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STUDIES ON THE PREDATORY ROLE OF THE CLADOCERAN, *LEPTODORA KINDTII* (FOCKE), IN SECONDARY PRODUCTION OF TWO LAKES WITH DIFFERENT TROPHY*

ABSTRACT: The mean biomass in two summer months for the layers: epi– plus metalimnion was 0.71 for Mikołajskie Lake, and 0.39 g/m^3 for lake Tałtowisko, and the production was 4.00 and 3.13 g/m^3, respectively. The daily food ration in Mikołajskie Lake was 30% of body weight of an *L. kindtii* individual, and 40% in lake Tałtowisko. The pressure of this predator on its food (filtrating cladocerans) is great; in lake Tałtowisko *L. kindtii* eliminated almost 50% of the *Cladocera* production in summer months.

1. INTRODUCTION

Leptodora kindtii (Focke) is a common planktonic predator in various trophic types of freshwater lakes (from a-mezotrophy to eutrophy) (J. Patalas and K. Patalas 1961), in ponds, and also in brackish waters, e.g., Szczecin Bay. Despite its wide distribution it is not very abundant – from 100 to 2 000 individuals/m^3.

Hydrobiological literature provides plenty of data on the occurrence and biomass of *L. kindtii*, but there are scarce data on the production of this species (Lebedev and Malcman 1967, Shcherbakov 1967, Cummins et al. 1969). The papers dealing more broadly on the subject of *L. kindtii* concern mainly the morphology (Sebestyen 1931, Cheremisova 1960), development in natural and laboratory conditions (Mordukhaï-Boltovskaya 1957, Sebestyen 1947), and also feeding in conditions of laboratory experiment (Mordukhaï-Boltov-

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skaya 1958, 1960). Recently a group of ecologists at the Pittsburgh University have presented several papers on biology and energy balance of this species (Costa and Cummins 1969, Cummins et al. 1969, Moshiri and Cummins 1969, Moshiri, Cummins and Costa 1969).

L. kindtii is one of the few bigger invertebrate predators in the lake pelagial. Thus the significance of this species as an effectively acting predator may be quite considerable for the functioning of the zooplanktonic community, mainly due to its wide distribution and its size, which exceeds 1 cm. Although the possibility of pressure of *L. kindtii* on zooplankton has been frequently pointed out (grazing may reach, e.g., 25–35% of *Daphnia* production – Hall 1964, Wright 1965), still the data on these numbers are very few.

2. FIELD AND METHODS

The studies were conducted in Mikołajskie Lake and lake Tałtowisko, belonging to the Great Lakes Lakeland (Masurian District, Northern Poland). Mikołajskie Lake is a holomictic, eutrophic lake with typical thermal and oxygen stratification (Paschalski 1960). It has 460 ha of surface, mean depth 11.0 m, maximal depth 27.8 m (Rybak 1972). Lake Tałtowisko is a b-mezotrophic lake (Olszewski and Paschalski 1959). It has 327 ha of surface, mean depth 14.0 m, maximal dept 39.5 m (Kajak, Hillbricht-Ilkowska and Pieczyńska 1972).

The studies were carried out in Mikolajskie Lake in May and from July to September 1967, in weekly intervals; in lake Tałtowisko from June to September, every two, three weeks (in 1968). Samples were taken with a 5-litre plankton sampler of Bernatowicz type. Catches with the net do not represent satisfactorily the real density of *L. kindtii* individuals in the habitat (Karabin 1971). Each series of samples consisted of three, mixed together, samples representing: epilimnion (0–7 m) metalimnion (8–11 m) and hypolimnion (from 12 m to the bottom) – in case of Mikołajskie Lake to the depth of 24 m, and in case of Tałtowisko – 30 m. In both top layers, samples were taken every metre, and in the bottom layer – every 3 m. Samples from particular layers were filtrated through a bolting cloth of a mesh size about 60 μ. The condensed samples were fixed in 4% formalin. The small numbers of *L. kindtii* and the size of examined individuals made it necessary to investigate the entire, mixed together, sample in order to determine their real number. The methods for estimating the food ratio and pressure of *L. kindtii* on zooplankton will be given together with the discussion on the subject.

3. RESULTS

3.1. Dynamics of numbers, age structure and population fertility

The factor determining the development of *L. kindtii* population is the temperature – the first individuals appear in spring, at 8–10°C (Cheremisova 1960, Cummis et al. 1969). In lake Tałtowisko (1968) the first individuals were observed in the sample taken on June 4, at 11.5°C. These were young individuals in the first and second development stage. Then the numbers were 30 ind./m^3. In Mikołajskie Lake the moment when the young ones hatch out of the wintering eggs had not been grasped. When the first samples were taken (May 15) the individuals were already in all development stages (sexually mature individuals were 29% of the population) – (Fig. 1). Considering the temperature of water in this month it has to be assumed that the young ones hatched in the first 10 days of May at temperature about 8°C.

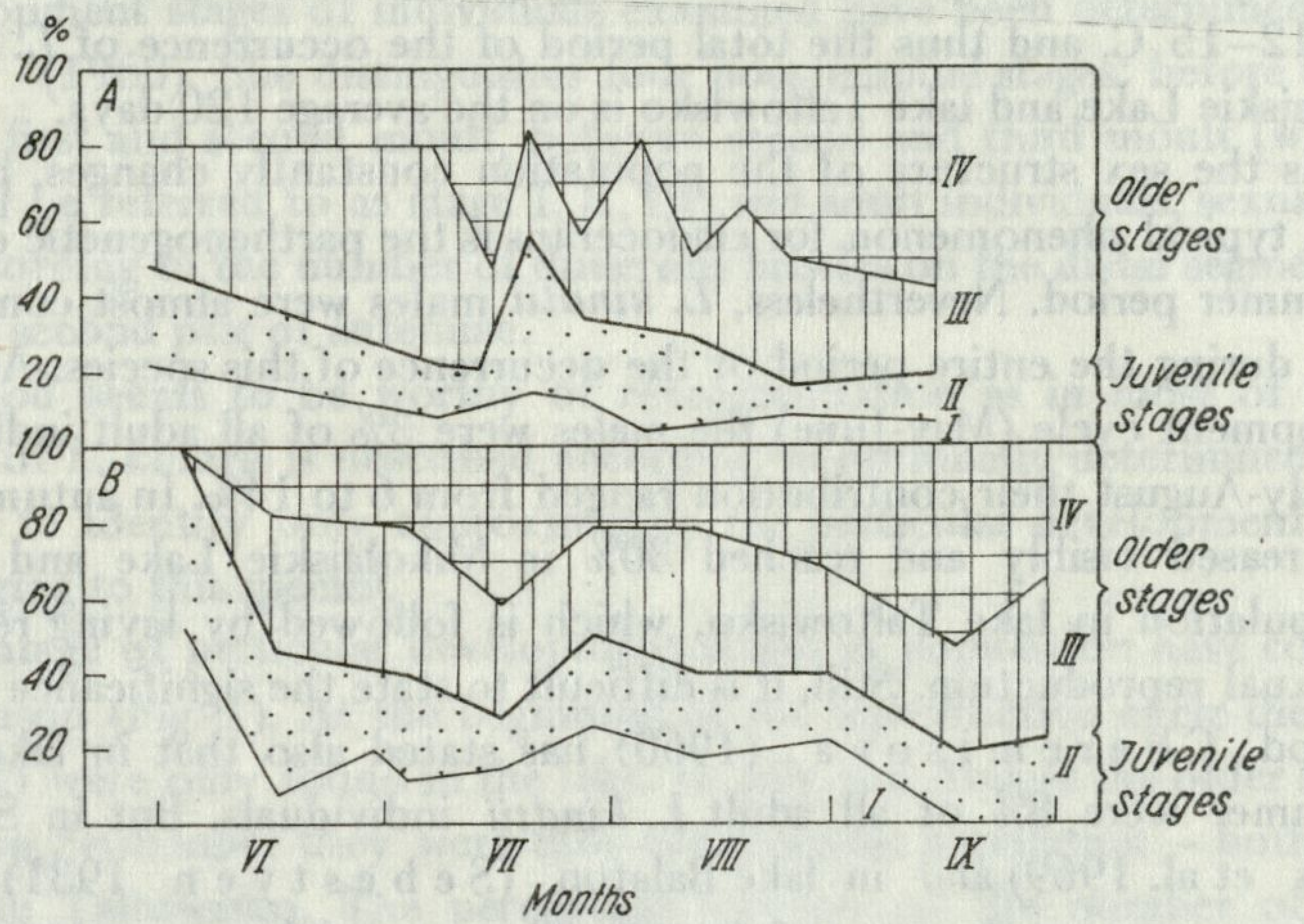

Fig. 1. Seasonal changes in percentage of particular development stages (I–III) and adults IV) in *L. kindtii* population

A – Mikołajskie Lake, *B* – Lake Tałtowisko

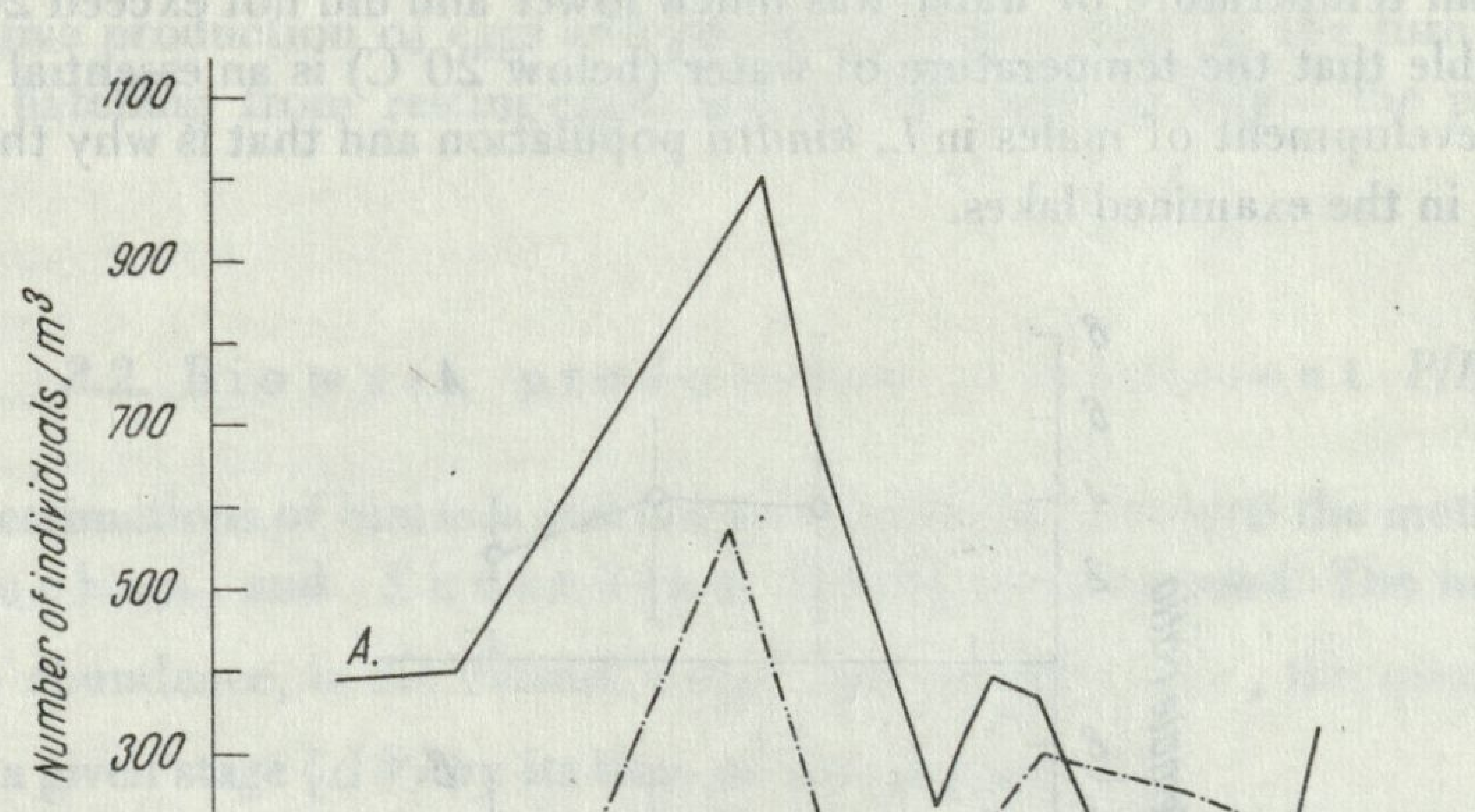

Fig. 2. Number dynamics of *L. kindtii* in lakes: Mikołajskie *(A)* and Tałtowisko *(B)* (mean values for epilimnion and metalimnion)

The dynamics of *L. kindtii* numbers show great similarity in both lakes (Fig. 2). The diagram presents the mean values for epilimnion + metalimnion. *L. kindtii* was sporadically found in the hypolimnion of both lakes. The two lakes had two periods of maximal abundance – the greater one at the beginning of July, and the second, smaller one, in the first 10 days of August. The fluctuations in numbers are high, the ratio of maximal to minimal numbers for the period from July (maximal numbers) to the end of the season is 4.8 for both lakes. From mid-August the numbers of *L. kindtii* are constantly decreasing. The biological cycle of this species comes to the end at the end of September, at water temperature 12–15°C, and thus the total period of the occurrence of *L. kindtii* population in Mikołajskie Lake and lake Tałtowisko is on the average 120 days.

During this the sex structure of the population constantly changes, but similarly in both lakes. A typical phenomenon for cladocerans is the parthenogenetic development in the spring-summer period. Nevertheless, *L. kindtii* males were almost constantly present in both lakes during the entire period of the occurrence of this species. At the beginning of the development cycle (May-June) the males were 3% of all adult individuals, but in the period July-August their contribution ranged from 6 to 14%. In autumn, the number of males increased visibly and reached 30% in Mikołajskie Lake and 39% of adult *L. kindtii* population in lake Tałtowisko, which is followed by laying resting – eggs as a result of sexual reproduction. Still, it is difficult to state the significance of males in the summer period. Cheremisova (1960) has stated also that in lake Drivyaty the males in summer were 8% of all adult *L. kindtii* individuals. But in Sanctuary Lake (Cummins et al. 1969) and in lake Balaton (Sebestyen 1931) the males have only started to appear on the turn of August. These two lakes are relatively warm ones and the mean temperatures of water in summer have exceeded 20°C in the years of studies. The males appeared when the temperature came close to or dropped below 20°C. In lakes where the males occurred all the season (lake Drivyaty, and the lakes examined here) the mean temperature of water was much lower and did not exceed 20°C. Thus, it may be possible that the temperature of water (below 20°C) is an essential factor determining the development of males in *L. kindtii* population and that is why they are found all the season in the examined lakes.

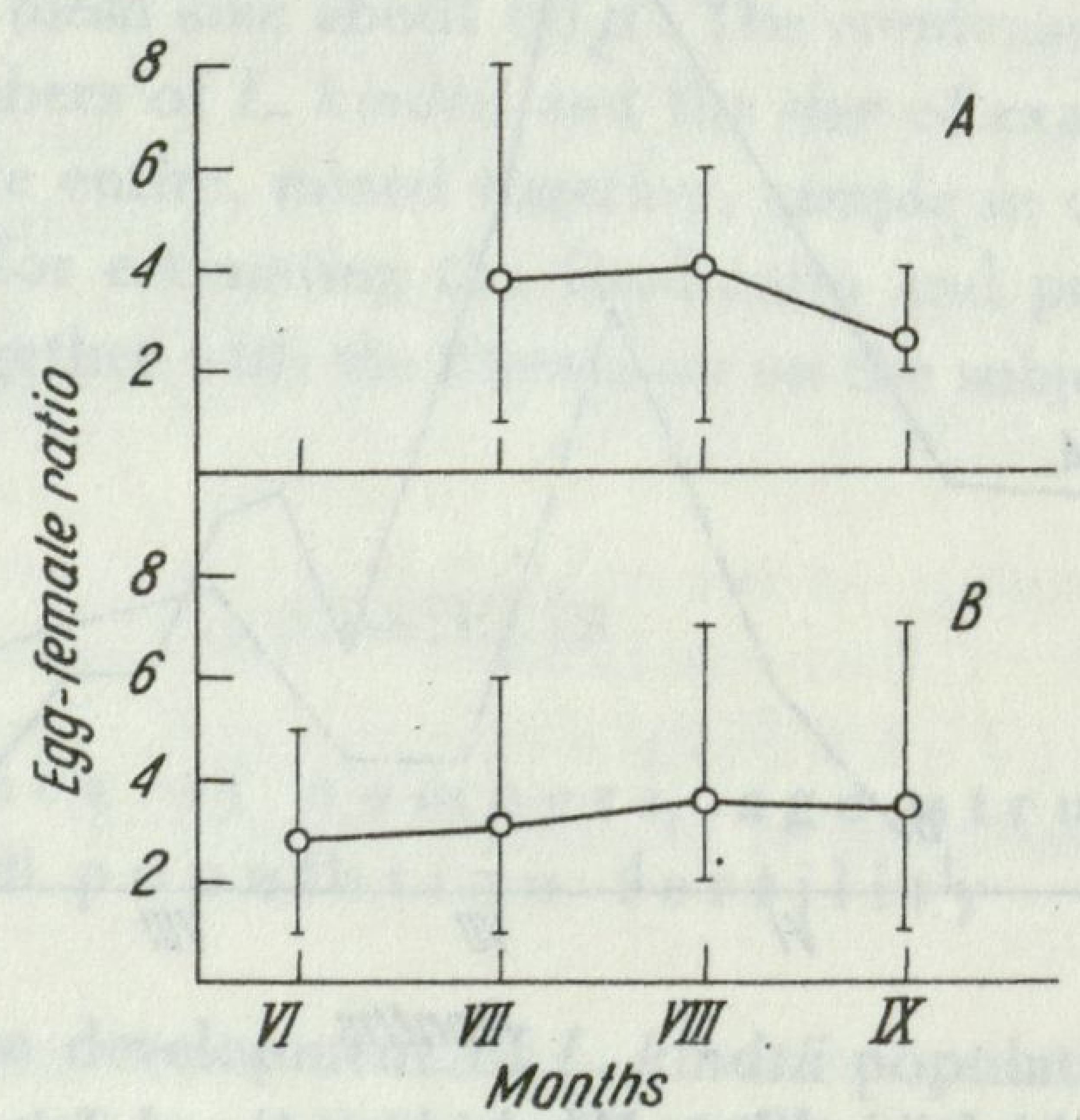

Fig. 3. Seasonal changes in mean fertility of *L. kindtii* population (number of eggs per female) and its range in lakes: Mikołajskie *(A)* and Tałtowisko *(B)*

During the entire period of occurrence of *L. kindtii* females with eggs were observed, or (more frequently) with young individuals in brood pouches. The number of eggs, or of young individuals, ranged from 1–9, and was most frequently 3–5 eggs per female. The mean fertility during the season slightly varied – at the end of the season it slightly decreaed in Mikołajskie Lake, but remained constant in lake Tałtowisko (Fig. 3). The fertility of *L. kindtii* did not differ in these lakes – the mean number of eggs per 1 female in the examined period of occurrence of this species was 3.5 in Mikołajskie Lake and 3.4 in lake Tałtowisko.

The development stages of individuals examined have been determined acc. to Cheremisova (1960). She distinguishes four post-nauplial stages: before the first moult, between the first and second moult, between second and third moult (which further in the paper will be referred to as stage I, II, III) and adult individuals, sexually mature[1] – identified according to the number of dimerous bristles on the distal segment of the outer branch of the second pair of antennae.

This method seems to be worthy of reccomendation as in most of the papers the development of *L. kindtii* is described according to optionally determined classes of size, which allows to identify only approximately the particular development stages of individuals belonging to this species.

The percentage of particular development stages in population have constantly varied during the season (Fig. 1). At the beginning of the reproduction cycle the juvenile forms (stage I and II) were only found in the lake. In July and August the older forms prevailed – 60%, and in September they were 80% of the whole population – both in Mikołajskie Lake and lake Tałtowisko. The percentage increase of the number of individuals in stage III and adult ones, at a simultaneous decrease in number of entire population and at the production of resting-eggs, proves the end of the reproduction cycle in the lake.

According to the seasonal changes in fertility and age structure of the population, it can be assumed, that *L. kindtii* despite its continuous recruitment has two periods of more intensive production of eggs and young ones: in spring (at the turn of May) – the generation hatching from resting-eggs, and at the turn of July – the parthenogenetic generation.

3.2. Biomass, production, coefficient *P/B*

For the estimations of biomass and net production of *L. kindtii* the method of Winberg, Pechen and Shushkina (1965) has been used. The main parameter, besides the abundance, is the diurnal weight increase $\left(\frac{\Delta W}{t}\right)$, i.e., the quotient of weight increase of a given stage (ΔW) by its time of development (t).

The development time of particular stages has been assumed after Cheremisova (1960) (Fig. 4). Several papers, e.g., the one by Pechen (1965), show that the relation between temperature and development time follows the Krogh's curve. And

[1] The stage of nauplius, which develops in the brood cell is not distinguished separately. The weight of nauplius is close to that of the egg and that is why these two forms have been treated jointly in calculating the biomass and production of *L. kindtii*.

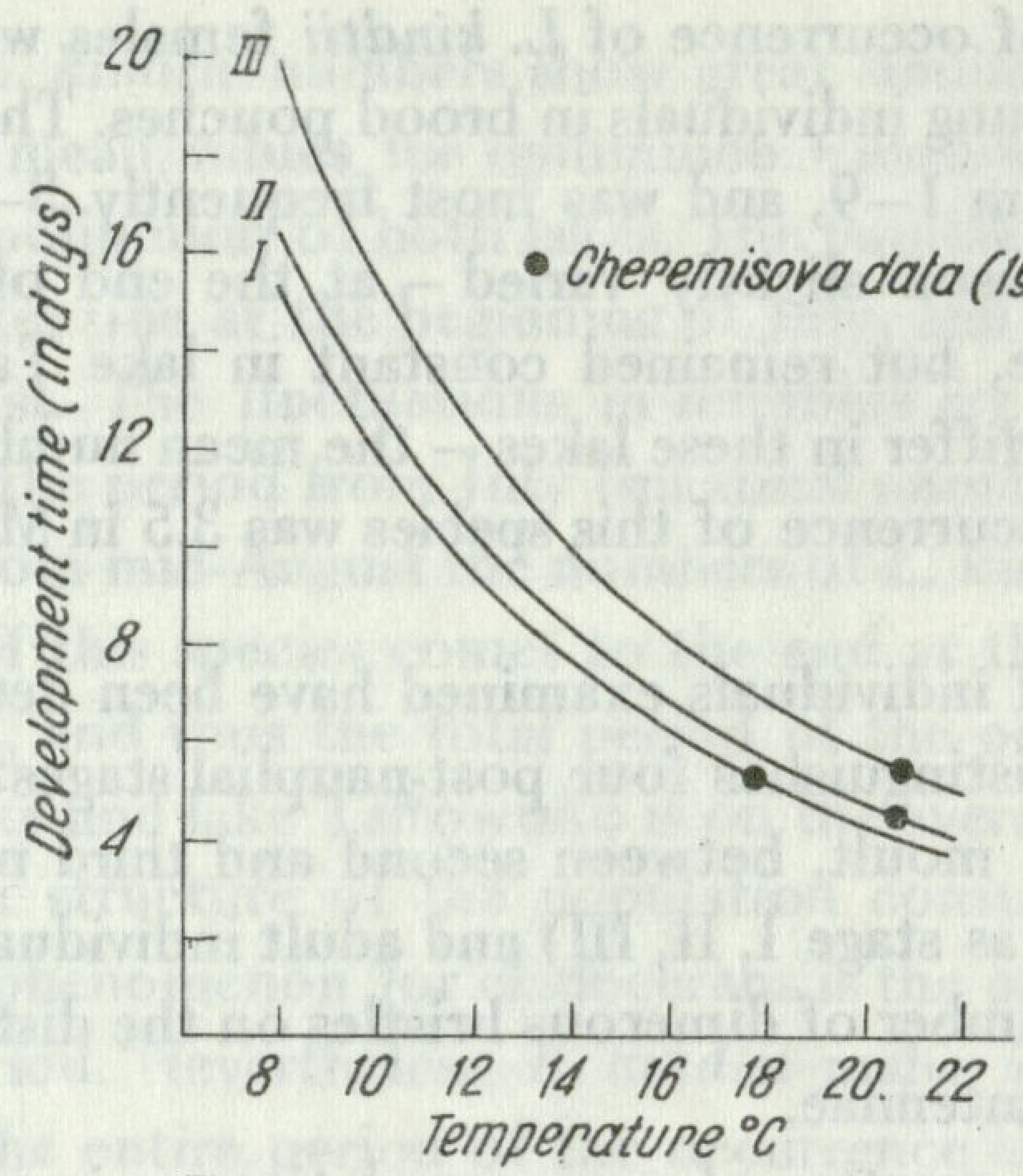

Fig. 4. Development time of particular stages (I, II, III) of *L. kindtii* according to temperature

therefore the development time in an experiment at a determined temperature can be calculated into another according to the appropriate corrections (W i n b e r g 1956).

The experimental data of C h e r e m i s o v a (1960) and corrections according to Krogh's curve allow to present graphically the relation between the development time of distinguished post-nauplial stages and the temperature (Fig. 4). The total development time of *L. kindtii* in relation to the mean temperature of water (for epi– plus metalimnion) is estimated as 16–25 days. The life length of adult individuals is calculated using the method of Patalas (H i l l b r i c h t - I l k o w s k a and W ę g l e ń s k a 1970). This equation assumes that the growth rate of adult individuals is three times slower than that of the juvenile forms. W ę g l e ń s k a (1971) confirmed this in experiments with several cladoceran species. The life length of adult forms of *L. kindtii* considerably varies and is from 3 to 15 days in the lakes examined. The body weight of individuals examined is determined by the method of calculating their volume. As the body of *L. kindtii* is considerably differentiated it has been divided into 5 parts: 1) head, 2) the first segment of the thorax, 3) other segments of the thorax, 4) antennae, 5) the branch of antennae – and each is equated to a cylinder of a determined diameter and length. Assuming that the weight density of *L. kindtii* is equal to the weight of water – the sum of volumes of these solid figures gives the weight of the animal.

The weight methods for estimating the body weight did not give good results because of the difficulties with drying away the water on the body of individuals. U l o m s k i ï's method (1951) (drying the individuals till the wet spots on the blotting-paper disappear) resulted in quick draining of internal body fluids, both in case of live and preserved individuals. Then, an attempt was made to vaporise slowly the water at room temperature and to weigh frequently (every 30 or 60 sec.). Thus, it should be expected that after some determined time of exposure there would be a moment at which the weight will not change or at least the rate of these changes will slow down (R e z v o ï and Y a b l o n s k a y a 1960). This would be the moment of evaporation of water on the animal's body before the evaporation of body fluids will take place. However, this phenomenon did not occur in case of *L. kindtii* – the changes in body weight had a continuous character (Fig. 5). Therefore, the volumetric method was applied. The described above method, at a great number of individuals examined, would require a lot of time as 10 measurements have to be made for one individual. Nevertheless, by comparing the animal's body to two cylinders (cephalothorax, antennae), which reduces the number of measurements to four, the differences in volume, and thus in weight, are not greater than 3–7% for various development stages in relation to the volume calculated according to the greater number of distinguished solid figures. That is why this „abbreviated method" has been used here.

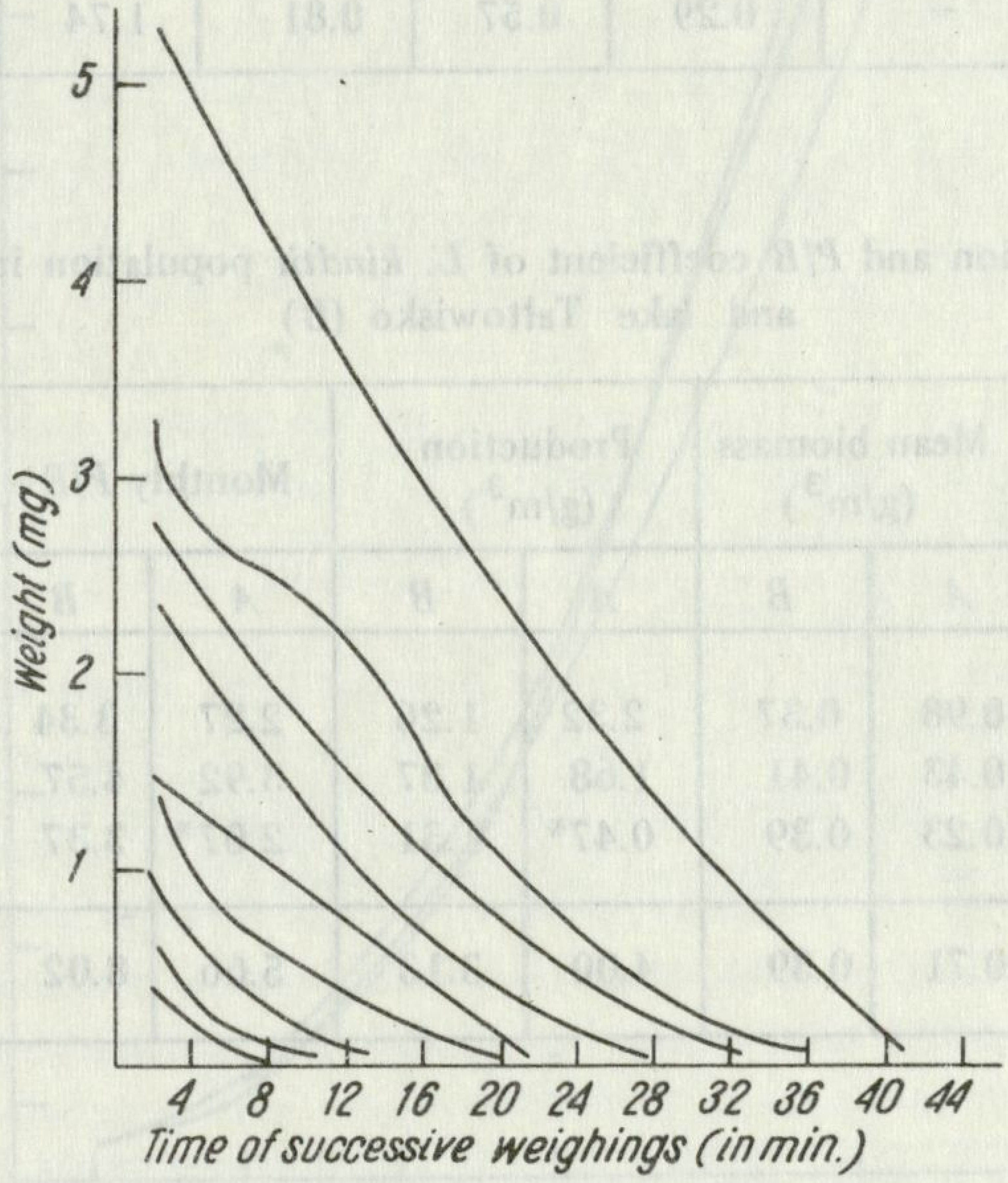

Fig. 5. Changes in body weight of *L. kindtii* in consecutive weighings – body weight estimated after Rezvoi and Yablonskaya (1960) (exemplary data for few individuals of different size)

Measurements of several hundreds of individuals of a different size show that the relation between the length and weight of body, calculated according to the method described above, takes the form of an exponential function (Fig. 6). Similar values are given by Moshiri and Cummins (1969) – body weight of *L. kindtii* ranges from 0.89 to 4.07 mg (adult females with eggs). Also, the weight estimated according to another volumetric method – Chislenko's nomographs (Chislenko 1968) – is approximate to the weight calculated by comparison with the two cylinders (Fig. 6).

As it has been observed that in particular development stages the size of individuals, and by the same their weight, changes constantly and considerably during the season in both lakes, the weight of these stages is separately estimated for each period of studies (Tab. I).

Results on biomass and production of *L. kindtii* in both lakes are presented in Table II.

Tab. I. Seasonal changes in body weight of distinguished stages (I, II, III) and adult individuals (IV) of *L. kindtii* (in mg) in Mikołajskie Lake (*A*) and lake Tałtowisko (*B*)

Months	Development stage							
	I		II		III		IV	
	A	*B*	*A*	*B*	*A*	*B*	*A*	*B*
VI		0.18	–	0.63	–	1.28	–	3.11
VII	0.17	0.14	0.63	0.42	1.72	1.37	3.43	3.50
VIII	0.12	0.13	0.47	0.64	1.46	2.02	3.03	3.53
IX	0.11	–	0.29	0.57	0.81	1.74	2.55	3.12

Tab. II. Biomass, production and *P/B* coefficient of *L. kindtii* population in Mikołajskie Lake (*A*) and lake Tałtowisko (*B*)

Months	Mean biomass (g/m^3)		Production (g/m^3)		Monthly *P/B*		Diurnal *P/B*	
	A	*B*	*A*	*B*	*A*	*B*	*A*	*B*
VII	0.98	0.37	2.32	1.26	2.27	3.34	0.08	0.11
VIII	0.43	0.41	1.68	1.87	3.92	4.57	0.13	0.15
IX	0.23	0.39	0.47*	1.31	2.07*	3.37	0.14*	0.12
Average VII–VIII	0.71	0.39	4.00	3.13	5.66	8.02	0.09	0.13

*September 1–15.

Tab. III. Percentage of *L. kindtii* and predatory *Cyclopidae* in biomass of zooplankton, and ratio of production of these predators to production of non-predatory zooplankton in lakes Mikołajskie (*A*) and Tałtowisko (*B*)

P_L/P_C – ratio of production of *L. kindtii* population (P_L) to food production (filtrating *Cladocera*) (P_C)

P_p/P_{np} – ratio of production of *L. kindtii* + predatory *Cyclopidae* (P_p) to production of non-predatory zooplankton – *Cladocera* + rotifers (P_{np})

Months	Contribution to biomass (%)						P_L/P_C		P_p/P_{np}	
	L. kindtii		*Cyclopidae*		Total					
	A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
VII	19	8	34	4	53	12	0.57	0.15	0.52	0.09
VIII	13	7	36	3	49	10	0.48	0.15	0.27	0.08

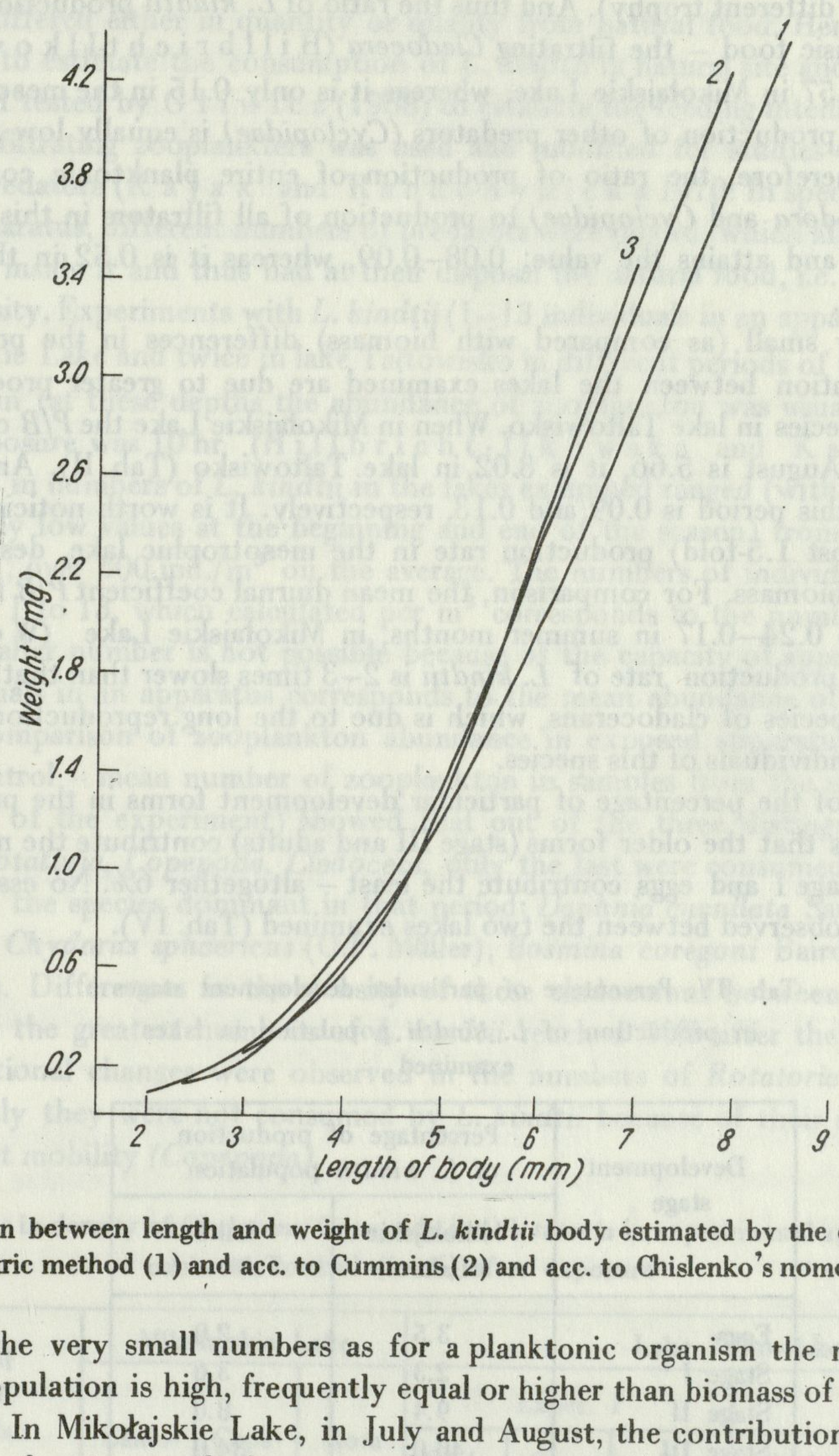

Fig. 6. Relation between length and weight of *L. kindtii* body estimated by the described in paper volumetric method (1) and acc. to Cummins (2) and acc. to Chislenko's nomographs (3)

Despite the very small numbers as for a planktonic organism the mean biomass of *L. kindtii* population is high, frequently equal or higher than biomass of other planktonic populations. In Mikołajskie Lake, in July and August, the contribution of *L. kindtii* to the biomass of entire zooplankton ranged from 13 to 19%, and in lake Tałtowisko it was 7–8% (Hillbricht-Ilkowska et al. 1972). Tałtowisko had also a smaller abundance of the predatory *Cyclopidae* (copepodites and adults), they covered only 3–4% of zooplanktonic biomass. But in Mikołajskie Lake the contribution of predatory stages of the *Cyclopidae* was almost 10-fold greater: 34–36% of biomass. And thus in Mikołajskie Lake the community of predators formed 49–53%, i.e. more than half of the biomass of the entire zooplankton, whereas in the mesotrophic lake Tałtowisko it was only 10–12% (Tab. III).

Production of *L. kindtii* population during the two summer months (July, August), in Mikołajskie Lake, was 4.0, and in lake Tałtowisko – 3.13 g/m^3. Quite striking are the differences in the proportion of production of predators to that of filtrators between the lakes examined (different trophy). And thus the ratio of *L. kindtii* production of the production of its basic food – the filtrating *Cladocera* (Hillbricht-Ilkowska et al. 1972) is 0.48–0.57 in Mikołajskie Lake, whereas it is only 0.15 in the mesotrophic lake Tałtowisko. The production of other predators *(Cyclopidae)* is equally low in the mesotrophic lake. Therefore, the ratio of production of entire planktonic community of predators *(Leptodora* and *Cyclopidae)* to production of all filtrators in this lake is very low in summer, and attains the value: 0.08–0.09, whereas it is 0.52 in the eutrophic Mikołajskie Lake.

The relatively small (as compared with biomass) differences in the production of *L. kindtii* population between the lakes examined are due to greater production efficiency of this species in lake Tałtowisko. When in Mikołajskie Lake the *P/B* coefficient in the period July-August is 5.66, it is 8.02 in lake Tałtowisko (Tab. II). And the mean diurnal *P/B* for this period is 0.09 and 0.13, respectively. It is worth noticing the relatively quick (almost 1.5-fold) production rate in the mesotrophic lake, despite the low production and biomass. For comparison, the mean diurnal coefficient *P/B* for all filtrating *Cladocera* is 0.24–0.17 in summer months, in Mikołajskie Lake (Węgleńska 1971). Thus the production rate of *L. kindtii* is 2–3 times slower than that of filtrating, non-predatory species of cladocerans, which is due to the long reproduction period and slow growth of individuals of this species.

The analysis of the percentage of particular development forms in the production of both lakes shows that the older forms (stage III and adults) contribute the most – about 85%, whereas stage I and eggs contribute the least – altogether 6%. No essential differences have been observed between the two lakes examined (Tab. IV).

Tab. IV. Percentage of particular development stages in production of *L. kindtii* population in lakes examined

Development stage	Percentage of production of *L. kindtii* population	
	Mikołajskie Lake	Lake Tałtowisko
Eggs	3.5	2.0
Stage I	2.3	3.6
Stage II	9.4	8.0
Stage III	40.0	34.0
Adults	44.5	52.0

3.3. Food preference and feeding intensity of *L. kindtii*

The way *L. kindtii* feeks (sucking the body contents of prey) makes it impossible to analyse the quality and quantity of consumed food from the contents of alimentary canals. Therefore, the papers aiming at an estimation of feeding intensity (consumption) have been usually based on laboratory experiments, in which *L. kindtii* individuals were given food that differed either in quantity or quality from natural food. Here, an attempt has been made to estimate the consumption of *L. kindtii* in natural site and on natural food. The method tested by G l i w i c z (1968) to estimate the feeding intensity and food preference of filtrating zooplankters was used and modified for studies on the feeding of plankton predators (K a j a k and R a n k e-R y b i c k a 1970. In special containers, inside the apparatus, different numbers of predators were placed, which after closing the apparatus got inside it and thus had at their disposal the natural food, i.e. zooplankton in a natural density. Experiments with *L. kindtii* (1–13 individuals in an apparatus) were made in Mikołajskie Lake and twice in lake Tałtowisko in different periods of the season, at the depth of 4 m (at these depths the abundance of zooplankton was usually the greatest). Time of exposure was 10 hr (H i l l b r i c h t - I l k o w s k a and K a r a b i n 1970). The changes in numbers of *L. kindtii* in the lakes examined ranged (with the exception of the extremely low values at the beginning and end of the season) from 100 to 1000 individuals/m^3; over 300 ind./m^3 on the average. The numbers of individuals in apparatus varied from 1 to 13, which calculated per m^3 corresponds to the numbers from 333 to 4 000. A smaller number is not possible because of the capacity of apparatus (3 l) – but 1–2 individuals in an apparatus corresponds to the mean abundance of *L. kindtii* in the lake. The comparison of zooplankton abundance in exposed apparatus and in control samples (control – mean number of zooplankton in samples from the site at the beginning and end of the experiment) showed that out of the three distinguished groups of plankters; *Rotatoria*, *Copepoda*, *Cladocera*, only the last were consumed (Tab. V). These were usually the species dominant in that period: *Daphnia cucullata* Sars., *D. longispina* O.F. Müller, *Chydorus sphaericus* (O.F. Müller), *Bosmina coregoni* Baird., *B. longirostris* (O.F. Müller). Differences in the density of these cladocerans between the site and apparatus with the greatest numbers of *L. kindtii* reached 50% after the experiment. No visible directional changes were observed in the numbers of *Rotatoria* and *Copepoda*. Most probably they were not consumed by *L. kindtii* because of their small size *(Rotatoria)* or great mobility *(Copepoda)*.

Tab. V. Changes in density of *Cladocera*, *Copepoda* and *Rotatoria* in experimental apparatus in relation to control (in %) after exposure

Number of *L. kindtii* individuals in experiment	Mikołajskie Lake			Lake Tałtowisko					
				Exper. I			Exper. II		
	Cladocera	*Copepoda*	*Rotatoria*	*Cladocera*	*Copepoda*	*Rotatoria*	*Cladocera*	*Copepoda*	*Rotatoria*
	Per cent								
1				95	101	99			
2	90	103	94	87	101	102	86	97	102
4	73	107	102	80	96	95	69	98	105
6				55	121	103	60	103	98
8	56	107	95	45	110	105	41	105	101
10	46	107	90	48	109	105	29	105	120
12	48	86	93				24	103	105
13				19	107	101			

The amount of food consumed in 24 h (food ration) has been calculated as the percentage of the mean weight of *L. kindtii* individuals used in the experiment (for details see Hillbricht-Ilkowska and Karabin 1970). The diurnal food ration of this predaceous cladoceran in the eutrophic Mikołajskie Lake is from 30% of body weight at average *L. kindtii* density to 48% at maximal density. In lake Tałtowisko the feeding intensity of *L. kindtii* is slightly higher, of the order 39–50% of body weight, at its analogous densities in the apparatus (Fig. 7). The higher food ration is probably due to

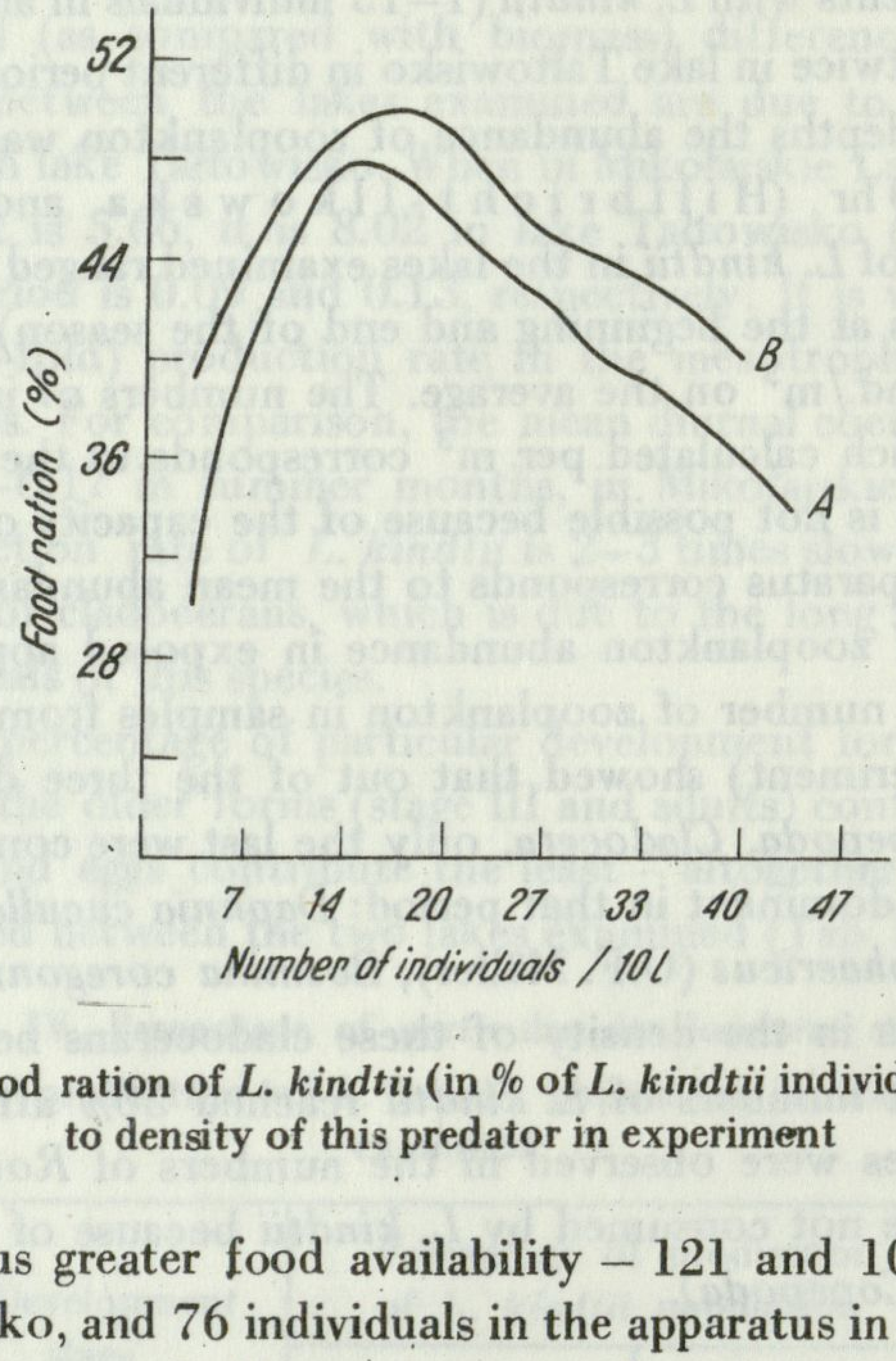

Fig. 7. Range of size of food ration of *L. kindtii* (in % of *L. kindtii* individual body weight) according to density of this predator in experiment

greater density and thus greater food availability – 121 and 109 individuals in the apparatus in lake Tałtowisko, and 76 individuals in the apparatus in Mikołajskie Lake, but at an approximate food biomass. *L. kindtii* does not show food preference as regards particular *Cladocera* species nor a preference for a particular class of size (Tab. VI). In these cases Ivlev's coefficient of food preference approximates 0.

These are data for individuals of stage III and adults as only then *L. kindtii* is a typical predator. In the first period of its development it feeds on bacteria, algae, organic detritus (Cummins et al. 1969).

3.4. Utilisation of production of filtrating *Cladocera* by *L. kindtii*

A comparison of the experimental data on the food ration of predatory stages of *L. kindtii* with the production of food they prefer – filtrating cladocerans – allows to estimate approximately what part of this production can be eliminated by *L. kindtii*. This has been calculated assuming that the mean food ration in Mikołajskie Lake is 30%, and

Tab. VI. Ivlev's index of food preference for *L. kindtii* in relation to various *Cladocera* species (changes of coefficient and mean values)

		Mikołajskie Lake		Lake Tałtowisko
Big species	*D. cucullata*	(+0.2) – (–0.29) (–0.07)	(–0.21) – (0.00) (–0.10)	(+0.03) – (–0.12) (–0.03)
	D. brachyurum	(+0.28) – (–0.07) (+0.10)		
	B. coregoni	(+0.04) – (–0.41) (–0.09)		
Small species	*Ch. sphaericus*	(+0.03) – (–0.21) (–0.04)	(+0.25) – (+0.01) (+0.13)	(+0.05) – (–0.02) (+0.01)
	B. longirostris	(+0.25) – (–0.06) (+0.05)		

in lake Tałtowisko 39% of body weight. The density in the experiment has been: 1 individual per apparatus, which corresponds to the mean (300 ind./m^3) numbers of *L. kindtii* in these lakes.

Tab. VII. Grazing of filtrating *Cladocera* by *L. kindtii*
A – production of filtrating *Cladocera* (g/m^3), *B* – amount of consumed *Cladocera* (g/m^3), c – % of consumed production of filtrating *Cladocera*

Months	Mikołajskie Lake			Lake Tałtowisko		
	A	*B*	*C*	*A*	*B*	*C*
VI	–	–	–	6.45	0.88	13
VII	3.93	9.29	236	8.48	4.01	47
VIII	3.41	3.83	112	12.91	5.14	39
IX	0.83	0.90	108	3.72	1.60	36

The analysis of obtained results points to the considerable significance of this predatory species in the community of pelagic zooplankton (Tab. VII). In summer months (July-August) the predatory stages of *L. kindtii* population used in lake Tałtowisko 39–47% of the production of filtrating *Cladocera*. But this is the period, when the production of *Cladocera* attains the maximal values, and in the year of studies it was: 8.48 g/m^3 in July, and 12.91 g/m^3 in August. In other months the pressure of *L. kindtii* on the production of *Cladocera* is smaller: 13% in June and 36% in September. It is worth noticing the relation between the amount of food consumed by the predator and the changes in the production of this food during the season: small pressure on food at its low production and high pressure at high food production.

In Mikołajskie Lake the calculated grazing values are higher than the value of food production (108–236%) (Tab. VII). However, these values have to be treated as approximate ones as the lack of data on the production of *Cladocera* in the year of studies made it necessary to use the data from 1966. Thus, it can be only concluded that the pressure of *L. kindtii* on food in Mikołajskie Lake is certainly equally high, and perhaps even higher than in lake Tałtowisko.

Although it has not been proved by the experiments that *L. kindtii* feeds also on other groups of plankters, still the laboratory research of many other authors show that *L. kindtii* is not limited only to cladocerans in its choice of food. Mordukhaï-Boltovskaya (1958, 1960) has observed in laboratory experiments that *L. kindtii* cultured on food consisting of *Copepoda* only, consumes them, chiefly the small species, but also copepodites and nauplii. *Leptodora* has also lived on food consisting of rotifers, although much shorter than on natural food. The authoress has also observed that large individuals attack the small *Chironomidae* larvae, and small larvas of fishes and sporadically the phenomenon of cannibalism. Thus, it can be assumed, that in the lake, especially in periods of small abundance of *Cladocera*, *L. kindtii* feeds also on the food described above. It is not unlikely that in unfavourable food conditions this predator feeds partly on plants. The use of algae as food, especially of the large forms and colonies (e.g. *Volvox)*, by the predatory stages of *L. kindtii* has been observed by Mordukhaï-Boltovskaya (1958, 1960) and Sebestyen (1960).

Altogether, despite its small abundance, *L. kindtii* is very important (as an essential component of biomass and production of zooplankton, and as an effectively acting predator) for the functioning of the whole zooplankton community. Hall (1964) and Wright (1965) have found that *L. kindtii* is the main agent limiting and reducing the abundance of *Daphnia* sp. In lake Tałtowisko *L. kindtii*, in the period of its maximal occurence, eliminates almost 50% of the production of pelagic *Cladocera*. And although the *Cladocera* are the main and preferred food of *L. kindtii* still this predator more or less affects the entire zooplankton community.

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4. SUMMARY

This is a comparison of the development of *L. kindtii* (Focke) population in two lakes: eutrophic Mikołajskie Lake and mesotrophic lake Tałtowisko (Great Lakes Lakeland). Their numbers are not great: 210–1000 ind./m^3 in Mikołajskie Lake, and 120–570 ind./m^3 in lake Tałtowisko (Fig. 2). The population fertility, contribution of males and seasonal changes in the age structure of this population are estimated (Fig. 1,3). Because the *L. kindtii* individuals are big, its contribution to the biomass of pelagic zooplankton is considerable, despite its small abundance. The mean biomass during the two summer months (July-August) is 0.7 in Mikołajskie Lake and 0.4 g/m^3 in lake Tałtowisko, whereas the production is 4.0 and 3.1 g/m^3 (Tab. II), respectively. Thus the relative production rate of this predatory species is low as it is in that period 5.7 (Mikołajskie Lake) and 8.0 (lake Tałtowisko). The diurnal food ration, determined as the percentage from the mean body weight of *L. kindtii* individual, ranges from 30% in Mikołajskie Lake to 49% in lake Tałtowisko (Fig. 7). The *Cladocera* are the preferred food of this predator. The predatory stages of *L. kindtii* population eliminated in summer months almost 50% of this food in lake Tałtowisko (Tab. VII).

5. POLISH SUMMARY (STRESZCZENIE)

Porównano rozwój populacji *Leptodora kindtii* (Focke) w dwu jeziorach: eutroficznym Jeziorze Mikołajskim i mezotroficznym jeziorze Tałtowisko (Wielkie Jeziora Mazurskie). Stwierdzono, że liczebność nie jest duża i wynosi w Jeziorze Mikołajskim od 210 do 1 000, a w jeziorze Tałtowisko od

120 do 570 osobn./m^3 (fig. 2). Oceniono także płodność populacji, udział w niej samców jak też sezonowe zmiany struktury wiekowej tej populacji (fig. 1, 3). Ze względu na duże rozmiary osobników udział *L. kindtii* w biomasie zooplanktonu pelagicznego, mimo małej liczebności, jest znaczny. I tak średnia biomasa w okresie dwu letnich miesięcy (lipiec-sierpień) wynosiła w Jeziorze Mikołajskim 0,7, a w jeziorze Tałtowisko 0,4 g/m^3, natomiast produkcja, odpowiednio: 4,0 i 3,1 g/m^3 (tab. II). Tak więc względne tempo produkcji tego drapieżnego gatunku jest niskie, wynosi bowiem w tym okresie od 5,7 (Jezioro Mikołajskie) do 8,0 (jezioro Tałtowisko). Zakres dobowej racji pokarmowej, określonej jako procent od średniego ciężaru ciała osobnika *L. kindtii*, wynosi od 30% w Jeziorze Mikołajskim do 49% w jeziorze Tałtowisko (fig. 7). Pokarmem preferowanym przez tego drapieżnika są *Cladocera*. Drapieżne stadia populacji *L. kindtii* eliminowały w miesiącach letnich w jeziorze Tałtowisko prawie 50% produkcji tego pokarmu (tab. VII).

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