

## ESTIMATION OF THE TROPHIC STATE OF LAKE VÖRTSJÄRV ON THE BASIS OF ROTIFERS (ROTATORIA)

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**Abstract.** Rotifers form 71% of the zooplankton species of the strongly eutrophic (total N  $2 \text{ g} \cdot \text{m}^{-3}$ , total P  $53 \text{ mg} \cdot \text{m}^{-3}$ ) Lake Võrtsjärv (Estonia), with *Anuraeopsis fissa*, *Keratella cochlearis*, *K. quadrata frenzeli*, *Polyarthra dolichoptera*, *P. luminosa*, *Synchaeta verrucosa*, and *Trichocerca rousseleti* making up 64% of all species.

Altogether 150 taxa of rotifers occur in the lake. Their number fluctuates from  $130.6 \cdot 10^{-3}$  (Dec) to  $2713.3 \cdot 10^{-3} \text{ ind} \cdot \text{m}^{-3}$  (May); biomass from 0.072 (Dec) to  $0.868 \text{ g} \cdot \text{m}^{-3}$  (May); production of grazers from 0.03 (Dec) to  $1.3 \text{ g C} \cdot \text{m}^{-2} \cdot \text{month}^{-1}$  (May); production of *Asplanchna* (*A. girodi*, *A. priodonta*) from 0.0001 (Dec) to  $0.02 \text{ g C} \cdot \text{m}^{-2} \cdot \text{month}^{-1}$  (Oct); food ration from 0.1 (Dec) to  $5.5 \text{ g C} \cdot \text{m}^{-2} \cdot \text{month}^{-1}$  (May); respiration from 0.04 (Dec) to  $5.5 \text{ g C} \cdot \text{m}^{-2} \cdot \text{month}^{-1}$  (Jun); assimilation from 0.1 (Dec) to  $6.1 \text{ g C} \cdot \text{m}^{-2} \cdot \text{month}^{-1}$  (Jun); daily production to biomass ratio of grazers is 0.6–0.27; that of *Asplanchna* is 0.02–0.1; mean weight of rotifers is from 0.0001 (Jul, Aug) to 0.0008 mg (Oct).

The contribution (%) of rotifers to total zooplankton between May and October (during the vegetative period) and across a year was: numbers 84 and 89; biomass 29 and 51; production of grazers and predators 35 and 58; respiration 29 and 49; food ration 35 and 55; assimilation 38 and 56%, respectively. The production of herbivorous rotifers is 46% of the total herbivorous zooplankton between May and October, and 65% across a year; the production of *Asplanchna* is respectively 14 and 10% of the whole predatory zooplankton production. The food ration of herbivores constitutes 39 and 62% of the food ration of all grazing zooplankton; the food ration of *Asplanchna* forms 2 and 3%, respectively, of the ration of the total predatory zooplankton.

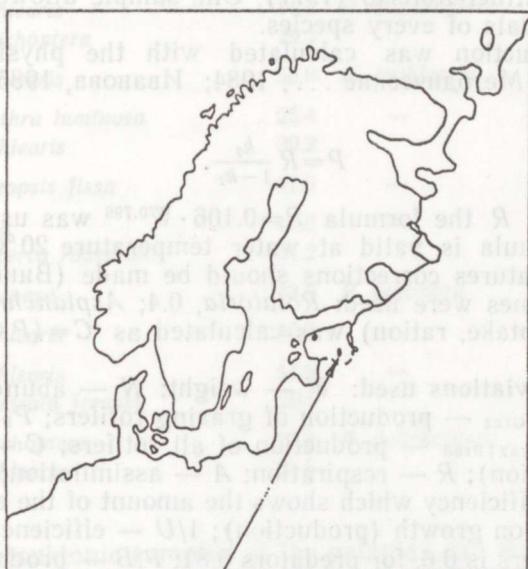
**Key words:** rotifers, abundance, biomass, production, percentage of rotifers in total zooplankton.

### INTRODUCTION

Lake Võrtsjärv, Estonia, is a large ( $270 \text{ km}^2$ ), shallow (mean depth 2.8 m, maximum depth 6 m) lake (Fig. 1). It is strongly eutrophic with the mean total N per year  $2 \text{ g} \cdot \text{m}^{-3}$  and the total P  $53 \text{ mg} \cdot \text{m}^{-3}$ . The water is alkaline (pH 7.5–8.5) with a great buffering capacity and a high seston content. During the ice-free period, the mean transparency does not exceed 1 m. The zooplankton abundance fluctuates between  $169 \cdot 10^3$

and  $4048 \cdot 10^3$  ind.  $\cdot m^{-3}$  and biomass between 0.1 and  $2.6 g \cdot m^{-3}$ ; Chl *a* content is 9.2–39.2 mg  $\cdot m^{-3}$ ; phytoplankton biomass 0.7–29.5 g  $\cdot m^{-3}$ . Dominant phytoplankton species are *Aulacoseira* spp. in spring and *Limnothrix redekei* (Goor) and *Planktolyngbya limnetica* (Lemm.) Kom. et Cronb. in summer and autumn (Haberman et al., 1995).

The dominance of rotifers in a eutrophic waterbody and their increasing share as eutrophication proceeds, are well-known phenomena (Reinertsen & Langeland, 1982; Gulati, 1983; 1984; Adamkiewicz-Chojnacka, 1983; Zánkai & Pónyi, 1986; Стерлигова et al., 1991). The present paper focuses on two main areas: (1) number, biomass, and production of rotifers; (2) share of rotifers in the whole zooplankton.



L. Vörtsjärv

Sample station

Fig. 1. Location of Lake Vörtsjärv and the sampling station.

## MATERIAL AND METHODS

For estimating the number, biomass, and production of rotifers the plankton of Lake Võrtsjärv was investigated from 1989 till 1993 (in 1990, 1992, and 1993 monthly; in 1989 and 1991 weekly). Samples were taken with a quantitative Juday net of 85 µm mesh in 1989 and 1990 and with a bathometer in 1991, 1992, and 1993 in the monitoring station of the lake (Fig. 1), from a depth of 5 m. Because plankton nets of this mesh size are too coarse for rotifers, correction coefficients were used. The coefficients, calculated from the comparison of simultaneous net and bathometer samples, increased rotifer numbers on an average eight times. The coefficients for dominant species were as follows: *Keratella cochlearis*, 8; *K. quadrata*, 6; *Polyarthra dolichoptera* and *P. luminosa*, 8; *Anuraeopsis fissa*, 27; *Trichocerca rousseleti*, 25.

The individual weights of rotifers were calculated from average body lengths after Ruttner-Kolisko (1977). One sample allowed to measure at least 20 individuals of every species.

Rotifer production was calculated with the physiological method (Waters, 1977; Методические..., 1984; Иванова, 1985) by using the formula

$$P = R \frac{k_2}{1-k_2}.$$

For determining  $R$  the formula  $R = 0.106 \cdot W^{0.796}$  was used (Галковская, 1980). This formula is valid at water temperature 20°C; in the case of different temperatures corrections should be made (Винберг, 1983). The following  $k_2$  values were used: *Rotatoria*, 0.4; *Asplanchna*, 0.3. The food consumption (uptake, ration) was calculated as  $C = (P+R)/U$ .

**List of abbreviations used:**  $W$  — weight;  $N$  — abundance (number);  $B$  — biomass;  $P_{\text{Graz}}$  — production of grazing rotifers;  $P_{\text{Pred}}$  — production of predators;  $P_{\text{Graz+Pred}}$  — production of all rotifers;  $C$  — food consumption (uptake, ration);  $R$  — respiration;  $A$  — assimilation;  $k_2$  — coefficient of assimilation efficiency which shows the amount of the energy of assimilated food spent on growth (production);  $1/U$  — efficiency of food utilization ( $U$  for grazers is 0.6, for predators 0.8);  $P/B$  — production to biomass ratio.

For the calculation of concentrations per  $m^2$ , the depth of the monitoring sample spot used was 5.0 m.

The following coefficients were used in rotifer calculations: 1 mg wet biomass = 0.056 mg  $C$  = 0.6 cal = 2.57 J (Иванова, 1979).

## RESULTS AND DISCUSSION

A total of 150 taxa of rotifers were identified (Kutikova & Haberman, 1986). Rotifers account for 71% of all zooplankton species and 64% of the dominant zooplankton species in L. Võrtsjärv. The species whose numbers and biomass at some time reached 20% or more of the total zooplankton were considered dominants (Хаберман, 1977). These were *Anuraeopsis fissa* (Gosse), *Keratella cochlearis* (Gosse), *K. quadrata frenzeli* (Eckst.), *Polyarthra dolichoptera* Idels., *P. luminosa* Kut., *Synchaeta verrucosa* Nipk., and *Trichocerca rousseleti* (Voigt) (Table 1).

The species composition of the rotifers of L. Võrtsjärv is the result of two factors. First, the shallowness of the lake, with a weakly indented shoreline, mostly low unforested shores (strong influence of winds mixing waters to the bottom) causes only slight differences in the species com-

Table 1

Dominance (%) of rotifer species in the total zooplankton number and biomass

Month	Number		Biomass	
I	<i>Synchaeta verrucosa</i>	33.4	<i>S. verrucosa</i>	49.2
	<i>Polyarthra dolichoptera</i>	29.7	<i>P. dolichoptera</i>	26.2
	<i>Keratella cochlearis</i>	23.4		
II	<i>P. dolichoptera</i>	45.4	<i>P. dolichoptera</i>	36.3
	<i>S. verrucosa</i>	21.5	<i>S. verrucosa</i>	36.2
III	<i>P. dolichoptera</i>	45.1	<i>S. verrucosa</i>	30.6
	<i>Keratella quadrata frenzeli</i>	20.0	<i>P. dolichoptera</i>	29.0
	<i>S. verrucosa</i>	20.0		
IV	<i>K. cochlearis</i>	44.5	<i>P. dolichoptera</i>	22.0
	<i>P. dolichoptera</i>	29.1		
V	<i>K. cochlearis</i>	50.0	<i>K. cochlearis</i>	20.9
VI	<i>Polyarthra luminosa</i>	25.4	—	
	<i>K. cochlearis</i>	20.2		
VII	<i>Anuraeopsis fissa</i>	41.9	—	
VIII	<i>A. fissa</i>	45.0	—	
	<i>Trichocerca rousseleti</i>	31.2		
IX	<i>P. luminosa</i>	43.0	<i>P. luminosa</i>	24.2
X	<i>K. cochlearis</i>	40.5	—	
XI	<i>K. cochlearis</i>	44.6	—	
	<i>K. quadrata frenzeli</i>	20.5		
XII	<i>P. dolichoptera</i>	22.2	<i>P. dolichoptera</i>	22.2
	<i>K. cochlearis</i>	21.5		

position of the planktonic complex of the pelagial and the littoral. Second, rotifer species characteristic of oligo- and mesotrophic waters have totally disappeared during the last 30 years or are disappearing. The rotifer population now consists of species characteristic of eutrophic waters. Together with the rise of the trophic level the number of some species has decreased, while that of others has increased (Table 2).

Winter dominants in L. Võrtsjärv are *S. verrucosa* and *P. dolichoptera* (sometimes also *K. quadrata frenzeli* and *K. cochlearis*) (Table 1). *S. verrucosa*, a cold stenotherm, is present from October to May at temperatures 0—14°C. Its development is most intense in early spring (Apr) at temperatures 2.1—5.5°C. In May, at 6—14°C, the species is insignificant and disappears at the end of May.

*P. dolichoptera* is found at the same temperatures as *S. verrucosa*. Appearing also in October when temperatures reach 9°C, its population increases rapidly to high numbers during winter. Its development comes to an end in May, after the population maximum in April.

In May, *S. verrucosa* is replaced by summer species like *S. grandis* Zach., *S. kitina* Rouss., *S. longipes* Gosse, *S. oblonga* Ehrb., *S. pectinata* Ehrb., and *S. stylata* Wierz. None of them ever occur as dominants. *P. dolichoptera* is replaced by *P. luminosa*. At the same time, there appear sporadically *P. major* Burckh., *P. minor* Voigt, *P. remata* Skor., and *P. vulgaris* Carl. *P. luminosa* develops from May to October with maxima in June and September.

## Changes in the composition of rotifers in 1964–94

Totally disappeared	Nearly disappeared	Abundance has increased	Abundance has decreased
<i>Asplanchna herricki</i> Guerne	<i>Bipalpus hudsoni</i> (Imhof)	<i>Anuraeopsis fissa</i> (Gosse)	<i>Asplanchna girodi</i> Guerne
	<i>Conochilus unicornis</i> Rouss.	<i>Brachionus angularis</i> (Gosse)	<i>Gastropus stylifer</i> Imhof
	<i>Euchlanis lucksiana</i> Hauer	<i>B. calyciflorus amphiceros</i> Ehrb.	<i>Keratella hiemalis</i> Carlin
	<i>Kellicottia longispina</i> (Kellicott)	<i>B. c. calyciflorus</i> Pallas	<i>Notholca squamula</i> (Müller)
		<i>Keratella cochlearis</i> (Gosse)	
		<i>K. c. tecta</i> (Gosse)	
		<i>Pomholyx sulcata</i> Huds.	

For determining  $R$  the formula of Trichocerca capucina (Wierz. et Zach.) (1980). This formula is valid at different temperatures corrections following  $k_1$  values were used:  $k_1 = 0.9$  (normal),  $k_1 = 0.8$  (low) and  $k_1 = 0.9$  (high). The consumption (uptake, ration) was considered as  $C = R \cdot R_{max} / R_{max}$ . The case of *T. rousseleti* (Voigt) (1983) is similar.

*K. cochlearis* s.l. is present practically around the year in several seasonally alternating ecological morphs: *K. cochlearis* s.s. (Gosse), *K. cochlearis macracantha* (Laut.), *K. cochlearis tecta* (Gosse), *K. cochlearis pustulata* (Laut.). The last two are limited to the warm season (Eloranta, 1982; Virro & Haberman, 1993). *K. cochlearis* has always been a dominant species in L. Võrtsjärv (Haberman, 1983), but its numbers have particularly grown in recent years; the share of *K. c. tecta* has increased too. The elevating trophic state of lakes is accompanied by the growth of the proportion of the "tecta" form in the population of *K. cochlearis*. This relationship is described by the regression  $TSI = 0.285 \text{ KCT} + 45.22$ , where TSI is the trophic state index and KCT is the proportion (%) of the "tecta" form in the population (Karabin & Ejsmont-Karabin, 1993). In recent years, *K. c. tecta* has accounted on average for 89% of the biomass of the whole *K. cochlearis* population in July and August, TSI being 71. A similar relation between the increased proportion of *K. c. tecta* and the lake's trophic level has been observed also in the Great Masurian Lakes (Karabin & Ejsmont-Karabin, 1993) and in the North Swedish Lakes (Nilsson & Pejler, 1973). Pejler (1962) found a strong correlation between the trophic degree and the spine length of *K. cochlearis* in Swedish lakes during summer. In oligotrophic lakes only more or less long-spined individuals occurred in summer, while forms with short spines or without spines dominated in eutrophic lakes.

Although *K. quadrata frenzeli* is not a numerous species in L. Vörtsjärv, it dominated there in March and November (Table 1). In L. Vörtsjärv it is represented with three forms: typical form I (total length 280—300  $\mu$ , length of posterior spines 80—100  $\mu$ ), form II (total length 300—320  $\mu$ , length of posterior spines 110—140  $\mu$ ), and form III (total length 210—240  $\mu$ , length of posterior spines 44—64  $\mu$ ).

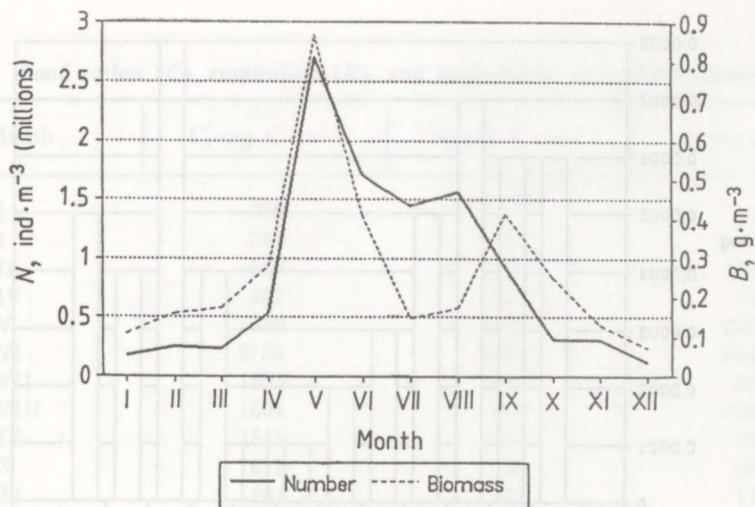


Fig. 2. The number and biomass of rotifers in Lake Võrtsjärv, 1989—93.

In the warmest months (Jul, Aug), the small-bodied *A. fissa* and *T. rousseleti* are abundant (Table 1). Their share in L. Võrtsjärv has grown during recent years (Haberman, 1976; 1995). *A. fissa* is a well-known indicator of eutrophy (Pejler, 1965; Gulati, 1990). As it feeds predominantly on detritus and bacteria (Pourriot, 1977), L. Võrtsjärv is a suitable habitat for this species. The rise of the lake's trophic level is often evidenced by the greater importance of *Trichocerca* spp. In L. Võrtsjärv this genus is represented by 14 species; among them the summer dominant *T. rousseleti* occurs. *A. fissa* and *T. rousseleti* are present from May (with a low abundance) to late September.

*Kellicottia longispina* and *Conochilus unicornis* are known as species favoured by a lower trophic level (Pejler, 1965; Кутикова, 1970). Both species dominated in the zooplankton of L. Võrtsjärv in the 1960s (Haberman, 1976) while at present, due to a rise of the trophic level, they have practically disappeared from plankton (Fig. 2). It is probable that the highly abundant *Keratella cochlearis* contributed to supplanting its food competitors *C. unicornis* and *K. longispina* (Pejler, 1957; Hakkari, 1969).

The abundance of rotifers in L. Võrtsjärv is high (Fig. 2), fluctuating between  $131 \cdot 10^3$  ind·m<sup>-3</sup> (Dec) and  $2713 \cdot 10^3$  ind·m<sup>-3</sup> (May) through the year. The average abundances are as follows: summer months (Jun, Jul, Aug)  $1573 \cdot 10^3$  ind·m<sup>-3</sup>, winter months (Dec, Jan, Feb, March)  $196 \cdot 10^3$  ind·m<sup>-3</sup>, vegetation period (from May to Oct)  $1443 \cdot 10^3$  ind·m<sup>-3</sup>, whole year  $856 \cdot 10^3$  ind·m<sup>-3</sup>. A high, statistically significant ( $R=0.71$ ) relationship was found between the abundance of rotifers and the trophic state index:  $TSI=26.15 N^{0.11}$  (Karabin & Ejsmont-Karabin, 1993). A rise of the trophic state of a waterbody is followed by an increase in rotifer abundance. TSI fluctuates between 45 and 62.4 during the year and between 49 and 62.4 during the vegetation period in L. Võrtsjärv. A comparison of the rotifer abundance of two large Estonian lakes, the strongly eutrophic L. Võrtsjärv and the moderately eutrophic L. Peipsi (Virro & Haberman, 1993), shows that the numbers in the latter are 2—3 times lower.

Rotifer biomass in L. Võrtsjärv is rather small (Fig. 2), which is to be expected considering the big share of small-bodied species (Table 1). It varies between 0.072 (Dec) and 0.868 g·m<sup>-3</sup> (May) through the year.

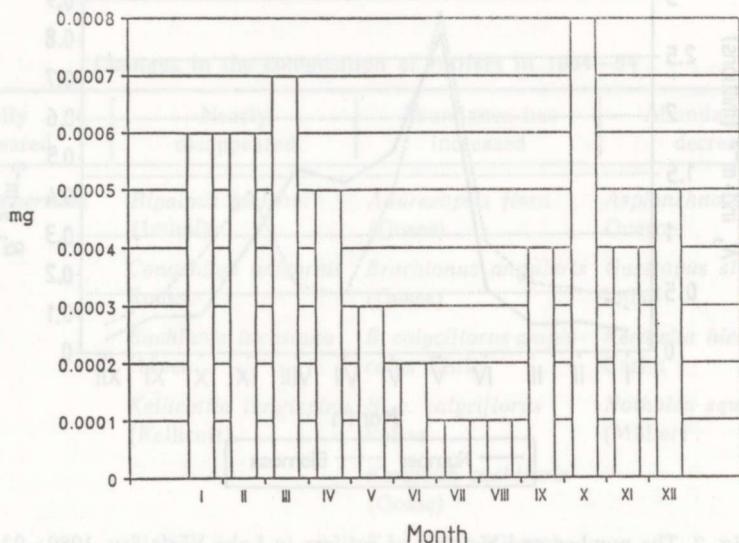
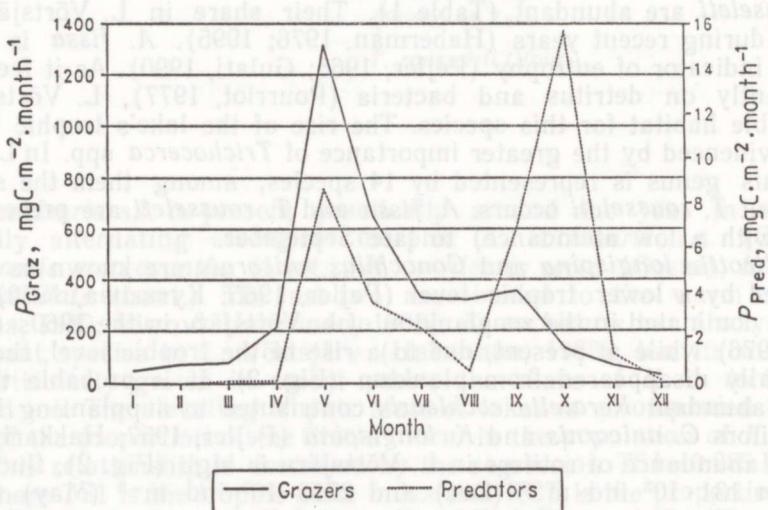
Fig. 3. The mean weight ( $B : N$ ) of rotifers in Lake Võrtsjärv, 1989–93.

Fig. 4. The production of rotifers in Lake Võrtsjärv, 1989–93.

The average biomasses are: summer months (Jun, Jul, Aug)  $0.243 \text{ g} \cdot \text{m}^{-3}$ , winter months (Dec, Jan, Feb, March)  $0.128 \text{ g} \cdot \text{m}^{-3}$ , vegetation period  $0.376 \text{ g} \cdot \text{m}^{-3}$ , whole year  $0.265 \text{ g} \cdot \text{m}^{-3}$ .

Biomass depends on the weight of rotifer species. The mean weight ( $B : N$ ) of rotifers in L. Võrtsjärv is small (Fig. 3), fluctuating between 0.0001 (Jul–Aug) and 0.0008 mg (Oct). Its average for the vegetation period is 0.0002 and for the whole year 0.0003 mg. In the eutrophic lakes of Poland the mean weight is also small (0.0001 mg and even smaller in Jul–Aug) (Karabin & Ejsmont-Karabin, 1993). The mean weight of rotifer communities decreases as the trophic state rises. This is the result of the increasing dominance of small sedimentators whose basic food is the bacteria—detritus suspension. The relationship between rotifer mean

Table 3

Food ration ( $C$ ), respiration ( $R$ ), and assimilation ( $A$ ) of the rotifers

Month	$C, \text{mg C} \cdot \text{m}^{-2}$	$R, \text{mg C} \cdot \text{m}^{-2}$	$A, \text{mg C} \cdot \text{m}^{-2}$
I	200	72	120
I	314	113	188
II	338	122	203
IV	897	323	538
V	5539	2001	3330
VI	2756	5483	6145
VII	1523	497	827
VIII	1604	630	1053
IX	1515	551	915
X	617	235	383
XI	287	104	173
XII	134	36	69
Average between May and October	2259	1566	2109
Average of year	1310	847	1162

weight and the trophic state of a lake can be described by the function  $\text{TSI} = 7.19 (B : N)^{-0.29}$  (Karabin & Ejsmont-Karabin, 1993). The average TSI of the vegetation period in L. Võrtsjärv is 82.5.

The seasonal dynamics of rotifer mean weight in L. Võrtsjärv (Fig. 3) is typical of a strongly eutrophic lake with the summer dominance of especially small-bodied rotifers. In cold-water months, owing to the dominance of relatively large-bodied *S. verrucosa* (0.001 mg) the mean weight is much higher than in the warm-water period, particularly in July—August. The small weight during the vegetation period is caused by two factors: (1) predominance of small rotifers (*A. fissa* — 0.00004 mg, *K. cochlearis* — 0.0001—0.0002 mg, *P. luminosa* — 0.0005 mg, *T. rousseleti* — 0.00006 mg; see Table 1), and (2) disappearance of several bigger species (*A. herricki*, *B. hudsoni*, *E. lucksiana*; Table 2).

The large mean weight in October is caused by the co-occurrence of the genus *Asplanchna* (*A. priodonta*, *A. girodi*) and *S. verrucosa* in the lake.

Rotifer production in L. Võrtsjärv is modest (Fig. 4),  $P_{\text{Graz+Pred}}$  varying between 0.03 (Dec) and 1.3 g C · m<sup>-2</sup> · month<sup>-1</sup> (May). The average of the vegetative period is 0.5 g C · m<sup>-2</sup> · month<sup>-1</sup>, that of the whole year is 0.3 g C · m<sup>-2</sup> · month<sup>-1</sup>. The production of grazers constitutes 99% and the production of the genus *Asplanchna* 1% of the production of all rotifers during the vegetative period. Rotifer production ( $P_{\text{Graz+Pred}}$ ) of three summer months (Jun, Jul, Aug, 1.3 g C · m<sup>-2</sup>) makes up 36% of the annual production, the production of four winter months (Dec, Jan, Feb, March, 0.2 g C · m<sup>-2</sup>) 6.4%, the production of the vegetative period (May to Oct) 86%. The production of rotifers is the highest in May (1.3 g C · m<sup>-2</sup>), forming 36% of the annual production.

Daily  $P/B$  coefficients (specific productivity of biomass) of herbivorous rotifers fluctuate between 0.05 (Jan, Dec) and 0.27 (Jul), with an average of 0.12; those of predators from 0.02 (March) to 0.10 (Jul, Aug), with an average of 0.04. Between May and October, the  $P/B$  of grazers is 20.9, that of predators 10.8. According to Ivanova (Иванова, 1985) the  $P/B$

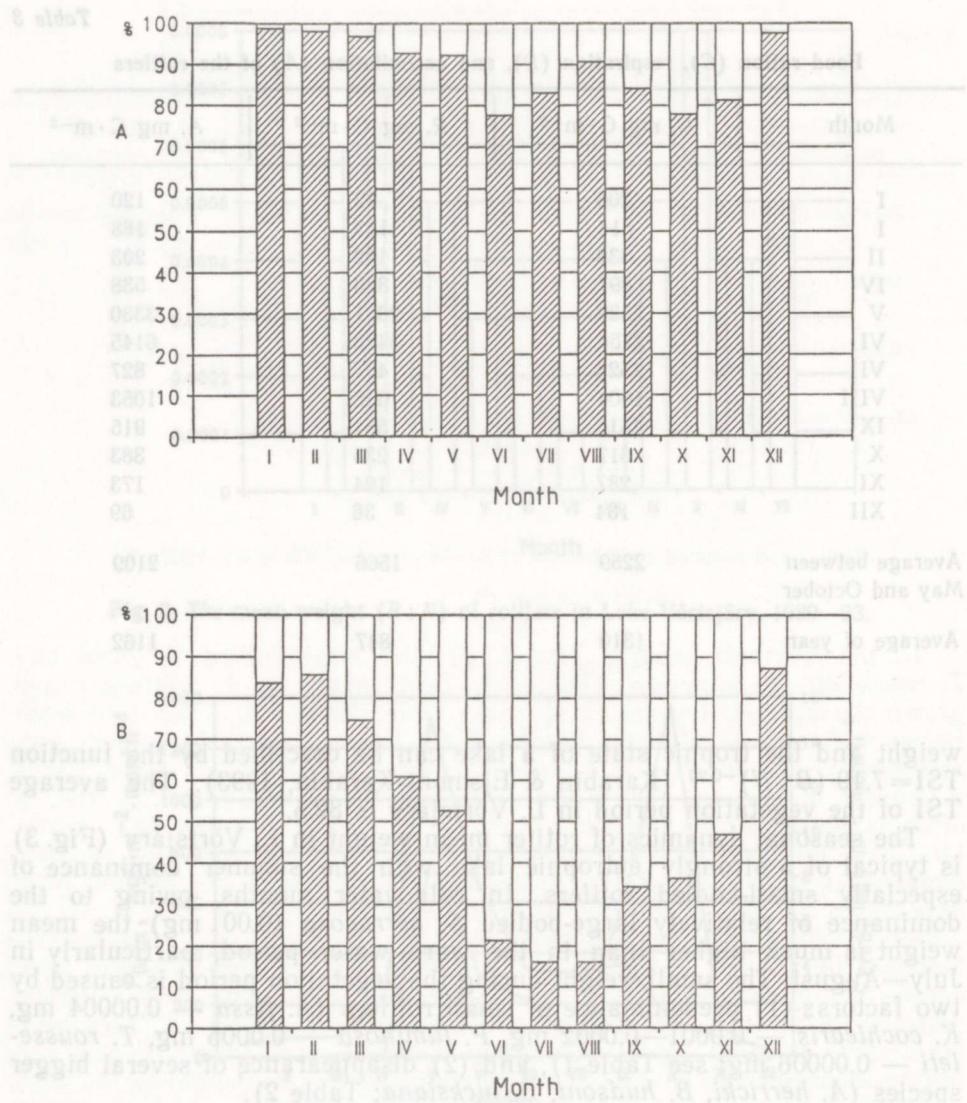


Fig. 5. The percentage of rotifers in the total zooplankton number (A) and biomass (B) in Lake Vörtsjärv, 1989–93.

coefficients for herbivorous crustaceans range from 4.3 to 45, for predatory forms from 1.9 to 37.8. Annual average  $P/B$  coefficients are  $14.5 \pm 3.5$  and  $9.4 \pm 1.5$ , respectively. The  $P/B$  coefficients of herbivorous rotifers in L. Vörtsjärv correlate well with the water temperature ( $r=0.815$ ).

Data on the seasonal dynamics of the food ration ( $C$ ), respiration ( $R$ ), and assimilation ( $A$ ) of rotifers are given in Table 3.

The contribution of rotifers to total zooplankton abundance, biomass, production, food ration, respiration, and assimilation is shown in Figs. 5–7. This confirms the great share of rotifers in a eutrophic waterbody. The average contribution (%) of rotifers to total zooplankton between May and October and through the year is as follows: abundance 84 and 89, biomass 29 and 51, production ( $P_{Graz+Pred}$ ) 35 and 58; respiration 27 and 47; food ration ( $C_{Graz+Pred}$ ) 35 and 55; assimilation 38 and 56, respectively.

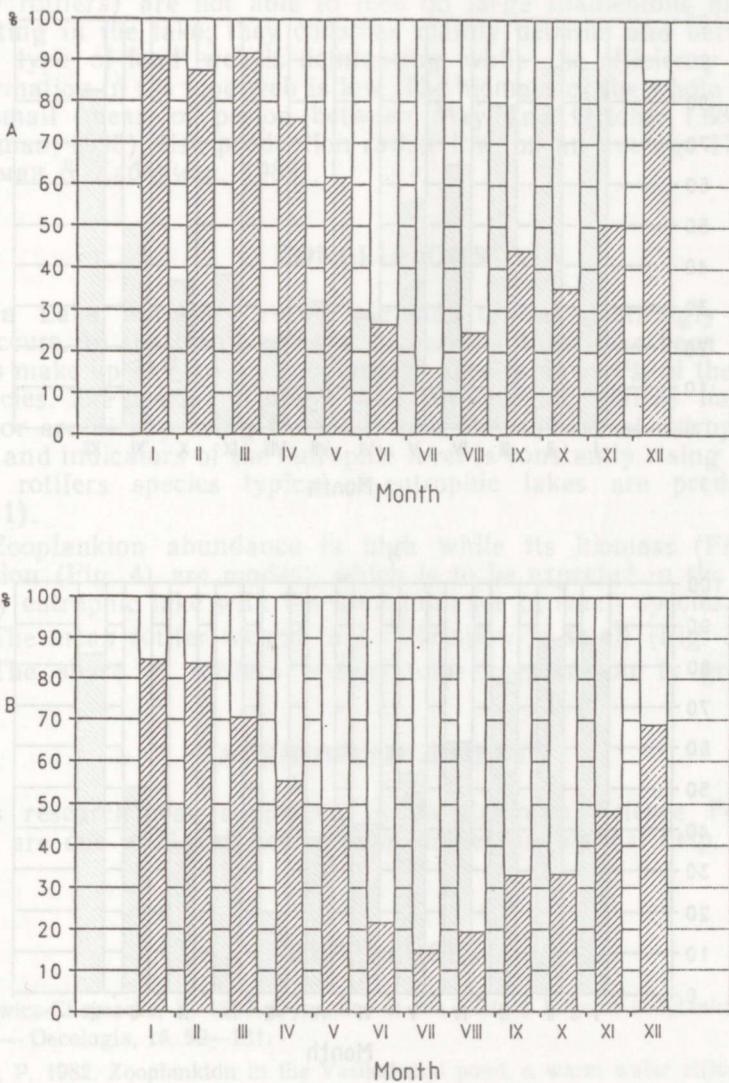


Fig. 6. The percentage of rotifers in the total zooplankton production (A) and respiration (B) in Lake Võrtsjärv, 1989–93.

The production of herbivorous rotifers ( $P_{Graz}$ ) is 46% of the total herbivorous zooplankton production between May and October, and 65% through the year; the production of *Asplanchna* is 14 and 10 of the total predatory zooplankton production. The food ration of grazing rotifers constitutes 39 and 62% of the ration of all grazing zooplankton; the ration of the *Asplanchna* forms 2 and 3% of the total predatory zooplankton food ration. Most researchers treat genus *Asplanchna* species as semi-predators (Казанцева & Смирнова, 1986; Парчук, 1990; Haberman, 1990); however, feeding on algae has also been established (Тимохина, 1983). The latter is possible also in the case of L. Võrtsjärv.

Rotifers dominate, by abundance, all the year round but their share is greater in cold water when they are often the only zooplankters present. Considering other criteria (biomass, production, food ration, respiration, assimilation), rotifers dominate in December, January, February, March,

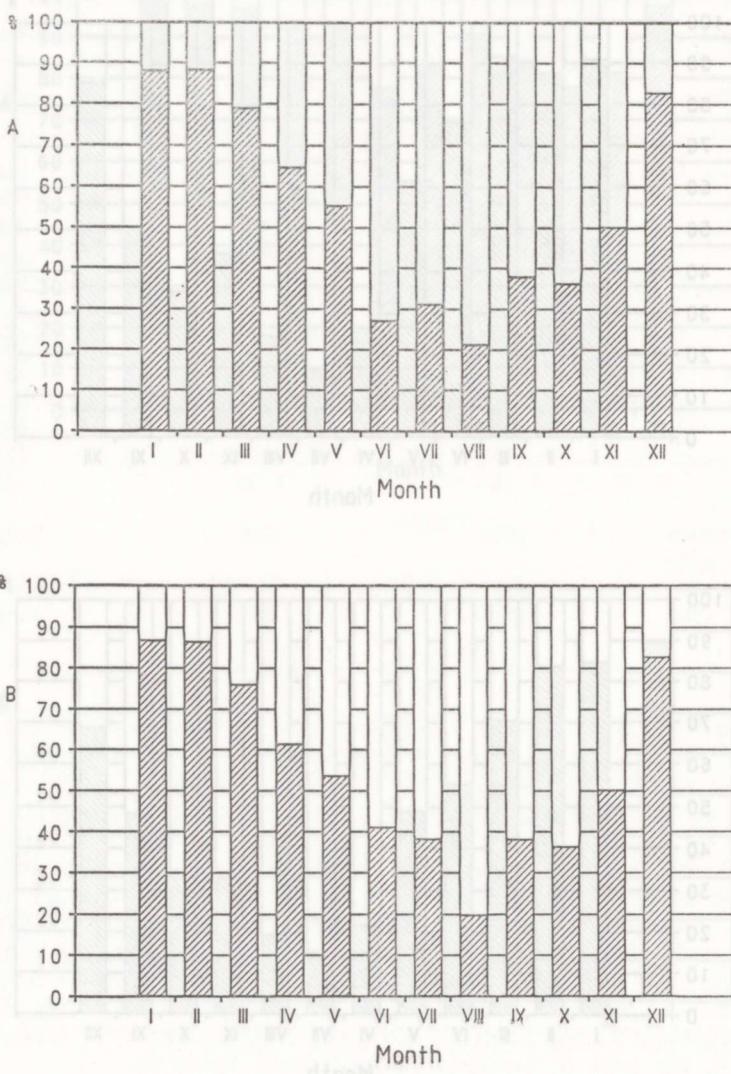


Fig. 7. The percentage of rotifers in the total zooplankton food ration (A) and assimilation (B) in Lake Võrtsjärv, 1989—93.

April, and May. In other months crustaceans dominate over rotifers. The causes of the spring dominance of rotifers between May and October are: (1) they attain sexual maturity most quickly and are the earliest to reach their maximum; (2) the rise of temperature in spring is sufficient for the reproduction of rotifers but still too low for cladocerans (food competitors for rotifers); (3) in spring, the number of eggs per individual is high. Such a fertility of the first generation in comparison with the subsequent ones is characteristic of the whole zooplankton. Rotifer dynamics can therefore be considered as an adaptation to the dynamics of the other zooplankton, in finding a "seasonal niche" in which competition is the lowest.

The great role of rotifers has notably influenced the total zooplankton community and the total ecosystem of L. Võrtsjärv. The mean weight of the whole zooplankton is small (0.0004—0.2 mg). Small zooplankters

(mainly rotifers) are not able to feed on large filamentous blue-greens dominating in the lake; they consume mainly detritus and bacteria. The detrital type of food web is dominating while the efficiency of energy transformation in the food web is low. The biomass of the whole zooplankton is small (mean of period between May and October  $1.681 \text{ g} \cdot \text{m}^{-3}$ ) (Haberman, 1995), fish production rather low, on an average  $17 \text{ kg} \cdot \text{ha}^{-1}$  (Хаберман & Хаберман, 1989).

## CONCLUSIONS

1. In Lake Võrtsjärv rotifer plankton typical of strongly eutrophic lakes occurs. In the lake's pelagic 180 rotifer taxa have been identified. Rotifers make up 71% of the zooplankton species and 64% of the dominating species. The species of oligo- and mesotrophic waters have disappeared or are disappearing from the lake; the number of eutrophic water species and indicators of the eutrophic level is constantly rising (Table 2). Among rotifers species typical of eutrophic lakes are predominating (Table 1).

2. Zooplankton abundance is high while its biomass (Fig. 2) and production (Fig. 4) are modest, which is to be expected in the case of a strongly eutrophic lake with the predominance of small species.

3. The mean rotifer weight in L. Võrtsjärv is small (Fig. 3).

4. The share of rotifers among total zooplankton is great (Figs. 5–7).

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## KERILOOMAD (ROTATORIA) VÖRTSJÄRVE TROOFSE ISELOOMUSTAJATENA

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Võrtsjärves on tüüpiline tugevalt eutroofsete järvede keriloomaplankton. Järve pelagiaalis on kindlaks tehtud 150 keriloomataksonit. 71% zooplanktoni liikidest ning 64% domineerivatest liikidest on keriloomad. Oligo- ja mesotroofsete vete zooplanktoni liigid on Võrtsjärvest kadunud või kadumas, pidevalt suurenib eutroofsete vete liikide ning eutroofsuse indikaatorite arvukus. Keriloomade arvukus on suur, kuid biomass ja produktsioon tagasihoidlikud. See on ootuspärale tugevalt eutroofse järve puhul, kus on ülekaalus väikesed liigid. Kerilooma keskmise kaal on Võrtsjärves väike, keriloomade osa kogu zooplanktonis aga suur. Arvukuselt domineerivad keriloomad planktonis terve aasta, teiste näitajate (biomass, produktsioon, toidutarve, hingamine, assimilatsioon) alusel domineerivad keriloomad talvel ning maikuus. Keriloomi on kõige rohkem mais.

## ХАРАКТЕРИСТИКА СТЕПЕНИ ТРОФНОСТИ ОЗЕРА ВЫРТСЪЯРВ НА ОСНОВЕ КОЛОВРАТОК

Юта ХАБЕРМАН

В озере Выртсъярв обитает типичный коловраточный зоопланктон, характерный для сильно эвтрофных озер. В пелагиали озера установлено 150 таксонов коловраток, составляющих 71% всех видов зоопланктона и 64% доминирующих видов. Зоопланктеры олиго- и мезотрофных вод или исчезли из озера или находятся на грани исчезновения, постоянно увеличивается численность видов эвтрофных вод и индикаторов эвтрофии. Среди коловраток доминируют типичные виды эвтрофных озер. Численность коловраток большая, но биомасса и продукция скромные, чего и следует ожидать в сильно эвтрофном озере, где доминируют мелкие виды. Средний вес коловраток в озере Выртсъярв незначительный, их значение в зоопланктоне велико. По численности коловратки доминируют в зоопланктоне круглый год, по другим показателям (биомасса, продукция, потребность в пище, дыхание, ассимиляция) они превалируют зимой и в мае. Численность коловраток наиболее высока в мае.