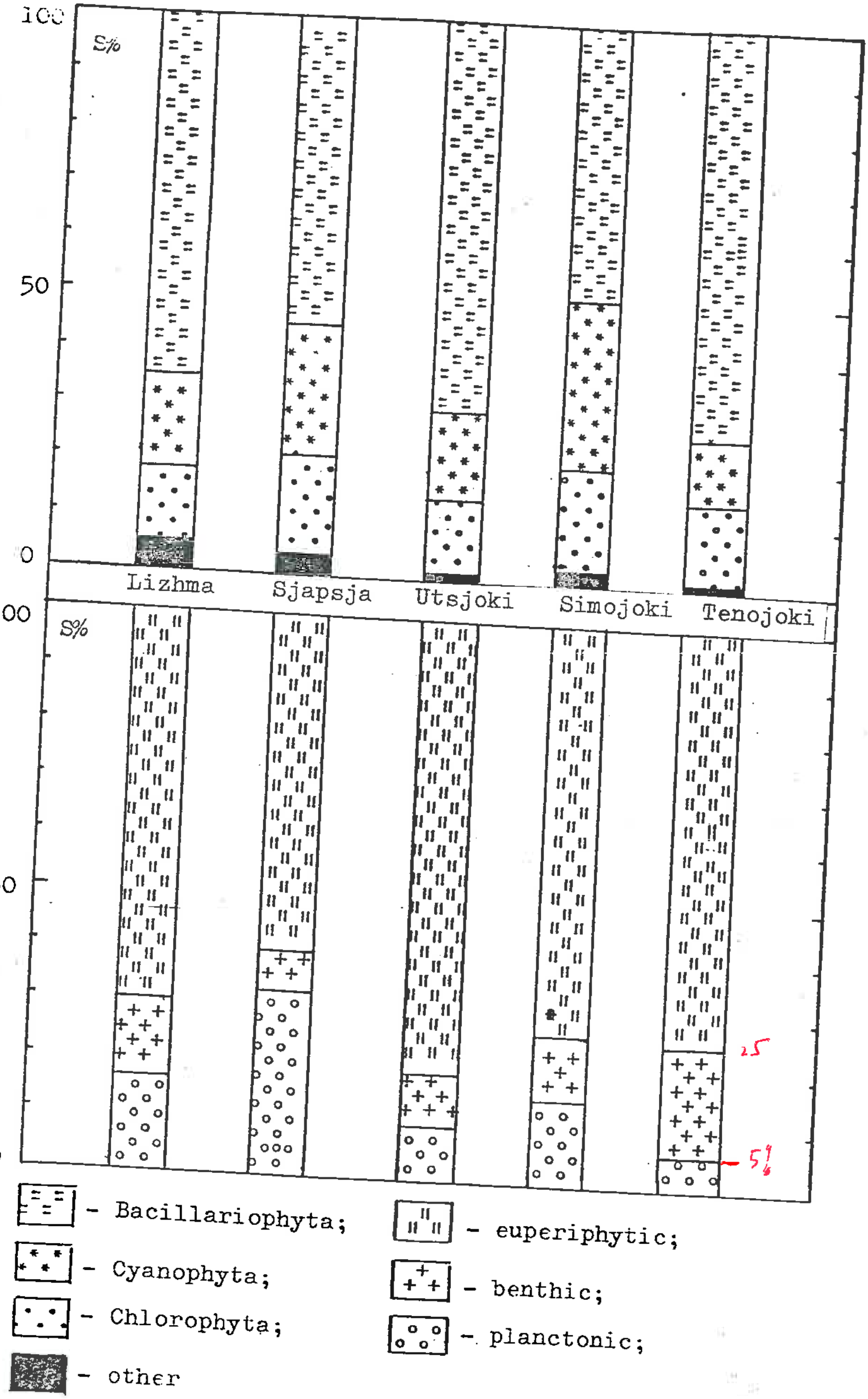

Fig.3. Toxonomic and ecological composition of periphyton in the rivers studied

appendix

Table IO

Species dominating in periphyton of the rivers studied

Species	rivers				
	Lizhma	Sjapsja	Utsjoki	Simojoki	Tenojoki
Stigonema mamillosum Lyngb.	+		+		
Stratonostoc verrucosum(Vauch.)Elenk.		+		+	
Aphanisomenon flos-aquae(L.)Ralfs		+			
Anabaena spiroides Kleb.		+			
Tolypothrix saviczii Kossinsk.			+	+	
Calothrix gipsophyla(Kütz.)Thur.	+	+	+	+	
Rivularia coadunata(Sommer.)Foslic.	+				
Gloeotrichia echinulata(J.S.Smith)Richt		+			
Oscillatoria agardhii Gom.		+			
Melosira islandica O.Müll.	+	+			
Tabellaria flocculosa(Roth.)Kütz.	+	+	+	+	+
Synedra ulna (Nitzsh)Ehr.			+		+
Ceratoneis arcus(Ehr.)Kütz			+		+
Eunothia diodon Ehr.		+	+	+	
Cocconeis placentula Ehr.	+				
Achnanthes minutissima Kütz.	+	+	+	+	+
Didimosphenia geminata Lyngb.	+	+	+		
Gomphonema constrictum Ehr.	+	+		+	
Epithemia sorex Kütz.				+	
Dinobrion sp.	+				
Chaetophora incrustans(Hadson)Hasch.	+				
Bulbochaete sp.	+	+	+	+	+
Zygnema sp.	+				
Mougeothia sp.	+	+	+	+	+
Batrachospermum sp.	+				

dominants for all rivers: Tabellaria flocculosa, Achnanthes minutissima, Buldochaete sp., and Mougeotia sp.

Diatoms were most various with the greatest abundance of taxa among genus Eunothia (11 species), navicula (12), Comphonema (10). The most common diatoms exhibiting significant cell densitie observed during the study period were: Melosira, Tabellaria, Fragilaria, Cocconeis, achnanthes and Synedra. The diatoms, the most crucial elements of biomass, were: Didymosphenia geminata and Achnanthes minutissima.

Six ceanophycean euperiphytic algae displayed intercommunity importance. Stratonostoc verrucosum and Calothrix gypsophhyla were much common in algocenoses. Other genera Mougeotia and Bulbochaete, belonging to greenalgae were widespead along the course of each rivers, while the rhodophyte Batrachospermum was a dominant in the attached communities only in the upper part of Lichzma River.

The development of algocenoses could be divided into two phases. During the first one, about a month, the periphyton density on substrates rapidly incraesed, and the incraese was slower and more even gradual in August- September as the hydrological regime became stable (Fig.4).

The seasonal responses of periphyton suggested the high spring indices decline during the flood, when the species richness, density and biomass have the lowest values. During summer the standing crops increased significantly and reached their second peak in August-September. Thus the maximum density of periphyton on plant substrate was observed, including: Phragmites austrles 1.8-5.4 10^6 cell cm^{-2}, Equisetum fluviatile 0.9-3.1 10^6 cell cm^{-2}, Fontinalis antipyretica 1.2-31 10^6 cell cm^{-2}.

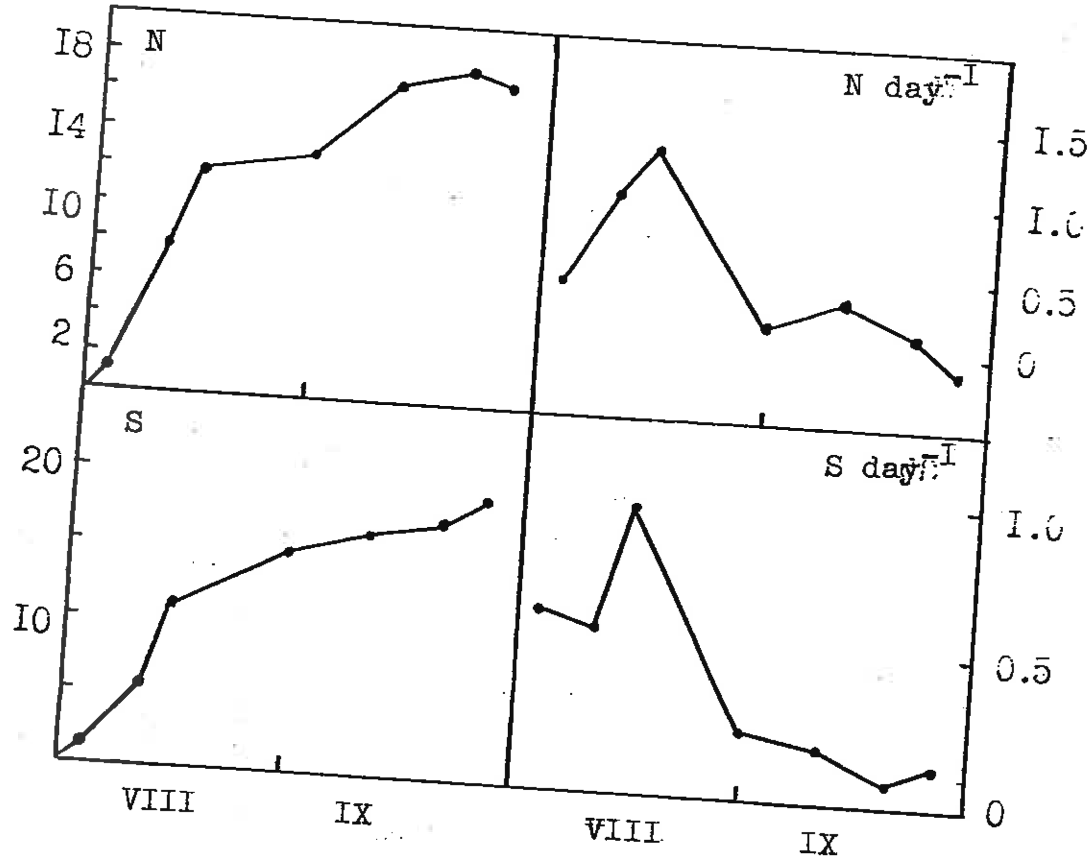

Fig.4. The density (N, cell $10^4 cm)^{-2}$ and abundance of species (S) of algae in periphyton developing on the glass plates (r.Lizhma, lower rapid)

The chlorophyll-a value varied significantly from 1 to 140 mg m^{-2}. In spring and summer the chlorophyll-a concentration closely correlated with the periphyton biomass (r=0.8 $\pm$ 0.05), in autumn this correlation decreased (r=0.5 $\pm$ 0,05). The percentage of chlorophyll in dry weight was greatest at the stations, where the amount of mineral particles and animals on the substrates was small. In these locations the proportion of the chlorophyll-a in dry weight was 0.05-0.3%, whereasе at ethers sites its value decreased to 0.01-0.02%.

Investigations of the periphyton have renealed that the differences in primary production at varous sites are large and vary within a wide range and generally correlated with the intensity of irradience (Fig.6). The daily P/B ratio for periphyton varied from 1.68-to 0.032 and decreased by autumn.

Zooplankton. In all, 78 zooplankton species, most of which represent a lacustrine planktonic complex, have been reported from the River Lizhma study area (Appendix), (Fig.7).

In the upper River Lizhma and its tributaries, Yelgamka andSyargeshka, the zooplankton shows the predominance of riverain Cladocera (60 to 100%), and the absense of Copepoda. Zooplankton as a food is of little importance in the spawning grounds in the upper River Lizhma (The amount of zooplankton is up to 1 400 individuals per cubic metre and its biomass is 0.04 g per cubic metre). The relatively poor planktonic fauna in the upper River Lizhma results from

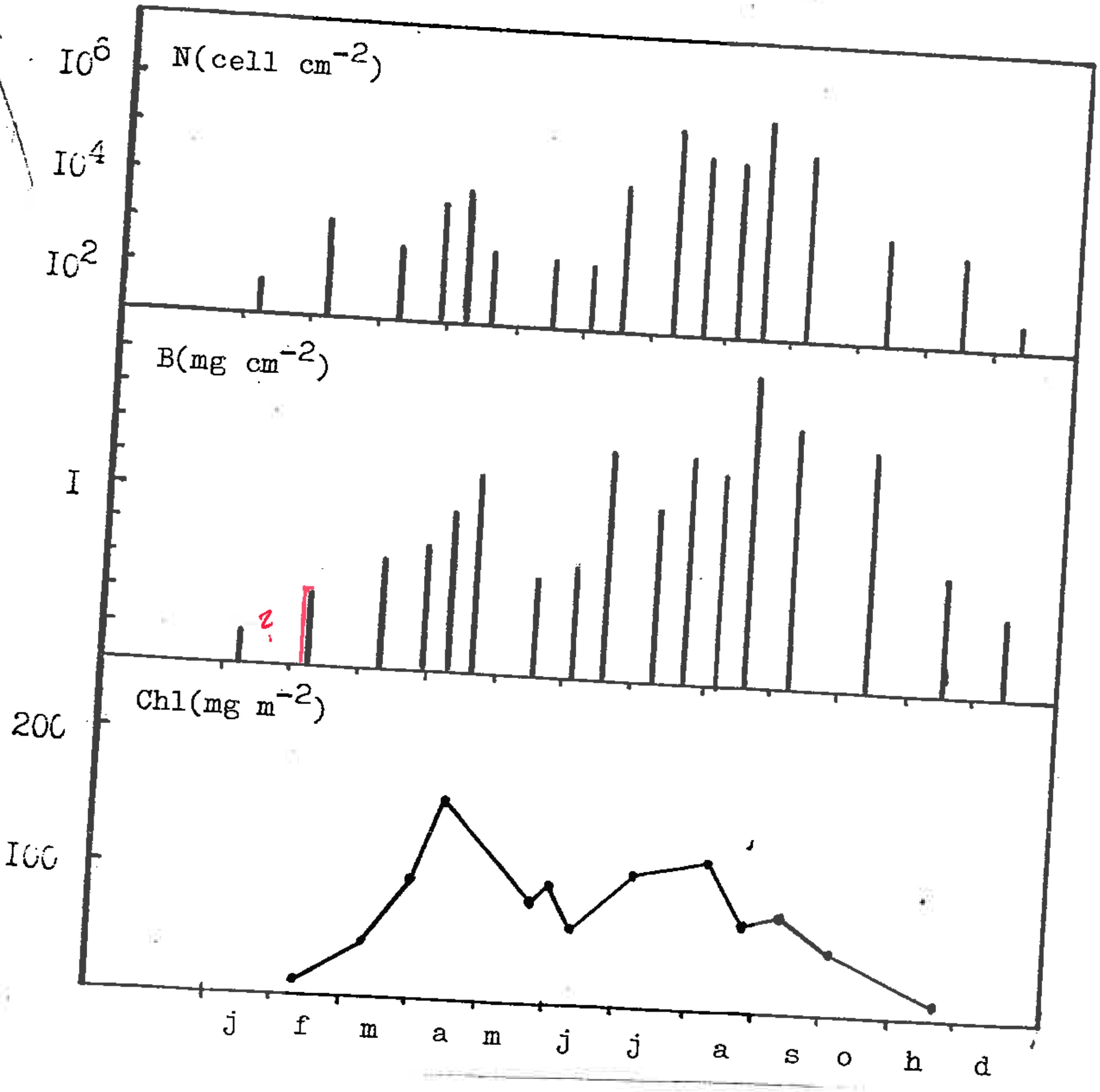

Fig.5. Seasonal changes in the density (N), biomass (B) of algae and chlorophyll content in periphyton of r.Lizhma (stones, lower rapid)

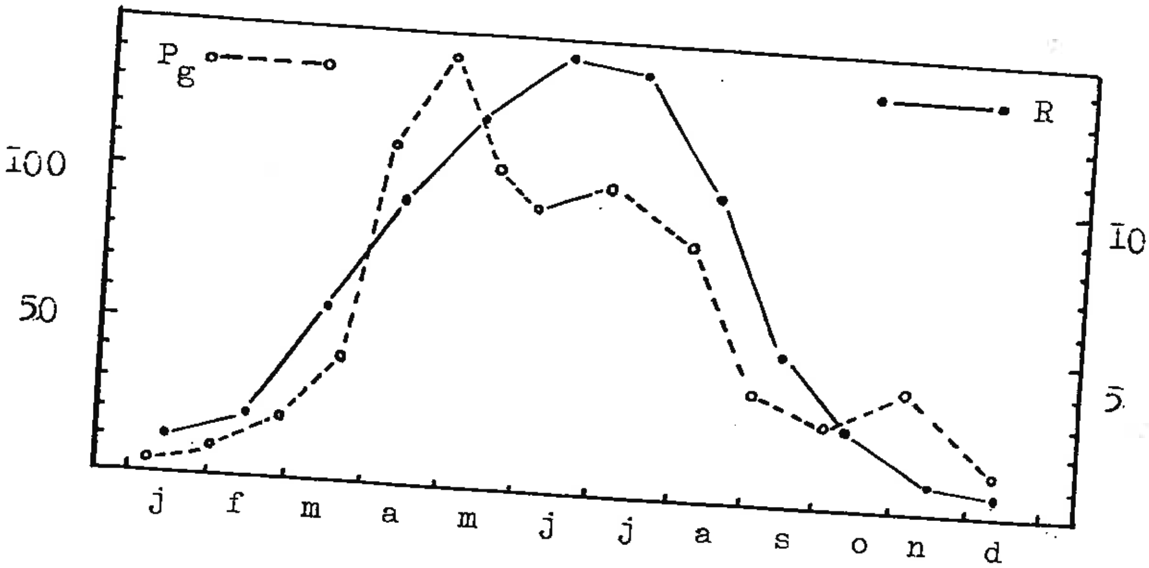

Fig.6. Seasonal changes of gross primary production of periphyton. (P_g, MgO_2 $cm^{-2} day^{-I}$) on the stones (r.Lizhma, lower rapid) R – total solar radiation (kkal cm^{-2} $month^{-I}$)

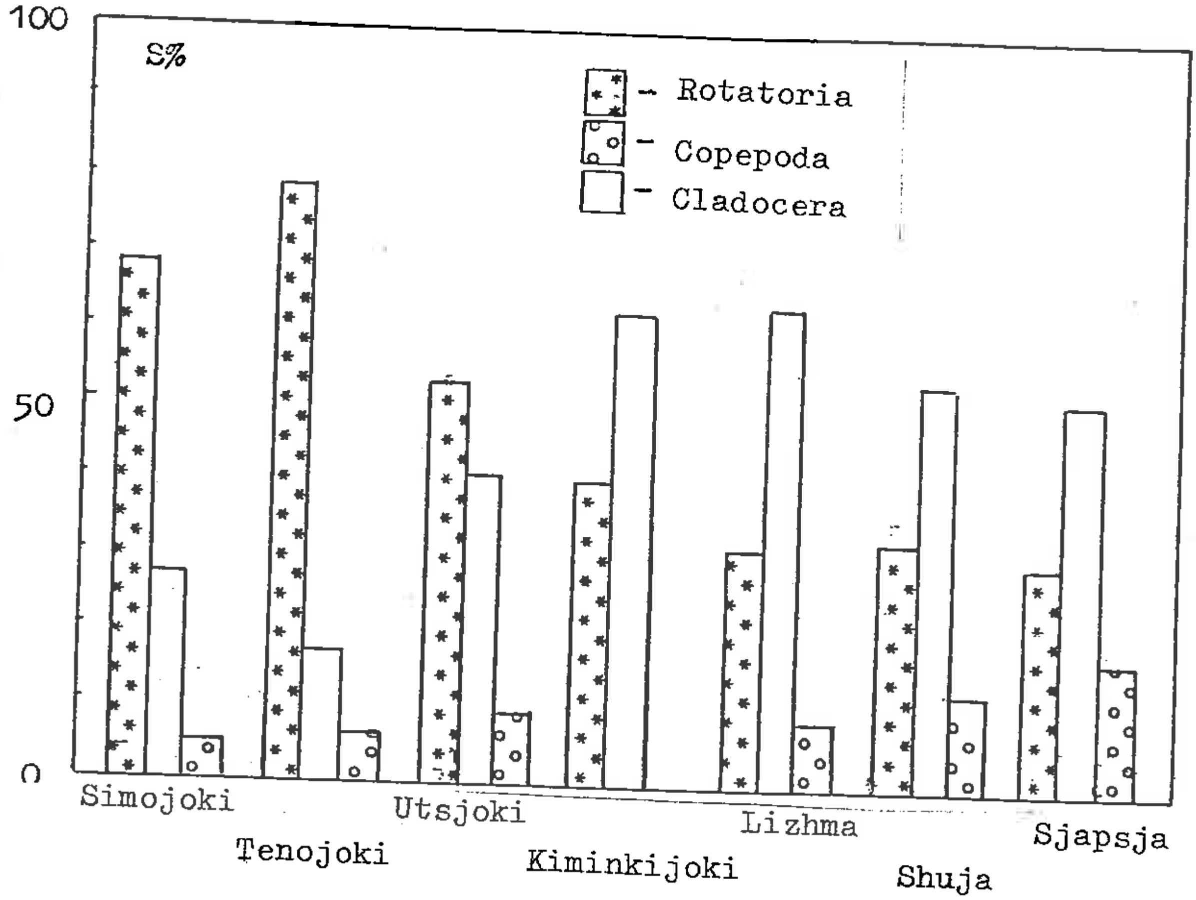

Fig.7. The ratio of the zooplankton species abundance in the study rivers

absence of drainage and channel lakes in this part of the fluvial system.

Lakes Kedrozero and Tarasmozero play the main role in the formation of the river zooplankton cenoses in the River Nizhnyaya Lizhma (Kruglova, 1981). Both the species composition and quantitative indices of zooplankton decrease distinctly from the headstream of the River Lizhma, which flows from Lake Kedrozero, towards its mouth. The planktonic fauna sharply diminishes because of some extensive rapids at the mouth of the River Lizhma which flows into Lake Onega. The zooplankton markedly replenished with the Lake Kedrozero fauna decreases by a few times down the River Kedra-Reka (tabl. 11.fig.8). In Lake Tarasmozero, the amount of zooplankton appreciably increases and slightly varies within deep slow portion, but after passing the rapids, notably the channel rapids, the zooplankton indices decline to a minimum. Such pattern of changes in the quantitative indices of zooplankton has been observed throuhout the entire observation period. Also, the species composition of zooplankton became poorer between the headstream of the River Lizhma, which flows out of Lake Kedrozero (60 species), and its mouth (30 species). The quantity of zooplankton decreases mainly at the expense of larger forms of Crustacea. Rotifers are most resistant, whereas small Cladocera and juvenile Copepoda are less resistant.

Aquatic vegetation has a substantial effect on the development of planktonic fauna. River portions overgrown with macrophytes normally show an abundance of zooplankton.

Tabl.11

Biomass of zooplankton in the river Kedra

Sampling site	Month of sampling				
	May	June	July	August	September
Source from lake Kedrozero	0,18	0,09	0,16	0,17	0,32
Mouth of the river Kedra	0,03	0,07	0,01	0,07	0,008

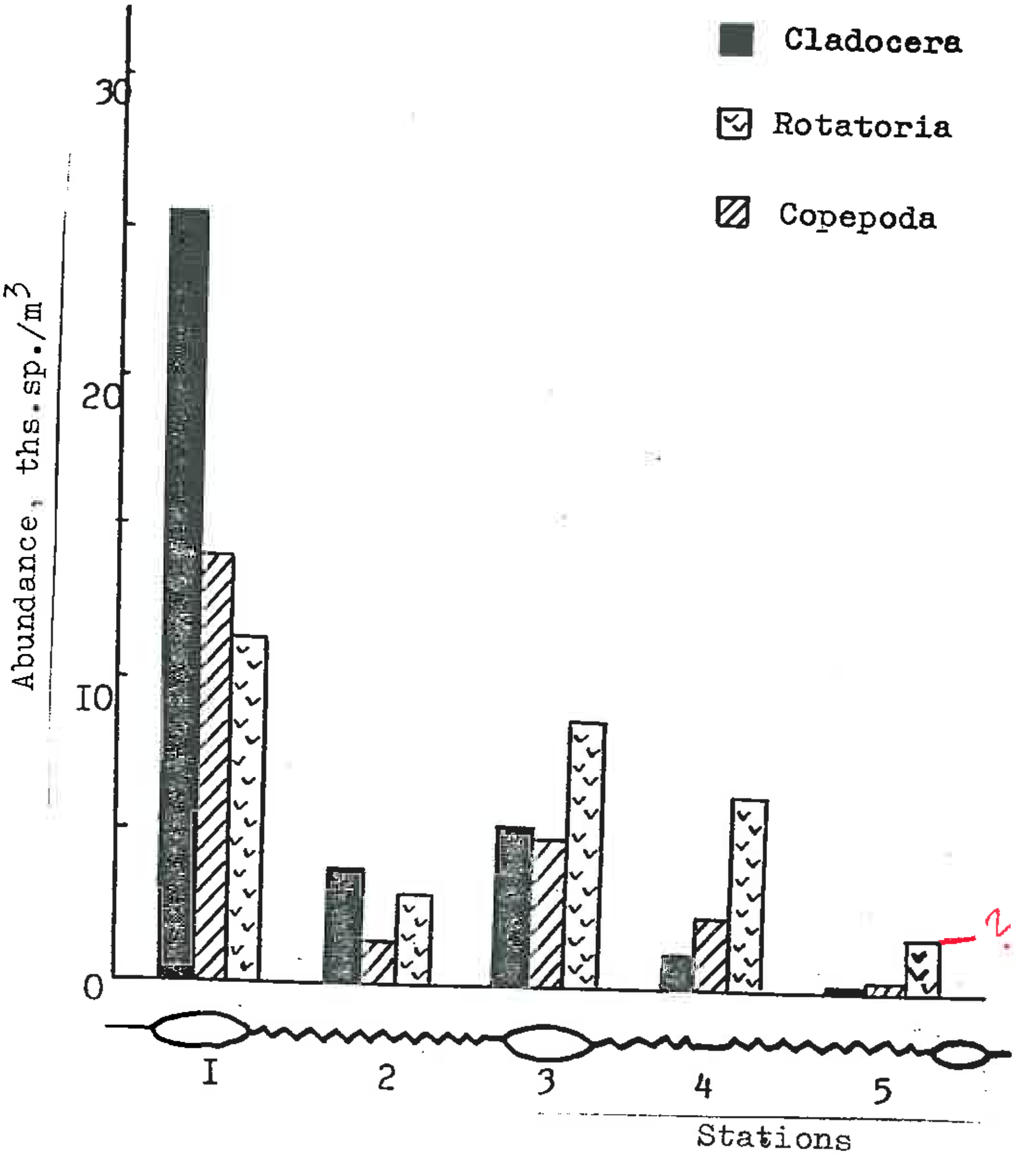

Fig.8. The abundance of summer zooplankton in r.N.Lizhma

I-efflux from lake Kedrozero,2-source of "Kedra--river", 3-efflux from Tarasmozoro lake, 4-"Zhivoi" most,5-mouth of r.N.Lizhma

Zooplankton distribution in different seasons is largely dependent on lakes. In spring (May), within the whole investigated portion of the River N.Lizhma the plankton was dominated by Copepoda, one -third of which was represented by both nauplial and copepodite stages. As a rule, the same species of crustaceans prevailed in lakes and river portions. In summer (June -August), when bodies of water are best heated, the plankton fauna is at its maximum (Fig.9). It is characterized by a variety of species and the highest quantitative indices. In summer, the bulk of zooplankton is formed by Crustacea and only in Lake Tarasmozero and its outlet by rotifers. In fall (September -October), the zooplankton is dominated by Cladocera in the whole River Lizhma.

Whether the early stages of the Salmonidae are provided with food depends on the amount of plankton available on the major spawning rearing grounds of the river. It has been found that zooplankton is taken away in large quantities from lakes Kedrozero and Tarasmozero (Kruglova,1975 a,b). In summer, the most appreciable growth in juvenile salmon in Lake Onega is observed together with a maximum amount of plankton suspended in river water and carried downstream. Some portions of the River Nizhnyaya Lizhma located between lakes Kedrozero and Tarasmozero are most productive. It is here that plankton is utilized by hydrobionts and both zoobenthos and drifting organisms are most abundant (Salmon spawning rivers of Lake Onega,1978; Smirnov, Shustov and

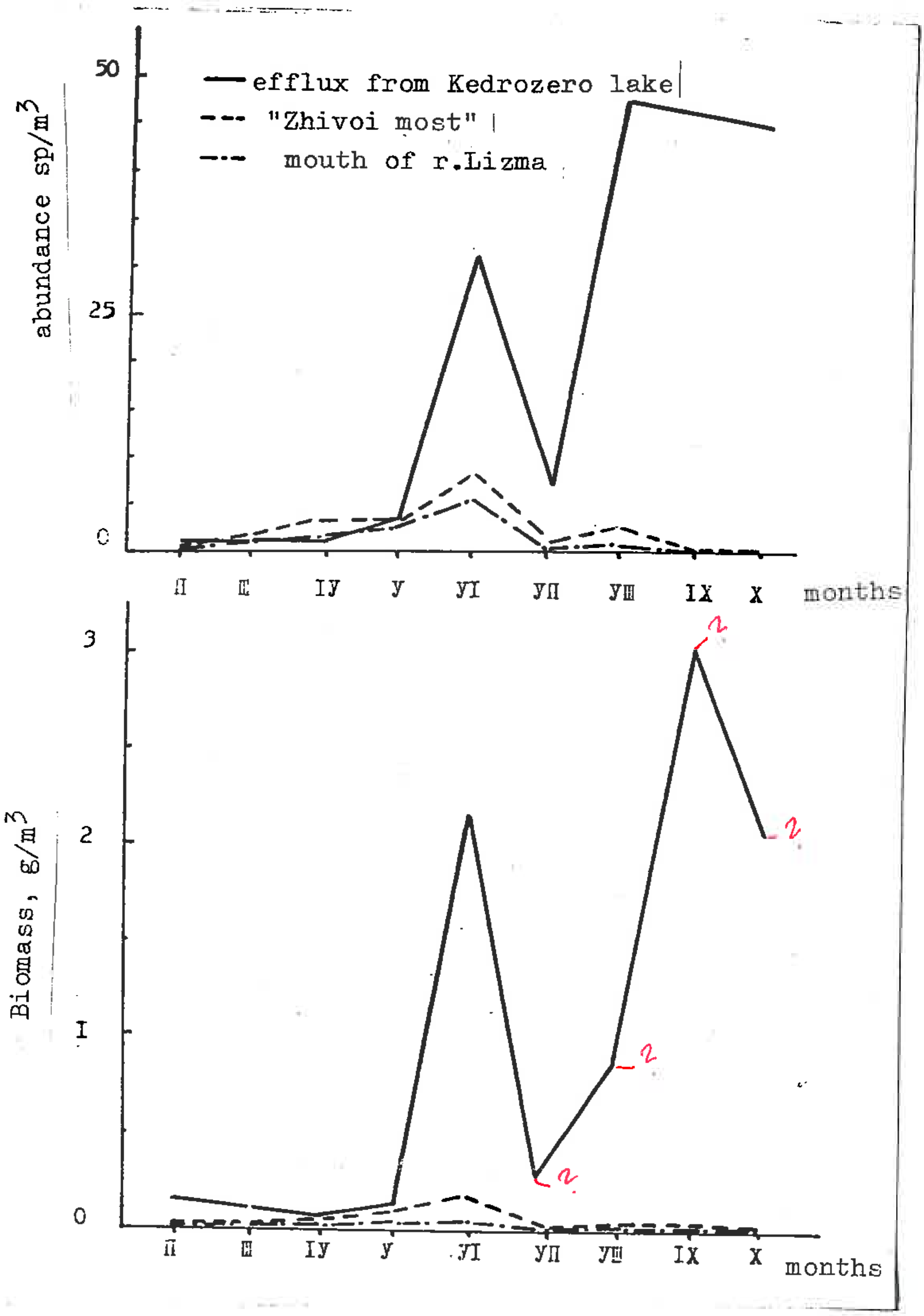

Fig.9. Seasonal dynamics of zooplankton in r.Lizhma

Shchurov, 1978). Macrophytes and periphyton contribute to the more effective utilization of the zooplankton carried away from the lakes.

A basis for the zooplankton cenoses in the River Shya study area is provided by rotifers and crustaceans from channel lakes Shotozero and Vagatazero. Their influence is responsible for a variety of planktonic fauna in the River Shuya (~~Appendix 1,~~ Fig.7).

River planktonic hydrofauna is most varied specifically and its quantitative indices are high at the stations directly related to lakes. The plankton of such localities is, as a rule, dominated by pelagic lacustrine species of crustacea (Eudiaptomus gracilis, Mesocyclops oithonoides, Cyclops vicinus, Daphnia cristata, Holopedium gibberum and Bosmina coregoni) and rotifers (Kellicottia longispina, Asplancna priodonta, Conochilus unicornis, Ploesoma truncatum and Pipalpus hudsoni). Copepods account for more than 60%.

The zooplankton of the River Syapsya is affected by Lake Syamozero and is, therefore, fairly variegated as well. The plankton fauna of the River Syapsya has been found to comprise 70 crustacean and rotifer species (Appendix 1). Like in the River Shuya, the major planktonic complex is formed by limnic species of small crustaceans and rotifers.

The maximum number of species (32) and the highest quantitative indices of zooplankton have been reported from the headstream of the river flowing out of Lake Syamozero. Crustaceans represent a group of plankton fauna which is predominant in both number and weight (over 90%3. They are represented by some species such as Eudiaptomus gracilis, Cyclops vicinus, Mesocyclops oithonoides,M. leuckarti, Daphnia cristata and Bosmina coregoni which prevail in Lake Syamozero as well (Lazareva, 1977). Away from the outlet, notably in the rapids, plankton fauna tends to decrease specifically (down to 15-20 species) at the expense of Cladocera and Copepoda. In the rapids, the leading role is played by rotifers and small crustaceans.

Seasonal changes in river zooplankton are dependent on the course of seasonal dynamics in lakes Syamozero, Shotozero, and Vagatozero. The quantitative indices of the plankton fauna in the rivers Shuya and Syapsya are relatively low in spring (Appendics 2,3). A basis for spring zooplankton is provided by crustaceans.

In summer, when living conditions become most optimum for many small planktonic crustaceans and rotifers, zooplankton is markedly entiched by summer of hydrofauna and the general developmental level of zooplankton incraeses (Appendices 4,5).

When fall sets in, the number of summer thermophilic species in zooplankton decreases, but crustaceans, which represent the most valuable group of zooplankton in the feeding of juvenile fish, continue to play the leading role (Appendices 6,7).

At the present time, extensive is being conducted in the catchment area of the rivers Shuya and Syapsya. Man-made canals are used to discharge water from reclamative systems to river channels and tributaries. Prior to drainage, many creeks that served as reclamative water receivers provided spawning grounds for fish. When reclamation began, the fish stopped coming to the creeks for spawning.

A considerable amount of various substances suspended in reclamative water is carried to river channels, notably during flooding. As a result, the concentration of both organic and mineral substances in the water of the River Shuya exceeds the maximum admissible concentration (Pyavchenko et. al., 1980, Vedyagina et. al., 1981). Also, peat and clay particles were carried along, thereby deteriorating the living conditions and decreasing the number of many planktonic crustaceans and rotifers, mainly filter-feeders. Disturbed bottom sediments and suspended sand particles decrease both water transparency and the intensity of photosynthesis. They are carried in a water flow to the filtratio apparatus and intestine of small crustacean filter-feeders, thereby disturbing both feeding and swimming (Kaigorodov, 1979; Zhuravlev et al., 1981; Rivier and Kudrin, 1982). Unlike crustaceans, rotifers have a rotator apparatus and, therefore, suffer to a lesser extent from the presence of mineral particles suspended in large quantities in river water (Rylov, 1940, a, b). In the River shuya study area, the effect of reclamative water is most appreciable near the village of Kindasovo. The species composition of zooplankton decreases bu almost 40% (Fig.10). The absence of some small crustacean filter-feeders such as Bosmina coregoni, Alona costata, and Cerio daphnia affinis is observed, as contrasted with the previous portion of the river (village of Nizhnyaya Salma) (Smirnov et al., 1983; Shirokov et al., 1983). In the River Syapsya, the influence of reclamation is apparent at stations 4-6 (Fig.10). Also, the composition of the zooplankton is poor Rotifers are most commonly represented by Bdelloida, Keratella, Filinia, and Euchlanis. Chydoridae are the most abundant cladocerans. As a rule, small Copepoda are not numerous in such zones. The reclamation canals, especially during flooding, are characterized by a lower evolutionary level of plankton fauna represented only by 3-4 species, Small crustacean filter-feeders, which occur in the relatively cleaner parts of the River Syapsya, are absent from this portion. Also, the quantitative indices of zooplankton are low (number 100 individuals / m^3, biomass 3.4 mg / m^3).

According to preliminary data obtained from some river portions studied in North Finland, the zooplankton is represented by 38 crustacean and rotifer taxa (Appendix 1). Of this number, Rotatoria account for species (53%), Cladocera 15 species (39%), and Copepoda 3 species (8%). The relation of the zooplankton groups in the rivers is shown in Fig.7. The rotator fauna includer representatives

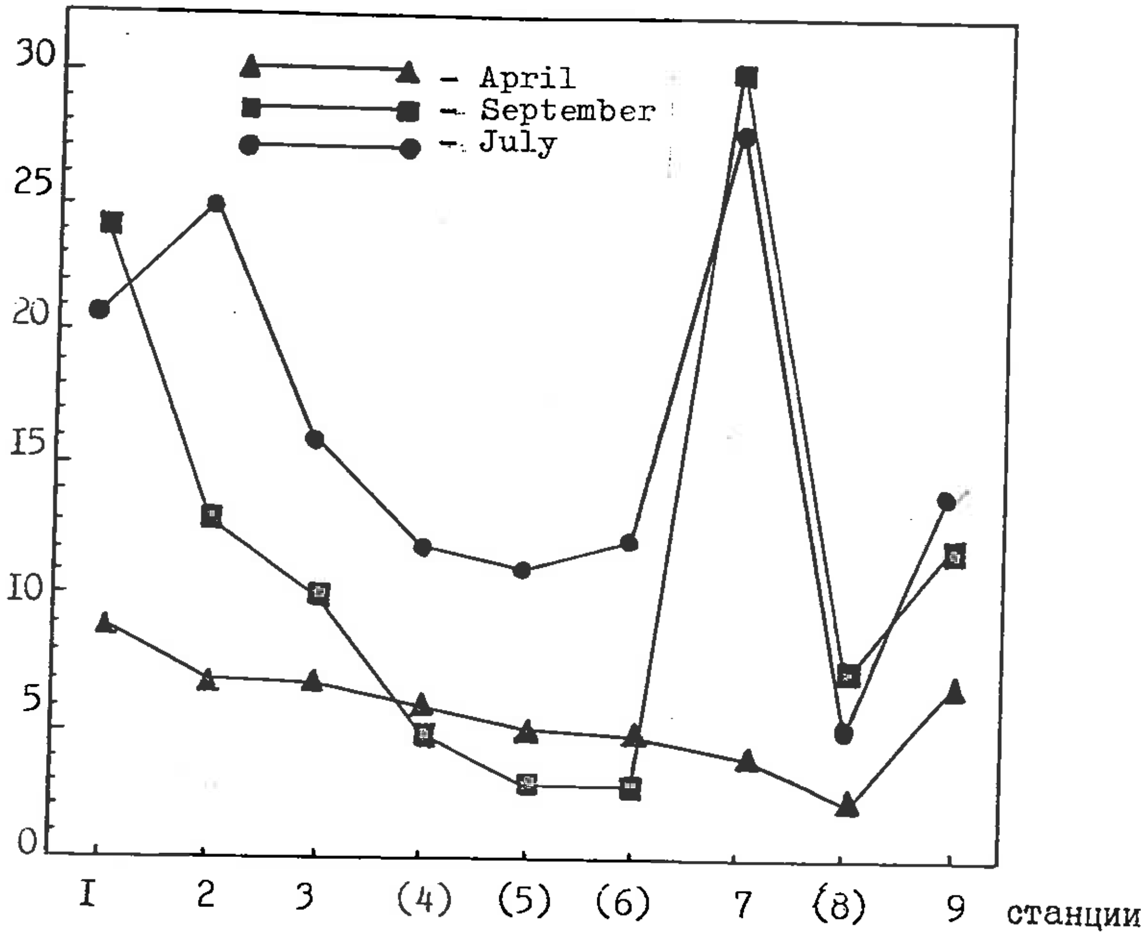

Fig.IO. The distribution of species of planktin crustacea - filtrators in r.Sjapsja (I982)

Stations:

I- tr."Tjukka"; 2- tr.Krakulsky, 3- "Manin" most, 4- tr."Sjapsja-lazma", 5- reclamation canal I, 6- reclamation canal 2, 7- Nizhnjaja Salma (r. Shuja), 9-tr."Jumanishki" (r.Shuja),8-Kindasovo (r.Shuja), (4) - Stations affected by reclamation.

of 9 families, the families Synchaetidae, Lecanidae, and Euchlanidae being most varied specifically. The bulk of rotifers (up to 60%), though not numerous (no more than 100 individuals per cubic metre), inhabit riverain sites overgrown with aquatic vegetation. These include some species characteristic of boggy water such as Cephalodella gibba, Trichotria truncata, and Euchlanis meneta). Lacustrine pelagic forms such as Synchaeta grandis, Asplanchna priodonta, Keratella cochlearis, and Kellicottia longispina have been found in lake - regulated rivers and in those having extensive deep slow portions.

Copepoda are fairly scarce (no more, than 400 individuals per cubic metre), and are being dominated by both nauplial and copepodite stages. They form part of the plankton fauna in the rivers Tenojoki, Utsjoki, and Simojoki.

Cladocerans form part of five families, Chydoridae being represented by the largest number of species (10).

Cladocerans as part of river zooplankton mainly belong to the riverain vegetation complex (over 80%). Individual representatives of lake zooplankton such as Holopedium gibberum and Daphnia longispina are encounered.

The quantitative evolutionary level of river plankton fauna is markedly different (Appendices 8,9).

The highest zooplankton number and biomass have been reported from some portions of the River Tenojoki and its tributary Utsjoki. A basis for the plankton fauna of the above rivers (up to 80% quantitatively) is provided by rotifers, mainly some representatives of the lacustrine pelagic complex such as Kellicottia longispina, Asplanchna priodonta, Synchaeta grandis, and Polyarthra luminosa.

Zooplankton formation in the rivers Tenojoki and Utsjoki and in similar types of fluvial - lacustrine systems of Karelia largely depends on some hydrographic characteristics of their basins. Drainage and channel lakes as well as deep slow portions, which form part of such systems, affect the biological regime and productivity of downstream river portions.

The plankton fauna in the rivers Simojoki and Kiiminjoki is dominated by both rotifers and, to a greater extent, some organisms inhabiting riverain vegetation such as Notommata pseudocerberus, Trichocerca longiseta, Euchlanis deflexa, Trichotria pocillum, and T.truncata, although these are not numerous (up to 100 individuals/m^3). In Karelia, these characteristic have been observed in minor rivers not regulated by lakes.

Zoobenthos.

Twenty groups of aquatic invertebrates have been reported from the rivers studied in Karelia and the same number from those in Finland. There is no appreciable difference in the faunistic composition of the groups predominating in Karelian and Finnish rivers. Some common characteristics have been observed in the structure of their biocenoses (Appendices 10-16).

Small-scale silting and the appearance of periphyton contribute to the increase in the number of hydrobiont groups and their specific variety. The predominance of the oligochaete - chironomid complex. The oligochaeta are dominated by Slavina appendiculata Udekem, Nais behningi Moch., Chaetogaster dophanis Gruith, and Stylodrilus heringianus Clap. High concentrations of juvenile oligochaeta and chironomids are observed in periphyton, but the availability of these hydrobionts as food to fish is minimum. Chironomid larvae are dominated by Endochironomus gr. tendens Kieff., Tanytarsus gr. mancus v. d. Wulp., Polypedilum gr. sealaenum Schr., Crocotopus gr. algarum Kieff., Eukiefferiella longicalcar Kieff., and Thienemanniella flaviforceps Kieff. In summer, the high number of chironomid larvae is mainly due to emerged generations. The state of food supply in the rivers clearly reflects the quantitative correlation of rheophilic forms of caddis flies, stoneflies, and mayflies (Fig.11). In the sample collected the larvae of Plecoptera are mainly represented by the following species: Leuctra fusca L., L. digitata Kemp., Isoperla difformis Klap., Diura bicaudata L., Isogenus nubecula New ., and Taeniopteryx nebulosa L.

The major representatives of this group of organisms emerge in spring or early summer. In the rivers studied , the mayfly group consists of Ephemerella ignita Poda, E. notata Bat., Heptagenia sulphrea Mull., H. fuscogricea Retz., Baetis rhodani Pict., B.vernus Qurt., Baetis scambus Faton., Caenis macrura Step., and Paraleptophlebia submarginata Steph. In all the rivers the group Ephemeroptera is one of the leading ones in terms of biomass. Its high number is maintained by a large proportion of juveniles of the families Baetidae, Ephemerellidae, and

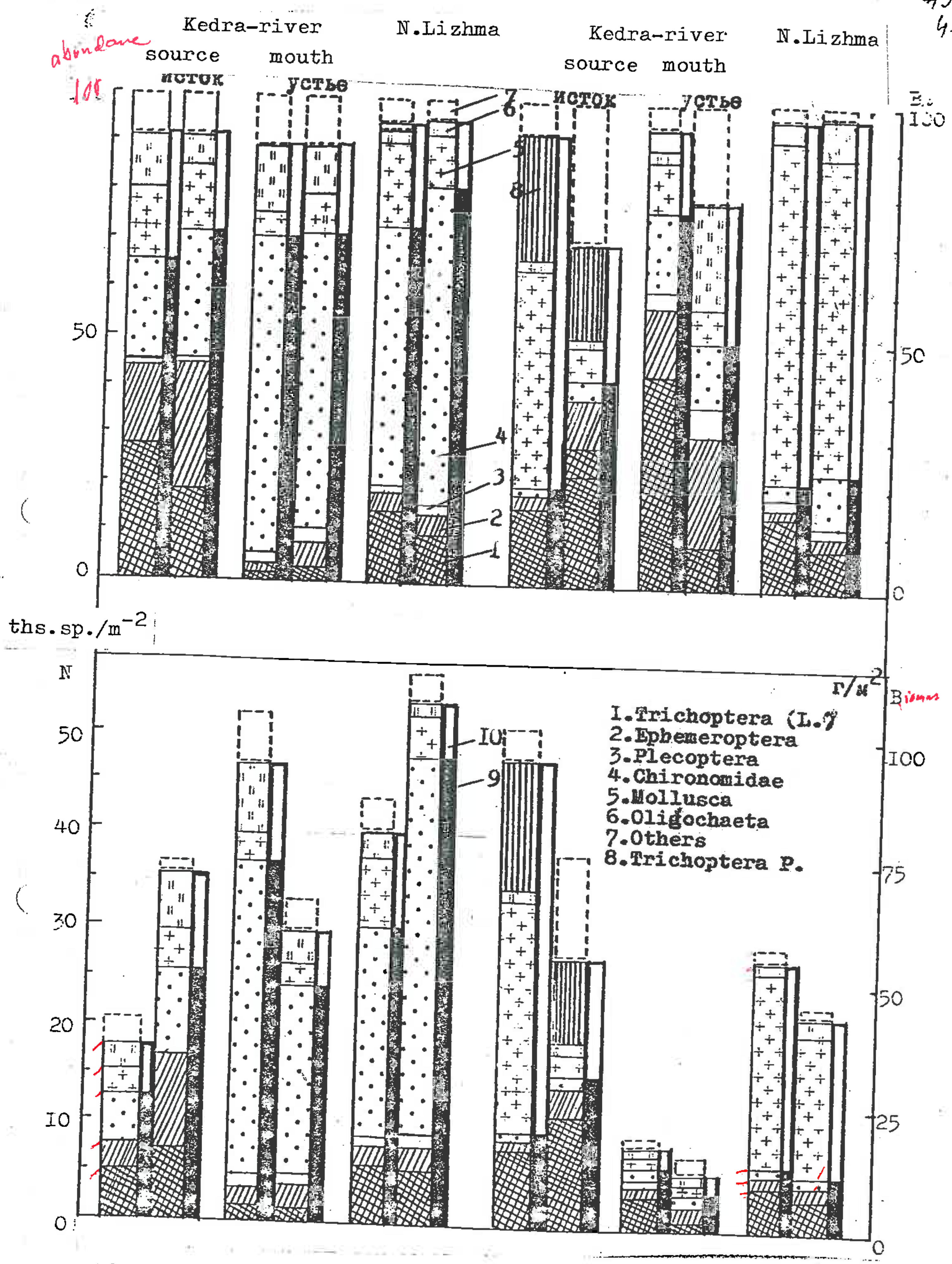

Fig.II. The structure of food resources of N.Lizhma river
9- additions food objects (Autumn)
10- food objects of young salmon(summer)

Heptageniidae. Caddis fly fauna is most representative of all prevalent groups of hydrobionts. The species, common in both Karelian and Finnish rivers are Hydropsyche silfvenii Ulm., H. angustipennis Curt., Arctopsyche ladogensis, Rhyacophila nubila Zett., Agapetus ochripes, Hydroptila tineoides Dalm., Psychomyia pusilla Ebr., Mirrasema setiferum Pict., Mystrophora intermedia Klap., Athripsodes exiqus Mort., Agapetus oxripes Curt., Polycentropus flavomaculatus Pict., and Axiethira distinctella Mel. The quantitative developmental indices of bottom fauna vary between individual river portions (Table 12).

In Karelia, low food supply indices have been reported from the rivers Verkhnyaya Lizhma, Yelgamka and Palaselskaya (Fig.12, Table 12). The major groups in the biocenosis are stabilized and the quantitative indices of benthos increase even in minor rivers such as Syargezhka if lakes form part of the catchment area (~~Table 12~~). Most productive are the spawning- rearing grounds of the salmon rivers Nizhnyaya Lizhma and Syapsya located either downstream from the lake outlet or between them (~~Table 12~~). In the River Syapsya, the major complex represented by oligochaetes, mollusks, leeches and caddis fly, mayfly, stonefly, beetle and chironomid larvae is ubiquitous. The bulk of the biocenotic biomass is formed by caddis fly larvae during the entine study period (~~Appendices 13 and 14~~). Besides caddis fly larvae, an increment in biomass is provided by mayfly and stonefly larvae in spring and by mayfly mollusk larvae in fall. Benthic biomass declines in summer. Caddis fly, mayfly, stonefly and chironomid larvae are most abundant

Table I2

The state of food resources of salmon rivers in the study period (Finland - August, I982, I986, Karelia- late Yuly - early August I982, I987)

Rivers	Abundance, ths, sp/m^{-2}: Total benthos (x̄ / min max)	Abundance, ths, sp/m^{-2}: for young salmon	Biomass, g/m^{-2}: Total benthos	Biomass, g/m^{-2}: for young salmon
Tenojoki, I982	6,78* I,98 - II,00	2,93 I,20 - 5,I3	8,62 3,I9 - I6,27	4,68 I,72 - 9,70
Utsjoki, I982	4,I6 0,88 - 5,78	3,07 0,I3 - 3,85	2,24 0,4I - 3,20	I,34 0,26 - 2,85
Utsjoki, I986	2,47 0,60 - 7,53	I,69 0.03 - 4,60	I,85 0,I4 - 5,73	0,8I 0,33 - I,60
Viogaveäosi, I986	8,55 7,55 - 9,55	5,89 5,70 - 6,08	I,69 I,46 - I,89	I,3I 0,95 - I,67
Simojoki, I982	6,49 5,38 - 7,60	3,84 3,I8 - 4,50	2,27 2,03 - 2,50	I,73 I,62 - I,84
Simojoki, I986	8,00 I,85 - I8,23	6,48 I,08 - I3,38	4,52 0,96 - 6,85	3,72 0,78 - 6,22
Elgamka, I987	4,93 3,88 - 6,48	3,I6 2,90 - 3,48	2,69 I,06 - 4,99	2,I8 0,83 - 4,36
laselgskaja, I987	4,50 2,90 - 6,65	2,79 2,03 - 4,I3	2,89 I,72 - 4,07	2,05 0,57 - 3,03
Sjargežka, 1987	25,24 22,78 - 27,70	I9,38 I4,80-23,95	I4,53 I0,2I-I8,84	5,0I 2,96 - 7,06
rhnjaja Lizhma, I987	I,79 I,I3 - 2,65	I,I9 0,70 - I,63	I,86 0,43 - 2,03	0,7I 0,22 - I,I5
Nizhnjaja Lizhma	4I,I0 20,05-58,65	30,64 I3,33 - 48,43	53,34 I5,20 - I02,98	I6,6 7,03-33,43
Sjapsja	I5,50 I0,I - I9,2	II,24 6,37 - I4,89	39,0 I7,9I-86,II	I9,76 II,I8-4I,58

\+ Notes: numerator - mean,

denominator - variations

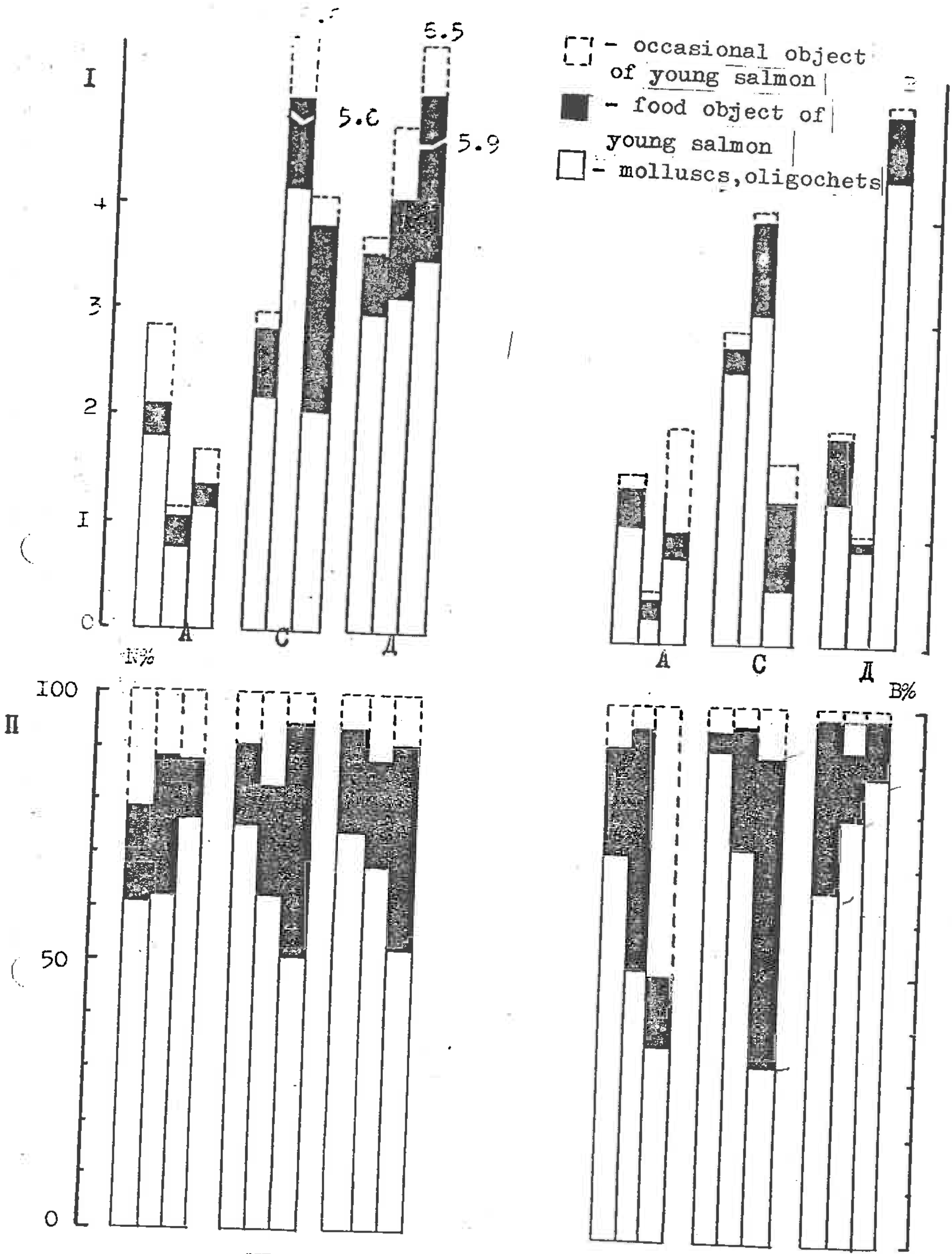

Fig.I2. Food resource of rivers of r.Lizhma System
A - Verhnjaja Lizhma; C - Palaselgskaja; D - Elgamka
I -Absolute values: N - abundance, sp/m^{-2}, B-biomass, mg/m^{-2}
II - Relative values in % of the total abundance (N%) and biomass (B%)

in summer-fall. Most of these are available as food to juvenile salmon (Fig. 13). Hydrobionts, seldom found as food for fish, are regarded as representatives of bed bugs, ticks, spiders,nematodes, ostracods, planarians, collembolans and Hydra. The rivers N.Lizhma and Syapsya show some common characteristics in the redistribution of the role of bott om invertebrates in the biocenosis. Variations in biomass observed in summer are due to the time of emergence of some prevalent species of amphibian insects. The high biomass indices of pupae, caddis flies and mollusks during the study period do not affect the stable relations between the groups in the biocenosis (Fig.11). Caddis fly, mayfly and chironomid larvae, known to be major food items for immature salmon, account for 16.6 g/m^2 on the average in terms of biomass and 30.6 thousand individuals/m^2 in terms of their number. The relevant indices for the River Syapsya are some what lower, but the food supply of the rivers N.Lizhma and Syapsya is 3-4 times that of Finnish salmon river portions (Table ~~12~~,Fig.13 and 14).

Drift. The bulk of migrating benthos in the rivers studied is formed by chirinomid larvae and pupae, black fly larvae and, more seldom, mayfly and stonely nymphs and caddis fly larvae (Fig.15). Of the organisms, seldom involved in drift and collectively referred to as "Others" in the Tables, no less than 80% in terms of their number are accounted for by water mites and beetle larvae (This is most intrinsic to the Finnish samples). Mayflies, chironomids and partly

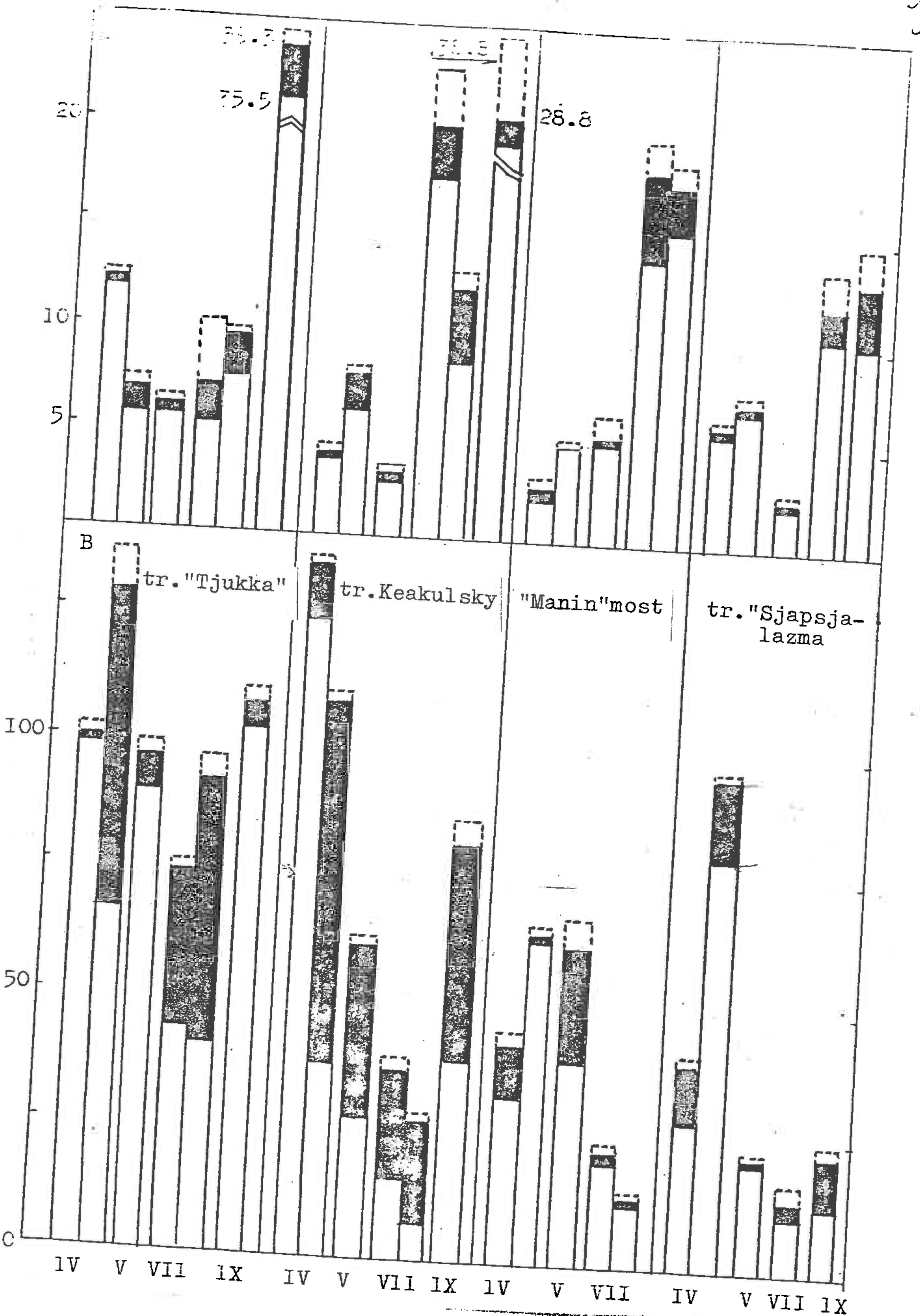

Fig.13. Seasonal changes in food resources in r.Sjapsja IV-IX (1982).For symbols see Fig.12.

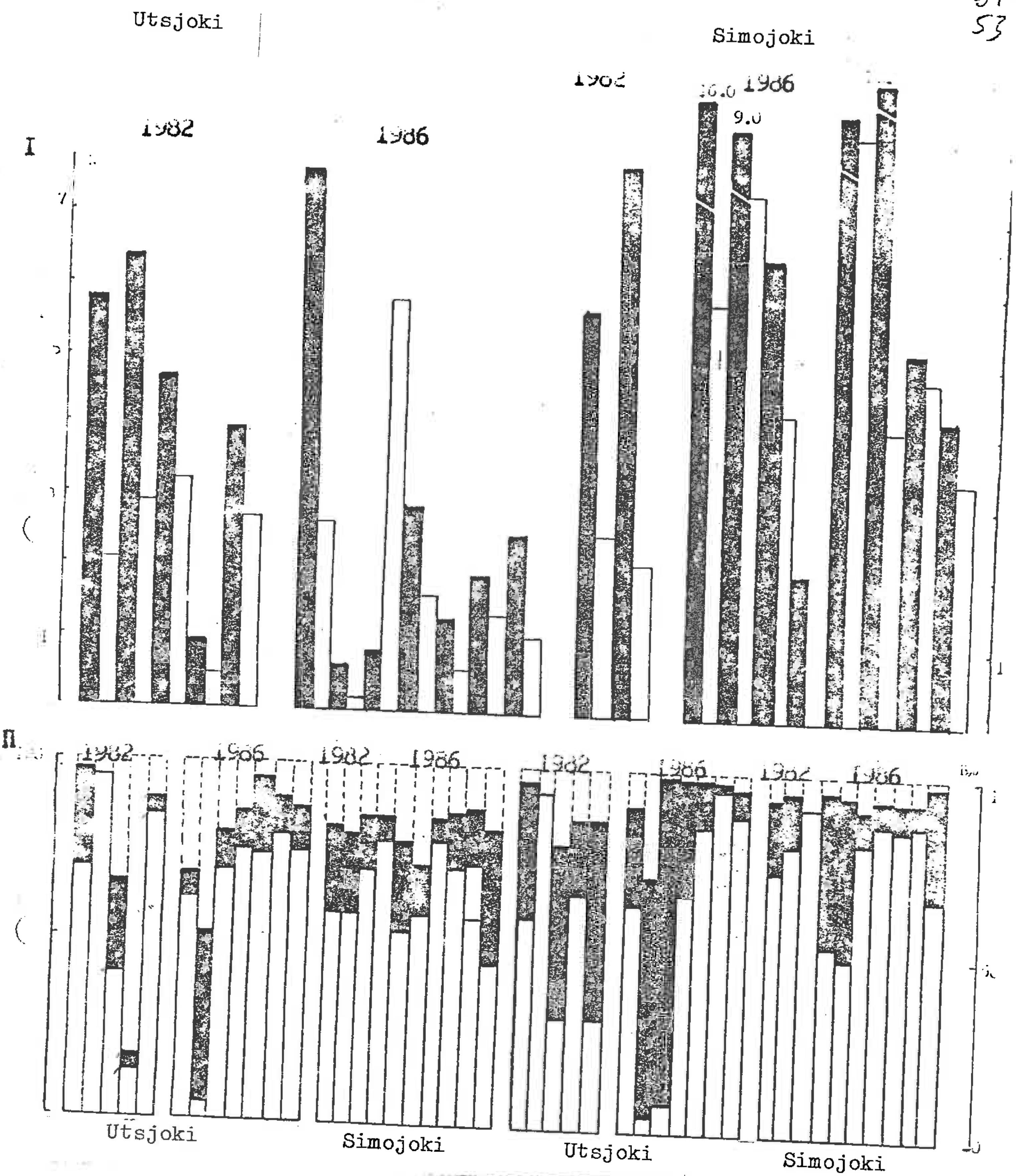

Fig.I4. The state of food resources of rivers
I.- absolute values of zoobenthos
B - biomassa, g/m^{-2}, N- abundance, ths.sp/m^{-2}
II - relative values of food resources of river sites
- major food objects of feeding, -molluscs, oligochaets

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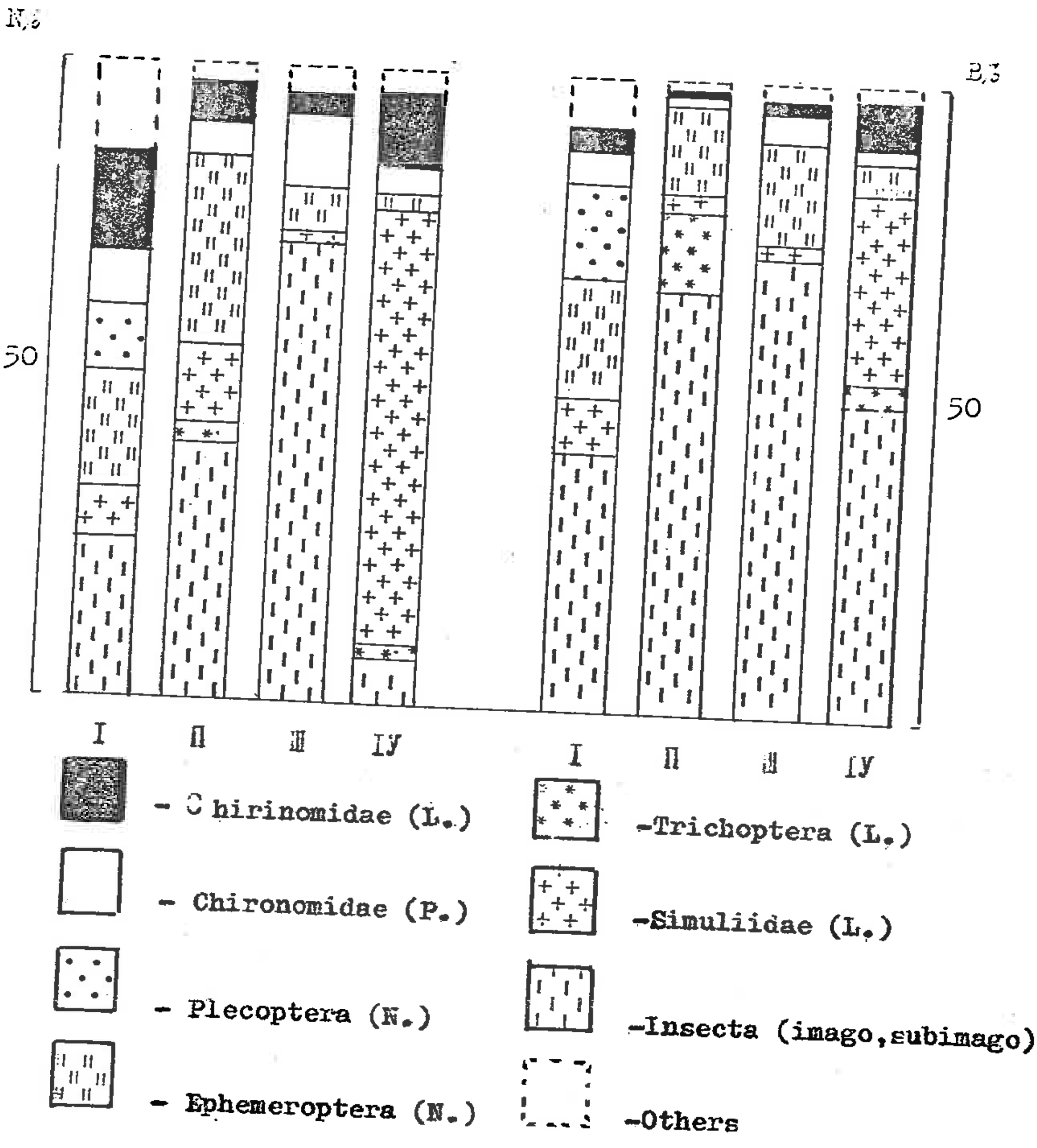


Fig.I5. Systematic group ratio of drift in r.Lizhma (N-% of the total number
B -% of the total biomass
I -r.Verhnjaja Lizhma, II - 100m down efflux from Kedrozero lake,
III- I00m up the offing to Tarasmozero lake,
IV - 300m down the efflux from lake Tarasmozero.

caddis flies, which form the bulk of food for juvenile Salmonidae, are represented by younger larvae. This is due to the fact the emergence of amphibians is largely over and juveniles are hatched in great number, The number of both the imaginal and subimaginal stages of amphibians and terrestrial insects is considerable in many samples. Both their number and biomass sometimes prevail over those of the "aquatic" fraction of drift (Appendices 17,18,19 and 20). The "aerial" fraction is most abundant in the drift of the River Teno (August 1982), where it account for up to 96% in number and 97% in biomass (Fig. 16).

The"aerial" fraction of drift in the majority the rivers studied is quantitatively dominated by the imago of chironomods, whereas the pterous stages of mayfly and, to a lesser extent, stonefly prevail in biomass. The only exception is provided by the brook Viogavedvi, in which the bulk of the "aerial" fraction is formed by terrestrial invertebrates (Appendix 18). Of the Finnish rivers, the highest quantitative drift indices have been reported for the River Utsijoki, the total number of drifting organisms being up to 3010 individuals/ hr/m^2 and their biomass up to 5162 mg/hr/m^2 (Appendix 17, Figs.17 and 18). Similar data have been obtained for the rivers Lizhma and Syapsya (Fig.19a, Appendix 20). Of the Finnish rivers studied, the minimum indices of drift are characteristic of the River Simo, where its biomass does not exceed 345 mg/hr/m^2 and its number is no more than 770 individuals /hr/m^2.

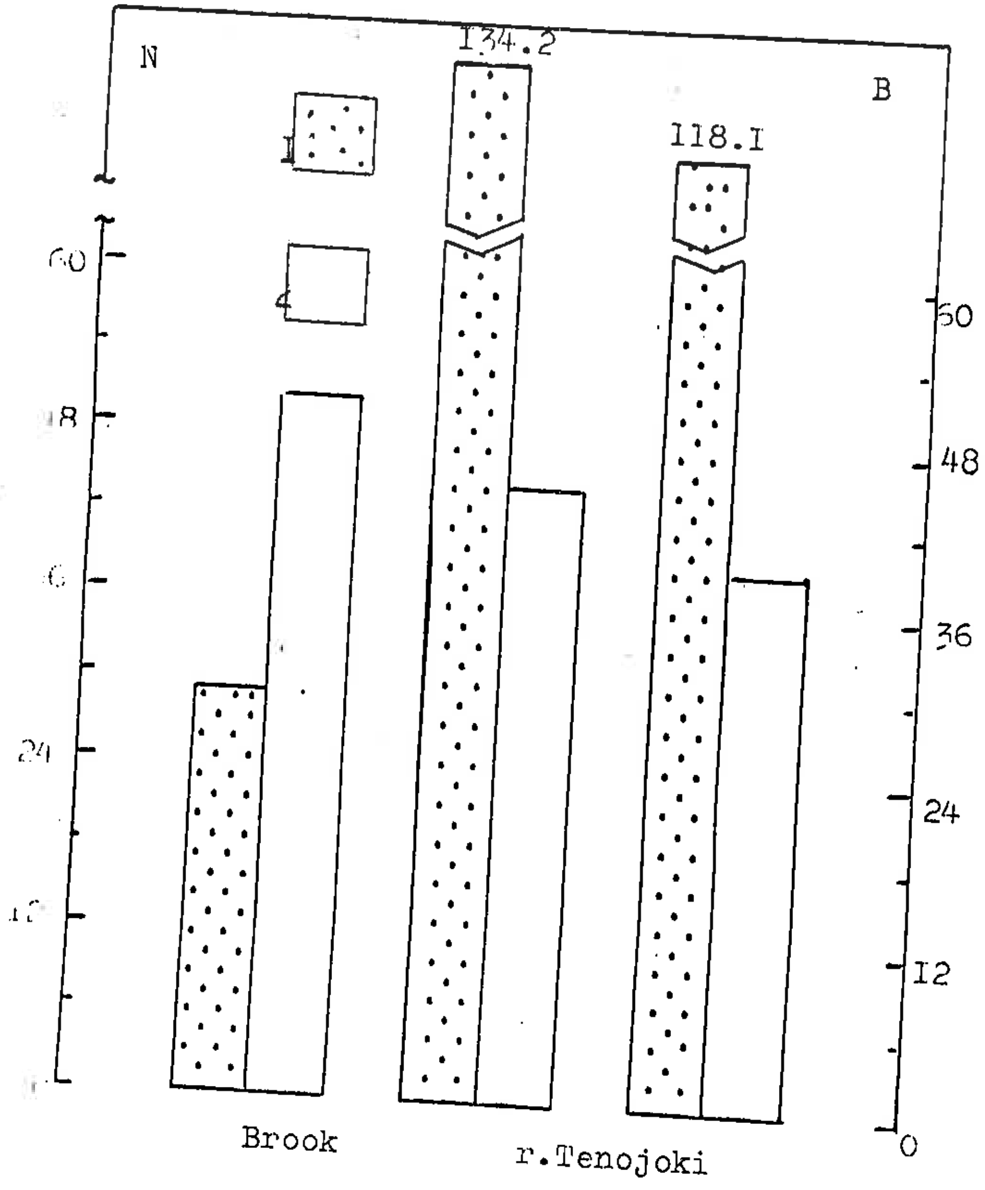


Fig.16.The values of total abundance and biomass of drift in the rivers studied (1982):

I - abundancs,sp.x $10^{-2}/hr/m^{-2}$

II - biomass, mg x $10^{-2}/hr/m^{-2}$

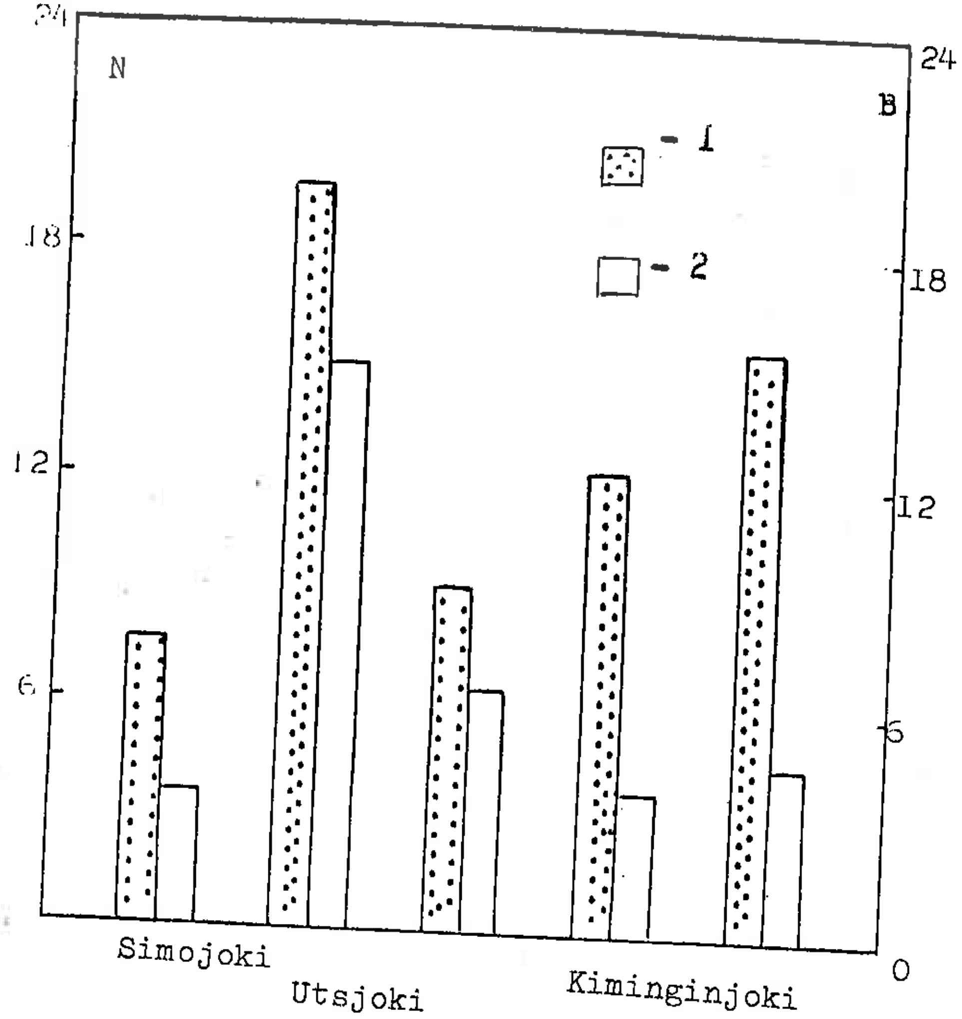
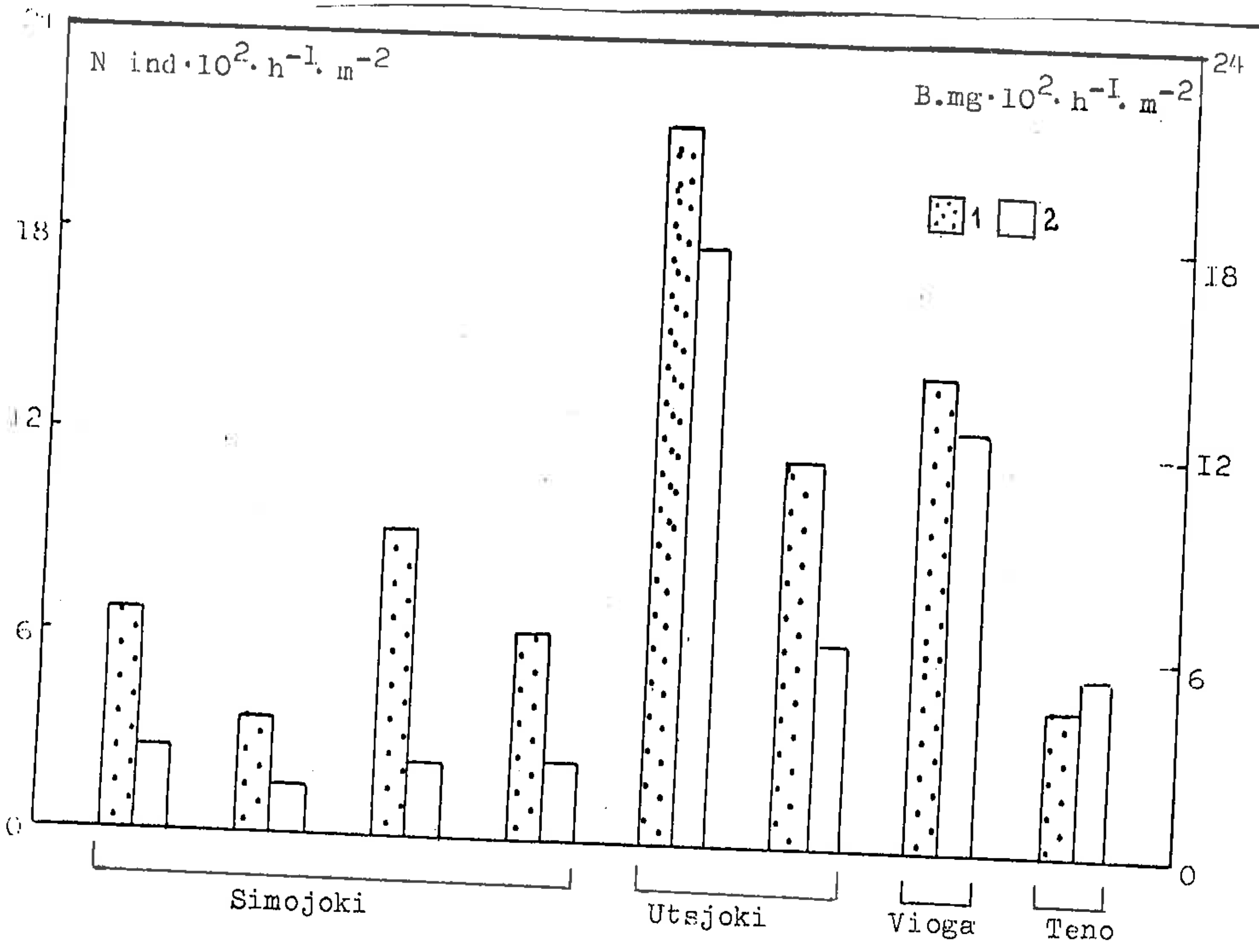


Fig.I7. The values of total abundance and biomass of drift in the rivers studied (I982):
I- abundance, sp. x $IO^2/hr/m^{-2}$
2- biomass, mg x $IO^2/hr/m^2$

Fig.I8. The values of total abundance and biomass of drift in the rivers studied (August I986):
I- abundance, sp.x $IO^2/hr/m^{-2}$;
2- biomass, mg x $IO^2/hr/m^{-2}$



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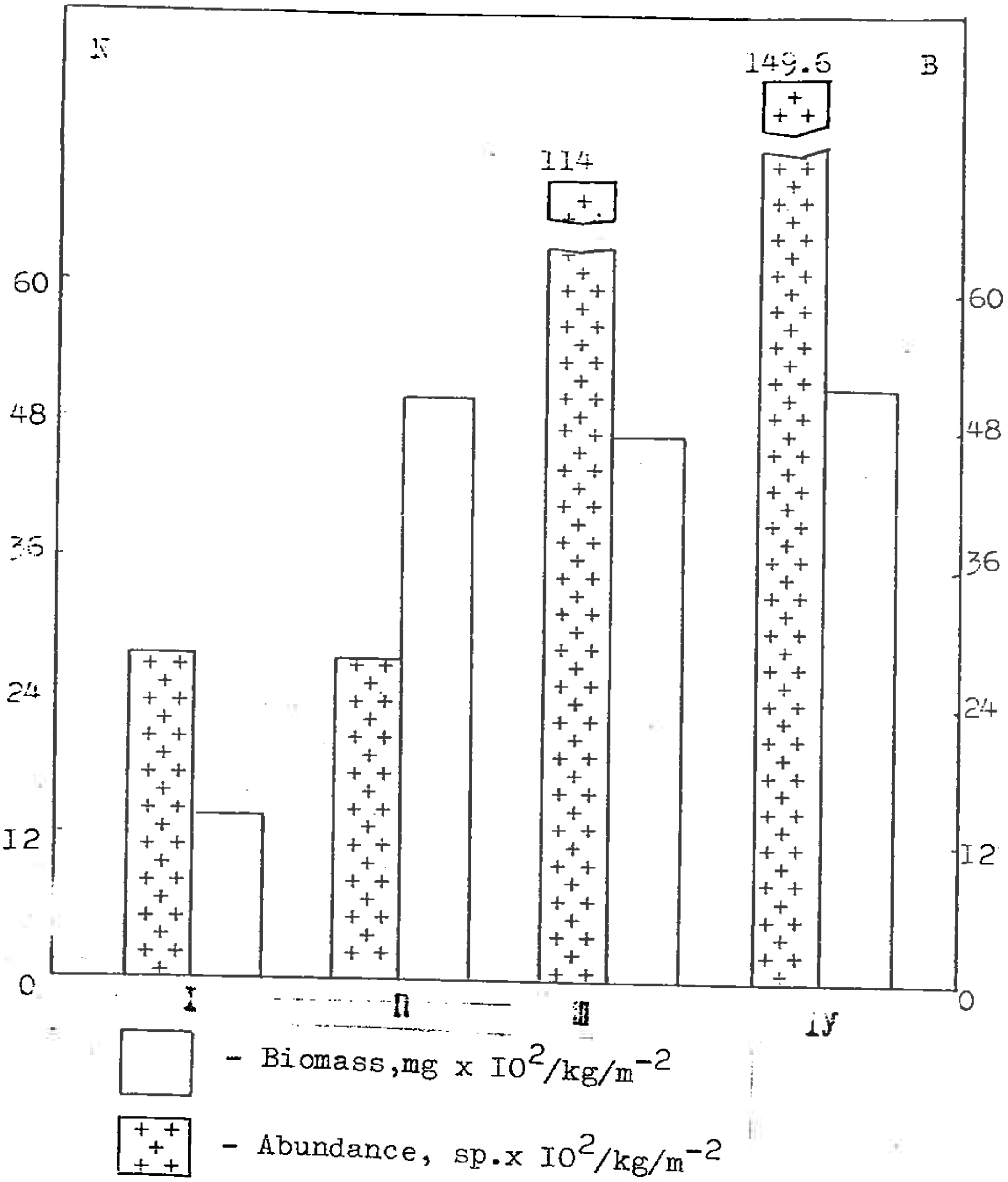


Fig.I9a The values of total abundance and biomass of drift in r.Lizhma:

I - r.V.Lizhma

II - IOOm down the efflux from Kedrozero lake

III- IOOm up the offing in lake Tarasmozero

IV -300m down the efflux from Tarasmozero

Similar values have been reported for drifting onvertebrates inthe rivers Yelgamka, Palaselgskaya, Syargezhka, Lizhma and Syapsya (field collections, 1987) (Table 13). Exceptions are provided by some downstream portions of the River Lizhma and the Syapsya-Lazma rapids in the River Syapsya (Appendices 19 and 20), where high quantitative drift indices are related, like in the River Teno in 1982, to the mass emergence of individual groups of hydrobionts.

Tabl. 13

5.4.2. Feeding of salmon.

Analysis of feeding of young salmon in the rivers studied, Lizhma, Simojokki and Tenojokki, has shown that benthic invertebrates and imagional-stage insecta are the basic food for young salmon (Appendix 21).

The feeding habit of this is mainly determined by the supply of fodder organisms and depends on the composition and abundance of their food base. It is natural that in rivers with different composition of benthos, the food of fish will be significantly different, for example, the larvae of Similids, whose number in individual months is large in the drift of Lizhma, are dominant in the diet of young salmon. At the time, in Tenojokki river, due to a small quantity of this group in benthos, the larvae of Chiromids are practically absent in their feeding.

Throughout the year the intensity of feeding and the quantitative composition of young salmon food undergo significant changes. Salmon are feeding actively in summer on aerial fodder. Morphological characteristics of young

Table 13

Quantifiative values of drift in Salmon rivers in the study period 1982,1986

Rivers	Abundance sp/hr/m^2	Biomass mg/hr/m^2
	x min max	
Tenojoki, 1982	12615 11810 – 13420	4247 3932 – 4562
Utsjoki, 1982	1440 920 – 1499	1077 655 – 1499
Utsjoki, 1986	1645 960 – 2220	1206 448 – 2082
Viogaveadsi, 1986	1420 1320 – 1520	1239 914 – 1564
Simojoki, 1986	662 280 – 940	206 108 – 332
Elgamka,1987	6620 5440 – 7800	3449 2150 – 4748
Palaselgskaja,1987	2030 1940 – 2120	787 732 – 842
Sjargezhka,1987	4400 1960 – 6840	3446 1780 – 5112
Verhnjaja Lizhma,1987	2760 2680 – 2840	1376 1072 – 1680
Nizhnjaja Lizhma,1987	9703 2500 – 18980	4976 4064 – 5666
Sjapsja	4939 1148 – 12720	1945 344 – 4750

Notes: above the line – mean
under the line – variations

Atlantic dalmon, viz. Large oral cavity, voluminous muscu-lary (masticatory) stimach, small number of gill stamens, enable the fish to feed not only on largr forms of benthic invertebrates but also to digest successfully the organisms with fairly hard coverings, viz. aerial insects, larvae of caddis flies, molluscs. It is noteworthy, that young salmon is characterized by high flexibility of feeding - practi-cally all the species of benthic inverterbrates are found in the fish diet.

In autumn, when the fish become relatively inactive and the intensity low the consumption of food decreases sharply, and food organisms are found singly in the stimach. Low in-tensity of fish feeding seems to be due not only to the acti-vity of fish and low of digestion but also to the decreased food supply (the drift of benthic invertebrates).

Pois

5.4.4. Genetic characteristics of salmons.

We fulfield works for the cytogenetic (chromosomal) analysis in two widely ecological studied populations of atlantic salmon of Lake Onega - stocks of rivers Lizhma and Shuja (including as subpopulation the stock of rever Syopsya). The main intention of this investigation - determain perhaps chromosomal differentiations and reveal peculiarity variety of karyotypes into studing population and forms of the atlantic salmon. In this, to according with early investigations (Rees ,1967; Nygren et al., 1968; Roberts, 1968,1970; Grammeltvedt, 1975 and et al.), superiority appeal our attention on the wide spectrum of variability for number of chromosomes, their morphology and number of chromosomal arms (Nombre fondamental - NE). The similar variation of diploid sets first may be consist the aneuplaid mosaicism, which was determained in counter impression into somatic tissues one individual, secondly, to take into consideration, that variability affect the morphology of chromosomes, so named modal or predominant haruatypes at different individual in a population, we must have in mind possibility the polymorphism, and what's more the polymorphism under certain significance, which base on existence in a population a few chromosomal morphs (forms) with high level frequency, that this differentions of morphs are not due result from repeated mutations. Obtaining dates for us from diverse metodics and using us in this study, confirme variaty number of chrosomes into individual and into some fishs, as part of

Table. 14

Distibution of matophases . r amber of ctromosomes(2n) ar. c nombre fondamental (NE3 in local populations of the atlantic salmon of river Lizhma (1) a nd river Shyia(2) of Lake Onega

Signs	N of population	Number of chromosomes in the complement (2n)														
		54	55		56		57				58				59	60
ombre fondamental in he diplidd complement NF)		72	72	74	70	74	72	74	75	76	73	74	75	76	74	76
umber of metaphases(C-itos) of studied	1	—	—	—	—	6	1	4	—	—	2	10	1	—	—	—
	2	1	1	1	1	2	1	3	2	1	2	6	2	1	—	1
of metaphases with ifferent number of chro-omes (C-mitos)	1	—	—		25,0%		20,8%				54,2%				—	—
	2	4,0%	8,0%		12,0%		28,0%				44,0%				—	4,0%
Number of metaphases, studied into emrons	1	—		—	—	2	—	5	—	—	—	8	—	—	6	—
	2	—		—	—	—	—	12	—	—	—	16	—	—	7	2
of metaphases with dif-ent number ofchromosomes e embrions	1	—	—		9,5%		23,8%				38,1%				28,6%	—
	2	—	—		—		32,45%				43,25%				18,9%	5,4%

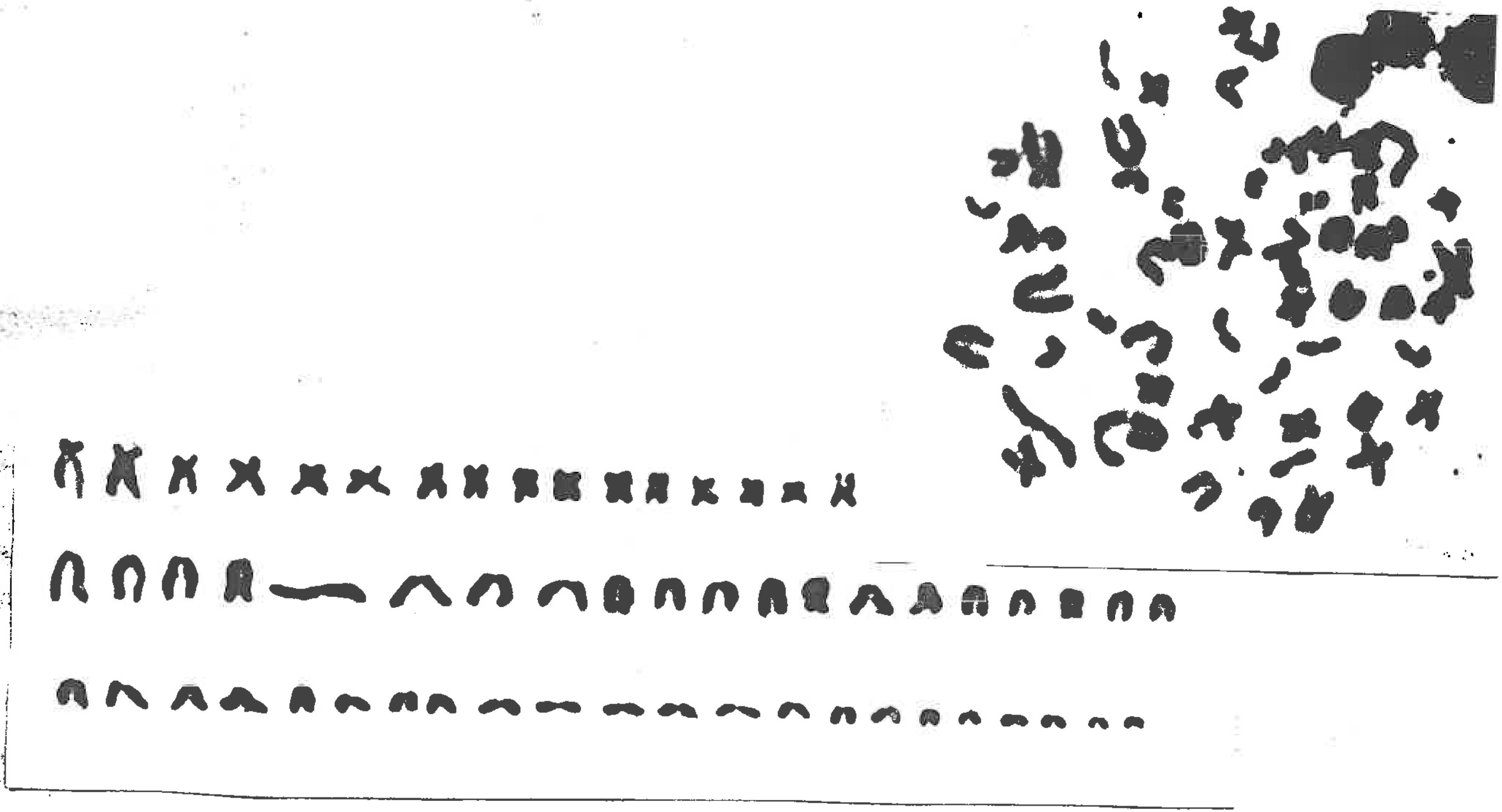
population. For analysis thei variety, we used the classification of chronosomes of the atjantic sanmon. which was suggesting by Grammeltvedt (1975) for the characteristic of chromosomes set of atjantic salmon from basis of Norvegian sea and what's more used us formely (Zelinsriy, 1980; Zelinskiy, Medvedeva, 1985). According this classification, in Karyotype of the atlantic sanmon with modal number - 2n= 58, NE=74, sub metacentrical chromosomes belong to group A, 14 submeta-, and metacentrics - to droup B, 2 large acro(telo)centric chromosomes - to group C,22 isomorphic telocentrics - to group D and 18 more small aiso isomorphic telocentrics - to group E. Erom presenting in this paper cromosomal sets of female with2n=58, NE= 74 (fig.19 -salmon from river Lizhma; fig.20 -salmon from river Shuya). 2 chromosomes of group A areisomorphical and obviosly homologous.10 chromosomes group B and morphological similsr may be union in morphological similse may be unio in five pairs, and the latest chromosome ground B from modal set (fig. 20 a, b) have secondary constuction and it without the satellite can to subtelocentric or submetacentric (correlation arms of this chromosomes approximately equally 3)

Chromosomes of the group C in this metaphase for our opinion have not morphological likeness an others chromosomes, but this chromosomes have centromeric, association with the acrocentric chromosome from group E (fig. 20 a,b). Distribution of other chromosomes of this set next; D-24(19 chromosomes second rows and 5 - third rows),E-17.

Fig. 19. Karyotype of the salmon of Lake Onega

(r. Lizhma)

2n=58, NE=74.



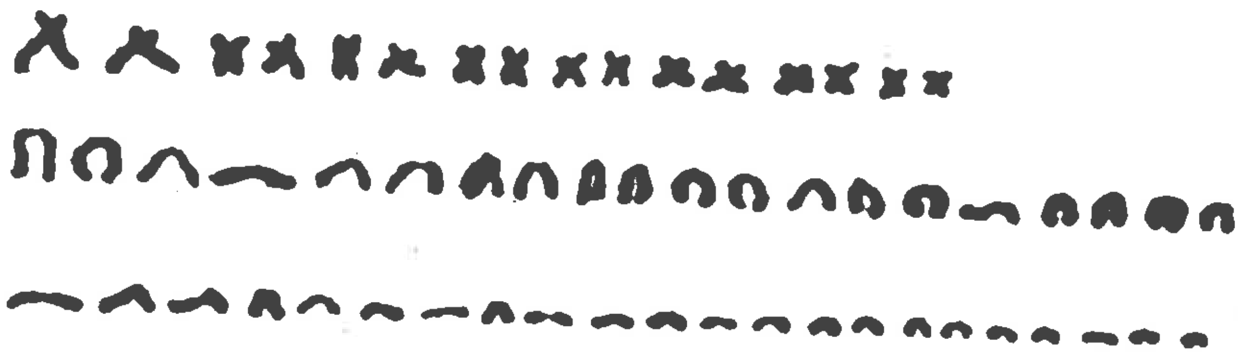
Fif.20. Karyotype (a) and metaphase plate (b) of the salmon female of the population in river Shuya of Lake Onega

2n=58, NE=74(73+1).

In the karyotype of male (fig. 21a, b - salmon from river Shuya) two chromosomes of the droup A from its morphology distinguish one from another and their are not concider as homologous, and from 14 chromosomes group B also only 10 chromosomes unite in 5 pairs as homology. Dostribu-toin acrocentric chromosomes of this set correspond to classification of Grammeltvedt (1975):C-2,D-22,E-18.

Showing on morphological distinoyion in modal kary-types, it is necessary, that they typical, observing in many mrtaphases in others populations, and therefore in may be study in connection all factors of variaty to propòsal as polymerphism include sex differenciation and it is possible all phenotypic peculiarities of analysing individuals.

Associations of chromosomes in metaphases of the atlantic salmon were mention in some sientific work (Bar-shene, 1978; Zelinsriy, 1980). Their analysis show, that associations take place in not only in centromeric regions of chromosomes (C-C), but also telomeric -centromeric (T-C) or (telomeric -telomeric) regions of chromosomes. In this connection, our interpretation of the morphology of individual chromosomes of set of the atlantic salmon, that particularly noticely at slight spiralization (fig. 22,a,b), - this confirm perharps similar associations. Evidently, this chromosomes because of difficult identi-fication at common methods of analysis, mostly belong to anybody types of monocentrics, thereby, if connection association was occur, assuming variety of quantatives parametres of a set. A assumption about perhability similar



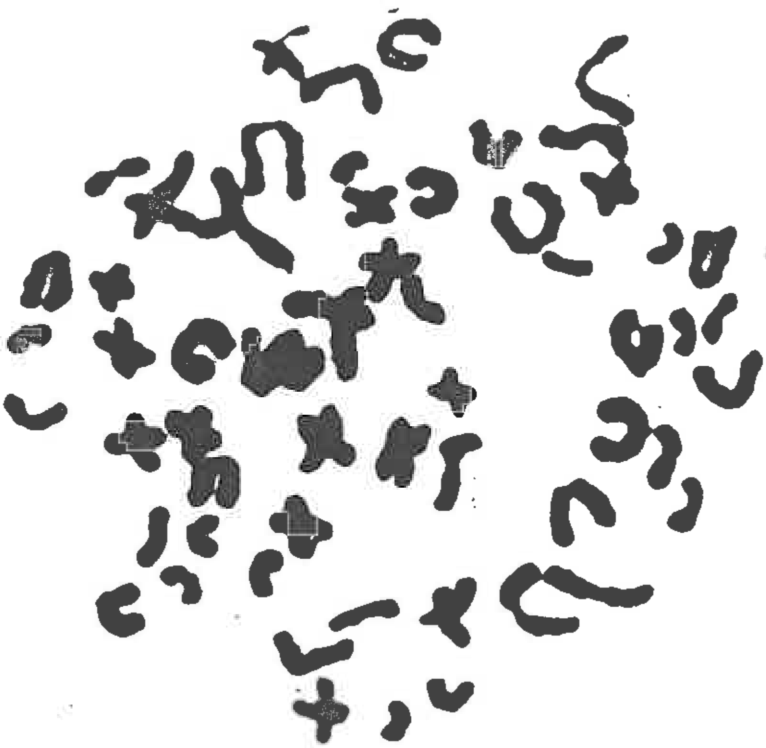
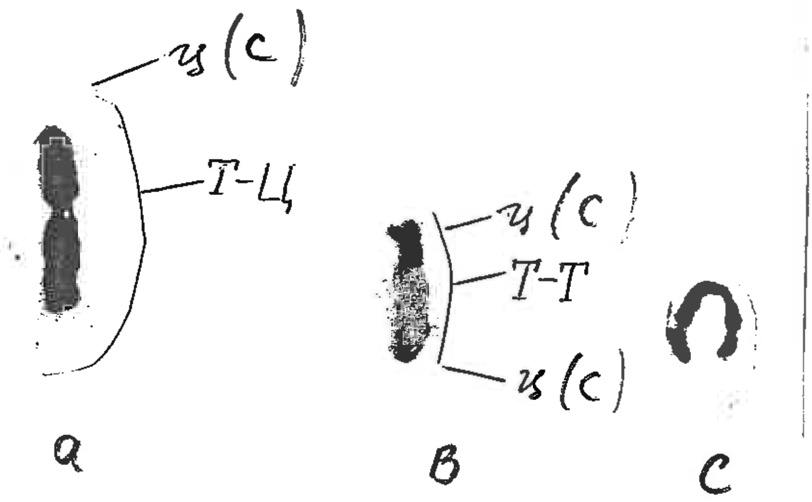


Fig. 21.Karyotype(a) and materphase plate(b) hot matured male of the salmon of the population in river Shuja of Lake Onrga,

2n=58,NE=74



Fif.22.About analysis of morphology individual chromosomes of from complement of the atlantic salmon:

a) T- C association chromosome (C- centomera);

b) T-T association of chromosome; c) acrocentric chromosome of group D, C -staine, evidence heterohromatic blocks near centromeric part and middle part of chromatid.

nearrangements of chromosomes correspond to availability C- segments, so near centromaric regoins, that is argument the property of structural heterochromatine lokalysing in this part of cromosomes of mamals (Oplov,1974), as in median part of the acrocentric chromosome group D (fif.22 c). Probably also,that this property lokakysing of some blicks og heterochromatic may be reflect tpe part of associations of evolutonary process os structural reorganizatinns of karyotype of this species for a line decrease number of chromosomes and nombre fondamental from sea-run ancestor's form of brown trout- Salmo trutta L., which have karyotype (n=80, NE= 100-1o2 (Nygren et. al,,1971) and appoximately equality with the antlantic salmon count DNA (Rees. 1967).

In connection of some question about populationary differentiations of Karyotypes, to compare modal chromosome sets of the population of salmon of Lake Onega, we can't not put clear distinction with some studing populans of sea-run and lake forms in the european part of arieea: Zn= 58, NE=74(73) fl (Rees,1967; Nygren et. al., 1968; Grammaltvedt,1975; Zelinskiy, 1976,1980; Zelinskiy et.al.,1980; Barshene,1977,1978,1981; Hartley, Horne,1984). At the same time, it may be some differences in poplymorthism of large submetacentric chromosomes group A (Boothroyd,1959; Roberts, 1968,1970.Zelinskiy,1976; Zelinskiy,Mrdvedeva, 1985). Thus, according to the results of studies conducted on brastula material, in the culture of ovary and some somatic fissner of sea-run and lake populations of the Atlentic salmon from the North-american continent, the chromosomes of group A are absolutely lacking or only one large submetacentric is represented with a frequensy of 37% in karyotypes fissue culture of the sea-run poputation (Bootrayd, 1959, Roberts,1968, 197o). Thus, karyotypes of the European populations of the Atlantic salmon have at least 2 large submetacentric chromosomes and some modal Karyotypes are evidenced to have 3 and 4 chromosomes of group A. only two of which,according to our data may be homologous. These differences in chromosome morphology, independently of the comparison between Karyologocal data on numerical values, on the one hand evidense for the subspecies status of European and North American populations (Payne et.al.,1971), first observed for transferrin alleses and, om the ohter hand they confirm the polymorthism of chromosomes of group A. The polymorthism, however, seems to have a wider basis, evidenced by the presence of mul ivalents in the metaphase of salmon parr male meiosis includinf octa,- hexa- and tetravalents and only 21-27 bivalents per diploid cell Nygren et.al., 1968; Barshene.1980; Zelinskiy et.al.,198o. As we can see rhe question suggests itself what is determing and what is the base of the polymorthism in the Atlentic salmon population.

It is known, that the formation of multivalents supports the structural heterozygosity of chrosomes, wtich seems to determine the heterosis effect in terms of the growth rate. From the evolutionary point niew, the muitivalents ensuring polymorphism are the result of chromosomal rearrangements caused by the specialization in tetraploid salmonids(Vasilev,1977). the problem of polymorphism is populationally connected with phenotypic differences of Atlantic salmon males wtich include together with Anadromous migrants, so-called parr-males maturating during the river period of their life and which are a reproductive part of the population structure. Perhaps, genetically specified factors determining the development according to the parr-male type are likely to be linked with six chromosomes which are morphologically polymorthic.

Thus, the ezistence of polymorphism måy be used as a basis for explanation of some variability of chromosome morhpology in modal karyotypes. At the same time it is odvious, that systematic analysis of the karyotype characteristics of Atlantic salmon represents a multiphase process. First, we must study individuals not only wiht a known phenotype but also with genotype which is, in its turn, real after special crosses and the analysis of off-spings in pure lines. Second, we must find approaches for applications of methods for exact morthological dyagnosis of chromosome (in terms og morphology). All this must be a part of extensive complex populational and genetic-selektive studies of Atlantic salmon and especially its land-locked populations as closely adaptive isolates, which have undergone a long term selection and are ander a strong antropogenic effect at a low reproductive number of spawing stooks. there are now no LKaryological bases for differentiation of the salmon population in Lake Onega from the sea-run form of the species living in the European part of the area, therefore it may be regarded as an ecological race of the species.

5.4.6. Behaviour of salmon Parr in the River of Lizhma.

Five most typical for the Lizhma river salmon parr's sites of life (biotops) were chosen. The sites were convwn-tionally sighned with A - E indexes (Fig. 23).

A,B,C sites are situated in the main river-bed. Here reach shallow part of the river with relatively calm surface current smoothly changes into rapids. D and E sites are shallow channel of the main river-bed characterized with small width and depth.

Biotops differ in hydrological parametres (Table 15), ground composition (Fig. 24) and according to salmon young fishes life density. Variety of microhabitat types (Fig. 25) determined with concrete biotops conditions is

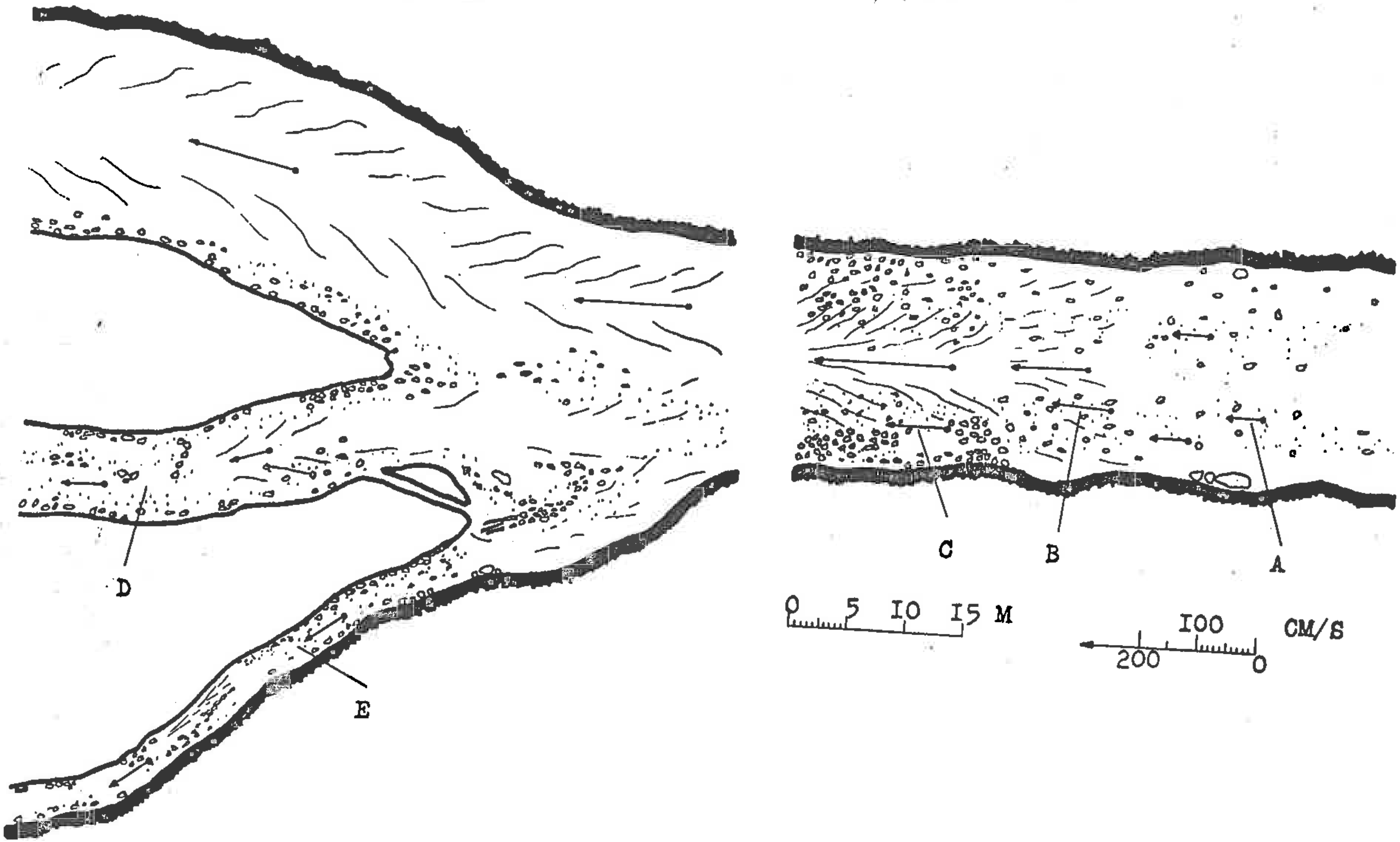


Fig.23. Biotopes of young salmon in river Lizhma

Table I5

Characteristic of biotopes of young salmon (age I+,2+) in the river Lizhma

Показатели	Biotopes				
	A	B	C	D	E
Width of river, m	I5 – I8	I5 – I8	I5 – I8	6 – 8	3 – 4
Depth, m	0,55 / 0,30 – 0,75	0,54 / 0,44 – 0,65	0,62 / 0,44 – 0,80	0,25 / 0,I5 – 0,38	0,36 / 0,24 – 0,50
Velocity of current on the surface of water	0,62 / 0,50 – 0,70	I,00 / 0,80 – I,20	I,09 / 0,70 – I,40	0,72 / 0,40 – I,40	0,80 / 0,50 – I,30
Velocity of current in the hunter position of parr.	0,23 / 0,I8–0,33 4I*	0,35 / 0,20–0,70 38*	0,3I / 0,I8–0,62 27*	0,22 / 0,I6–0,32 23*	0,I7 / 0,I0–0,50
Deneity of parr, sp/IOm²	6	7	I0 – I2	4 – 5	5

\+ number of measurements

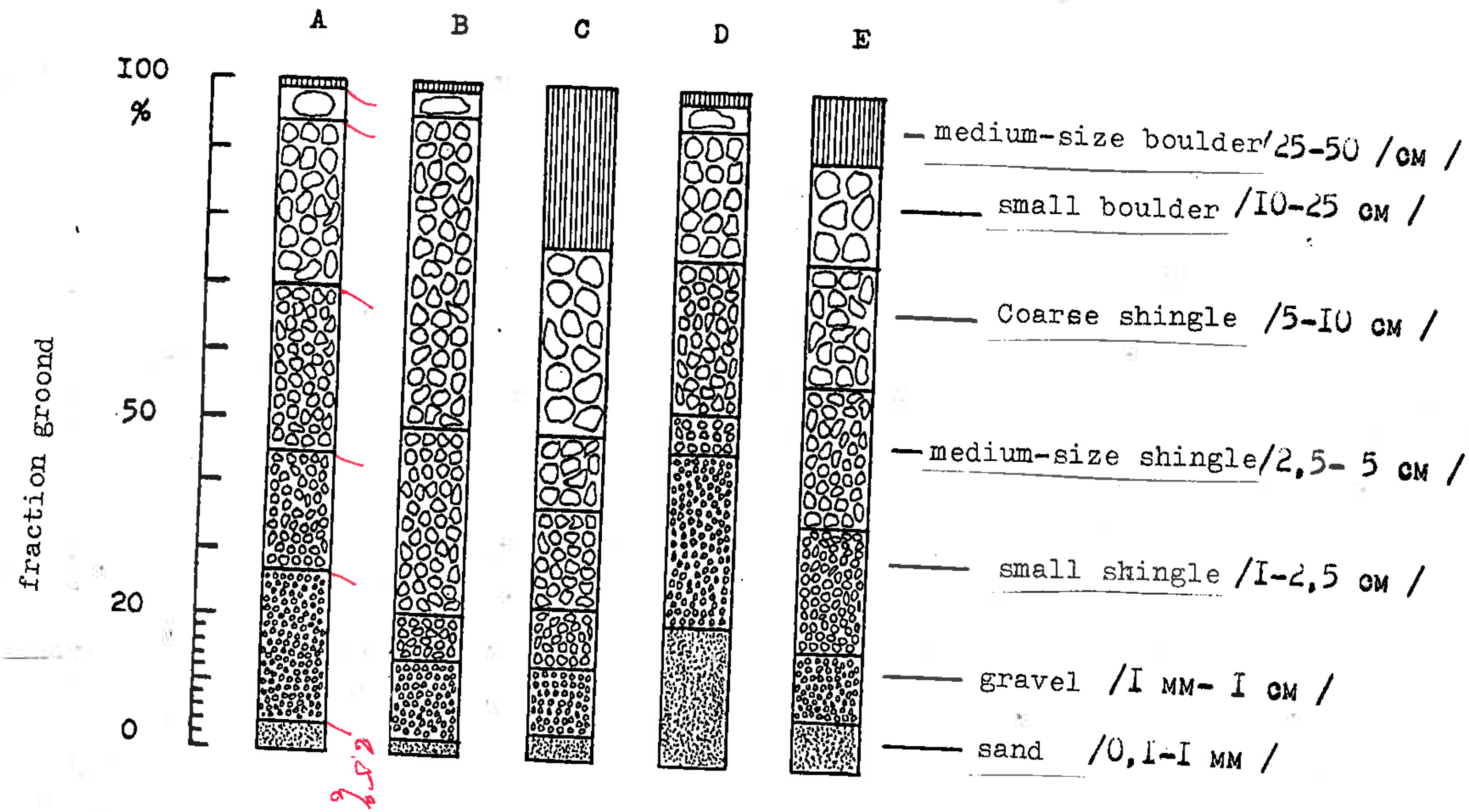


Fig.24. The structure of ground in biotopes (A-E) of young salmon

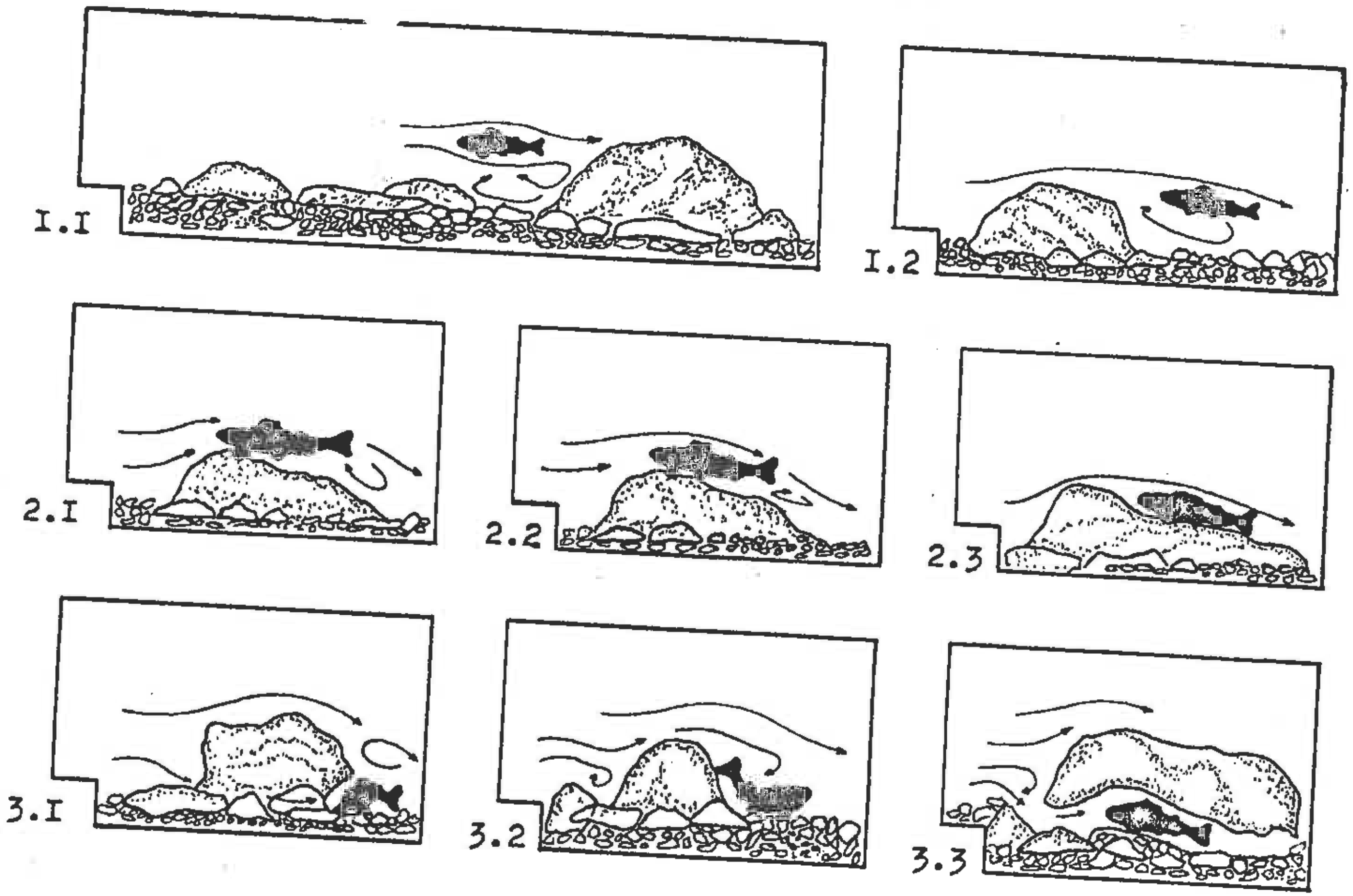


Fig.25. Typical microstation of young salmon

I.I-I.2. - nonkontact, 2.I-2.3. - kontact-observation
3.I-3.3 - kontact covered

observed in summer. Three main types of microhabitats for salmon parr can be destinguished according to our observation: non-contact, contact- look out, contact-shelter.

Non contact microhabitats

The latter can be observed in A -type biotops. A parr is "hanging" in the thickness of water in 5-15 cm from the bed at dead centres in front of or behind a big boulder. It is holding itself in the water thickness with the help of pectoral and abdominal fins without touching the stones - just folding and spreading its fins depending on the pulsating stream strength. The stream appering from turbulence caused by its interaction with a boulder has complex structure. It makes the fish slightly correct body ovientation with the tail, which doesn"t work constantly although. Evidently parr"s body is kept by water prop from the boulder. Young fishes are keeping up strictly the distance to the bed and to the boulder for minimal movement energy expenditure constantly steering with pectoral fins. In the rapids parts of the C - biotop type specific variety of non-contact microhabitat so called " barrel" is possible: salmon parr is constantly inside a circular stream, doesn't stir, just correcting its body by folding and spreading fins. Feeding objects rather often get inside the same "barrel" and fish just gulps them down. But the time salmon parr is inside the water rotation is limited with several minutes - and such cases are found rather seldom.

Contact - look out microhabitats.

They are characterized with observation head-against-the- current position of salmon parr on the elevation- more often on the boulder bigger in its size than the length of the parr.

Stream speed increase from 0,18 to 0,70 m/sec in the close-to-bed water layers in the microhabitats being compared influences upon degree of contact, young salmons have with the ground.

That degree can be marked with the number of fins-on- the- stone fulcrums (Fig. 25).

Salmon parr is holding itself on the "lee side" of the boulder with pectoral fins (2 fulcrums) having abdominal and tail fins in surm, slightly working with the tail, correcting body orientation.

Rather often it is observed that fish leans on pectoral and abdominal fins (4 fulcrums) (~~Fig. 25~~), while the tail performes steering -to-the-former-place function, for the steam is moving the fish body to the stone's edge.

At the highest speed of the stream (about 0,7 m/sec), which can ba sood by parr, it leans on the boulder -often in its recess - with pectoral, abdominal, anal and tail fins (6 fulcrums in all). The tail doesn't work, the body is suring by the stream with 1 time per second frequency and amplitude up to 1 cm.

At the same time with the stream influence increase the distance of feeding rushes reduces from 1,5 m to

0,40 -0,30 m. The frequency of rushes to the water surface falls. 3 rushes of 10 are to the surface - with two fulcrums, 2 from 10 - with four fulcrums, and 1 from 20 and even more seldom with full 6 fulcrums leaning scheme.

Salmon young fishes way of feeding is caused mostly by the water stream speed sctructure.

Short-term (1-8 sec. according to our observations) motive efforts take place during feeding objects catching process, 15 minutes of static observation showed, that the total time of feeding rushes is short and is equail to 31 seconds on the average i.e. 2% of the fish's hunting time.

Thus the most period of hunting time the parr is observing possible feeding objects without moving.

When the latter appears within 30-50 cm, the parr spreads up pectoral fins at an angle to the cotrary stream and working with tail uses lifting capacity for coming up into the surface layer feeding objects movement. After gulping the object down the fish turns its pectoral fins down at an angle to the contrary stream - here momentary body throw back happens downstream in order to be closer to the bed-to the former mocrohabitat. During the feeding rush head-against-the-stream orientation remains.

More seldom (1 side rush in 10 ahead rushes) side feeding rushes are found, when an object swims in 40-70 cm.

The fish has to stand side water pressure and having gulped down an object come downstream to the bed. After that the fish turns in the near-bed space against the stream and swims to the former microhabitat. Similar hunting methods are typical for non-contact and contact - look out microhabitats.

Contact - shelter microhabitats

They are typical for rapids parts of the river (C-type). Salmon young fishes choose big boulders, cracks between boulders and under-the-boulder space as shelters.

Turbulent streams caused by boulders are used too. That case the fish orients on the local stream, that is often contrary. to the main stream of the river, thus the variety of poses observed takes place (Fig. 25).

Fishes contact by abdominal, pectoral fins with pebble- sand bed or flat stone. Sometomes leaning by a tail fin is added.

Rather often inclined or even vertical body position with a head iriented up or down cam be observed. Orientation in these cases can be determined by the choise of optimal niche in the water stream, where the fish is able to keep in with the help of hydrodynamic performances of the body and static work of fins.

On the contact-shelter microhabitats fish usually gulps down feeding objects using method of short "toss" of the body with abdominal fins over the bed with simultaneuos turn of the head. Using this method the fish keeps ita tail in contact with the ground. Rush hunting methods in th rapid water thickness are difficult because of the strong stream. Fulfilment of this method can make salmon parr move several metres downstream.

Microhabitats of young salmon during winter.

During winter young salmon's behaviour has a series of pecularities, caused by climat changes and specifically low near-zero temperature of water. If in summer salmon parrs are allocated on the river ground surface, then in winter period fishes hide beneath small or middle boulders. Moreover they can be often found not only beneath the first boulder, but beneath the second or the third one from the river groud surface. In winter fishes are inactive and the fright reaction upon underwater observer is lacking. At the moment of turning the shelter boulder over the parr sluggishly turns, head to the newly formed in the near-bed water layer local stream; in some seconds in tries to hide ita head in the ground leaving its tail out-side.

In the case the discovered parr gets into the main stream with a speed equail to 0,8 m/sec and higher it is thrown downstream. Apparently in winter young salmon can actively hold out against the stream and fulfill frequent and rapid feeding rushes into the water depth and to the water surface, that makes it hide deep on stones.

Discussion

Hydrological regime of rivers

One of the main tasks in assessing the biological productivity of water bodies is to determine the distributional regularities of major elements of biological regime (periphyton, zooplankton, zoobenthos, drift). Of special interest is the formation of productivity at river-bed sites of lake-river systems, because the degree of food base development in rivers determine the provision of early stages of salmonids with food.

Detailed long-term investigations of the dynamics of hydrobiological regime were conducted on the Karelian rivers. We have only single samples for rivers Teno and Simojoki. These rivers occupy geographically more northern position than rivers Lizhma and Sjapsja. Nevertheless, our earlier investigations show that in salmonid rivers of different latitude the dynamics of hydrobiocenoses is mainly the same. This allows to compare the rivers and to judge of the state of hydrobiological resources on the basis of available marerials.

The periphyton taxonomic composition of all the rivers examined is fairly consistent with those reported on other clear. oligothrophic running waters of the Northern Hemisphere. As study was conducted in late summer,both,dominant species typical for summer (Achnanthes,Synedra) and autumn (Gomphonema,Navicula) were common for algocenoses.

The lowest species richness was characteristic of Teno River (Fig.26), with dominance of few species and widespread taxa common only for the spring population in Karelian rivers,including Ceratoneis arcus, Ulothrix zonata and some others.

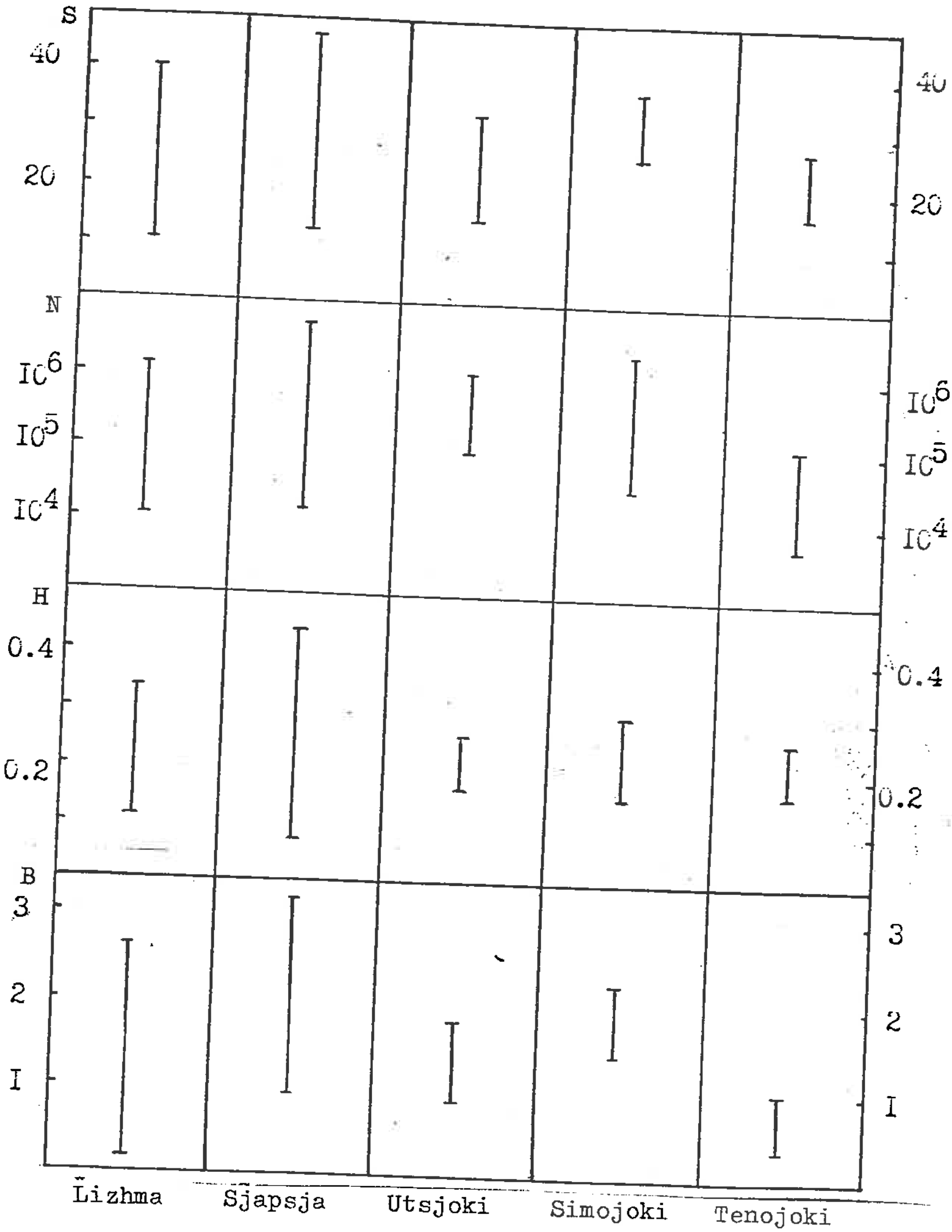


Fig.26. Maximum and minimum values of the abundance of species (S), density (N), species diversity (H) and biomass (B) of algae in river periphyton

A large number of lakes in drained catchments of Karelian rivers leads to significant diversity of periphyton communities along the course of rivers. The maximum cover was recorded for down-the-lakes sites,particularly im riffles with stable substrates and current speed of about 0.3m c^{-1},simültaneously the abundance of planctonic forms increased. In the same locality (Sjapsja River,"Tukka rapid"),the planctonic algae dominanted in periphyton and the total quantitative value for planctonic forms was greater that for periphytic ones(Fig.27).

The considerable longitudinal and horizontal differences of current,depth,substrate ranging in size as well as the alternation of riffles and pools result in greater periphyton variability in Karelian rivers as compared with Finnish ones.

In contrast to other examined rivers, in Sjapsa River the influence of human activities on periphyton development was recorded. Lake eutrophycation in the last years resulted in the increased number of mesosaprobic algae in the attached communities at the outlet of Sjamozero Lake,such as: Gloeothrichia ehinulata,Anabaena spiroides,Aphanisomenon Flos-aquae. In the middle zone where agricultural utilization of peatlands is being carried out,the increased density and richness of algae (Closterium,Cosmarium,Eunothia) common for mires were observed.

~~River zooplankton is represented by some species widespread in Holarctic.~~ Its formation in some portions of both Karelian (Lizhma,Shuya and Syapsya) and North-Finnish (Tenojoki,Utsjoki, Simojoki and Kiiminkijoki) rivers inhabited by juvenile salmon is largely dependent on whether channel and drainage lakes form part of a river system.The zooplankton found in the spawning rearing grounds of the rivers Lizhma,Shuja,and Syapsya located downstream, away from lake outlets, shows a considerable speci-

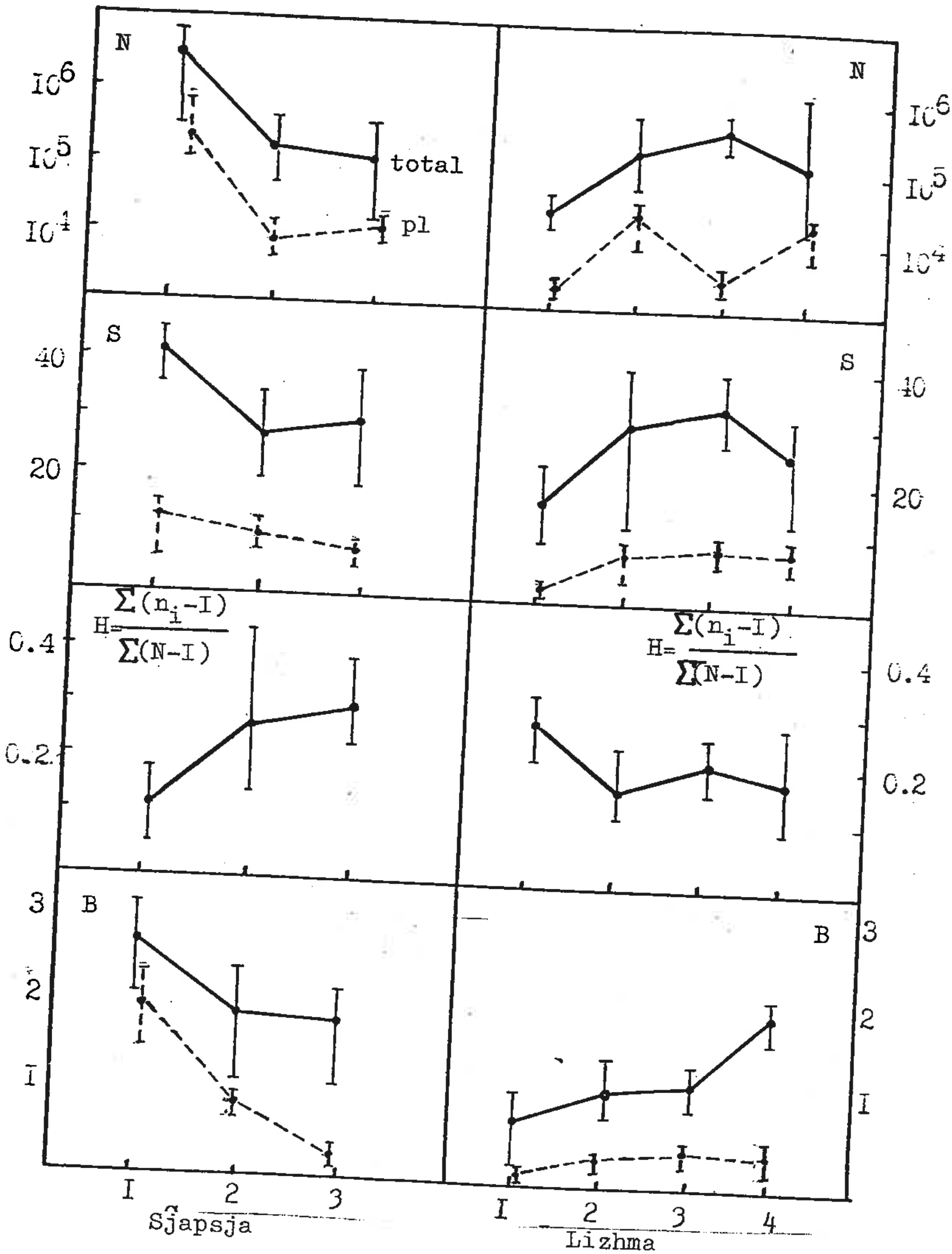


Fig.27. Density (N,cell), the abundance of species (S),specirs diversity (H), and biomass (B, mg cm^{-2}) of algae in periphyton.Sjapsja,pas- test rapids:
I- Tjukka, 2 "Krakylsky", 3- Sjapsja-lazma
Kizhma: I-B.Lizhma,2-3- Kedra-river,
4- N.Lizhma.

es variety and the highest productivity. Salmon juveniles are fully provided with food in such river portions because in fluvio - lacustrine systems zooplankton is removed from lakes and bottom invertebrates become more abundant.

The rivers in North Finland are characterized by less number of lakes. A certain effect of lakes is only felt in the river systems Tenojoki and Utsjoki,where the plankton fauna is more abundant and more varied specifically. The role of zooplankton as food for immature salmon decreases.

Permanent removal of phyto- and zooplakton fron lakes contributes to an increase in both the number and biomass of invertebrate predators. A decline in benthos indices away from lakes depends to a certain extent on a decrease in the amount of plankton (Fig.28). The advantage of rapids in lake outlets in terms of abundant benthos fauna is due to the imago of amphebian insects actively flying against the current. Both lakes and lake--skaped river portions provide a mayor natural impediment for further movement. The high concentration of both young and adult insect larvae is ensured by good trophic conditions related to the removal of mineral substances and organic matter from lakes.

Because the conditions are favourable in the above river portions, the downstream rapids are subsequently inhabited by migrants,i.e. the larvae of various insect groups that cannot compete for food and space on heterogeneous rocky substrate. Many caddis fly,stonefly,mayfly,black fly and chironomid species prefer certain ground types and current velocities. This makes them move actively along the river bottom and downstream.While moving in a stream, they become part of drift which makes them more accessible as food for juvenile salmon.

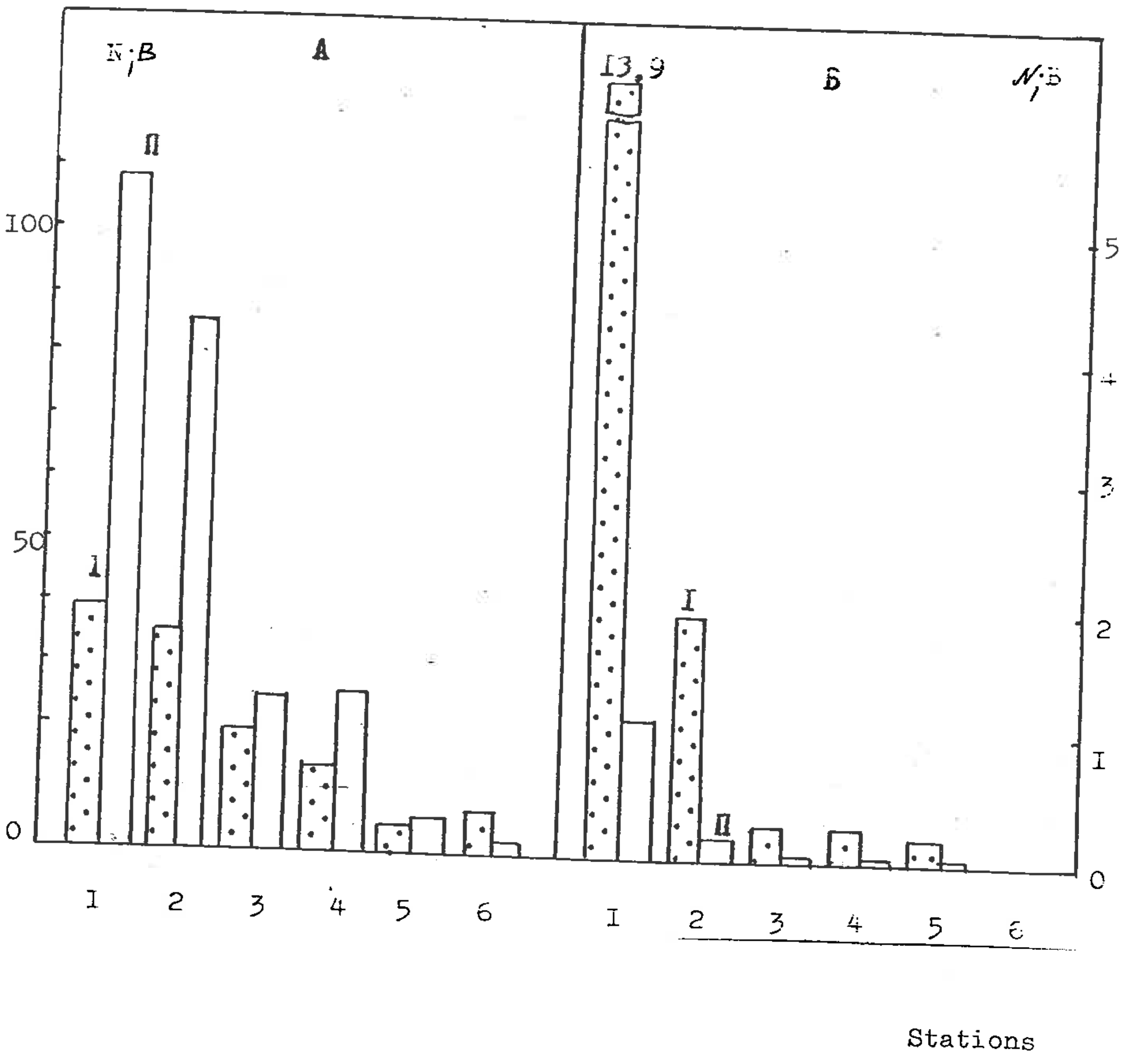


Fig.28. Value ratio of zoobenthos (A) and zooplankton (B) in r.Sjapsja in autumn,1982.
I- tr."Tjukka", 2- tr.Krakulsky, 3- "Manin most", 4- tr."Sjapsja-lazma", 5,6 -sites affected by reclamation.
A:- I- abundance, ths.sp./m^{-2}, II-biomass g/m^{-2}
B: I- abundance, ths.sp./m^{-2}, II-biomass,g/m^{-3}

The following characteristics of drift in the rivers studied can be distinguished. Compositionally, the systematic groups are relatively uniform, but qualitatively they are somewhat poorer than benthas.

The quantitative indices of drift are not identical and depend on many factors. Drift as food for Salmonidae is far more accessible than benthos. Drift is dominated by chironomid larvae and pupae as well as the imago and subimago of insects that account for a large fraction of total drift. The latter circumstance is important because immature Atlantic salmon actively feeds on the "aerial" fraction of drift.

Drifting invertebrates are most abundant in the rivers Utsjoki and Nizhnyaya Lizhma and least abundant in the River Simojoki. The drift level is generally higher in Karelian rivers thar in the Finnigh rivers studied.

The organic portion of the suspended matter in a lake (phyto- and zooplankton) is intensely transformed and utilized in the channel portions of fluvio-lacustrine systems, especially those closest to lake outlets. As a result, the development of zoobenthos is enhanced and the amount of drifting invertebrates increases, i.e. the food supply of juvenile salmon is enricked and the juveniles grow better.

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