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THE EFFECT OF EXPERIMENTALLY INDUCED VARIATIONS IN THE ABUNDANCE OF *TENDIPES PLUMOSUS* L. LARVAE ON INTRASPECIFIC AND INTERSPECIFIC RELATIONS*

The artificial increasing of the abundance of larvae of *Tendipes plumosus* L. in experimental cages on the bottom of a lake exerts an unfavourable influence on the growth and development, and also on the survival, of the larvae of this and some other species. Artificially increased abundance of the large larvae of *T. plumosus* was not in general maintained – it fell to a level only slightly higher (or even lower) than in the lake. These facts, evidence of the strong interaction of the benthos organisms, took place even when the abundance of the benthos was relatively small. The reduction in numbers taking place is not however evidence that more numerous fauna cannot live in this habitat, since in many cases a spontaneous growth in numbers of *T. plumosus* and also of other species was found. It is, however, probably only possible as a result of the gradual changes in conditions taking place in the cage during the duration of the experiment.

The aim of the work was to investigate the mutual relations of the benthos organisms by means of observing the effects caused by the experimental variations in the abundance of larvae of *Tendipes plumosus* – a species belonging, in the habitat examined, to dominants from the aspect of abundance (and the more so from the aspect of biomass), and therefore undoubtedly playing a dominating role in the benthos biocenosis.

Work was carried out in the Śniardwy lake on a station about 2 km. from the nearest bank, depth on this station being 7.5 m. The area of the lake is 102 sq.km., mean depth 4.5 m. The depth at which the experiments were carried out is typical of the greater part of the lake. The lake is polymictic and the

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whole area of the bottom lies within the epilimnion, so that the oxygen conditions are good throughout the whole ice-free period (Olszewski and Paschalski 1961, Kosicki 1960).

Cages measuring 30 × 30 × 30 cm. constructed of perlon (nylon) gauze of 0.5 × 0.5 mm. mesh were used for the experiments; the mud together with the fauna from 4 Ekman dredges (dredging surface of Ekman dredge – 225 sq.cm.) was placed in these cages in the given place in the lake; endeavours were made

The effects of artificially increased (or decreased) abundance of the larvae of *Tendipes plumosus* L. in experimental cages in comparison with variations in the benthos in the vicinity of the cages (only those species which exhibited correlation with variations in the abundance of *T. plumosus* are given)

Tab. I

Species		Abundance, individuals per 1 sq.m.			
		vicinity of the cages	cages		
		1^x	1^x	5^x	0^x
Tendipes plumosus L. all larvae	*A*	300	300	1500	0
	B	249	645	300	44
T. plumosus older larvae > 15 mm.	*A*	300	300	1500	0
	B	249	255	120	11
T. plumosus younger larvae $\leqslant$ 15 mm.	*A*	0	0	0	0
	B	0	390	180	33
Tendipes anthracinus Zett.	*A*	0	0	0	0
	B	0	0	0	111
Microtendipes chloris Mg.	*A*	0	0	0	0
	B	0	160	45	135
Procladius sp.	*A*	55	55	55	0
	B	53	55	0	245
Valvata piscinalis (Müll.)	*A*	0	0	0	0
	B	0	255	77	1776
		Mean length of larvae, mm.			
T. plumosus older larvae > 15 mm.	*A*	23.50	23.50	23.50	
	B	25.04	24.25	24.00	*
T. plumosus younger larvae $\leqslant$ 15 mm.	*A*	–	–	–	*
	B	–	8.65	7.81	

1^x, 5^x, 0^x – initial density of the larvae of *T. plumosus* in relation to the state in the lake at the beginning of the experiment.

A – state at the beginning of the experiment – 27.VI.1960.

B – state at the end of the experiment – 29.VII.1960

In the cage with zero initial density of *T. plumosus* mud deprived at the beginning of the experiment of the whole of its macrofauna; in other variants of the experiment the only change in relation to the control variant was the adding of *T. plumosus*.

* too small a number of larvae to calculate mean length

Effects of artificially increased abundance of the larvae of *Tendipes plumosus* L. in experimental cages in comparison with variations in the benthos in the vicinity of the cages

Tab. II

Stage of experiment	Abundance of larvae of *T. plumosus*, individuals per 1 sq.m.			
	vicinity of the cages	cages		
	1^x	1^x	2.5^x	3.5^x
Beginning (11.IX.1960)	186	186	465	651
End (22.X.1960)	211	178	266	289

1^x, 2.5^x, 3.5^x – initial density of the larvae of *T. plumosus* in relation to the state in the lake at the beginning of the experiment.
The abundance of the young larvae was similar in the lake and in all the variants of the experiments, and formed several % of the total number of larvae.

to disturb the structure of the mud as little as possible (more detailed data Kajak in press a). The larvae of *T. plumosus* obtained from this place in the lake (also by means of the Ekman dredge) were next added to the cage in quantities sufficient to obtain the required density (Tab. I, II, III) in relation to the abundance in the lake. The larvae were removed, after sifting the mud through a sieve, with the greatest possible care, by placing a special spatula under them (laboratory cultures of larvae obtained in this way revealed their good condition and very low percentage of mortality). The larvae were put into a jar containing water, and after a suitable quantity had been obtained the contents of the jar were poured into the experimental cage, the cover fastened down and the whole submerged on the bottom of the lake.

The lower degree of density of the *T. plumosus* larvae (Tab. I – mud devoid of macrofauna at the beginning of the experiment) than that in the habitat of the lake bottom was obtained in the following way: the samples taken were sifted through a sieve in a large cuvette and the mud obtained in this way was placed in an experimental cage. The mud was thus at first completely devoid of macrofauna; during the experiment fauna appeared in large numbers but *T. plumosus* attained small numbers only, and these chiefly consisted of young forms (Tab. I). At the beginning and end of the experiments samples were, of course, also taken in the lake in the immediate vicinity of the cages. All the material was sifted through a sieve of 0.4 × 0.4 mm. mesh. In this paper I have analysed only the data on *T. plumosus* and those species which exhibited a distinct reaction to the variations in the abundance of *T. plumosus*. In order to give a fuller description of the benthos in the lake I have set out data referring to whole fauna in the vicinity of cages, at the beginning and end of the experiments, in Tab. IV.

Effects of the artificially increased abundance of the larvae of *Tendipes plumosus* L. in experimental cages in comparison with variations in the benthos in the vicinity of the cages (only those species which exhibited correlation with variations in the abundance of *T. plumosus* are given)

Tab. III

Species		Abundance, individuals per 1 sq.m.			
		vicinity of the cages	cages		
		1^x	1^x	3.5^x	8^x
Tendipes plumosus L.	A	133	133	466	1064
	B	231	200	244	511
Tendipes anthracinus Zett.	A	0	0	0	0
	B	9	189	78	0
Procladius sp.	A	22	22	22	22
	B	62	167	167	266
% of pupae of *T. plumosus* (from the total abundance of *T. plumosus*)	A	0	0	0	0
	B	11.5	44.4	10.9	19 1
		Mean length of larvae, mm.			
Tendipes plumosus	A	23.0	23.0	23.0	23.0
	B	26.5	27.1	24.9	24.7
Tendipes anthracinus	A	–	–	–	–
	B	*	14.1	9.7	–
Procladius sp.	A	8.0	8.0	8.0	8.0
	B	10.0	9.0	8.8	7.9

1^x, 3.5^x, 8^x – initial density of the larvae of *T. plumosus* in relation to the state in the lake at the beginning of the experiment.
A – state at beginning of experiment – 1.VII.1961.
B – state at end of experiment – 3.VIII.1961.
Young larvae of *T. plumosus* did not occur during the experiment.
* too small a number of larvae to calculate mean length.

The density of the larvae of *T. plumosus* at the beginning of the experiment was not as a rule maintained – a reduction in numbers took place. In general the abundance in the cages "crowded" with the larvae of *T. plumosus* was, at the end of the experiment, at most only up to 1.5 times greater than in the lake (Tab. I and II). Only in the case in which the density of *T. plumosus* was increased by 8 times at the beginning of the experiment was the abundance of the larvae at the time when the experiment was ended over twice as high as in the lake (Tab. III). It is worthy of note that this relatively high survival rate took place when a spontaneous increase in the numbers of the larvae of *T. plumosus* took place in the lake and in the control cage (Tab. III), probably caused by immigration; (immigration into the cages could have taken place here, as the covers of the cages in 1961 were made of coarser gauze, with 1.5 × 1.5 mm. mesh.). The fact that no young larvae occurred at all throughout the entire period of the experiment is evidence that it was a case of immigration and not of the appearance of young larvae.

State of benthos in the lake at the beginning and the end of different series of experiments (Abundance of organisms per 1 sq.m.)

Tab. IV

Taxonomic group	Duration of each series					
	27.VI–29.VII 1960		11.IX–22.X 1960		1.VII–3.VIII 1961	
Oligochaeta	333	26	79	189	36	98
Tendipedidae	444	320	710	599	289	471
Tendipes plumosus L.	300	249	186	211	133	231
Tendipes anthracinus Zett.	0	0	0	0	0	9
Einfeldia carbonaria Mg.	78	0	462	344	89	0
Limnochironomus tritomus Kieff.	11	0	0	0	0	18
Cryptochironomus defectus Kieff.	0	0	35	44	0	0
Cryptochironomus viridulus F.	0	0	0	0	0	89
Cryptochironomus conjugens Kieff.	0	9	0	0	45	0
Tanytarsus gregarius Kieff.	0	9	0	0	0	53
Procladius sp.	55	53	9	0	22	62
Ablabesmyia monilis L.	0	0	9	0	0	0
Orthocladiidae gen. *orielica* Tshern.	0	0	0	0	0	9

It was therefore found: a) a considerable decrease in abundance (approximately to the level prevailing in the lake) in those cases in which abundance in the lake was maintained on a more or less constant level, b) a relatively smaller decrease in abundance when a tendency to increase was observed in the lake; these facts are evidence of the decisive importance to survival and abundance of the conditions on the bottom of the lake. In a situation in which these conditions permitted of a larger number of larvae living there and even probably evoked an increase in abundance through immigration, the survival capacity of the larvae was also greater.

In one series of experiments (Tab. I) in the control cage the abundance of larvae (comparison should be made with larvae over 15 mm. since only such occurred in the lake during the experiments; appearance of young larvae was found only in the experimental cages) was maintained on the same level as in the lake, while in the variant with a density of *T. plumosus* larvae 5 times as great, it fell to about a half of abundance in the lake. It would seem that under the conditions prevailing during this series of experiments the unfavourable interaction of the over-crowded larvae was especially strong.

As has been mentioned above, the young larvae of *T. plumosus* in this series appeared in large numbers only in the experimental cages, while they were entirely absent in the lake; the young generation in the cage, with 5 times as great a density of larvae at the beginning of the experiment, appeared in far fewer numbers than in the control cage. What is more, the larvae in the control cage were far larger than in the cage with 5 times as great a density of larvae[1] (Tab. I).

The dependence of the mean size of the larvae on their density was also established in a different series of experiments (Tab. III). The greater the initial crowding of larvae the smaller their size at the end of experiment. Also the percentage of pupae in the crowded cages was lower than in the control cage (although proportionality to density was not found here).

The facts discussed above are undoubtedly evidence of the deterioration of conditions for the growth and development of larvae when their numbers were artificially increased.

In addition to the intraspecific relations discussed, the distinct influence of *T. plumosus* on other species was established. Thus a related species – *Tendipes anthracinus* Zett. occurred in increasingly fewer numbers with an increased density of *T. plumosus*; in the case of the considerable initial density, 8 times as great, of this latter species, *T. anthracinus* did not occur at all (Tab. III). In another series of experiments this species occurred only in the variant with mud deprived at the start of the experiment of its macrofauna, where the abundance of *T. plumosus* at the end of the experiment was very small[2] (Tab. I). What is more, the mean size of the larvae of *T. anthracinus*, which is evidence of the conditions of their development, was smaller when the density of *T. plumosus* was greater (Tab. III). In this same series of experiments distinct dependence on the density of *T. plumosus* was exhibited by: *Microtendipes chloris* Mg., *Procladius* sp. and *Valvate piscinalis* (Müll.) All these species occurred in large numbers in the control variant and in the variant deprived of macrofauna at the beginning of the experiment, less numerously (or not at all) in the variant with density of *T. plumosus* 5 times as great (Tab. I).

[1] The greater length of the larvae and higher percentage of pupae in the control cage in relation to the surrounding habitat of the lake bottom is the result of the conditions for development being on as a rule better in the cages than directly in the lake (Kajak, in press a). The exception to this rule formed by the size of the large larvae of *T. plumosus* in one series of experiments (Tab. I) is probably apparent only; the smaller length of the larvae in the cages was the result of the older larvae, owing to the more rapid development in the cages, having already left the bottom habitat (as imagines), and their place having been taken by young larvae, which despite their rapid growth had on the whole slightly smaller mean dimensions.

[2] The low abundance of *T. plumosus* in this variant of the experiment is presumably the result of the quicker occupation of the habitat deprived of fauna, by other species, chiefly *Valvata piscinalis* (Müll.), which inhibited an abundant appearance of *T. plumosus*.

In one of the series of experiments (Tab. III) the greater the density of *T. plumosus* the more numerous the occurrence of *Procladius* sp. It must therefore be assumed that this was caused by the abundance and easy accessibility of food for this predator. The unfavourable interaction of the over-crowded population of *T. plumosus* resulted in its poorer condition (Tab. III – size of larvae of *T. plumosus*), and thus probably weakened its ability to escape and resist predators. The unfavourable influence of over-crowded populations, referred to above, of *T. plumosus* on other species gives grounds for assuming that they also were more liable to be eaten by predators The mean length of the larvae of *Procladius* sp., smaller in the cages than in the lake at the end of the experiment, and consequently decreasing with the increase of *T. plumosus* density, is probably the result of the accelerated development in the cages, especially with the greater numbers of the larvae of *T. plumosus*; as a result, with the greater density of larvae of *T. plumosus*, a greater percentage of grown individuals of *Procladius* sp. left the bottom habitat after metamorphosis into imagines, and on account of the more numerous appearance of the young larvae in the cages with a greater density of *T. plumosus*, the mean length of the individual *Procladius* sp. is smaller there.

To sum up: artificially induced density of larvae of *T. plumosus* carried out under conditions as near as possible to natural ones (cf. Kajak in press a) as a rule caused a decrease in abundance to a level not greatly exceeding the abundance established naturally, and not infrequently even to considerably smaller numbers. This is in agreement with the results of my other work carried out in a completely different habitat, in the oxbow pond where the depth was only about 1 m. (Kajak 1958).

The relatively high capacity for survival of the larvae in the cages to which a large number of larvae were introduced was observed only in those cases in which there was a natural tendency in the lake to an increase in abundance.

In the majority of cases it was found that an increase in the abundance of larvae of *T. plumosus* causes a slowing-down of the development (smaller percentage of pupae) and of the growth of individuals at different stages of age. Experimental increase of the numbers of the larvae of *T. plumosus* also causes a reduction in the capacity for survival of the young larvae. These facts confirm the general rule – that with an increase in density competition increases and the condition of the individual deteriorates (Ivlev 1955). The establishment of the fact that these phenomena occur in a benthos biocenosis even with relatively small (see further on) density of organisms, is significant.

In many cases the increased number of *T. plumosus* was found to exert a distinctly unfavourable influence on the abundance and often also on the condition of other species – *Tendipes anthracinus*, *Microtendipes chloris*, *Valvata piscinalis*. In one series of experiments a positive correlation was shown to exist between the abundance and rate of development of the predatory form – *Procladius* sp. and the abundance of *T. plumosus*. This was probably the result of the deterioration in the condition of the non-predator forms (and perhaps also of the increase in the abundance of *T. plumosus*) and in effect – the increase in their accessibility to predators.

Attention has been drawn above to the fact of the outstandingly greater increase in capacity for survival in a crowded aggregation of larvae, with a tendency to increase in numbers in the neighbourhood of the experimental cages. This rule is well correlated with the situation described in another paper (Kajak in press b), where the increase in numbers by means of immigration in the lake was accompanied by an increase in numbers in the cages caused by the appearance of the young generation (the immigration of grown forms into the cages was impossible on account of the fine mesh of the net). Thus the population of *T. plumosus* adapted itself in various ways to take the greatest possible advantage of the opportunities formed by the habitat.

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The cases discussed above of the distinct dependence of the state of benthos organisms on the abundance of one of the species, is evidence of the considerable intensity and important role of reciprocal relationships, and of the close interdependence of these relationships on habitat conditions. It must be remembered that the abundance of *T. plumosus* was not very great – 200–300 individuals per 1 sq.m., and in the cases of maximum experimental density – 1 500 individuals per 1 sq.m. Assuming distribution to be even, there was therefore an area of about 40 sq.cm. per individual with the density prevailing in the lake, that is, an area with a radius of about 3.5 cm., in excess of the length of the animal; when density was 1 500 individuals per sq.m., there is an area of about 6.7 sq.cm. per individual. Abundances many times greater are often observed in nature – up to about 60,000–70,000 individuals per 1 sq.m. in natural bodies of water (Lepneva 1950, Žadin 1950, Thienemann 1954, Kajak 1958, Levanidova 1959, and others). An even greater abundance not infrequently occurs in polluted waters (for a review of literature see Konstantinov 1958) – of up to hundreds of thousands of individuals per 1 sq.m. Under such circumstances the larvae lie closely side by side (several individuals per 1 sq.cm.) and even so exhibit a rapid rate of growth and low degree of mortality (Levanidova 1959, Konstantinov 1958). The conditions observed in the situations discussed and in connection with them, the mutual relations of the organisms, made it possible for such great densities to exist.

Very little is known on the subject of the possible ways and mechanisms of the mutual relations of benthos animals, nevertheless certain ideas about them can be formed on the basis of existing data – e.g. of getting the food by filtering, or by taking it from the surface of the bottom, while the animal emerges from its tube (Šilova 1955, Konstantinov 1958), of the great timidity of benthos organisms (Kajak 1963), of food selection (Rodina 1957, Konstantinov 1958) etc. It is possible to imagine, for instance, reciprocal frightening of larvae inhabiting tubes, frightening them by free living forms, competition for certain kinds of food etc., which causes a smaller amount of food to be consumed, poorer condition and in the final effect a decrease in abundance.

It would seem that the case which I have described, of development of one *T. plumosus* generation only, in shallow water with a good oxygen supply and where the abundance of benthos was very great (K a j a k 1958), is also the effect of competition relations between benthos organisms. Judging by the data on the number of generations of *Tendipedidae* (L a c h o v 1954, K o n s t a n t i n o v 1950, 1961, B o r o d i č 1956, Š i l o v a 1958) a greater number of generations should be expected to occur in the conditions prevailing in this body of water. It may be assumed that the competition relations, intensifying with the growth of the organisms, slowed down the rate of development and in consequence affected the number of generations.

Facts of the increase of benthos production as the result of the depredations of fish (L a c h n o v i č 1953, H a y n e and B a l l 1956) are also evidence of the competition relationships of benthos organisms. Fish, in reducing the abundance of the population by feeding on it, probably weaken the competition relationships among the benthos organisms, which creates conditions for a more abundant appearances of young larvae and acceleration of the rate of development.

An exact understanding of the mechanisms of the mutual relationships depends of course of further research. From the material described here and the discussion given, only the fact of the important role played by these relations, even with relatively small abundance of organisms, and of the considerable variations in the mechanisms of these relationships under different natural conditions, are clear.

On the other hand the conclusion should not be reached from the facts given that it is impossible for a larger number of organisms to live in the habitat examined. As shown previously (K a j a k in press a) the benthos fauna in the cages used here often spontaneously attained an abundance several times greater, owing to the greater survival of the juvenile stages. Despite the greater abundance, the rate of growth of the organisms was not lower (as in the cases described of artificially increased abundance of *T. plumosus*), but higher than in the habitat surrounding the cages, where populations with a lower degree of density lived.

Evidently certain changes in conditions take place in the cages which make it possible for a larger number of organisms to live in them. Neither the concentration of oxygen nor the number of organic substances increased, but it is possible that a growth in the concentration of certain substances took place as a result of the life activities of benthos, owing to the greater calmness of the water in the cages (K a j a k in press a). These variations in conditions caused the formation of different mutual relations between the benthos organisms, making their more abundant occurrence possible.

This type of interference in the abundance of organisms as applied in the present work — the artificial increasing of the abundance of large larvae of *T. plumosus* at the beginning of the experiment, did not in general cause a far higher abundance to be maintained. Nevertheless in certain cases, (Tab. III —

density increased by 8 times) this type of interference gave good results, possibly due to the change in conditions in this place which took place exactly during the duration of the experiment.

CONCLUSIONS

1. The artificially increased abundance of larvae of *T. plumosus* in experimental cages in a natural habitat was not in general maintained – a decrease in numbers took place until a level was reached not much higher than that in the neighbourhood of the cages, and sometimes even lower.

2. A far greater abundance than in the vicinity of the cages was obtained by means of artificially increasing the density of the larvae, when a spontaneous tendency to increased abundance of larvae took place in the habitat studied.

3. The artificial increase in the abundance of larvae of *T. plumosus* produced a deterioration in their growth and development (smaller dimensions, lower percentage of pupae).

4. The increase in the abundance of the larvae of *T. plumosus* also caused a decrease in the capacity for survival and in abundance, and a slowing down of the rate of development of the young larvae of this species.

5. Many of the benthos species (*Tendipes anthracinus*, *Microtendipes chloris*, *Valvata piscinalis*) occurred in large numbers when the abundance of *T. plumosus* was artificially reduced, and in smaller numbers when the abundance of *T. plumosus* was increased. In the case of *T. anthracinus*, the growth of the larvae of this species was also found to be poorer when the density of the larvae of *T. plumosus* was greater.

6. In certain cases an increase in the abundance of the predatory form – *Procladius* sp. was found, with an increase in the density of *T. plumosus*.

7. The facts presented are evidence of the important role played by the mutual relationships of benthos organisms, even when their density is relatively slight, as was the case in the habitat studied.

8. The fact that the artificially increased abundance of the larvae of *T. plumosus* was not maintained, does not mean that a greater number of larvae cannot live in the given habitat, since several times spontaneous, quite great increase in the abundance of larvae was observed in the experimental cages in relation to their surroundings. These facts are rather evidence that increase in abundance is possible when there is an appropriate change in conditions, and in consequence in the character of the relations and interaction of the organisms; possibly these variations take place as the result of the gradual transformation of the habitat by the benthos contained in the experimental cages, owing to the relative weakening of the circulation of the water.

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WPŁYW EKSPERYMENTALNIE INDUKOWANYCH ZMIAN LICZEBNOŚCI LARW *TENDIPES PLUMOSUS* L. NA STOSUNKI WEWNĄTRZGATUNKOWE I MIĘDZYGATUNKOWE

Streszczenie

Celem pracy było zbadanie efektów sztucznego zwiększania liczebności dużych larw *Tendipes plumosus* L., w warunkach maksymalnie zbliżonych do naturalnych. Eksperymenty przeprowadzono w śródjezierzu jeziora Śniardwy, na głębokości 7,5 m, w specjalnych klatkach o wymiarach 30×30×30 cm, obszytych gazą perlonową o oczkach 0,5×0,5 mm (wieczka siatki w niektórych seriach eksperymentów sporządzano z gazy rzadszej). Doświadczenia prowadzono w różnych sezonach 1960–1961.

W każdej klatce umieszczano zawartość czterech chwytaczy Ekmana (muł wraz z fauną) pobranych w danym środowisku oraz dodawano odpowiednią, dla uzyskania żądanego zagęszczenia, liczbę larw *Tendipes plumosus* uzyskanych z tegoż środowiska. Po kilku tygodniach klatkę wyciągano i zawartość jej przesiewano. Na początku i końcu doświadczenia pobierano również próby z dna jeziora w sąsiedztwie klatek.

Stwierdzono, że sztucznie podwyższona liczebność larw *T. plumosus* na ogół nie utrzymywała się – następował spadek liczebności do poziomu niewiele wyższego niż w sąsiedztwie klatek, a niekiedy nawet niższego (tab. I, II, III). Dość znacznie, bo ponad dwukrotnie wyższą liczebność *T. plumosus*, uzyskano przy pomocy sztucznego zagęszczenia jedynie w tym wypadku, gdy w sąsiedztwie klatek na dnie jeziora miała miejsce samorzutna tendencja do wzrostu liczebności larw, drogą imigracji. Przypuszczalnie tę imigrację w jeziorze oraz wyższą przeżywalność w klatce spowodowała jakaś korzystna dla tego gatunku zmiana warunków środowiska, która zaszła w trakcie trwania eksperymentu.

Sztuczne zwiększenie liczebności dużych larw *T. plumosus* powodowało zmniejszenie tempa ich wzrostu i rozwoju, jak również spadek przeżywalności i tempa rozwoju młodych larw tego gatunku.

Szereg gatunków bentosowych (*Tendipes anthracinus* Zett. *Microtendipes chloris* Mg., *Valvata piscinalis* (Müll.)) występowało liczniej przy sztucznie zmniejszonej liczebności *T. plumosus*, a mniej licznie – przy zwiększonej jego liczebności. W przypadku *T. anthracinus* stwierdzono także wolniejszy wzrost larw tego gatunku przy większym zagęszczeniu larw *T. plumosus*.

W niektórych wypadkach ze wzrostem zagęszczenia *T. plumosus* stwierdzono wzrost liczebności formy drapieżnej – *Procladius* sp. Przypuszczalnie jest to wynik wyższej liczebności i większej dostępności (z powodu gorszej kondycji) ofiar w warunkach większego zagęszczenia *T. plumosus*.

Omówione fakty świadczą o dużej roli oddziaływań wzajemnych organizmów bentosowych, nawet przy stosunkowo niewielkim ich zagęszczeniu, jakie miało miejsce w badanym środowisku. Maksymalne zagęszczenie *T. plumosus* w jeziorze nie przekraczało bowiem 300 osobników na 1 m², zaś w warunkach maksymalnego zagęszczenia – 1 500 osobników na 1 m². Maksymalne zagęszczenie wszystkich *Tendipedidae* nie przekraczało odpowiednio 700 osobników na 1 m² i 1 660 osobników na 1 m². W przyrodzie spotyka się zagęszczenie wielokrotnie większe – do kilkudziesięciu tysięcy osobników na 1 m². Przemawia to za ścisłym powiązaniem stosunków i oddziaływań wzajemnych organizmów i warunków środowiskowych.

Nieutrzymywanie się sztucznie zwiększonej liczebności larw *T. plumosus* w wyżej omówionych eksperymentach oraz niekorzystne oddziaływania wewnątrz- i między-

gatunkowe, jakie zaistniały w wyniku zwiększenia liczebności tego gatunku, nie świadczą o niemożności życia w danym środowisku liczniejszego bentosu. W klatkach eksperymentalnych wielokrotnie obserwowano samorzutny, kilkakrotny wzrost liczebności larw *Tendipedidae* (Kajak in press a). Omówione fakty świadczą raczej o tym, że podwyższenie liczebności jest możliwe jedynie przy odpowiedniej zmianie warunków, a w konsekwencji charakteru stosunków i oddziaływań wzajemnych organizmów; być może zresztą, że zmiana warunków jest wynikiem stopniowego przekształcania środowiska w klatkach przez zespół organizmów bentosowych w trakcie trwania eksperymentu, dzięki słabszej wymianie wody z otoczeniem.

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