INSTITUTE OF ECOLOGY-POLISH ACADEMY OF SCIENCES

EKOLOGIA POLSKA

Vol. XXI Warszawa 1973 No. 38

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EXPERIMENTALLY INCREASED FISH STOCK IN THE POND TYPE LAKE WARNIAK XII. NUMBERS AND BIOMASS OF THE FAUNA ASSOCIATED WITH MACROPHYTES*

(Ekol. Pol. 21: 595–610). Two years of studies showed that the numbers and biomass of fauna associated with *Elodea* and *Stratiotes*, and also the average weight of one *Chironomidae* individual are smaller in the stocked (with an increased fish stock) than in the control (with a normal fish stock) part of the lake, which seems to be due to the grazing of fish.

I. INTRODUCTION

The zone of vegetation in water bodies is undoubtedly a habitat having a great food significance for fish because of the great numbers of invertebrate fauna. This is proved by the data of many authors, who compared the biomass of fauna associated with plants with the biomass of bottom fauna. As a rule, the former have a considerably greater biomass. And so, Gromov (1960) in his studies of the Kamskij dam reservoir found that the biomass of fauna associated with plants is more than twice greater than the benthos

*Praca wykonana w ramach problemu węzłowego Nr 09.1.7.

biomass. Morduchaj-Boltovskoj (1954) recorded also a twice higher biomass of fauna associated with plants in water bodies connected with a river. In the ponds of the Ukraine, Špet (1958) observed that the fauna biomass of the zone of submerged vegetation was 4–5 times higher than in the zone void of plants. McLachlan (1969) recorded an about 5 times greater fauna biomass after the appearance of submerged vegetation in the newly built Kariba dam reservoir. Ščerbakov (1967) observed that in lake Glubokoe the fauna biomass of the vegetation zone was almost 6 times higher than of the open lake zone. And Morduchaj-Boltovskoj (1958) recorded for the Rybinskij dam reservoir a 10 times higher fauna biomass of the vegetation zone than of the open part of the reservoir. It is obvious, that the nourishment significance of the discussed zone is greater in shallow water bodies, overgrown by vegetation to a considerable extent.

This paper is a part of complex research conducted in the years 1967–1969 in lake Warniak. Carp and bream were introduced into the lake and an attempt was made to observe the effect of thus increased fish stock on the lake biocenosis. Each year, in spring, fish were introduced into the lake, and in autumn intensive catches took place. And so in 1967, 800 kg of carp and 849 kg of bream were introduced, in 1968 – 1680 kg of carp, and in 1969 – 200 kg of carp (Zawisza and Ciepielewski 1973).

The studies in the years 1968–1969 were conducted in order to:

1) estimate the food resources for fish of the vegetation zone; two species found in distinctly monospecific aggregations were chosen for the analysis: water-weed (*Elodea canadensis* Rich.) and water-soldier (*Stratiotes aloides* L.) and the associated with them invertebrate fauna (numbers, biomass and composition);

2) observe the effect of fish grazing on the invertebrate fauna associated with macrophytes.

II. HABITAT

Lake Warniak has a surface 38.4 ha and mean depth 1.5 m, and is a eutrophic water body of a natural pond type as understood by Stangenberg (acc. to Zachwieja 1965). The lake is overgrown to a considerable extent: emergent macrophytes cover 4.8 ha (*Phragmites communis* Trin. dominates) and submerged macrophytes – 29.1 ha (*Ceratophyllum demersum* L. dominates) (Bernatowicz 1969).

In order to differentiate spatially the fish stock the enclosure method was used. Fishing-nets on pales were used to separate some parts of the lake, thus having the stocked part (with an increased fish stock due to introduc-

tion) and control part (normal stock). A diagram of fishing experiments in lake Warniak, in particular years, is given by Zawisza and Ciepielewski (1973). It is worth pointing out that in 1969, as compared with the previous year, the stocked part was changed into the control one and vice versa.

Within these studies two sites were chosen in *Elodea* aggregation in the stocked and control part, and analogously two sites among the *Stratiates* aggregation, in places about 0.5 m deep. Systematic catches of fauna associated with plants were conducted there.

III. METHOD

There is a great variety of quantitative methods of examining the fauna associated with plants in hydrobiological literature. Therefore, the results of different papers are practically incomparable. Among these methods, we may distinguish those, where the numbers (biomass) of fauna is per:

1) surface unit of the bottom of water body overgrown with vegetation (m^2, ha); the most common method: Macan (1949, 1965a), Balkanovskaja (1953), Gromov (1960), Ščerbakov (1961, 1967), G. A. Sokolova (1965), McLachlan (1969), Beattie et al. (1972);

2) volume unites of water with plants (e.g. m^3): Margolina (1958), Morduchaj-Boltovskoj (1956, 1958), Karassowska and Mikulski (1960);

3) plant surface units – leaves and stems: Entz (1947), Rosine (1955); a useful method of estimating the plant surface is the application of detergents (Harrod and Hall 1962);

4) plant weight units (e.g. kg of fresh weight): Frost (1942), Zimbalevskaja (1965, 1966).

These 4 methods were compared by Kořinkova (1971a) using the fauna associated with few species of submerged plants (mainly *Elodea canadensis*) in a carp pond.

Each of these methods has its limitations. In the first and second method the different plant density (e.g. of few comparable species) basically affects the quantitative estimation of fauna associated with plants and does not provide much information. In the third method the result is not only due to the surface area but also to its structure (e.g. pinnated leaves). The fourth method does not give an accurate estimate of plant weight (different hydration when estimating the fresh weight, incrustations when estimating the dry weight). It is also additionally complicated by using various types of apparatus with different fauna selectivity, and especially of fauna loosely connected

with plant substrate (floating fauna). Furthermore, it is worth pointing out the complicated relations between invertebrate fauna and vegetation, indicated among others by Kabanov (1963). This is reflected by the character of occurrence of fauna associated with plants. And so, Beattie et al. (1972), in their studies of fauna of lake Tjeukemeer ("polder reservoir"), distinguish the fauna living on the surface of plant substrate and moving freely (*Gammarus*, *Gastropoda*), and fauna living in the substrate (mainly *Chironomidae* and *Oligochaeta*). Whereas, Kořinkova (1971b) in her studies of carp pond, distinguishes 3 groups of fauna, variously related to the *Elodea* stand density (direct relation, indirect relation, no apparent relation).

A very simple method has been used in this research. The plants were collected by hand and put into 1-litre jars and after preparation in the laboratory the numbers and biomass of fauna were related to the fresh weight of plants. The previous sampling with the sampler of Macan type (in the modification of Czechoslovakian hydrobiologists – Dvořak 1965) was not successful, because due to its considerable weight, the sampler got stuck in the muddy bottom, thus making it impossible to obtain samples of "clean" vegetation void of mud. A comparison of these two methods (samples taken by hand and Macan sampler) did not show much differences between them, at least as regarding the qualitative fauna composition.

In both years of studies, the samples were taken on each site from May to September, in monthly intervals, in series of 5 samples. Altogether, 50 samples of *Elodea* and 50 samples of *Stratiotes* were taken each year.

IV. CHARACTERISTICS OF THE FAUNA ASSOCIATED WITH MACROPHYTES

As regards the numbers and biomass of fauna, great differences are observed, both between plant species and the successive years of investigations (Tab. I). The numbers of fauna on *Elodea* was definitely greater than on *Stratiotes*: almost twice as high in 1968, and over three times in 1969. However, the biomass of fauna on *Elodea* was lower (1968) or slightly higher (1969) than on *Stratiotes*. The numbers and biomass of fauna were much higher in both plant species in the second year of investigations. The numbers of fauna increased 5 times on *Elodea*, and the biomass almost four times; on *Stratiotes* the numbers increased three times and the biomass almost twice. It is worth pointing out that the vegetation abundance in the lake (the size of overgrown area, plant density) was according to visual appraisal much smaller in 1969 than in 1968. Therefore, the food resources of this zone for fish did not seem to be greater, despite the increase of fauna biomass.

Numbers, biomass (in g) and percentage of particular fauna groups associated with *Elodea* and *Stratiotes* in lake Warniak

Mean values (per kg plants) from May to September, in brackets – range of fluctuations, in frames – dominant forms

Tab. I

	Elodea				*Stratiotes*			
	Numbers		Biomass		Numbers		Biomass	
	1968	1969	1968	1969	1968	1969	1968	1969
Total fauna	5550 (2920–11860)	27840 (6770–70620)	2.76 (1.33–4.75)	9.84 (4.66–19.91)	2800 (830–6270)	8410 (2630–22530)	5.84 (1.16–8.35)	8.93 (4.02–20.71)
	Percentage							
Hydrozoa	1.1	4.0	0.7	4.9	1.9	3.1	0.3	1.6
Turbellaria	0.1	< 0.1	0.4	0.3	0.7	<0.1	1.3	0.2
Mermithidae	–	–	–	–	–	<0.1	–	< 0.1
Oligochaeta	25.1	27.3	4.9	7.9	8.0	1.8	0.6	0.3
Hirudinea	0.4	0.3	3.3	2.8	7.2	2.8	26.9	14.7
Mollusca	1.1	0.5	17.0	4.9	2.0	0.6	13.8	3.7
Isopoda	–	–	–	–	0.1	<0.1	0.3	0.2
Odonata	0.7	0.1	11.0	3.8	0.2	<0.1	2.5	0.7
Ephemeroptera	6.5	10.5	13.6	19.9	4.0	3.0	4.7	5.1
Sialidae	–	–	–	–	<0.1	–	0.1	–
Lepidoptera	1.3	0.7	6.4	8.0	1.3	0.4	13.7	13.4
Heteroptera	–	< 0.1	–	<0.1	–	< 0.1	–	0.3
Coleoptera	–	< 0.1	–	<0.1	<0.1	<0.1	0.1	0.1
Trichoptera	1.3	0.8	7.3	7.6	4.4	1.6	7.9	6.8
Heleidae	–	1.1	–	1.1	0.5	2.8	0.1	1.1
Chironomidae	61.4	54.0	33.7	37.9	68.7	81.8	24.7	48.3
Diptera varia	0.8	<0.1	1.4	<0.1	0.6	1.7	0.6	2.3
Argyronetidae	–	<0.1	–	0.2	0.1	<0.1	2.3	0.1
Hydracarina	0.1	0.4	0.3	0.6	0.1	0.3	0.1	0.2

As regards the few, comparable data of other authors on the numbers and biomass of fauna associated with plants they are as following: Špet (1958), in the Ukraine ponds, recorded the numbers and biomass of fauna (without *Mollusca*, calculated per kg plants): on *Elodea* 1880–2500 individuals, biomass – 4.0–4.5 g; on *Stratiotes* 640 individuals, biomass 3.8 g. These values are lower than in this research, especially as regards the numbers of fauna. But the biomass of fauna associated with plants in water bodies connected with the river Dnieper (Zimbalevskaja 1965) and characterized by the share of large molluscs (also calculated per kg plants) was: 23.49 g on *Elodea*, 39.61 g on *Myriophyllum*, 43.53 g on *Ceratophyllum*, 56.90 g on *Potamogeton*. These values are higher than the average ones in this research, although they do not differ much from the maximal values (19.91 g on *Elodea*, 20.71 g on *Stratiotes* – Tab. I), despite the fact that the share of molluscs was usually small.

As regards the composition, the dominant role of *Chironomidae* (Tab. I) is striking at the great similarity of fauna associated with *Elodea* and *Stratiotes*. The share of *Chironomidae* in the total numbers is very high (54.0–81.8%), but also, this group is usually the first dominant in the biomass (24.7–48.3%). This result is confirmed by several authors. And so, G. A. Sokolova (1965) found in a shallow eutrophic lake Baltym that the *Chironomidae* are 75–80% of the total numbers and 35–40% of the biomass of fauna associated with *Elodea* aggregations. Gromov (1960) in the Kamskij dam reservoir found on few species of submerged plants (among others *Elodea* and *Potamogeton*) a considerable share of *Chironomidae*, attaining 85.8% of the numbers and 49.0% of the biomass of entire fauna. Matlak (1963) found that *Chironomidae* composed 80% of the fauna numbers on few plant species in ponds (among others *Potamogeton* and *Sagittaria*), and also their biomass prevailed. Karassowska and Mikulski (1960) in their studies on animal groupings associated with submerged and floating vegetation in lake Drużno, also observed on *Stratiotes* the domination of *Chironomidae* in numbers (they were of lesser significance as far as biomass was concerned). Then Margolina (1958), when studying the fauna associated with vegetation composed of several plant species from different ecological groups in the Rybinskij dam reservoir, pointed out the dominant role of *Chironomidae*. The results of Kuflikowski (1970) were incompatible with the above ones. Kuflikowski analyzed the fauna associated with the submerged vegetation in a pond and dam reservoir; *Chironomidae* were scarce on *Elodea* and were less numerous than other groups (*Hirudinea*, *Gastropoda*, *Ephemeroptera* and *Odonata*).

In present investigations, among the other fauna groups, the important ones are: on *Elodea* – *Oligochaeta* and *Ephemeroptera* (numbers), *Mollusca*, *Ephemeroptera* and *Odonata* (biomass); on *Stratiotes* – *Hirudinea*, *Lepidoptera*

and *Mollusca* (biomass) (Tab. I). The number of fauna components is slightly greater on water-soldier (19) than on water-weed (16).

V. EFFECT OF GRAZING OF FISH ON FAUNA ASSOCIATED WITH MACROPHYTES

The available literature does not present a quantitative approach to the effect of grazing of fish on the fauna associated with plants, although many authors stress the significance of the fauna of vegetation zone for the feeding of fish (among others Balkanovskaja 1953, Špet 1958, Gurzęda 1959, Maksimova 1961, G. A. Sokolova 1965). Maksimova (1961) calculated (using the physiologically determined from weight increases and metabolism losses food ration of fish) that during 24 hr. fish consume 12–30% *Chironomidae* biomass of the vegetation zone. However, attempts have been made to estimate the effect of grazing of fish on bottom fauna, which is undoubtedly to a great extent related to the fauna associated with plants. Zimbalevskaja (1966) made an attempt to classify the littoral fauna, distinguishing among others the group of phytophilous-bottom species (some molluscs and mayflies, *Asellus aquaticus*, various *Gammaridae*).

In estimates of the effect of grazing of fish on the bottom fauna two methods have been used:

1) Differentiation of the density of fish stock in ponds (among others Vass-van Oven 1957, Assman 1962, Müller and Merla 1962, Zięba and Skaziński 1964, Wójcik-Migała 1966). As a rule, it was found that the greater the fish stock the lower the numbers (biomass) of the bottom fauna. But the pond studies not always provided similar results. E.g., Wójcik-Migała (1966) observed that up to some densities of fish stock the quantitative development of *Chironomidae* was stimulated. Hayne and Ball (1956) point out the small influence of fish on the biomass of benthos, and a very strong, intense one on its production. Also, Maksimova (1961) writes about the little influence of fish on the formation of biomass of the bottom fauna. This is probably due to the fact that the effect of fish on the bottom fauna can not be identified with the direct effect – grazing. Also the indirect effect of habitat transformation (e.g. fertilization with faeces) may be important as it stimulates the quantitative development of benthos and obliterates the effect of grazing. An interesting contribution to the problem of the complex effect of fish on the food fauna may be the work of Macan (1965b). He observed, that in the pond, into which fish had been introduced, their effect became visible in the change of spatial distribution of dominant *Heteroptera* species (at a lack of fish, they were found in the entire pond, and after the introduction of fish – only in the near-shore zone, overgrown and inaccessible for fish).

2) Separating some parts of the habitat (cages, enclosures) and then comparison of the numbers (biomass) of benthos in places accessible and inaccessible for fish. This method has been applied both in shallow pond habitats (Lellák 1957, 1966, Hruška 1961, Zięba 1963, Borodič 1967, Kořinkova 1967) and in slightly deeper habitats in lakes and dam reservoirs (Kajak 1964, 1972, N. Ju. Sokolova 1965, Hruška 1966). On the whole the numbers (biomass) of the bottom fauna in unprotected from fish habitats was lower. However, this method has its limitations (among others, change of conditions in experimental devices as compared with the

Numbers and biomass of fauna associated with *Elodea* in the stocked (*S*) and control (*C*) part of lake Warniak in 1968

Mean values for May-September individuals or g/kg plants; values below 100% are underlined

Tab. II

	Numbers			Biomass		
	S	*C*	*S/C %*	*S*	*C*	*S/C %*
Total fauna	5000	6100	82.0	2.60	2.93	88.7
Chironomidae	2820	4000	70.5	0.72	1.15	62.6
Oligochaeta	1400	1400	100.0	0.12	0.15	80.0
Ephemeroptera	410	310	132.3	0.35	0.40	87.5
Trichoptera	90	60	150.0	0.20	0.20	100.0
Lepidoptera	60	90	66.7	0.17	0.18	94.0
Mollusca	60	70	85.7	0.57	0.37	154.1

Numbers and biomas of fauna associated with *Stratiotes* in the stocked (*S*) and control (*C*) part of lake Warniak in 1968

Mean values for May-September, individuals or g/kg plants; values below 100% are underlined

Tab. III

	Numbers			Biomass		
	S	*C*	*S/C %*	*S*	*C*	*S/C %*
Total fauna	2470	3130	78.9	5.82	5.86	99.3
Chironomidae	1610	2240	71.9	1.04	1.85	56.2
Oligochaeta	110	340	32.4	0.02	0.06	33.3
Ephemeroptera	130	90	144.4	0.34	0.21	161.9
Trichoptera	160	90	177.8	0.49	0.43	114.0
Lepidoptera	30	50	60.0	0.50	1.10	45.5
Mollusca	50	60	83.3	0.69	0.92	75.0

Numbers and biomass of fauna associated with *Elodea* in the stocked (*S*) and control (*C*) part of lake Warniak in 1969

Mean values for May-September, individuals or g/kg plants; values below 100% are underlined

Tab. IV

	Numbers			Biomass		
	S	*C*	*S/C* %	*S*	*C*	*S/C* %
Total fauna	15320	40350	38.0	5.56	14.13	39.3
Chironomidae	11360	18740	60.6	2.22	5.24	42.4
Oligochaeta	1180	14010	8.4	0.18	1.38	13.0
Ephemeroptera	1240	4630	26.8	1.01	2.90	34.8
Trichoptera	170	300	56.7	0.45	1.05	42.9
Lepidoptera	170	230	73.9	0.60	0.97	61.9
Mollusca	160	130	123.1	0.29	0.67	43.3

Numbers and biomass of fauna associated with *Stratiotes* in the stocked (*S*) and control (*C*) part of lake Warniak in 1969

Mean values for May-September, individuals or g/kg plants; values below 100% are underlined

Tab. V

	Numbers			Biomass		
	S	*C*	*S/C* %	*S*	*C*	S/C %
Total fauna	8040	8770	91.7	7.73	10.14	76.2
Chironomidae	6940	6810	102.0	3.89	4.74	82.1
Ephemeroptera	140	360	38.9	0.26	0.66	39.4
Trichoptera	100	170	58.8	0.45	0.76	59.2
Diptera varia	90	190	47.4	0.13	0.27	48.1
Lepidoptera	40	20	200.0	1.68	0.71	236.6
Mollusca	30	70	42.9	0.17	0.49	34.7

surrounding habitat, which may effect the quantitative level of fauna) and the answers as to the fish pressure are not always unanimous.

In the present paper a comparison is made of the numbers and biomass of fauna associated with *Elodea* and *Stratiotes* in the stocked (with an increased fish stock) and control (with a normal fish stock) part of the lake. It shows that in the stocked part, on both plant species, and in both years of studies, the numbers and biomass of fauna (the average for the season)

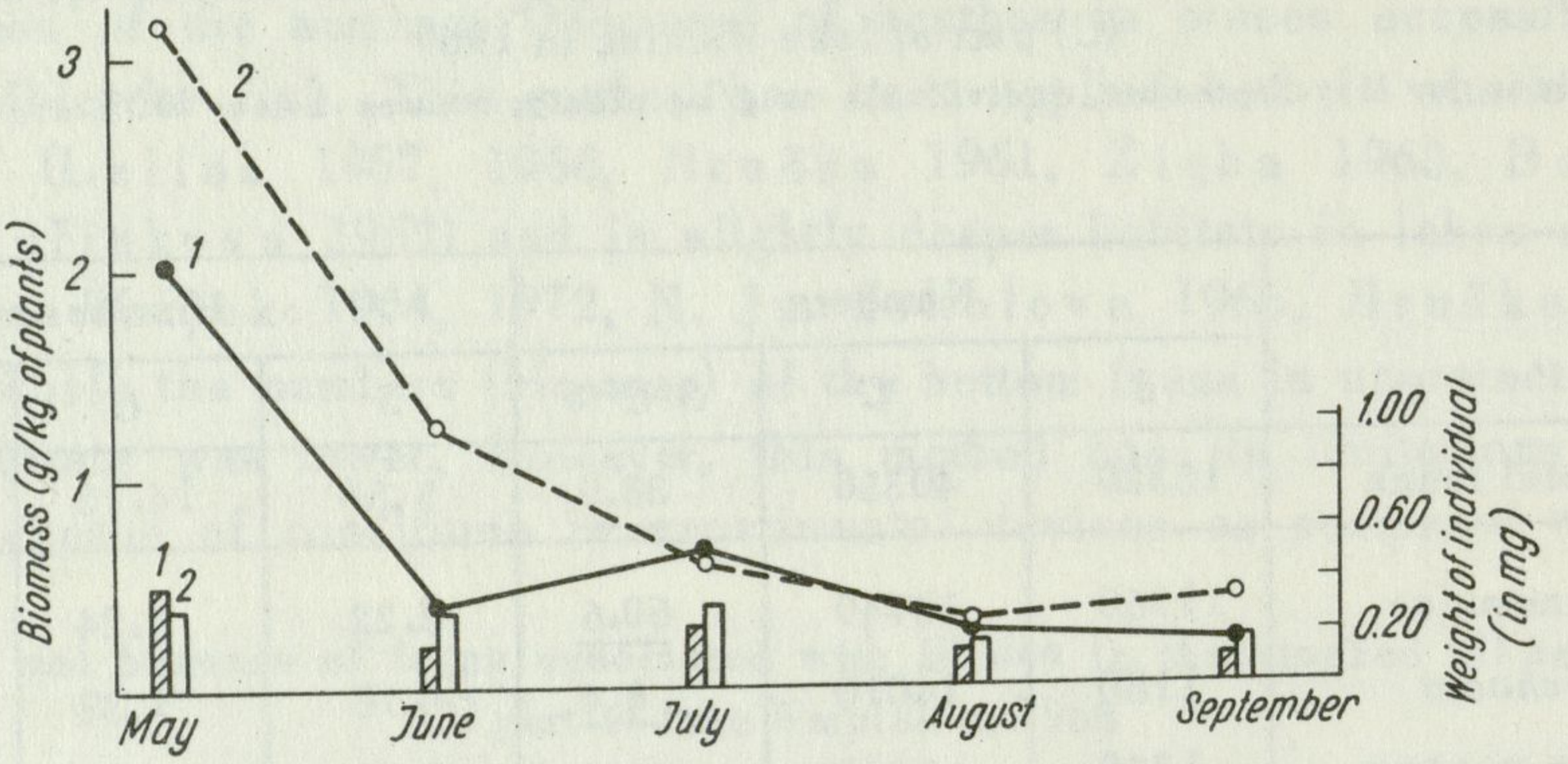

Fig. 1. Biomass dynamics of *Chironomidae* associated with *Elodea* in the stocked (*1*) and control (2) part of lake Warniak in 1968

In columns – weight of an individual

Average weight of an individual from May to September: *1* – 0.25, *2* – 0.29 mg

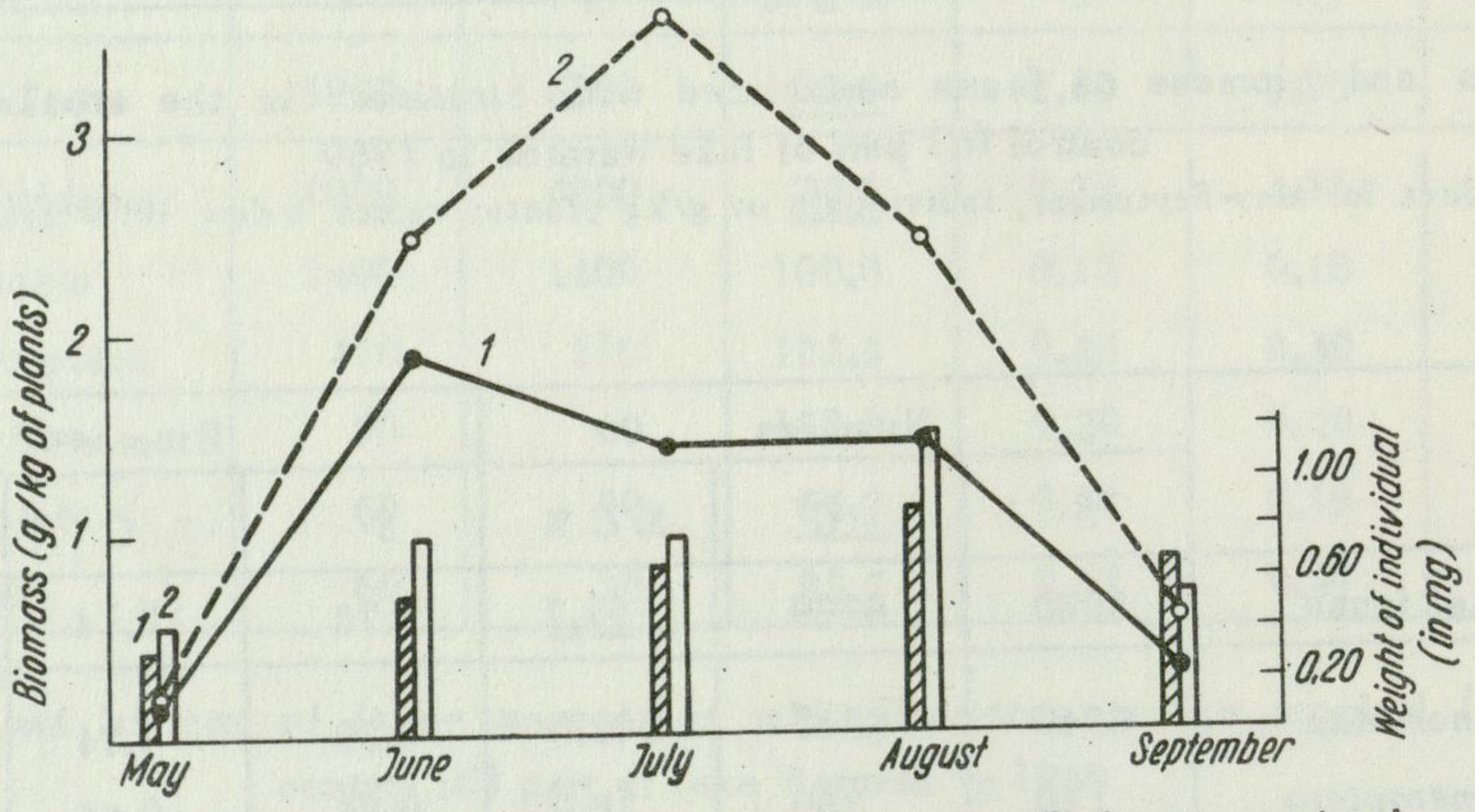

Fig. 2. Biomass dynamics of *Chironomidae* associated with *Stratiotes* in the stocked (*1*) and control (2) part of lake Warniak in 1968

In columns – weight of an individual

Average weight of an individual from May to September: *1* – 0.65, 2 – 0.82 mg

is lower than in the control part (Tab. II–V). It seems, that this result may be interpreted as the result of fish grazing, especially as the mentioned differences in the quantitative level of fauna were observed in both years, despite the fact that in 1969 as compared with the previous year the stocked part was changed into the control one and vice versa.

Especially visible were the differences in *Chironomidae* – the dominant group among the fauna associated with the both examined plant species. It is typical that in all instances the biomass losses were greater than the number losses.

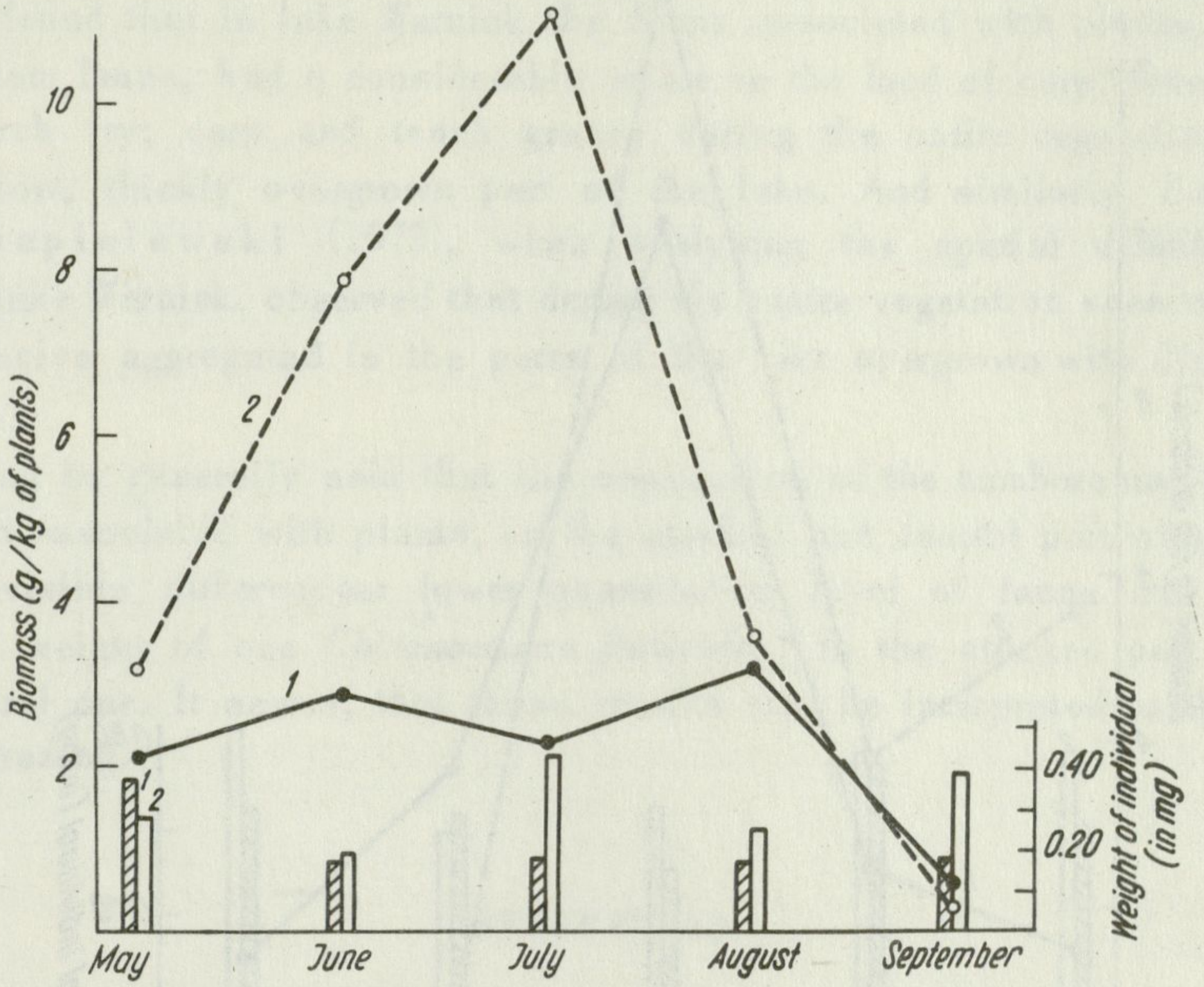

Fig. 3. Biomass dynamics of *Chironomidae* associated with *Elodea* in the stocked (*1*) and control (*2*) part of lake Warniak in 1969

In columns – weight of an individual

Average weight of an individual from May to September: *1* – 0.21, *2* – 0.31 mg

Analogous regularities were observed in several other fauna groups, which could be used as fish food. And so, a biomass on *Flodea* was lower in the stocked (as compared to the control) part of the lake of the following: *Oligochaeta, Ephemeroptera* and *Lepidoptera* in 1968, *Oligochaeta, Ephemeroptera, Trichoptera, Lepidoptera* and *Mollusca* in 1969. Whereas on *Stratiotes*: *Oligochaeta, Lepidoptera* and *Mollusca* in 1968, *Ephemeroptera, Trichoptera, Diptera* varia and *Mollusca* in 1969. On the whole, it can be said, that the differences in the quantitative level of fauna associated with both plant species in the stocked and control part of the lake were greater in the second year of investigations; they were also observed in a greater number of fauna components (Tab. II–V).

The biomass dynamics of *Chironomidae* associated with both plant species in the stocked and control part of the lake were more thoroughly examined. As a result the curves illustrating the differences between the compared parts of the lake (Fig. 1–4) were plotted. It is typical that these differences (higher biomass of *Chironomidae* in the control part than in the stocked one) are less visible at the end of the examined period (August-September).

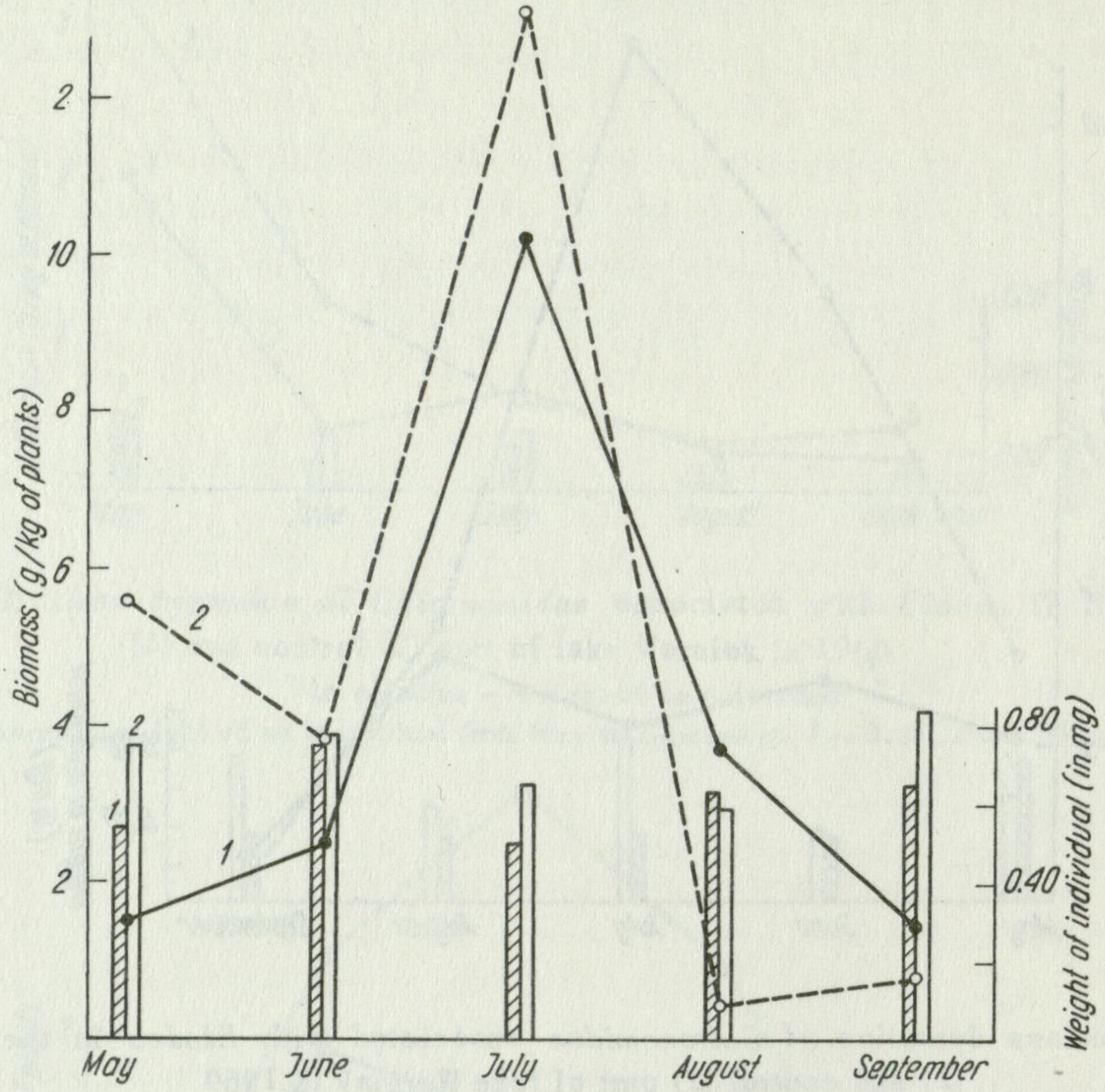

Fig. 4. Biomass dynamics of *Chironomidae* associated with *Stratiotes* in the stocked (*1*) and control (*2*) part of lake Warniak in 1969

In columns – weight of an individual

Average weight of an individual from May to September: *1* – 0.61, *2* – 0.72 mg

This is probably due to the equalization in both examined parts of the lake of the fish stock, due to the leakiness of the net barrier (Zawisza and Ciepielewski 1973). The figures, illustrate also the average weight of a *Chironomidae* individual in the stocked and control part of the lake. As it can be seen, it is as a rule, less heavy in the stocked part than in the control one, which is valid for both plant species and both years of investigations (Fig. 1–4). This would prove that the fish eat more frequently the bigger *Chironomidae* individuals (this explains also the previously mentioned greater biomass than number losses of *Chironomidae*). An analogous result was obtained by Kořinkova (1967) in pond experiments on the effect of fish on benthos; the average weight of *Chironomidae* individual was greater in the part of habitat protected from fish than in the unprotected one.

In the parallely conducted studies on the feeding of fish (Prejs 1973) it was found that in lake Warniak the fauna associated with plants, besides the bottom fauna, had a considerable share in the food of carp, tench, bream and perch fry; carp and tench grazed during the entire vegetation season in shallow, thickly overgrown part of the lake. And similarly, Zawisza and Ciepielewski (1973), when analysing the spatial distribution of fish in lake Warniak, observed that during the entire vegetation season various fish species aggregated in the parts of the lake overgrown with *Elodea* and *Stratiotes*.

It can be generally said that the comparison of the numbers and biomass of fauna associated with plants, in the stocked and control part of the lake, shows visible differences: lower quantitative level of fauna and smaller average weight of one *Chironomidae* individual in the stocked part than in the control one. It seems, that these results may be interpreted as the effect of fish grazing.

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EKSPERYMENTALNE ZWIĘKSZENIE OBSADY RYB W STAWOWYM JEZIORZE WARNIAK XII. LICZEBNOŚĆ I BIOMASA FAUNY ZASIEDLAJĄCEJ MAKROFITY

Streszczenie

W ramach zespołowych badań analizowano zasobność pokarmową dla ryb strefy roślinności. W latach 1968–1969 oceniano liczebność, biomasę i skład jakościowy fauny zasiedlającej skupienia moczarki (*Elodea canadensis* Rich.) i osoki (*Stràtiotes aloides* L.). Stwierdzono wyraźne różnice w liczebności i biomasie fauny (odnoszonej do ciężaru roślin) zarówno między gatunkami roślin, jak i w kolejnych latach, przy dużym podobieństwie składu jakościowego (tab. I). Z porównania dwu części jeziora (odgrodzonych sieciami rybackimi): zarybionej (o zwiększonej obsadzie ryb, przez introdukcję karpia) i kontrolnej (o normalnej obsadzie ryb) wynikło, że poziom ilościowy fauny jest niższy w części zarybionej (tab. II–V). Szczególnie wyraźne różnice obserwowano u *Chironomidae*, grupy dominującej wśród fauny zasiedlającej makrofity: ich biomasa na obu gatunkach roślin i w obu latach badań była niższa w zarybionej niż w kontrolnej części jeziora; niższy w częsci zarybionej był też średni ciężar osobnika (fig. 1–4). Wydaje się, że wyniki te można interpretować jako efekt żerowania ryb.

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