A CT A I CH T H Y O L O G I C A E T P I S C A TO R I A
Vol. XXI, Fasc. 2 Szczecin 1991

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Fish biology

CATCHES AND G ROWTHRA TIOF *ABRAMIS BALLERUS* (L., 1758) FROM LAKE DĄBIE A NDTHE FIRTH OF SZCZECIN

POŁOWY I SZYBKOŚĆ WZROS TUROZPIÓRA, *ABRAMIS BALLERUS* (L., 1758) Z JEZIORA DĄBIE I ZALEWU SZCZECIŃSKIE GO

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Regular, very intensive fluctuations of the catches of *Abramis ballerus* occur in 7–8 year cycles. Scale back-calculations (with the method of Rosa Lee) showed that growth of this fish was a little faster in the Firth of Szczecin compared to Lake Dąbie. However, considerable similarity of the parameters in von Bertalanffy's equation and the distribution of catches suggest that *A. ballerus* forms a single stock in the two water bodies.

INTRODUCTION

Abramis ballerus was a rare fish in Polish waters before the 2nd World War. Mass appearance of this fish in Lake Dąbie, the Firth of Szczecin and lower Odra, has been noted since mid-sixties. So far, studies on *A. ballerus* in Poland embraced growth rate, some meristic features, food and feeding behaviour and parasitic of this fish in Lake Dąbie (Kompowski 1971a, 1971b, Wierzbicka 1979). About 20 years has passed since (with the exception of parasitologic studies by Wierzbicka). Considerable changes took place in the meantime as regards environmental conditions, which induced changes in the ichthyofauna (Kompowski and Pieńkowski, in press). These environmental changes i.e. strong eutrophication, might have affected biology of *A. ballerus,* caught in the Firth of Szczecin has never been studied so far. It is also unknown whether it belongs to a separate population or forms a single stock with *A. ballerus* from Lake Dąbie.

The objective of this study was to analize catch statistics of *A. ballerus* since the moment when the fish had been reported as a separate item i.e. since 1966, as well as to state whether there were any changes in the growth rate of this fish in Lake Dąbie after 20 years, and to study its growth rate and some aspects of its biology for the first time in the Firth of Szczecin.

MATERIALS AND METHODS

Fishes for studies were obtained from commercial catches of a Fishery Cooperative "Certa" in 1985 and 1986. 228 fish from Lake Dąbie and 237 from the Firth of Szczecin were measured up to 1 mm (l.c.). Total weight up to 1 g was established for 210 fish from Lake Dąbie and 237 from the Firth of Szczecin. Sex was determined from gonads. All fish for which it was not possible to establish sex by macroscopic viewing (I stage of development according to Maier's scale) were classified as immature. Scales used for determining the growth rate were collected under the lateral line, at the height of anterior edge of the dorsal fin. Scales were measured along the caudal radius, up to 0.01 mm, using a microscope with a micrometric screw and movable base. Scales collected from 227 fishes from Lake Dąbie and 234 from the Firth of Szczecin were measured. Review of the materials is given in Table 1. As results from Fig. 1, which presents the relationship between caudal scale radius and fish body length, the dependence seems to be the same for the two water bodies. Distribution of points is similar (Fig. 1). In view of this, correlation was calculated jointly for the two water bodies. This correlation was very close to a straight line. It is expressed by the equation $v = 0.1261\ l.c. - 0.1526$ (where v – caudal scale radius). Hence, Rosa Lee's method was used for back-calculations, the correction being 1.19 cm i.e. the distance between the point where the regression line crosses the axis and the axes begining (Fig. 1).

Catch statistics were obtained from the Marine Office in Szczecin. They are presented in Fig. 2 after being smoothed with the method of moving averages.

Table 1

A review of the biological studies

Parameter	Lake Dąbie			Firth of Szczecin			Total
	1985	1986	total	1986	1986	total	
Measurements of fish length	136	92	228	110	127	237	465
Measurements of fish weight	118	92	210	110	127	237	463
Measurements of scale radius	136	91	227	109	125	234	451
Back calculations of the growth rate	120	91	211	107	125	232	443
Determination of sex and maturity	118	92	210	110	127	237	447

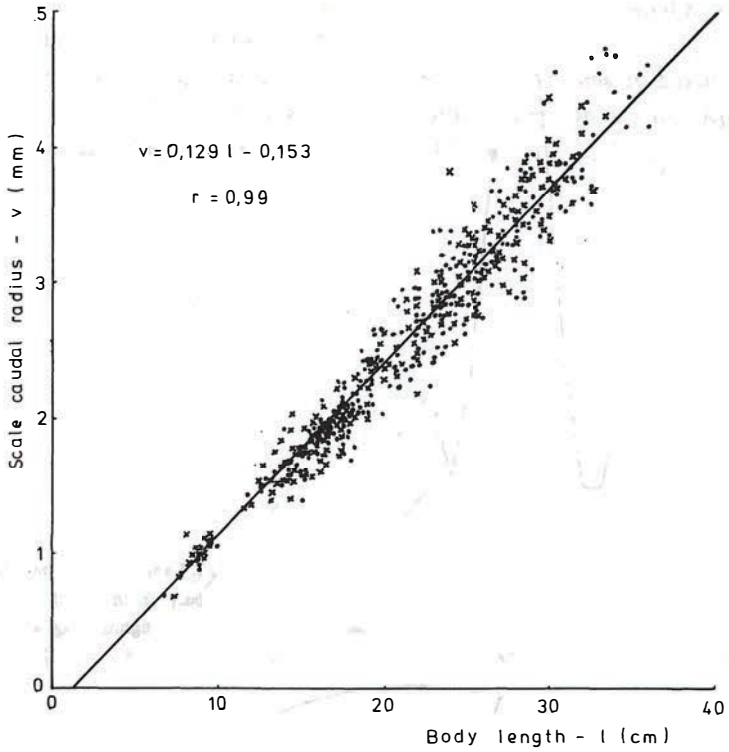


Fig. 1. Dependence between body length and caudal scale radius of *Abramis ballerus* from Lake Dąbie – x and the Firth of Szczecin

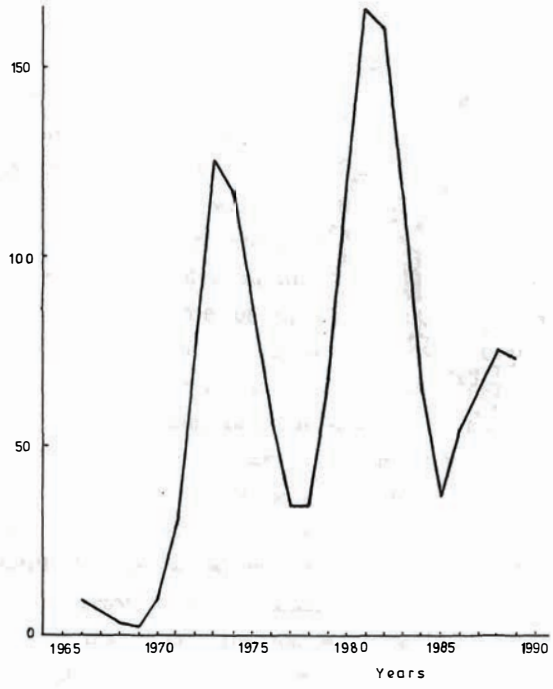
RESULTS

Catches of *Abramis ballerus* and their fluctuation

Fig. 2. presents annual landings of *A. ballerus* in 1966–1989. Catches originate from Polish part of the Firth of Szczecin and the neighbouring water bodies supervised by the Marine Office in Szczecin. Characteristic, intensive variations of *A. ballerus* catches occuring in 8-year cycles are well noticeable.

And thus, in 1968 and 1969 landings of this fish were low (about 2.5 t), then they increased rapidly to 126 t in 1973, to drop again to about 18 t in 1978, and then increasincrease to a record level of about 170 t in 1981. Thereafter, they decreased again to 36 tons in 1985. In the recent years (1988, 1989) an increase of *A. ballerus* landings was observed again.

Majority of the catch – almost 3/4 – is obtained from Lake Dąbie. Two fishery harbours collecting fish landings from this lake (in Dąbie and Stołczyn) supplied on the average 71.7% of total *A. ballerus* catches in 1966–1988 (Fig. 3). The remaining



. 2. Landings of *A. ballerus* in Po-
part of the Firth of Szczecin
the neighbouring water bodies

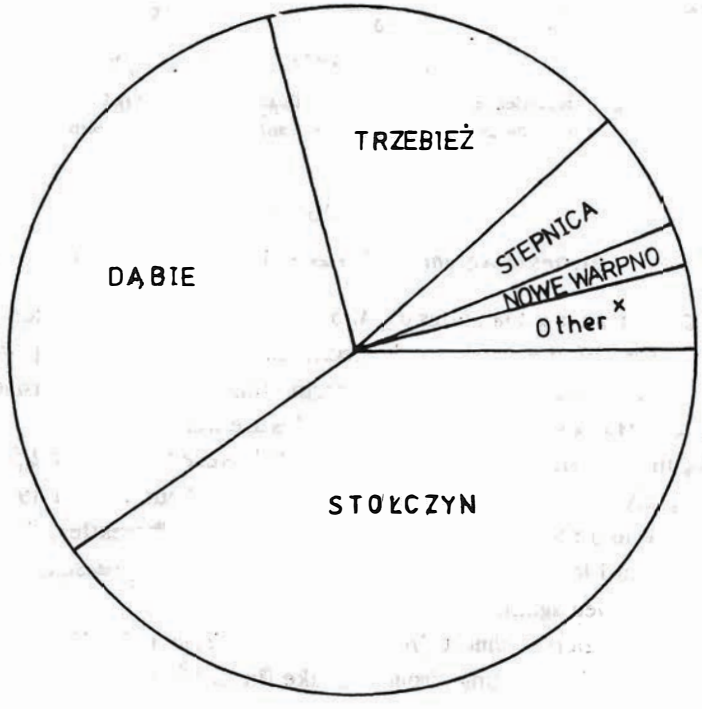


Fig. 3. Share of particular fishing harbours in the catches of *Abramis ballerus*. Average for 1966–1988.
*Wolin, Lubin, Kamień Pomorski, Karsibór, Przytor

28.3 % was in most part obtained from two fishing harhours located near the estuary of the Odra River: in Trzebież (17.5%) and Stepnica (5.6%).

A. ballerus was caught mostly during the vegetation season: since April till the end of September. Two maxima can be distinguished: in spring (April, May) and late summer (July-September), with a period of lower catches in June (Fig. 4).

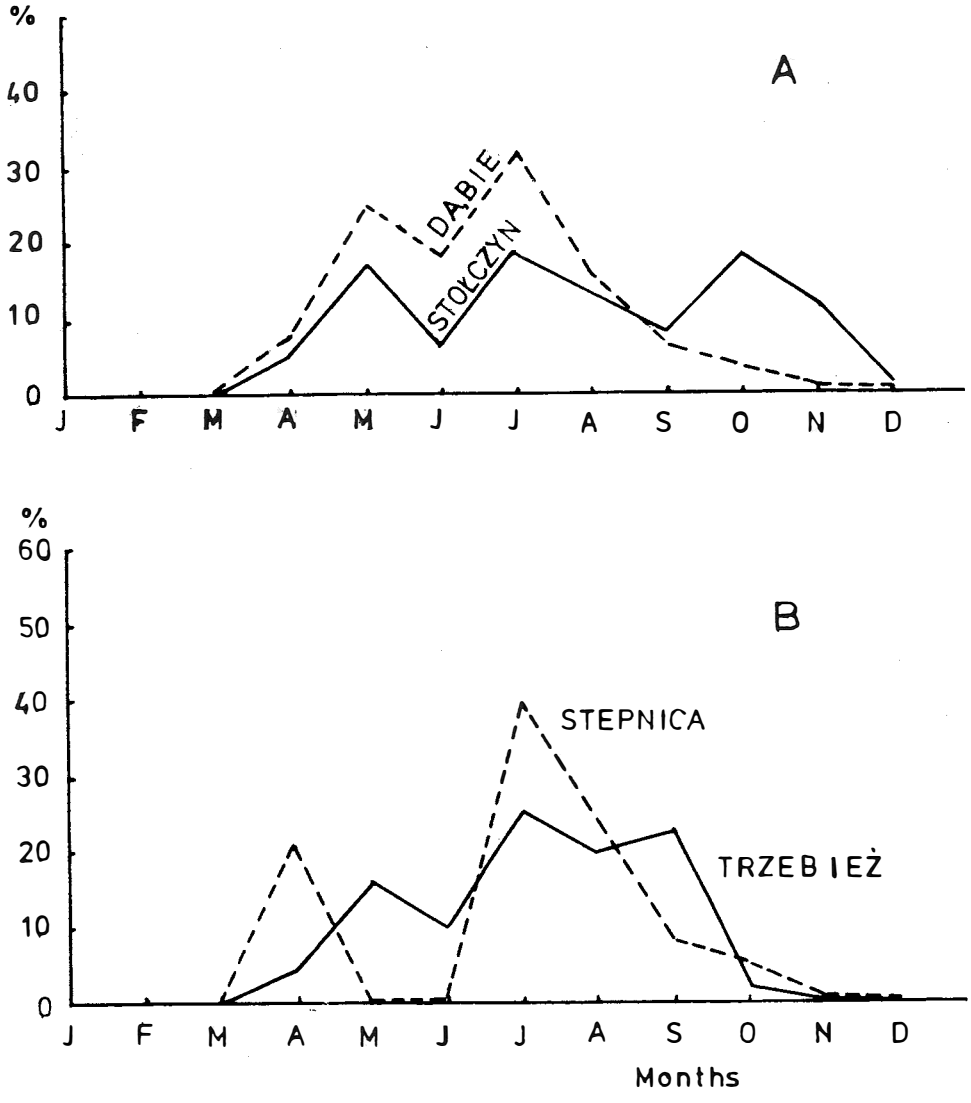


Fig. 4. Seasonal distribution of the catches of *Abramis ballerus* in Lake Dąbie— A and the Firtn of Szczecin — B. Average for 1986—1987

Rate of growth

Table 2 presents rate of growth of *A. ballerus* caught in the two water bodies under study. Rate of growth (most rapid in the first year of life) decreased in consecutive

Table 2

Average lengths in consecutive years of life of *Abramis ballerus* in Lake Dąbie and the Firth of Szczecin (l.c. in cm). Theoretical lengths from von Bertalanffy's equation are also given

Age (years)	Lake Dąbie				Firth of Szczecin			
	$\bar{x}$ length	±s	n	theoretical length	$\bar{x}$ length	±s	n	theoretical length
1	8.40	1.29	211	8.44	8.96	1.25	232	9.04
2	13.32	1.92	199	13.52	14.35	1.94	224	14.33
3	17.66	2.17	133	17.78	19.10	2.27	147	18.70
4	21.57	1.81	94	21.36	22.16	2.54	76	22.34
5	24.66	1.64	87	24.37	25.33	2.21	72	25.34
6	26.81	1.41	69	26.90	27.73	1.98	58	27.84
7	28.93	1.27	34	29.02	29.71	2.14	42	29.91
8	30.79	–	11	30.80	31.81	1.89	24	31.62
9	30.95	–	2	32.30	34.27	–	10	33.05

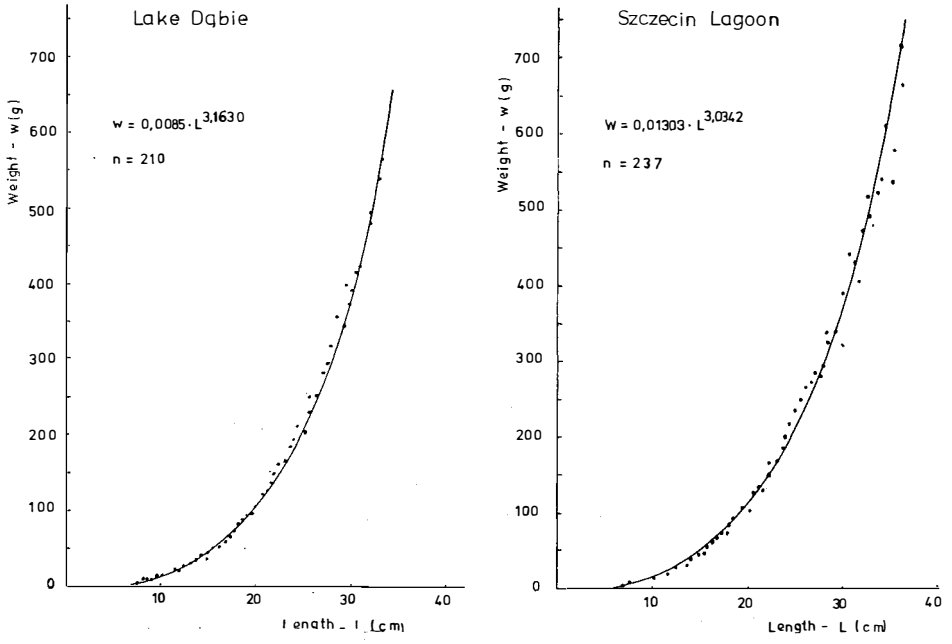


Fig. 5. Dependence between body length (L) and weight (w) of *Abramis ballerus* from Lake Dąbie and the Firth of Szczecin

years of fish life, with no noticeable variations. Rate of growth was slightly more rapid in the Firth of Szczecin than in Lake Dąbie.

An attempt to present rate of growth with von Bertalanffy's equation yielded the following mathematical parameters of the growth curve: *A. ballerus* from Lake Dąbie $L_\infty = 40.16$ cm, $K = 0.174$, $t_0 = -0.353$ year, and for *A. ballerus* from the Firth o Szczecin $L_\infty = 39.94$ cm, $K = 0.187$, $t_0 = -0.369$ year. Hence the obtained parameters are almost identical for the two water bodies. Theoretical fish lengths, calculated for consecutive years using von Bertalanffy's equation with the the above parameters were almost the same (Tab. 2) as the empirical data obtained from back -calculations, thereby proving that the growth model could have been used.

Table 3

Average weight in consecutive years of life of *Abramis ballerus* in Lake Dąbie and the Firsth of Szczecin

Age (years)	x body weight (g)	
	Lake Dąbie	Firth of Szczecin
1	7.2	10.4
2	32.1	42.0
3	76.4	94.2
4	136.4	161.6
5	207.0	236.8
6	283.0	315.0
7	359.7	391.6
8	434.2	463.6
9	504.7	530.2

Dependence between body length of fish in the two water bodies and fish weight is presented in Fig. 5. It is expressed with two power equations: for *A. ballerus* from Lake Dąbie $w = 0.0085 \cdot L^{3.1630}$, and for *A. ballerus* from the Firth of Szczecin $w = 0.01303\ L^{3.0342}$. Introducing fish length in particular years of life (Tab. 2) into these equations it was possible to obtain respective fish weights (Tab. 3), while introducing L_∞ value, W_∞ value was obtained. The latter value amounted to 1005.2 g for Lake Dąbie and 941.7 g for the Firth of Szczecin.

Length and age at first maturity

Fig. 6 present percentages of immature fish (males and females) in particular length classes. Up to 17.5 cm in length (inclusive) in Lake Dąbie and to 15.0 cm in

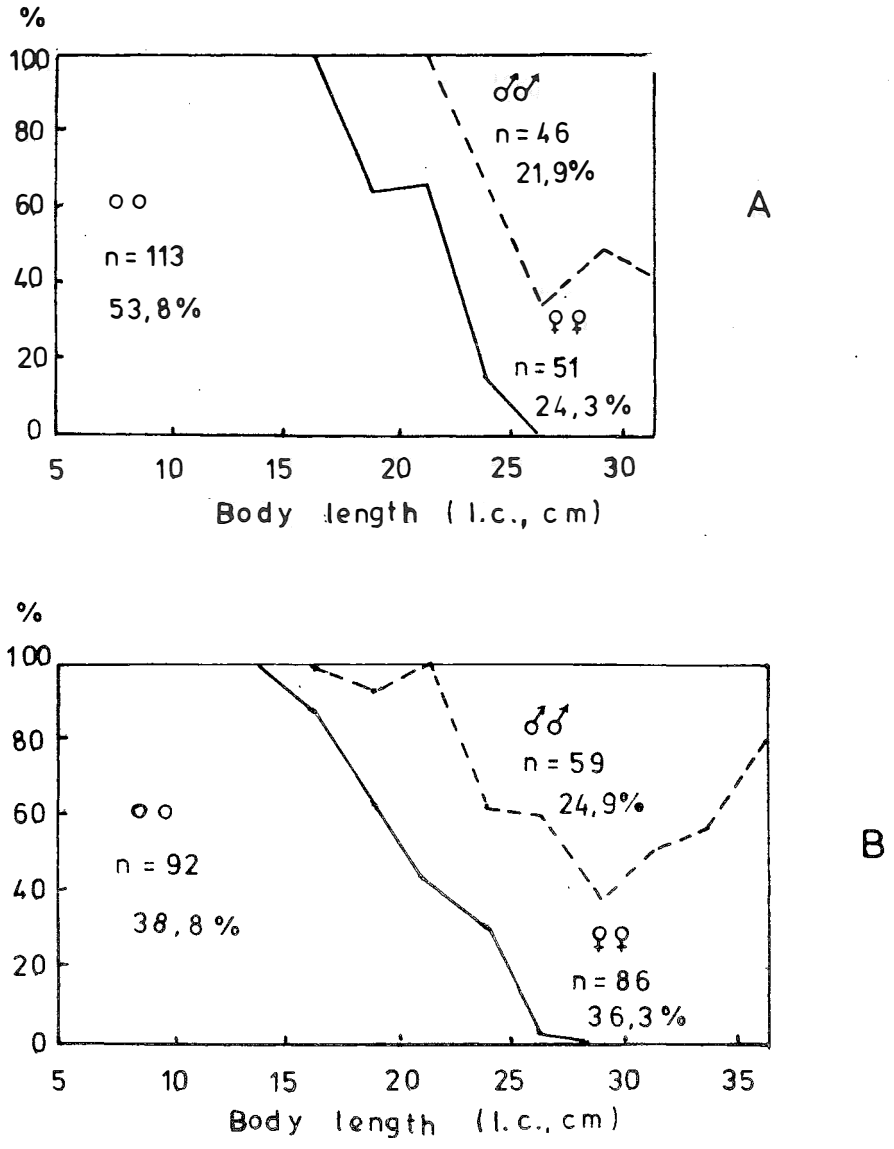


Fig. 6. Percentage of immature individuals (oo), males (♂♂) and females (♀♀) in particular 2.5 cm length classes of *Abramis ballerus* from Lake Dąbie – A, and the Firth of Szczecin – B

the Firth of Szczecin all fish were immature. The smallest female from Lake Dąbie was 18.2 cm in length, while in the Firth of Szczecin it was 17.3 cm long. The smallest males found were respectively 23.7 cm and 19.3 cm. All fish bigger than

25 cm in Lake Dąbie and 27.5 cm in the Firth of Szczecin were sexually mature. If fish length at which 50% of all specimen are sexually mature is taken as representing fish length at first maturity, then this length will be 27 cm in Lake Dąbie and 20. 3 cm in the Firth of Szczecin. When these values are introduced into the von Bertalanffy's equation, fish age at first maturity is obtained. It amounts to 4.2 years in Lake Dąbie and 3.2 years in the Firth of Szczecin.

DISCUSSION

There is no proof on the occurrence of *A. ballerus* in the Odra estuary before the 2nd World War. This fish was never mentioned in an extensive monography by Zimdars (1941) on the fishery in the Firth of Szczecin. This author listed 22 species as occuring regularly and 14 met sporadically: among them even such species as grayling, sturgeon and *Rhodeus sericeus.* It is quite improbable that Zimdars simply omitted *Abramis ballerus.* According to Pęczalska (1973) „... this species did occur after the 2nd World War but was very rare." Until 1965 it did not exist in the official catch statistics of the Marine Office. It appeared as a separate item in 1966. Since then it has been recorded, and until 1988 overal landings of this fish from waters supervised by the Marine Office amounted to 1359.9 t i.e. to 59.1 t anually on the average. This represents 2.2% of all fish catches.

Intesive variations of *A. ballerus* catches seem to be characteristic for this species. They were observed by a number of authors (Jurovickij 1958, Lapickij 1958, Smirnov 1966, Poddubnyj and Gordiejev 1968, Strelnikov et al. 1983) who ascribed them as due to considerable fluctuations of year-class strength. Variations of year-class strength were observed also for *A. ballerus* from the Oder River estuary. In 1968 and 1969 Kompowski (1971a) observed that the generation born in 1967 predominated the fish catch in Lake Dąbie. This study revealed that as regards *A. ballerus* catch of 1985 and 1986, specimens born in 1983 predominated both in Lake Dąbie and in the Firth of Szczecin.

Reasons for the fluctuation of year-class strength are not clear. Jurovickij (1958) and Poddubnyj and Gordiejev (1968) stated that strength of *A. ballerus* year-classes in Rybiński Dam Reservoir (Volga River) was affected by water level during the fish spawning. According to Jurovickij, pike spawned just before *A. ballerus.* When water level was low, pike spawning was unsuccesfull and *A. ballerus* fry had no enemy in form of pike fingerlings. Hence, in years with low water level, strong generations of *A. ballerus* were formed. Poddubnyj and Gordiejev suggested just the opposite. They stated that in years with low water level, when the shore zone was not flooded, weak generations of *A. ballerus* were born because spawning conditions for this phytophili fish were not good.

As regards *A. ballerus* from the Odra River estuary it is worth noting that catch fluctuations are very strong and fairly regular. Peaks of catches occur every 7–8 years. Hence, these fluctuations may be defined as typical "cycles" of Townsend (1989). *A. ballerus* matures in the Odra estuary at the age of 3 to 4 years, and spawns a few times during its life-span. Hence, the fluctuations cannot be caused (as it was formulated by Townsend) by internal features of the population dynamics of this species. More probably, they are caused by periodical events in the environment, either biotic or abiotic, which tend to occur every 7–8 years. At present it is not possible to clarify this problem.

Last published data on the growth rate of *A. ballerus* in Poland refer to 1968–69 (Kompowski 1971a). They deal with *A. ballerus* in Lake Dąbie.

Since then intensive changes have taken place in the ichthyofauna both in the lake and in the whole Odra estuary, of a succession character typical for the eutrophication process (Kompowski and Pieńkowski 1990). It was interesting to find out whether water pollution affected the growth rate of *A. ballerus*. Comparison of the fish growth rate in Lake Dąbie in 1968–69 and 1985–86 is presented in Tab. 4. It appears that average fish lengths in the first period were slightly bigger than in the second period, especially as regards 2–, 3– and 4-years old fish. Due to this, growth curve in the first period was more convex. It is interesting that these changes are quite the opposite than those noted for bream from the same water body. In case of the latter fish, growth curve became more convex compared to the previous period (Kompowski 1988). There are also differences as regards the relationship between fish weight and length in the two periods: in 1968–69 this relationship was $w = 0.01342\ L^{3.2067}$ and in 1985–86 it was $w = 0.0085\ L^{3.1630}$.

Rate of growth of *A. ballerus* in the Firth of Szczecin was slightly more rapid than in Lake Dąbie. The differences of average length were small but noticeable in all age groups. And thus, rate of growth of *A. ballerus* in the Odra estuary increased from south to north, the same being true for bream (Kompowski 1982, 1988)and roach (Kompowski et al. 1987). This difference suggests that there might be two different stocks of *A. ballerus:* one in Lake Dąbie and the other in the Firth of Szczecin. On the other hand, shape of the ghrowth curve is almost identical in the two water bodies, as reflected by almost identical parameters of the von Bertalanffy's equation. Hence, also the opposite is highly probable i.e. that there is only one *A. ballerus* stock. Most probably Lake Dąbie constitutes the main habitat of this stock, while some fishes migrate during the vegetation period to grazing ground in south part of the Firth of Szczecin, going away from the Odra estuary. This hypothesis is confirmed by the distribution of catches (see Fig. 3) and by the domination of the same year-class of 1983 in the two water bodies. Differences as to the rate of growth might have been caused by the fact that bigger individuals more readily undertook migration to other

grazing areas. Final decision as to which to the two hypotheses is a true one necessitates further studies.

Table 4

Average lengths of *Abramis ballerus* in consecutive years of life in Lake Dąbie (l.c. in cm). Comparison of data from 1968–69 (after Kompowski, 1971a) and 1985–86 (this paper)

Age (years)	1968–1969			1985–1986	
	back calculation from scales	back calculation from operculum	n	back calculation from scales	n
1	8.2	8.7	302	8.4	211
2	14.7	14.7	295	13.3	199
3	19.2	19.1	153	17.7	133
4	22.5	22.2	80	21.6	94
5	24.8	24.7	37	24.7	87
6	27.7	27.6	17	26.8	69
7	28.1	18.0	3	28.9	34

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Translated: Dr. M. Bnińska

Received: 1990.07.02

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POŁOWY I SZYBKOŚĆ WZROSTU ROZPIÓRA *Abramis ballerus* (L., 1758) Z JEZIORA DĄBIE I ZALEWU SZCZECIŃSKIEGO

STRESZCZENIE

Analiza statystyk połowów rozpióra od 1966 r., tj. od momentu pojawienia się tego gatunku w statystykach jako odrębnej pozycji, wykazała istnienie bardzo intensywnych i stosunkowo regularnych fluktuacji (rys. 2) – powtarzających się w cyklu 7–8 letnim.

Badania szybkości wzrostu oparto na odczytach wstecznych łusek metodą Rosa Lee (rys. 1). Szybkość wzrostu długości rozpiórów poławianych w Zalewie Szczecińskim jest nieco niższa od szybkości wzrostu rozpióra z jez. Dąbie (tab. 2). To samo dotyczy szybkości wzrostu masy (tab. 3). Krzywa wzrostowa rozpiórów poławianych w jez. Dąbie w latach 1985–1986 jest mniej wypukła w porównaniu do danych z lat 1968–1969 (tab. 4). Zależność między długością ciała rozpiórów i ich masą wyraża się dla ryb z jez. Dąbie wzorem: $w = 0.0085\ L^{3.163}$ zaś dla Zalewu Szczecińskiego: $w = 0.013\ L^{3,034}$ (rys. 5). Bardzo podobne parametry równania wzrostowego von Bertalanffy'ego: $L_\infty = 40.16$ cm; $W_\infty = 1005.,2$ g; $K = 0,174$; $t_0 = -0,353$ roku – rozpióra z jez. Dąbie oraz $L_\infty = 39,94$ cm; $W_\infty = 941,7$ g; $K = 0,187$; $t_0 = -0,369$ roku – rozpióra z Zalewu Szczecińskiego – jak również skupienie połowów w jez. Dąbie (71,7%) oraz w pd.części Zalewu – sugerują hipotezę o tym, że rozpiór z obu tych zbiorników tworzy jedno stado. Różnice w szybkości wzrostu mogą być spowodowane większą zdolnością szybciej rosnących osobników ze stada do podejmowania odleglejszych wędrówek. Długość pierwszej dojrzałości płciowej wynosi dla rozpiórów z jez. Dąbie 22 cm, zaś dla rozpiórów z Zalewu Szczecińskiego 20,3 cm (rys. 6).

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