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BIOMASS AND PRODUCTION OF *DREISSENA POLYMORPHA* (PALL.) IN SOME MASURIAN LAKES*

ABSTRACT: *Dreissena polymorpha* (Pall.) biomass was estimated in 21 Masurian Lakes. The big differences in its values found in particular lakes were mainly connected with different abundances of this mollusc and to some extent with the age structure of the population and the "condition" of individuals. Annual production of total animal biomass fluctuated considerably in particular reservoirs. *P/B* coefficients were contained between 0.42 and 0.81.

Contents

1. INTRODUCTION

Abundance, occurrence in aggregations and "condition" of individuals of *Dreissena polymorpha* (Pall.) in 36 Masurian Lakes were described. In 1962 mutual interaction of the investigated characteristics of populations in different reservoirs was found (out Stańczykowska 1964). Basing on the same materials as well as on some additionally gathered in 1972, the biomass data were processed and the annual production in 21 selected Masurian Lakes was estimated. It was also the aim of this work to point out to what degree biomass differentiation in different lakes is connected with abundance and to what extent it is influenced by the age structure of the population.

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2. MATERIAL AND METHOD

Research area and the methods of gathering and preliminary processing of the materials were described elsewhere (Stańczykowska 1964). In 1972 some additional samples were taken in 11 lakes in order to describe the percentage of water in the body and participation of the shell in the dry mass of the animal using the previous method.

Molluscs used for the studies were processed in 4% formalin and they were kept in this solution from one to three months. After opening the shells and draining the animals on blotting paper they were weighted to wet weight. Secondly, they were dried in an oven to the constant dry weight. Thirdly, the shells were weighted after removing flesh tissue. In this way the mass of the body was estimated.

The recived date allowed to get the per cent of water in the mollusc body and the per cent of shell in the biomass. Biomass and its production were counted for *Dreissena* body (without the shell) and for the total animal biomass with the shell. Biomass of mollusc is described by various scientists in different ways: basing exclusively on the wet or the dry weight, taking into consideration either the animal with its shell or only its body. In the present work, estimations are based on the dry biomass (body with the shell and without it), presuming that the wet mass measurements have big errors connected within a different water contents inside the animal body, especially in the mantle cavity.

Annual production of the biomass was estimated according to the method worked out by Greze (1965). This method consists of abundance estimation of individuals for different age groups and annual growth of their biomass – for the unit of the bottom surface. The method was used for the research in bentos production (Kajak and Rybak 1966), *Unionidae (Bivalvia)* production by Tudorancea and Florescu (1968, 1969), Magnin and Stańczykowska (1971) and Lewandowski and Stańczykowska (1975) and also in research of *D. polymorpha* production (Stańczykowska 1965). The production of *D. polymorpha* biomass presented in this last work was based upon the assumption that these molluscs live up to 10 years (Stańczykowska 1963). Basing upon the gathered data obtained during the last few years from the regional experiments and the detailed analysis of growth rings (among others – from the shell grinds it was stated that life period of *D. polymorpha* in the Masurian Lakes region usually do not exceed five years – Stańczykowska and Lewandowski unpubl.). Age structure of *D. polymorpha* population in the Masurian Lakes region was analysed once more basing on this assumption.

3. RESULTS

For the majority of mussels the weight of shell presents a considerable per cent of animal weight. It shows from our research in the Masurian Lakes region that averagely shell composes 91.4% of *D. polymorpha* individual dry weight. These values, however, fluctuate in different lakes (for example, for *Dreissena* population in 1962 in Śniardwy shell weight composed 96%, whereas in lake Szymon it composed about 84% of mollusc weight; they also underwent some changes in different years of research (Table I). It was found out that shell weight to body weight relation in all the lakes increases distinctly with the age of the animal; the eldest individuals' shell is relatively the heaviest, the young ones' – the lightest (Table II).

Water contents per cent in *D. polymorpha* body, as it followed from our research, was very

high: at adult individuals it was about 95%. It seems, however, that this value might be artificially hightened by the inaccuracy of the measurement method. When we dried *Dreissena* on the blotting paper not all the water from the mantle cavity was removed. A part of it remains and causes that the dry mass estimated in the above described way in relation to the wet one shows a lower percentage than in reality.

It follows from previously analysed materials (Stańczykowska 1964) that *D. polymorpha* abundances in the studied lakes oscillated in a very wide range from several to several thousand individuals per sq. m in this mollusc zone occurrence (from 0.2 m to 8 m).

In this connetion 3 groups of lakes were distinguished according to different abundance; in the first group of lakes, molluscs occurred in density from several to several tens of individuals per sq. m; in the second group – several hundred, and in the third group – several thousand individuals per square meter of the surface.

The present analysis pointed out some distinctive differences of the mollusc biomass for 1 sq. m.

The dry mass oscillated from tenth parts of a gram to 50 grams, and dry body mass of whole mussel from some grams to several hundred grams. For the majority of cases the correlation of biomass and abundance for the unit of surface in the zone of occurrence was estimated (Figs. 1 and 2). Sometimes, however, the lakes of the same abundance were characterized by different biomass; for example, in lakes Wilkus and Śniardwy the abundance in both reservoirs amounted to about 600 ind./m^2 whereas dry mussels biomass for 1 m^2 was about 3 times bigger and estimated in dry body mass was about 6 times bigger in lake Wilkus than in lake Śniardwy.

In some cases the lakes of bigger density in the *Dreissena* occurrence zone, were characterized by smaller biomass than the lakes of lower abundances, for example, lake Jagodno and lake Mamry.

Lack of complete abundance and biomass correlation for a unit of bottom surface, was mainly caused by two reasons: difference in "condition" of individuals and different age structure of the populations. In the studied Masurian Lakes differences of "condition" were connected with, as it was previously stated (Stańczykowska 1964), abundance of *D. polymorpha*.

In the lakes where abundance was big, "condition" of individuals (i.e. size and weight) was worse than in the lakes where *D. polymorpha* occurred in small density. On the whole, in the lakes of similar *Dreissena* population density, there was also similar mollusc weight observed.

Sometimes we found exceptions to this rule – "condition" of this mussel in some lakes is positively better or worse than in other lakes with similar *Dreissena* density; such an exception in the analysed material is presented in lake Wilkus, mentioned above, in which body weight and the total animal were about twice bigger than in other lakes belonging to the same group.

Table I. Shell weight in relation to total weight (with shell) of *Dreissena polymorpha* (Pall.) from different lakes given in per cent of dry mass

Year	Bełdany	Mikołajskie	Tałty	Śniardwy	Niegocin	Jagodne	Tałtowisko	Boczne	Szymon	Stręgiel	Żabinka	Average date
1962	90.7	93.1	89.7	96.2	89.2	90.8	92.5	92.8	83.8	89.4	90.9	91.4
1972	92.2	91.3	88.0	92.3	88.9	93.1	95.1	94.8	93.2	90.7	92.8	

Table II. Shell weight in relation to total weight of *D. polymorpha* (with shell) of different age groups given in per cent of dry mass. Average date from all lakes investigated

Year	Age groups (years)				
	1	*2*	*3*	*4*	*5*
1962	85.0	89.5	90.6	95.8	95.5
1972	86.4	90.1	92.5	94.6	94.9

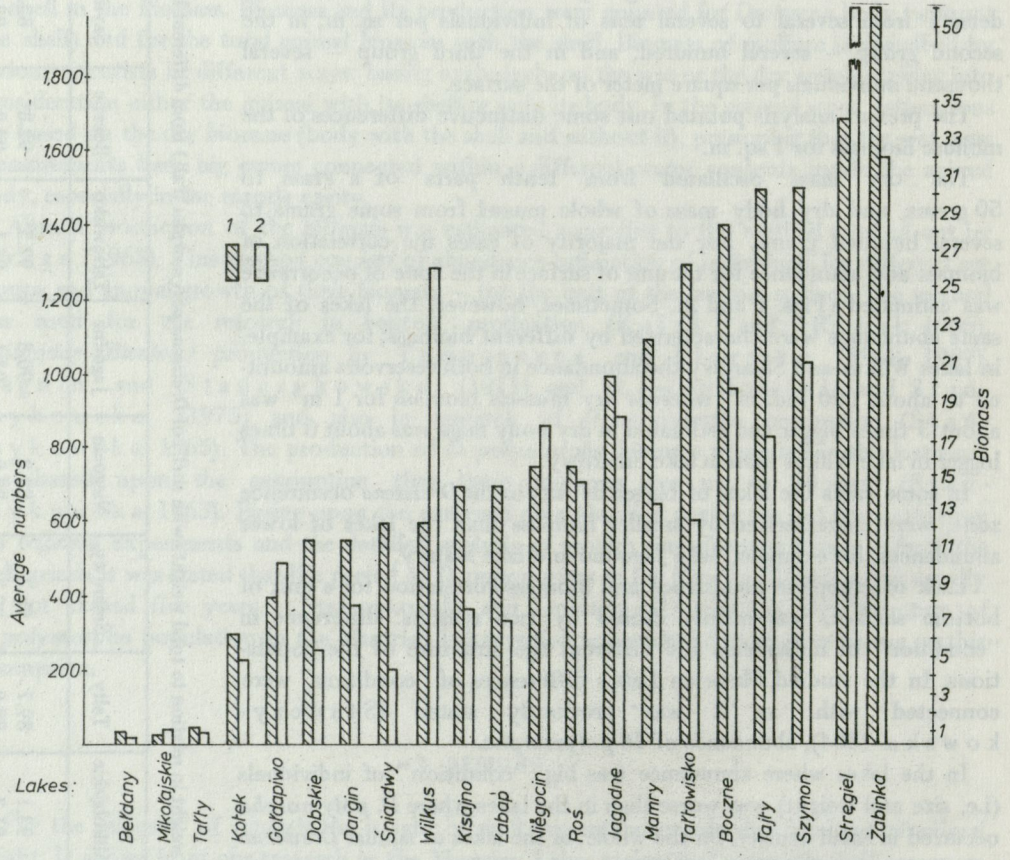

Fig. 1. Abundance and biomass (in g dry wt, without shell) of *Dreissena polymorpha* (Pall.) per 1 m^2 in the Masurian Lakes in 1962
1 – numbers, *2* – biomass

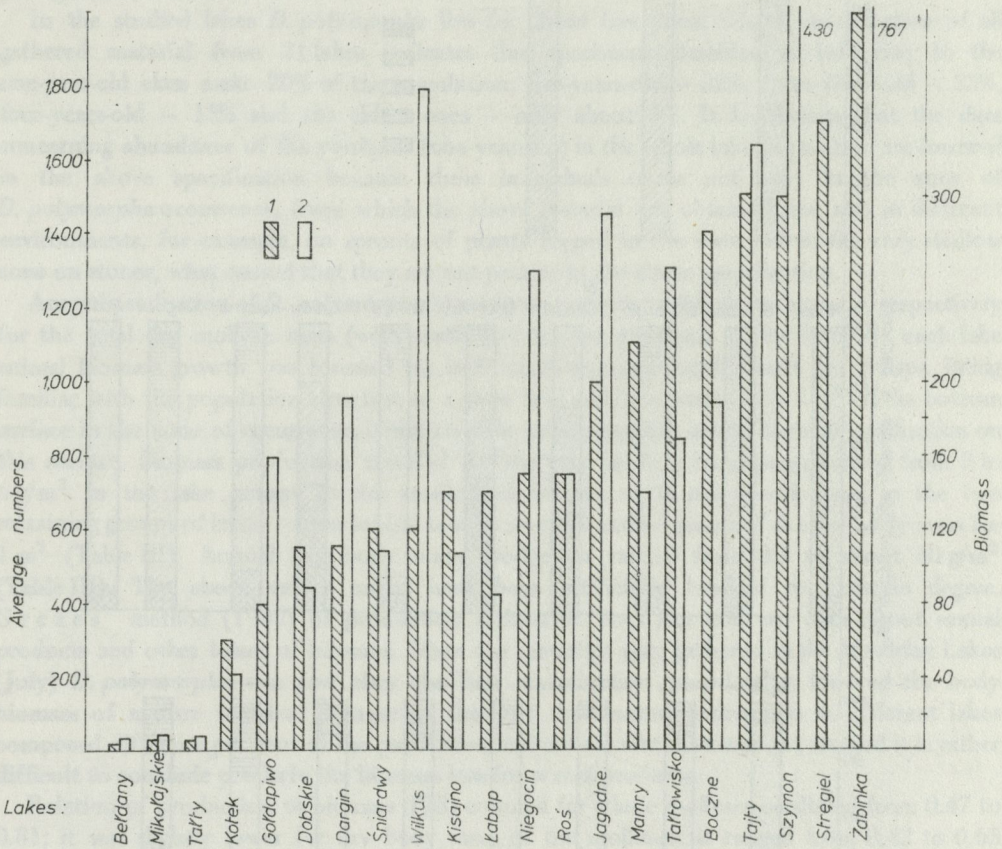

Fig. 2. Abundance and biomass (in g dry wt, with shell) of *D. polymorpha* per 1 m^2 in the Masurian Lakes in 1962
1 – numbers, *2* – biomass

Considerable overweight of *D. polymorpha* biomass on 1 m^2 estimated in lake Wilkus in comparison to lake Śniardwy, was caused not only by big "condition" of the individuals but also by different age structure of the population. Small and light individuals, one and two years old composed about 80% in the lake Śniardwy and in lake Wilkus only 13% of the population.

In lakes Jagodno and Mamry the main reason of discomformity of abundance and biomass, seems to be the differences in the age structure. Abundance of individuals was similar in both lakes, but the age structure differed considerably. In lake Mamry young individuals prevailed, whereas in lake Jagodno they composed only a small per cent of the population (Fig. 3).

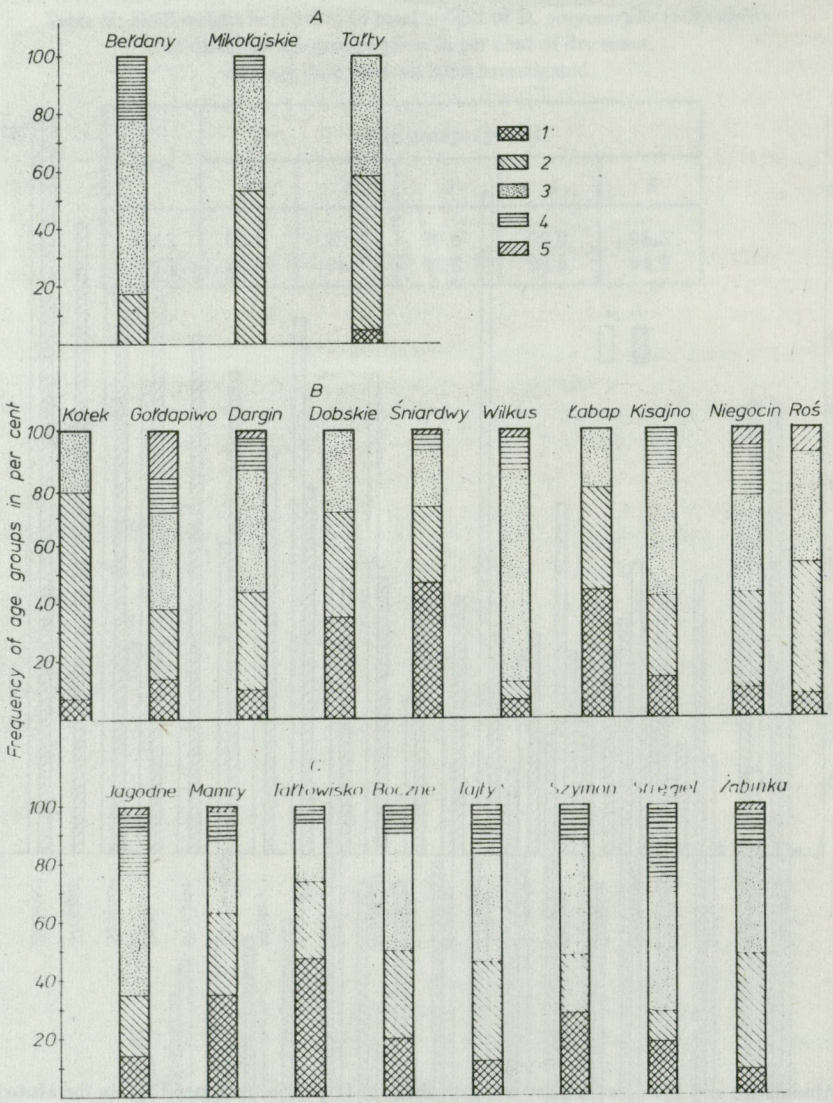

Fig. 3. *D. polymorpha* age structure in the Masurian Lakes in 1962
1–5 — from 1st to 5th age groups, *A, B, C* — lake groups characterized by different abundances of *D. polymorpha*

Detailed analysis of age structure in 21 compared lakes showed considerable differences in various reservoires (Fig. 3). In some lakes more than 50% of the population was composed by the youngest individuals (one and two years old), for example in lakes Tałty, Kotek, Dobskie, Śniardwy, Łabap, Tałtowisko and Mamry.

In some populations the youngest *Dreissena* were scarcely represented, often even below 20%, for example in Bełdany or Wilkus lakes.

Dissimilarity of age structure in particular lakes was not connected with the abundance of *D. polymorpha* populations (Fig. 3). In each group of lakes characterized by different abundances of this mollusc were found lakes with *D. polymorpha*, both lakes with majority of young individuals or old ones.

In the studied lakes *D. polymorpha* live for about five years. Global specification of all gathered material from 21 lakes indicates that specimens classified as belonging to the one-year-old class make 20% of the population, two-years-old – 32%, three-years-old – 35%, four-years-old – 13% and the eldest ones – only about 5%. It is obvious that the data concerning abundance of the youngest (one-year-old) in the whole lake population are lowered in the above specification because these individuals occur not only in the zone of *D. polymorpha* occurrence, from which the above material was obtained, but also in different environments, for example, on sprouts of plants dipped in the water, or in the very shallow zone on stones, what caused that they are not present in the above specification.

Annual production of *D. polymorpha* biomass was counted similarly to biomass, respectively for the total dry mollusc mass (with shell) and for the dry mass of the body. In each lake animal biomass growth was counted for individuals representing different age groups. Being familiar with the population structure in a given lake and its abundance in 1 m^2 of the bottom surface in the zone of occurrence, it was possible to estimate the annual biomass production on this surface. Biomass production counted for the total mollusc biomass amounted from 3 to 6 g/m^2 in the lake groups of the smallest abundance of *D. polymorpha* and in the two remaining groups of lakes – from several tens to several hundred grams of the dry body mass for 1 m^2 (Table III). Annual dry body mass production ranged from 0.1 to about 30 g/m^2 (Table III). The above values might have been artificially lowered to a certain degree. Greze's method (1965) of production estimation does not concern data about sexual products and other losses of biomass. When the materials were gathered in the Masurian Lakes (July) *D. polymorpha* was just after the first reproduction period what lowered the body biomass of mature females. Because of the fact that mature individuals in different lakes composed different per cent of the population and the sex structure was not studied it is rather difficult to conclude precisely the biomass loss for sexual products.

Relation of production to biomass (*P/B*) counted for whole molluscs oscillated from 0.47 to 0.81; it was slightly lower for dry body mass of the molluscs: it ranged from 0.42 to 0.65 (Table III).

4. DISCUSSION

It follows from the obtained data that values of *D. polymorpha* biomass are connected to the highest degree with the density of population, and to some extent with its age structure and the "condition" of individuals. In accordance with this, in the lakes where *D. polymorpha* abundances were different, biomasses also ranged within a wide scope.

As it was previously stated (Stańczykowska 1964), there was no direct dependence between density of molluscs in different Masurian Lakes, their trophy and some other selected features of the environment, one should not expect such connection with biomass as well.

Abundances of *D. polymorpha* in Masurian Lakes are not the highest and their biomasses are also not big, as compared with some data in the literature. For example, Wiktor (1969) estimated in Zalew Szczeciński (the Szczeciński Lagoon) wet biomass of this mollusc up to 20 kg/1 m^2, Ljachov and Micheev (1964) – up to 6.8 kg/m^2 in Kujbyšev Reservoir, whereas our data recounted from dry mass to wet one did not even approach 1.5 kg/m^2.

Table III. Abundance, biomass and annual production of *D. polymorpha* in the Masurian Lakes in 1962

Lake group	Lake name	Numbers/m^2	Dry mass of molluscs			Dry mass of molluscs without shell		
			biomass (g/m^2)	annual production (g/m^2)	annual *P/B*	biomass (g/m^2)	annual production (g/m^2)	annual *P/B*
I	Bełdany	16	6.0	3.3	0.54	0.2	0.1	0.65
	Mikołajskie	25	8.7	6.1	0.70	0.6	0.3	0.56
	Tałty	30	8.1	5.6	0.69	0.6	0.3	0.57
II	Kotek	300	45.8	33.4	0.73	4.7	3.1	0.65
	Gołdapiwo	400	161.8	77.2	0.42	9.7	4.0	0.42
	Dargin	550	–	–	–	7.7	3.8	0.49
	Dobskie	550	88.4	60.6	0.68	5.4	2.9	0.55
	Śniardwy	600	106.1	66.8	0.63	5.2	3.2	0.61
	Wilkus	600	361.0	229.5	0.63	25.8	18.4	0.71
	Łabap	700	83.5	59.4	0.71	6.9	4.1	0.59
	Kisajno	700	107.9	67.4	0.62	7.4	3.8	0.52
	Niegocin	750	264.6	137.7	0.52	17.7	7.8	0.44
	Roś	750	–	–	–	13.9	8.8	0.63
III	Jagodne	1,000	–	–	–	18.4	8.6	0.47
	Mamry	1,100	140.2	98.1	0.69	13.4	7.8	0.58
	Tałtowisko	1,300	168.9	116.5	0.69	12.6	7.9	0.62
	Boczne	1,400	188.7	152.7	0.89	19.6	11.4	0.58
	Tajty	1,500	324.4	227.1	0.70	11.2	11.2	0.65
	Szymon	1,500	430.9	317.3	0.74	21.0	11.0	0.52
	Stręgiel	1,700	–	–	–	51.3	29.8	0.58
	Żabinka	2,000	767.0	525.9	0.68	32.2	16.9	0.53

However, comparing with different benthos groups in the Masurian Lakes, *D. polymorpha* biomass is very abundant. In the lake Tałtowisko in the central zone the benthos invertebrate biomass (without molluscs) ranged between 0.1 to 36 g/m^2, in the Mikołajskie Lake between 3.2 and 21.5 g/m^2 and in the lake Śniardwy about 5 g of wet mass per 1 m^2, (K a j a k and D u s o g e, 1975a, 1975b, 1976). Such big *D. polymorpha* biomass values in comparison with biomasses of other water invertebrate groups, cause that only after comparison performed on biomass units, not on the abundance, the meaning of the molluscs in the basin in visible.

Annual biomass production data are quite different – the production is not so high as in some other bottom animals groups. According to K a j a k and D u s o g e data (1975a, 1975b, 1976) in the central zone in the lake Tałtowisko, the annual benthos production (wet weight) without molluscs ranged from 0.3 to 312 g/m^2, in the Mikołajskie Lake from 11.2 to 180 g/m^2 and in the lake Śniardwy from 50 to 60 g/m^2. So it was of the same order as *D. polymorpha* biomass production in the explored lakes. Biomass growth in these mollusc populations is much lower than in other bottom invertebrates.

Coefficients *P/B* stated for *D. polymorpha* are from several to several tens times lower than those determined for other benthos animals, but they are higher than those given for *Unionidae* in the Mikołajskie Lake (L e w a n d o w s k i and S t a ń c z y k o w s k a 1975).

5. SUMMARY

In 21 Masurian Lakes for which abundances, aggregational occurence and "condition" of *Dreissena polymorpha* (Pall.) specimen were previously analysed, the biomass and its annual production were estimated. Biomass estimated for whole animals (dry mass) ranged from several to several hundred grams per 1 m^2 in the zone of occurrence, estimated for dry body mass (without shell) from tenth of gram to 50 gram (Figs. 1 and 2). Biomass differences for 1 m^2 of the bottom surface in the different lakes were related to the highest degree with abundance and to some extent with the age structure and "condition" of the individuals (Fig. 3). In the investigated material shell weight was about 91% of the total weight of dry animal; the older *Dreissena* being relatively heavier than the young one (Tables I and II). Body tissue was considerably watered – in the mature specimen amounting to 95%. Annual total biomass whole animal production (dry mass) ranged from several grams to several hundred grams and of the dry body mass from 0.1 to about 30.0 g/m^2 of the bottom in the mollusc occurrence zone (Tables II and III). Coefficients of the annual *P/B* ranged from 0.42 to 0.81 (Table III).

6. POLISH SUMMARY (STRESZCZENIE)

W 21 jeziorach mazurskich, w których analizowano uprzednio liczebność, kolonijne występowanie i „dorodność" (condition) osobników *Dreissena polymorpha* (Pall.), przeprowadzono ocenę biomasy i jej produkcji rocznej. W strefie występowania biomasa całych małży (sucha masa) wynosiła od kilku do kilkuset gramów na 1 m^2, a suchej masy ciała (bez muszli) od dziesiątych części grama do 50 gramów (fig. 1 i 2). Różnice w biomasie na 1 m^2 powierzchni dna w różnych jeziorach związane były przede wszystkim z różną liczebnością, a także ze strukturą wiekową oraz „dorodnością" osobników (fig. 3). W badanym materiale muszle stanowiły około 91% całkowitego suchego ciężaru małży, przy czym muszle osobników starszych były cięższe niż młodszych (tab. I i II). Tkanka ciała wykazywała znaczne uwodnienie, które u osobników dorosłych dochodziło do 95%. Produkcja roczna biomasy całych zwierząt wahała się od kilku do kilkuset gramów suchej masy na 1 m^2 w pasie występowania, a produkcja biomasy ciała wynosiła 0,1–30,0 g s.m./m^2 (tab. II i III). Współczynniki rocznego *P/B* były zawarte między 0,42 a 0,81 (tab. III).

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