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Biometric and ecological studies on the bleak, *Alburnus alburnus* (LINNAEUS) (*Pisces*, *Cyprinidae*) from different bodies of water in Poland, in connexion with the geographic variability of this species

[With 6 tables and 1 map]

The bleak, *Alburnus alburnus* (LINNAEUS), is a very common fish in Polish waters. It is of no special significance in fish farming. But the better and more economic is the management of water objects the greater is its significance in the biocenosis of Polish waters. This fish, because of its small size, is available as a food for some valuable predators (pike-perch). Fragmentary data on the quantitative share of bleak in the composition of Polish ichthyofauna can be found in the paper by ZDZIENNICKI (1935). The occurrence and stock density of the bleak depending on the character of rivers is mentioned by PENCZAK (1969). KOŁDER (1967) says about the adaptation of the bleak in dam reservoirs; SKÓRA (1965) mentions the bleak as a food component of burbot; KOZIKOWSKA (1966) is interested in the horizontal distribution of the bleak in lake conditions.

This paper on the biometrics of this fish from different bodies of water in Poland compared with data from the neighbouring and more distant parts of Europe is a contribution to learn about the differentiation of this species population in the ecological and geographical aspect.

MATERIAL AND METHOD

The material was being compiled for a considerable long time (1954–1969). Meristic and mensural characters in 1305 specimens from three ecologically different types of the bodies of water (map 1), including 8 lakes, 7 rivers and 2 firths, were examined.

The majority of lakes are eutrophic but in various stages of eutrophy. The data on the lake characteristics are illustrated in Tab. 1. The surface of lakes and their depth are cited after the Catalogue of Polish Lakes (KONDRACKI, 1954). The characteristics of Wdzydze Lake are based on the data publish-

Map 1. Localities at which samples of the bleak *Alburnus alburnus* (LINNAEUS) were taken in Poland. 1 — Wisła River at Kazimierz, 2 — Warta River at Poznań, 3 — Trzebiocha stream, 4 — San River at Dwerniczek, Smolnik, Przemyśl, 5 — Solinka River, 6 — Wetlina River, 7 — Muszynka River; 8 — Licheń Lake, 9 — Wdzydze Lake, 10 — Seksty Lake, 11 — Mikołajskie Lake, 12 — Bimbinek Lake, 13 — Dgał Lake, 14 — Mamry Lake, 15 — Hańcza Lake; 16 — Firth of Vistula, 17 — Firth of Szczecin.

ed by PATALAS (1961). Licheń Lake is supplied since 1958 with hot water drained off the power station, due to which the thermal conditions of water increased considerably, in winter the temperature of water is never below 6°C.

The rivers are of lowland and submontane type. To the former belong: Vistula (the surroundings of Kazimierz Dolny), Warta (the surroundings of Poznań) and San (the samples come from three places — Dwerniczek, Postołów, Przemyśl). To the submontane type of rivers belong Solinka and Wetlina,

Table 1. Characteristics of lakes

Name	Surface in ha	Depth in meters		Limnological character	Locality
		maximum	mean		
Licheń	153.6	13.3	4.5	eutrophic	Basin of the Warta River Konin district
Mikołajskie	470.0	27.8	—	,,	Masurian Lakeland Mrągowo district
Bimbinek	7.5	18.0	3.6	,,	Masurian Lakeland Węgorzewo district
Dargin	2773.0	35.0	—	,,	Masurian Lakeland Węgorzewo district
Dgał	93.9	18.8	—	,,	Masurian Lakeland Węgorzewo district
Hańcza	305.8	108.5	—	oligotrophic	Suwalskie Lakeland Suwałki district
Wdzydze	818.8	68.0	19.6	eutrophic	Kaszubskie Lakeland Kościerzyna district

the first is a tributary of San River, and the second a tributary of Solinka. The third river of this type is Muszynka, the tributary of Poprad River. Also, to this type of rivers, belongs the stream Trzebiocha (5.5 km long), which although on a lowland, drains the water off the moraine hill (Sakowicz 1961a) to the Wda River (Vistula drainage), which flows into Wdzydze Lake. This stream has on some part of its course a stony-gravel bottom and thermal conditions for the zone in between the brown trout and the barbel (Sakowicz 1961b). In this part of the stream there are the natural spawning places of the lake trout (*Salmo trutta* morpha *lacustris*) from Wdzydze Lake.

The firths are wide-spread and rather shallow bodies of water. Some time ago they were parts of the gulfs of Baltic, but in the course of time, due to sea waves and currents, they become cut off from these gulfs and now join the sea only by narrow channels (Wiktorowie 1959). Therefore, the water in the firths is to some extent saline. In the Firth of Szczecin the salinity is not very high and in the Firth of Vistula it is slightly higher. The surface of the Firth of Szczecin is 90300 ha, mean depth 4.0 m, the surface of the Firth of Vistula — 81500 ha, mean depth 2.6 m.

The meristic and mensural characters have been examined exclusively on material fixed in formalin. The two-years old and older specimens with well developed gonads were taken into account. In counting the vertebrae the first four ones (Weberian apparatus) were included and the urostyle was treated as the component of the last vertebra. The biometrics and statistical calculations were made according to PRAVDIN's 1939 method because of the possibility of comparing own data with that of other authors using the same method. The head length was measured from the tip of the snout to the hind osseous edge of the gill cover. In order to illustrate the differences in the mean values of characters the formula was applied $M_{diff} = \frac{M_1 - M_2}{m_1 + m_2}$, according to this the difference amounts to no less than 3.

MERISTIC CHARACTERS

Number of scales on the lateral line

The number of scales on the lateral line in 1305 specimens of the bleak stays within the range 45–55(56), and most frequently 49–50. The range of this character in all three types of the bodies of water is identical. However, the arithmetic means, calculated out of statistical means separately for the bleak from rivers, lakes and firths, point to some differentiation of this character depending on the type of the body of water. In the bleak from lakes this mean is 50.65 (with the exception of Licheń Lake, which is not typical — 49.77). The bleak from rivers have a total mean 49.31, and of the firths — 48.82.

When discussing this character in the bleak of Polish lakes, it should be pointed out, that the number of scales in the bleak from Licheń Lake is affected by the high temperature maintained there all the year. Therefore the number of its scales is smaller as compared with the bleak from other lakes. In Licheń Lake it is 46–53, $M = 49.77$, whereas in other lakes it is 48–55, $M = 50.65$.

Comparing the latter with the data of MILINSKIJ (1946) for the bleak from Syamozero Lake (Karelska ASSR), where $M = 51.42$, and the data of PETROV (1930) for Pskov Lake with $M = 50.10$, we can see that the bleak in our lakes have an intermediate value. Despite the more southern locality of our lakes as compared with those mentioned above the number of scales is not decreasing.

As regards the southern European lakes (Balkan Peninsula) according to DIMOVSKI et GRUPČE (1971a) the bleak of Prespa Lake and Doiran Lake have a very high number of scales $M = 53.95$, whereas the bleak from Ohrid Lake have $M = 50.68$. In this respect, the bleak from the latter does not differ from the bleak from lakes of northern and central Europe.

As MANFREDI (1916) did not take this character into account for the bleak of lakes of north Italy — Como and Maggiore — we have to limit the information to general data of TORTONESE (1970) for both the bleak of lakes and rivers (Tab. 2).

Discussing this character in the bleak from rivers, we can observe a considerable differentiation in the number of scales depending on the type of river and both climatic and geographical conditions (Tab. 2).

On our area the bleak from the Vistula River (middle course) have the lowest mean value $M = 48.08$, and the bleak from the sub-Carpathian Muszynka River have the highest mean $M = 50.36$. The difference between these two sites is $M_{diff} = 8$. The difference in the number of scales is due to their formation in different climatic conditions of the habitat. Muszynka is a river of submontane type (brown trout zone), 590 m above the sea level, and thus in a more severe climate and a longer winter period than the Vistula, which is a typical lowland river. The effect of the temperature of the environment on the formation of scales on the lateral line has been known for a long time. In a colder climate the number of scales usually increasses (VLADYKOV 1934: 107). Similarly, mean values of the bleak from the Trzebiocha stream ($M = 50.58$) and the mentioned Muszynka River ($M = 50.36$) can not be ommitted in further analysis. This similarity is because in both cases the scales are formed in similar environmental conditions, namely: morphology of the river-bed, water current and thermal conditions. As regards the thermal conditions in the Trzebiocha stream SAKOWICZ (1961b: 322) says "Thermal conditions in Trzebiocha are more approximate to those existing in the parts of rivers in between the brown trout and barbel zone". Furthermore, this bleak, which among the river bleak, has the greatest number of scales on the lateral line, gravitates towards the bleak from lakes. Some information about this similarity is given by SAKOWICZ (1961c: 370): "The bleak appears in this stream (Trzebiocha) abundantly in late spring and at the beginning of summer. This phenomenon is undoubtedly due to the reproduction of this species". It is not unlikely, that this is the population from the neighbouring Wdzydze Lake, in which the bleak is characterised by $M = 50.13$. For lack of more definite data on the biology of the bleak from the Trzebiocha stream, mentioned similarity to the bleak from Wdzydze Lake may be explained by the fact that the brood of bleak swim down stream to the lake before the formation of scales on the body, which develop only under the conditions of lake habitat.

Also, we should discuss the mean number of scales in the bleak from sub-Carpathian rivers: Solinka ($M = 48.95$) and Wetlina ($M = 48.85$) about 530 m above the sea level (basin of the San River), as opposed to the number of scales in the bleak from the Muszynka R. ($M = 50.36$) near Krynica, about 590 m above the sea level. The smaller number of scales in bleak from the first

Table 2. Meristic characters of the bleak *Alburnus alburnus* (LINNAEUS) from the Poland

	No.	Locality and author	N	Lateral line scales Range	$M \pm m$
River	1	Wisła at Kazimierz, author, 1970	100	(45) 46–50 (51)	48.08 ±0.11
	2	Warta at Poznań, author, 1954	63	47–51	49.12 ±0.04
	3	Trzebiocha, author, 1959	50	(46) 47–53 (54)	50.58 ±0.27
	4	San at Dwerniczek, Smolnik, Przemyśl, author, 1959–1966	161	47–52	49.21 ±0.08
	5	Solinka, author, 1966	43	(46) 47–52 (53)	48.95 ±0.22
	6	Wetlina, author, 1966	33	(45,46) 47–51 (52)	48.85 ±0.26
	7	Muszynka, author, 1968	47	47–54 (55)	50.36 ±0.27
	8	Vyčegda (USSR), LUKAŠ, 1923	29	45–53	49.00 —
	9	Kama (USSR), KOZMIN, 1951	100	45–51	48.16 —
	10	Ural (middle course), ŠAPOŠNIKOVA, 1964	33	42–52	47.11 —
	11	Ural (lower course), ŠAPOŠNIKOVA, 1964	20	44–49	46.80 —
	12	Ural (delta), PETROV, 1930[1]	52	43–49	45.90 ±0.22
	13	Volga (delta) at Astrahan, author, 1959	13	46–48	47.00 —
	14	Dnepr (BSSR), ŽUKOV, 1965	49	45–52	47.96 ±0.26
	15	Zap. Dvina (BSSR), ŽUKOV, 1965	49	46–53	48.30 ±0.34
	16	Odra (ČSR), OLIVA et ŠAFRÁNEK, 1962	35	40–52	46.97 ±0.50[3]
	17	Laba (ČSR), OLIVA et ŠAFRÁNEK, 1962	401	(41,42) 43–52	47.38 ±0.10[3]
	18	Danube (ČSSR), OLIVA et ŠAFRÁNEK, 1962	80	(41) 42–51	47.49 ±0.26[3]
	19	Tisa (USSR), Vladykov, 1931	15	(47,48) 49–51 (52)	49.57 ±0.35[3]
	20	Timiș, Rumania, BANARESÇU, 1946	47	(45) 46–49 (51)	— —
	21	Timiș, author, 1962	12	46–51	47.60 —
	22	Danube R. basin (Iskăr, Vit, Jantra) Aegean S. basin (Marica, Vardar, Struma) ŠIŠKOV, 1941	92	45–52 (53)	48.46 ±0.13[3]
	23	Marica (middle course), MIHAILOVA, 1963	58	(43,45) 47–49 (52)	— —
	24	Vardar, DIMOVSKI et GRUPČE, 1971a,b	100	(42,43) 45–51	47.33 ±0.18
	25	Struma, DIMOVSKI et GRUPČE, 1971a	100	(36,37) 38–48	43.17 —
	26	Ticino, MANFREDI, 1916[2]	100	—	— —
Lake	27	Licheń, author, 1966	100	47–53 (55)	49.77 ±0.15
	28	Wdzydze, author, 1958	52	(47) 48–55 (56)	50.13 ±0.31
	29	Seksty, author, 1964	100	47–55	50.85 ±0.18
	30	Mikołajskie, author, 1968	70	48–55	51.01 ±0.22
	31	Bimbinek, author, 1954	32	48–53 (54)	50.06 ±0.28
	32	Dgał, author, 1957	43	48–55	51,72 ±0.25
	33	Mamry, author, 1957–1968	150	47–55 (56)	50.27 ±0.14
	34	Hańcza, author, 1961	120	48–53	50.53 ±0.12
	35	Syamozero (Karelska ASSR), MILINSKIJ 1941	54	(44,46) 47–53 (55)	51.42 ±0.16
	36	Pskov (USSR), PETROV, 1930	50	46–55	50.10 ±0.22
	37	Ohrid, DIMOVSKI et GRUPČE, 1971a	100	(47) 48–55	50.68 —
	38	Prespa, DIMOVSKI et GRUPČE, 1971a	100	(47) 48–59 (60)	53.95 —
	49	Doiran, DIMOVSKI et GRUPČE, 1971b, a b	100	47–56 (57)	50.82 ±0.21
	40	Como, MANFREDI, 1916[2]	100	—	— —
	41	Maggiore, MANFREDI, 1916[2]	100	—	— —
Firth	42	Zalew Wiślany, author, 1963	41	47–53	49.15 ±0.23
	43	Zalew Szczeciński, author, 1958	100	46–52	48.50 ±0.16

[1] *Alburnus alburnus charusini* HERZENSTEIN; [2] *Alburnus alborella* (FILIPPI) *A. a. alborella* (FIL.) according to TORTONESE, 1970; [3] All these mean values are calculated by the author of this paper.

in comparison with that of the other countries

Dorsal fin branched rays Range	M	Anal fin branched rays Range	M ± m
7–9	8.00	16–21	18.05 ± 0.12
8–8	8.00	16–19	17.50 ± 0.01
7–8 (9)	7.92	15–19 (20)	17.34 ± 0.15
(7) 8–9	8.04	(15) 16–21	17.88 ± 0.19
7–8 (9)	7.96	15–20 (21)	18.06 ± 0.19
7–9	8.00	(16) 17–20	18.33 ± 0.16
(7) 8–9	8.10	15–20	17.84 ± 0.18
—	—	15–18 (19)	17.00 —
7–10	8.18	17–21	18.55 ± 0.10
7–9	8.10	15–20	17.32 —
8–8	8.00	15–21	17.95 —
7–9	7.91	14–18	16.40 —
7–8	7.85	16–19	17.46
7–9	8.17	15–20	17.47 ± 0.11
7–8	7.98	16–18	17.24 ± 0.09
7–9	8.00	16–19 (20)	17.34 ± 0.18[3]
7–9	7.91	14–20	17.22 ± 0.05[3]
7–9	7.92	14–18 (19)	16.28 ± 0.10[3]
8–9	8.11	16–19	17.71 ± 0.16[3]
7–9	—	(15) 16–19 (20)	— —
—	—	17–19	17.67 —
7–9	8.00	14–19	16.72 ± 0.09[3]
7–9	—	15–18	16.00 —
7–8 (9)	7.94	14–17 (19)	15.21 ± 0.09
7–8	7.91	14–17	15.28 —
7–9	7.91	12–17	16.70 —
7–8 (9)	7.98	15–20	17.11 ± 0.11
8–9	8.04	16–19	17.50 ± 0.15
7–8 (9)	7.97	16–20	17.75 ± 0.21
8–8 (9)	8.01	16–21	17.55 ± 0.08
7–8 (9)	7.95	15–19	17.37 ± 0.16
7–8 (9)	7.93	(15) 16–19 (20)	17.30 ± 0.14
7–9	7.98	15–19 (20)	17.07 ± 0.07
(7) 8–8 (9)	8.00	(15) 16–19 (20)	17.22 ± 0.09
7–9	8.00	15–22	18.04 ± 0.16
7–9	7.91	14–20	16.80 ± 0.15
7–8	7.97	12–15	13.23 —
(7) 8–9 (10)	8.05	12–15	13.05 —
7–9	8.07	14–17	15.29 ± 0.06
(6) 7–9	7.90	12–16	13.93 —
6–9	8.30	13–17	15.33 —
7–9	8.05	16–19	17.27 ± 0.15
7–8	7.95	15–20	17.16 ± 0.09

ctd. table 2

No.	Gill rakers Range	Gill rakers $M \pm m$	N	Vertebrae Range	Vertebrae $M \pm m$
1	(16) 17–22 (23,24)	19.12 ± 0.15	49	41–44	42.29 ± 0.10
2	18–21	19.28 ± 0.14	53	41–44	42.26 ± 0.12
3	(17) 18–23	19.94 ± 0.18	50	41–44 (45)	42.44 ± 0.11
4	15–21	18.76 ± 0.11	51	42–44	42.63 ± 0.18
5	(17) 18–22	19.64 ± 0.18	30	(41) 42–43 (44)	42.70 ± 0.12
6	(17) 18–21	19.29 ± 0.18	30	41–43	42.13 ± 0.21
7	17–23	18.87 ± 0.17	47	41–44	42.79 ± 0.12
8	17–22	18.60 —	—	—	— —
9	19–25	21.09 —	100	44–48	45.68 —
10	20–29	24.41 —	—	41–45	42.20 —
11	22–28	25.10 —	20	40–43	42.00 —
12	—	— —	—	38–42	— —
13	19–24	22.00 —	13	40–43	41.70 —
14	17–22	19.24 ± 0.19	—	—	— —
15	17–22	20.08 ± 0.26	49	41–44	42.14 ± 0.11
16	—	— —	—	—	— —
17	—	— —	—	—	— —
18	—	— —	—	—	— —
19	—	18.00 —	—	(40) 41–41	— —
20	—	— —	—	42–44 (45)	— —
21	20–23	21.60 —	8	42–43	42.62 —
22	18–21	19.18 ± 0.21[3]	—	—	— —
23	(19) 20–22	— —	58	36–41	40.00 —
24	(18) 19–23	20.78 ± 0.11	100	37–41	39.12 ± 0.10
25	(18) 19–23 (24)	21.02 —	—	—	— —
26	(15) 16–21 (22)	18.61 —	100	36–39	37.34 —
27	18–24	20.18 ± 0.12	50	41–43	41.94 ± 0.16
28	18–23 (24)	20.54 ± 0.19	30	41–44	42.57 ± 0.16
29	17–20 (22)	18.64 ± 0.16	36	42–44	42.67 ± 0.19
30	17–21	19.23 ± 0.10	51	41–44	42.73 ± 0.13
31	(16) 17–21 (22)	19.20 ± 0.23	30	42–44	42.70 ± 0.21
32	17–22	18.95 ± 0.19	30	42–43 (44)	42.73 ± 0.20
33	16–22	18.89 ± 0.13	110	41–44	42.77 ± 0.07
34	15–21	18.71 ± 0.13	52	42–44	42.73 ± 0.13
35	16–21	18,76	25	41–44	42.20 ± 0.17
36	—	— —	—	42–46	— —
37	(17) 18–22	19.92 —	—	—	— —
38	30–36 (38)	33.61 —	—	—	— —
39	20–25 (26)	22.58 ± 0.11	100	39–42	39.78 ± 0.90
40	16–22 (23)	18.77 —	100	37–40	38.69 —
41	16–23	19.43 —	100	(36) 37–40	38.60 —
42	18–23	20.10 ± 0.23	25	42–43 (44)	42.48 ± 0.25
43	16–22 (23)	19.55 ± 0.14	50	41–44	42.62 ± 0.19

two rivers should be partly explained by the thermal and climatic conditions. According to SCHMUCK (1959: 137): "In Carpathians the sums of insolation increase from the west to the east. And when it is 57.5 kcal near Cieszyn, it is 60 at Krynica. More to the east it can be 62.5 kcal and more. This is an area with the highest insolation sums in Poland, and covers the entire San River drainage". The summer there is longer, and the winter slightly shorter as compared with the region of the Muszynka River.

Thanks to several papers, which take into account the meristic characters of the bleak from rivers of a different geographical localities, the relation between the number of scales and the thermal factor can be thoroughly examined as regards first of all the changes in the direction north-south. The bleak from the locality farthest to the north (Vyčegda River) presents high mean value of the scales in the lateral line, $M = 49.00$ (LUKAŠ 1923, quoted after KOZMIN 1951). In the southern direction this value diminishe gradully. The bleak from the Kama River (Volga tributary) has $M = 48.16$, then in the middle course of the Ural River it has $M = 47.11$ and in the lower Ural R. still less – $M = 46.80$ (ŠAPOŠNIKOVA 1964). These data point to the regular variability of this character as related to the thermal factor.

Examining this character on the basis of data concerning the bleak from central Europe, including Poland, Byelorussian SSR, Ukrainian SSR, Czechoslovakia and Rumania (Tab. 2), we observe some disturbance in the diminishing of the number of scales in direction from north to south. The total mean for our rivers $M = 49.25$ is higher than that for the bleak from the Vyčegda River, where $M = 49.00$. The bleak from Byelorussia has on the average less scales than the bleak from Polish rivers, although the climate of Byelorussian SSR is slightly colder, more continental. The data for Czechoslovakia and Rumania – areas situated south of Poland and Byelorussia – confirm the diminishing of scales depending on the warming up of the climate.

Observing this character further to the south we have the following data for Bulgaria (ŠIŠKOV, 1941) for the bleak from the rivers: Marica, Vardar, Struma (Aegean Sea drainage) and rivers: Iskăr, Vit, Ogosta and Jantra (southern tributaries of the Danube) $M = 48.46$ scales at the range 45–53. But these data belong to two different drainages. The author does not give the number of the vertebrae of the bleak, which leaves it open for discussion whether this material can be identified with the typical form. More detail data concerning the bleak from the Balkan Peninsula are found in a paper by MIHAILOVA, 1963. She found the range of scales as 47–50 for the bleak from the middle course of Marica R., and gave also the number of vertebrae (38) 40 (41). Without taking the latter into account she says that the examined specimens belong to the typical form, which however, is characterised by a higher range of vertebrae, namely 42–44(45).

BERG (1949: 748), who takes into consideration a smaller number of scales on the lateral line and a smaller number of vertebrae says: "In the rivers Marica, Struma, Vardar, Penne, falling into the Aegean Sea, the bleak is represented by the subspecies *macedonicus* Karaman 1929, and not by the typical form". To what extent this is true we shall probably learn from the further detail studies on the bleak of the Balkan Peninsula initiated by Dimovski et Grupče (1971).

The data in Tab. 2 show that the bleak from lakes has a greater number of scales on the lateral line as compared with the bleak from rivers. This is also pointed out by Dimovski et Grupče (1971a: 74) as regards the bleak from the Balkan Peninsula. The following data illustrate this point. The bleak from Syamozero Lake (Karelian ASSR) has on the average 51.42 scales, whereas the bleak from the Vyčegda R. (USSR), which is more or less on the same geographic latitude, has on the average only 49.00 scales. In Poland, on two localities of the same latitude the bleak from Wdzydze Lake has on the average about 50.13 scales on the lateral line, whereas the bleak from the Warta River — 49.12. On the Balkan Peninsula the bleak from Doiran Lake has the mean 50.82 scales, whereas from the Vardar River — 47.33 only.

The effect of higher temperature on the diminishing number of lateral line scales in direction from north to south is not confirmed by any example of the bleak from Prespa Lake and Doiran Lake on the Balkan Peninsula.

The bleak in our firths has the lowest number of scales as compared with the bleak of our lakes and rivers. In both these bodies of water the range is approximate to the data for rivers. In these bodies of water the effect of warmer climate in the Firth of Szczecin on the dimishing number of scales is observed.

Vertebrae

The number of vertebrae of 774 specimens from rivers, lakes and firths stays within the range 41–44(45). This may slightly differ due to the thermal and ecological conditions of the habitat.

The untypical Licheń Lake confirms the well known thesis (Jordan, 1893; Hubbs, 1922; Vladykov, 1934; Tåning, 1950; Orska, 1957; Šapošnikova, 1964 and others) about the diminishing number of vertebrae depending on rises of temperature of the habitat. In Licheń Lake the mean number of vertebrae decrease to 41.94, whereas in typical lakes the mean values are within 42.57–42.77 vertebrae (Tab. 2). In the mentioned lake the number of vertebrae in the bream (Gąsowska, 1968) was also smaller. The effect of the thermal factor on the number of vertebrae may be confirmed by the data from two Polish rivers with different climatic conditions, i.e. the Sub-Carpathian Muszynka River with the bleak having the mean number of vertebrae 42.79 and the lowland Warta River with the mean number 42.26 and the submontane Wetlina River with a very similar mean number — 42.13. The specific character of the latter river has been discussed in the chapter devoted to scales.

A similar character of changes in the number of vertebrae in bleak is recorded for other areas where it occurs. These changes affected by the climate are confirmed by the data of ŠAPOŠNIKOVA 1964 for the typical form of the bleak from the Ural River.

For the bleak from the middle course of this river the recorded range is 41–45, mean value 42.20 vertebrae, whereas for the bleak from the lower course the range is 40–43, mean value 42.00. But for the bleak from the delta of Ural, PETROV (1930) recorded an even smaller number of vertebrae and therefore identifies this bleak as *Alburnus alburnus charusini* HERZENSTEIN. A characteristic deviation from the number of vertebrae of the typical form is observed in the case of the bleak from the Kama River (range 44–48, mean value 45.68), and therefore its position in the systematics should be revised.

A differentiation in the number of vertebrae due to the ecological background is observed when comparing the data for the bleak of our rivers and lakes. In the case of rivers 41 vertebrae are more frequently recorded (7 %) of examined specimens), whereas in lakes only 0.68 %. This is the reason why the total mean value calculated for the bleak from rivers is slightly lower than for the bleak from lakes. In the first case it is 42.46, and in the second – 42.71. These calculations do not include Licheń Lake; high temperature of water caused the diminishing of the number of vertebrae to the mean value 41.94 at a range 40–43 (Tab. 2). A similar phenomenon is recorded for south European area. DIMOVSKI et GRUPČE (1971b) found for the bleak from the Vardar River $M = 39.12$ and the range 37–41, and for the bleak from Doiran Lake $M = 39.78$ and the range 39–42. This differentiation is even more visible in the case of *A.a.alborella* from the Ticino River as compared with the bleak from Como and Maggiore Lakes in the North Italy. MANFREDI (1916), who examined 100 specimens on each locality, provides the following data: Ticino River $M = 37.34$, range 36–39; Como Lake $M = 38{,}69$, range 37–40: Maggiore Lake $M = 38.10$, range (36)37–40 vertebrae.

Anal fin

The number of soft rays in the anal fin in the bleak from Poland is (14)15–21 and is such as for the typical form. The mean values calculated for different types of the bodies of water do not differ much among themselves. The greatest mean value is that of the bleak from the rivers – 17.86, in the bleak from the lakes it is – 17.36, and the lowest mean value – 17.22 is recorded for the bleak from firths. It should be pointed out that the bleak from the untypical Licheń Lake have a slightly smaller number of soft rays as compared with the majority of our lakes.

We have tried to analyze the variability of this character in connection with the differentiation of the climate and geographic position of the bodies of water. Taking into consideration the data concerned the nominal form in the East Europe in direction from the North to the South we do not state the close interdependance between the increase of the temperature and diminishing of the number of branched rays in the anal fin. The bleak from the Vyčegda River, which is situated most of the North, is characterised by M = 17.00 (Lukaš, 1923 cited after Milinskij, 1946). The bleak from the middle course of the Ural River shows M = 17.32 and that from the lower course shows M = 17.95 (Šapošnikova, 1964). The bleak from the delta of Volga R. (National Park at Astrahan) is characterised by M = 17.46. Just in the delta of Ural River the number of branched rays become clear smaller – M = 16.40. This form combines the lower number of branched rays as well as the lower number of vertebrae (range 38–42) in comparison with the nominal form and is classified as *Alburnus alburnus charusini* Herzenstein by Petrov, 1930.

The values of this character in the bleak from the Kama River is of special interest. (Kama R. is situated between geographical position of the Vyčegda R. and Ural R.). Namely the bleak of the Kama River is characterised by high number of branched rays (M = 18.55), and also by the high number of vertebrae (M = 45.00).

Comparing the data concerning this character in the bleak from the Middle Europe (Poland and neighbouring countries – Byelorussia and Czechoslovakia) we have found that the mean value of branched rays in the bleak from the Polish rivers is higher than in that from the rivers of Byelorussia, which climate is rather colder. In Czechoslovakia, which is situated south of Poland, we observe the diminishing number of branched rays (Tab. 2). The remarkable diminishing shows the bleak from the Danube River (territory of Slovakia), this fish is characterised by M = 16.28 (Oliva et Šafránek, 1962).

The way of the variation of this character in the bleak from the Middle-South Europe is based on the data obtained from the bleak of the tributaries of Danube: Tissa River, USSR (La Russie Sous-Carpathique, Vladykov, 1931) and the Timiş River (Rumania, Banarescu, 1946 and the author 1969). As it can be seen from the Tab. 2 the number of branched rays in the bleak from these rivers is typical to that of the nominal form. The data of Šiškov (1941) concerning the bleak from the territory of Bulgaria shows smaller mean value M = 16.72. These data however concern the bleak from two different basins, that of south tributaries of the Danube (Vit, Jantra, Ogosta) and the rivers of the Aegean Sea basin (Marica, Vardar, Struma). In this case it is most probably that Šiškov (1941) had investigated the bleak belonging to two different forms. The investigation of the other authors indicate that the bleak from the rivers discharging their waters to the Aegean Sea are characterised by the smaller number of branched rays in the anal fin. In the bleak from the Marica River Mihailova (1963) stated for this character M = 16.00 and Dimovski et Grupče (1971a) noted in the bleak from Vardar River M = 15.21 and for the bleak from Struma R. M = 15.28. Stephanidis (1950) stated in the bleak from the

Pinios River (Greece, Thessaly) the range 14–16(17) and classifies this bleak as *Alburnus alburnus thessalicus.*

The diminishing number of branched rays in the anal fin was also found in the bleak from the lakes of the Balkan Peninsula as well. According to Dimovski et Grupče (1971a) the number of branched rays ranges from 12–17 in the bleak from Ohrid Lake, Prespa Lake and Doiran Lake, Tab. 2.

From Italy only the data of Manfredi (1916) concerning *Alburnus alborella* (Filippi) from Como Lake, Maggiore Lake and Ticino River were available. This author found the number of rays ranging 15–20, when counting together rigid and branched rays. However the real range should be 12–17, because three rays represents the rigid ones. This last range of branched rays is in agreement with the data of Tortonese (1970), who characterises the bleak from the North Italy by the formula III 13–17 rays in the anal fin, and classifies it as *Alburnus alburnus alborella* Filippi.

Referring to the differentiation of this character according to the ecological specifity of various type of the bodies of water, stated in Poland, we shall discuss this fact on the data from other countries. On the Balkan Peninsula, the data of Mihailova (1963) for the bleak originating from the Marica R. and that of Dimovski et Grupče (1971a) from Vardar R. and Struma R., show a definitly greater number of branched rays in the anal fin as compared with the bleak from Ohrid Lake and Prespa Lake. The only exception is the bleak from Doiran Lake, which has as many soft rays as the bleak from the mentioned above rivers (Tab. 2). Looking for further examples it is worth stressing the data of Manfredi (1916), who examined from this point of view the bleak from the Ticino River and Como Lake and Maggiore Lake in North Italy. According to the correction discused above, the bleak from the Ticino River has the mean value 15.15 of branched rays, from Maggiore Lake – 15.33, and from Como Lake – 13.93. The number of these rays in the bleak from the Ticino River is considerably greater than in the bleak from Como Lake. But the data from the Ticino River and Maggiore Lake are almost identical. The Ticino River, which flows out of Maggiore Lake, is one water system with the lake. And therefore, the population of these two bodies of water may be the offspring of one population and have not differentiated yet under the effect of variable environmental factors.

The number of soft rays in the anal fin is closely correlated with the number of vertebrae. Both this characters in the bleak change parallel one to another, depending on geographical locality and climate. Together they are the grounds to identify the subspecific forms (the delta of Ural River, Balkan Peninsula, North Italy.).

Within the nominal form, characterized the best by the number of vertebrae, (on the average about 42.00) this character slightly varies, which can be seen even in the data of Šapošnikova (1964) on the bleak from the middle and lower course of the Ural River, and in the data on the bleak from the delta of Volga (National Park at Astrahan). In the cited examples the number of soft rays in the anal fin is not much different from the mean value for the nominal form, although the number of vertebrae decrease already partly due to the rise in the temperature of the environment. And only when the number of vertebrae visibly decreases the number of soft rays decreases also, delta of the Ural River, Tab. 2.

A similar correlation of these two characters is observed in the bleak from the Kama River. A visible increase in the number of vertebrae goes together with the visible increase in the number of soft rays. KOZMIN (1950) called attention to this fact and explained the tendency to a change of meristic characters in direction from the west to the east. To the elements increasing in that direction belong: gill rakers, vertebrae and soft rays in the anal fin. The decreasing character is the number of lateral line scales. Also MENŠIKOV (1951) points to the geographical variation of some elements in fish (European part of the USSR in comparison with Siberia). However, this author underlines the great significance of the thermal factor in the formation of meristic characters.

Dorsal fin

The number of branched rays in the dorsal fin of the bleak in Poland is 7–9. As concerns the frequency of occurrence of these numbers no differences were observed between the bleak from rivers, lakes and firths. Eight branched rays were found in 93.4 %, and 7 or 9 rays were found in 3.3 %. These data are almost the same as those characteristic for the nominal form.

This character is quite constant both in the nominal form and in the subspecies form according to the data of MANFREDI (1916) for the bleak of Northern Italy, and of DIMOVSKI et GRUPČE (1971b) for the examined bleak of the Balkan Peninsula including Ohrid Lake. Eight rays dominate. As concerns the bleak from Ohrid Lake, the authors mentioned above do not confirm the data of Oliva et ŠAFRANEK (1962), on the domination of 9 rays in the bleak in that lake.

A slightly greater number of branched rays is observed in the bleak of the Kama River (Tab. 2), but it should be pointed out that this bleak is characterised by a greater than in the typical form number of vertebrae and soft rays in the anal fin.

Gill rakers

When examining 1160 specimens it has been found that the number of gill rakers counted on the first gill arch is between 16 and 24. It can be said that this character depends to some extent on the thermal factor (Tab. 2).

A greater number of gill rakers have the bleak from the rivers Solinka and Wetlina as compared with the bleak from the Muszynka River. The former are in a warmer climate than the Muszynka River, which has been elaborated in the chapter on scales. As concerns the stream Trzebiocha where the bleak has the greatest number of gill rakers among the bleak from the rivers, its distinctness is due to the fact that its population is most probably mixed with the bleak from Wdzydze Lake (see chapter on scales). On the other hand, the bleak from Wdzydze Lake has the greatest number of gill rakers among the bleak from lakes.

Licheń Lake, known from its high annual temperature, and Wdzydze Lake situated in the western part of the country, in the range of milder climate, have the bleak with greater number of gill rakers than the bleak of Hańcza Lake, which is in the range of the most severe climatic conditions of our lakeland.

The data for Poland confirm the fact that the number of gill rakers increases in the typical form due to the rise of temperature in the environment, and thus with the change of the geographical latitude, i.e. from north to south. For the northern regions of Europe Milinskij (1941) gives the following data: Syamozero Lake – range 16–21, $M = 18.76$; Onega Lake – range 17–19, $M = 18.30$; Vyčegda River – range 17–22, $M = 18.60$. These mean values correspond to our lowest values. In the southern regions of the typical form the number of gill rakers clearly increases. Šapošnikova (1964) found that the bleak from central Ural River has the range 20–29 ($M = 24.41$), for lower Ural R. 22–28 (M = 25.10).

Whereas, this character for the bleak of our firths is the opposite than in the two discussed above types of the bodies of water. In conditions of a warmer climate (Firth of Szczecin) the bleak has less gill rakers. It is quite possible that in these bodies of water the factor of different water salinity, and the size of the body of examined specimens, have been of some significance, as the number of gill rakers increases with the growth of an individual (Menšikov, 1951, Pęczalska, 1958, and others). The bleaks from the Firth of Szczecin are almost 2 cm amaller than those from the Firth of Vistula.

In southern Europe (Balkan Peninsula, Northern Italy), where are subspecific forms (Tab. 2), the number of gill rakers increases slightly because of the warmer climate, but still not as much as recorded for the typical form in south-eastern Europe. It should be pointed out that the number of gill rakers in the bleak from Prespa Lake is very large ($M = 33.61$, Dimovski et Grupče 1971a), which shows a great specificity of environmental conditions and a considerable distinctness of this form.

Pharyngeal teeth

The teeth counted in 390 specimens show a great variety and 15 variants have been recorded. The greatest variety was observed in the bleak from rivers (12 in Vistula), lakes (6) and firths (5). The percentage of these categories is as following: 2.5–5.2, 73.8%; 2.5–5.1, 6.7%; 1.5–5.1, 3.8%; 3.5–5.2 and 2.4–5.2, 3.3%; 1.5–5.2, 2.1%; 2.5–4.2, 1.5%; 2.5–4.1, 1.3%; 2.5–5.3, 1.0%.

Table 3. Mensural characters of the bleak *Alburnus alburnus* (Linnaeus) from Poland in com-

	No.	Locality and author	*N*	Body length in mm	
				Range	Mean
River	1	Wisła, author, 1970	100	73–105	86.0
	2	Warta, author, 1954	65	68–115	87.5
	3	Trzebiocha, author, 1959	50	83–140	104.1
	4	San, author, 1959–1966	161	50–144	94.0
	5	Solinka, author, 1966	45	94–115	106.0
	6	Muszynka, author, 1966	47	114–148	126.4
	7	Dnepr, Žukov, 1965	78	80–155	110.2
	8	Zap. Dvina, Žukov, 1965	49	105–135	114.6
	9	Vyčegda, Lukaš, 1923	29	—	—
	10	Kama, Kozmin, 1951	100	—	—
	11	Ural (middle course), Šapošnikova, 1964	33	—	—
	12	Ural (lower course), Šapošnikova, 1964	20	—	—
	13	Danube basin (Vit, Iskăr, Jantra, Ogosta) Šiškov, 1941	68	65–118	—
	14	Struma, Marica, Šiškov, 1941	51	64–105	—
	15	Marica, Mihailova, 1963[1]	—	79–83	—
	16	Marica, Mihailova, 1963[2]	—	106–116	—
	17	Vardar, Dimovski et Grupče. 1971b	100	87–140	113.5
Lake	18	Licheń, author, 1966	100	68–109	88.1
	19	Mikołajskie, author. 1968	100	74–104	83.1
	20	Bimbinek, author, 1954	38	111–144	124.9
	21	Mamry, author, 1955–1959	150	71–121	94.0
	22	Dgał, author, 1957	43	90–115	104.1
	23	Hańcza, author, 1961	120	111–146	128.5
	24	Wdzydze, author, 1958	53	90–142	113.6
	25	Pskov, Petrov, 1931	72	—	—
	26	Syamozero, Milinskij, 1946	50	—	—
	27	Onega, Milinskij, 1946	—	—	—
	28	Doiran, Dimovski et Grupče, 1971b	100	111–168	139.5
Firth	29	Zalew Wiślany, author, 1963	41	98–137	120.3
	30	Zalew Szczeciński, author, 1958	100	93–122	103.7

[1] *Alburnus alburnus.*

[2] *Alburnus alburnus* morpha *lacustris,*

[3] These mean values are calculated by the author of this paper, basing on particular data of Šiškov, 1941.

parison with that of the other countries expressed in the percentages of the body length

Maximum body depth		Minimum body depth		Head length	
Range	$M \pm m$	Range	$M \pm m$	Range	$M \pm m$
20.8–25.6	23.26 ± 0.13	7.0–10.2	8.81 ± 0.05	20.0–24.0	22.48 ± 0.09
21.6–26.2	23,63 ± 0.13	7.4– 9.5	8.33 ± 0.07	20.2–23.4	21.98 ± 0.07
19.3–26.0	21.87 ± 0.25	7.3– 9.2	8.18 ± 0.07	20.1–22.8	21.22 ± 0.09
18.2–23.5	20.65 ± 0.04	7.7– 9.4	8.52 ± 0.03	20.2–23.0	21.70 ± 0.05
19.0–24.2	22.26 ± 0.13	7.5– 9.0	8.23 ± 0.05	20.8–24.2	22.14 ± 0.11
20.3–24.5	22.42 ± 0.14	7.7– 9.2	8.50 ± 0.06	20.1–22.3	21.20 ± 0.08
17.7–26.0	22.68 ± 0.18	6.1–10.0	8.29 ± 0.11	18.6–24.6	21.64 ± 0.13
20.5–25.5	22.21 ± 0.18	7.5– 9.5	8.48 ± 0.08	20.5–23.5	22.05 ± 0.11
—	21.40 —	—	8.20 —	—	20.52
21.2–25.5	23.02 —	7.1– 9.5	8.26 —	18.0–21.0	19.74 —
21.5–29.7	24.56 —	7.8–10.3	9.15 —	19.1–23.4	21.04 —
21.5–26.2	24.35 —	7.6– 9.6	8.90 —	20.8–23.4	21.95 —
18.8–25.6	22.05[3] —	7.2–10.0	8.76[3] —	19.7–23.8	21.74[3] —
19.4–25.2	22.00[3] —	7.9–10.0	8.83[3] —	21.7–24.6	22.26[3] —
20.9–23.9	22.30 —	8.2–10.8	9.30 —	20.8–24.4	22.80 —
24.0–30.3	25.10 —	8.8–14.0	10.10 —	21.0–25.3	22.80 —
20.2–27.4	23.24 ± 0.14	8.2–10.1	9.31 − 0.04	19.5–25.0	22.73 ± 0.09
17.9–23.8	20.86 ± 0.12	7.0–9.0	7.99 ± 0.04	18.9–22.2	20.78 ± 0.06
18.1–23.4	20.74 ± 0.08	7.0–8.7	7.75 ± 0.04	19.0–22.2	20.38 ± 0.06
18.6–23.0	21.23 ± 0.17	7.7–8.9	8.23 ± 0.05	18.5–21.1	19.75 ± 0.10
17.4–23.4	19.98 ± 0.12	6.6–9.0	7.76 ± 0.04	19.1–23.2	20.89 ± 0.11
17.2–19.6	18.58 ± 0.08	6.9–8.6	7.91 ± 0.06	19.6–22.4	21.14 ± 0.09
17.1–21.6	19.46 ± 0.07	6.8–8.7	7.97 ± 0.03	18.2–20.8	19.41 ± 0.04
18.7–23.1	21.09 ± 0.14	7.4–8.9	7.96 ± 0.04	19.0–21.8	20.43 ± 0.09
19.2–24.0	21.34 ± 0.16	7.1–9.7	8.23 ± 0.06	19.5–22.7	20.95 ± 0.09
—	20.23 ± 0.11	—	7.66 ± 0.06	—	19.87 ± 0.09
—	18.00 —	—	6.90 —	—	20.30 —
17.6–21.4	19.96 ± 0.07	7.4–8.8	8.26 ± 0.03	19.6–23.5	21.47 ± 0.06
21.9–26.5	23.50 ± 0.18	7.1– 9.1	8.23 ± 0.07	19.1–21.5	20.25 ± 0.08
20.3–25.0	22.45 ± 0.09	7.6– 9.7	8.53 ± 0.04	19.4–22.4	20.95 ± 0.06

ctd. Table 3

No.	Caudal peduncle length		Predorsal distance		Postdorsal distance	
	Range	$M \pm m$	Range	$M \pm m$	Range	$M + m$
1	14.6–21.4	18.23 ± 0.12	51.6–58.2	55.21 ± 0.12	31.1–37.2	34.13 ± 0.12
2	17.0–23.0	20.48 ± 0.14	50.6–56.6	55.47 ± 0.21	32.6–38.5	35.73 ± 0.18
3	17.1–23.6	20.87 ± 0.21	53.0–59.6	55.72 ± 0.20	31.9–38.2	35.78 ± 0.21
4	18.5–23.3	20.79 ± 0.08	52.5–57.4	54.68 ± 0.08	33.3–38.8	36.09 ± 0.08
5	16.0–20.6	18.14 ± 0.15	52.0–57.5	55.03 ± 0.18	30.7–36.0	33.24 ± 0.18
6	18.2–23.0	20.41 ± 0.14	53.9–57.2	55.62 ± 0.14	33.2–37.2	35.60 ± 0.15
7	14.6–23.6	18.86 ± 0.21	51.8–59.1	55.06 ± 0.21	31.7–39.1	35.17 ± 0.17
8	16.5–22.5	19.45 ± 0.24	53.5–59.5	55.63 ± 0.19	31.5–37.5	33.85 ± 0.21
9	—	19.30 —	—	54.70 —	—	35.90 —
10	15.6–21.3	18.07 —	52.0–56.4	54.60 —	—	—
11	15.8–23.1	19.56 —	51.7–60.0	55.90 —	—	—
12	15.9–21.5	18.21 —	53.3–59.0	55.80 —	—	—
13	17.7–22.2	20.20[3] —	51.5–58.8	55.00[3] —	33.4–38.6	36.35[3] —
14	17.8–23.1	20.23[3] —	53.1–58.3	55.50[3] —	32.2–37.6	35.42[3] —
15	19.5–25.3	21.90 —	47.4–56.6	54.40 —	32.2–41.5	36.90 —
16	—	21.20 —	52.7–59.0	55.77 —	33.3–42.0	37.40 —
17	17.4–23.0	20.22 ± 0.10	48.2–56.4	54.19 ± 0.15	—	—
18	17.5–24.4	21.35 ± 0.13	52.0–57.8	54.89 ± 0.12	33.4–39.2	36.38 ± 0.12
19	18.1–23.9	21.61 ± 0.09	52.5–58.6	54.92 ± 0.11	33.3–40.2	36.61 ± 0.11
20	17.8–22.2	19.63 ± 0.17	53.1–57.1	55.22 ± 0.15	32.7–35.8	34.55 ± 0.16
21	19.9–23.8	21.52 ± 0.09	52.1–58.2	55.41 ± 0.12	31.7–39.0	35.88 ± 0.13
22	17.6–21.9	19.35 ± 0.18	51.6–56.6	54.66 ± 0.17	31.8–36.9	33.73 ± 0.17
23	18.4–23.8	21.05 ± 0.08	52.1–57.1	54.77 ± 0.09	33.3–40.8	36.43 ± 0.10
24	18.6–23.6	21.15 ± 0.17	50.0–57.2	55.00 ± 0.40	31.4–36.4	34.00 ± 0.34
25	17.5–23.6	20.70 ± 0.16	53.1–60.1	56.70 ± 0.16	32.5–39.5	36.30 ± 0.10
26	—	20.49 ± 0.14	—	55.61 ± 0.13	—	35.81 ± 0.18
27	—	21.20 —	—	55.60 —	—	—
28	17.8–22.8	20.91 ± 0.09	50.3–57.8	54.84 − 0.22	—	—
29	17.6–21.4	19.69 ± 0.15	52.9–58.5	55.43 ± 0.18	33.4–37.4	35.15 ± 0.14
30	16.0–22.5	19.17 ± 0.14	52.3–57.6	55.34 ± 0.11	31.3–38.0	35.58 ± 0.15

Dorsal fin height		Dorsal fin length		Anal fin height	
Range	$M \pm m$	Range	$M \pm m$	Range	$M \pm m$
14.6–20.0	17.17 ± 0.08	8.9–12.5	11.80 ± 0.07	11.5–15.8	13.21 ± 0.08
13.4–18.3	15.92 ± 0.12	8.0–11.5	9.83 ± 0.08	10.1–14.5	12.23 ± 0.11
14.0–17.4	15.63 ± 0.11	8.4–11.7	9.84 ± 0.10	10.4–13.1	11.69 ± 0.09
14.7–18.9	16.50 ± 0.06	8.4–11.5	9.79 ± 0.05	10.4–15.4	12.84 ± 0.07
14.0–17.5	15.58 ± 0.12	9.2–11.4	10.27 ± 0.09	10.9–13.8	12.20 ± 0.10
14.6–18.5	16.33 ± 0.12	8.4–11.0	9.39 ± 0.08	11.0–14.0	12.08 ± 0.08
13.6–20.6	16.99 ± 0.19	8.0–13.0	10.44 ± 0.15	9.7–16.4	13.44 ± 0.17
13.5–18.5	15.66 ± 0.22	9.5–13.5	10.65 ± 0.12	11.5–15.5	12.49 ± 0.12
—	—	—	—	—	—
13.0–19.6	17.01 —	7.0–13.0	9.86 —	11.0–15.0	12.83 —
10.9–19.8	14.93 —	8.4–13.1	10.41 —	7.4–14.1	10.39 —
13.2–17.5	15.29 —	9.4–12.5	10.80 —	9.3–13.4	11.65 —
13.6–17.8	15.76[3] —	8.2–11.1	9.65[3] —	10.1–14.6	11.70[3] —
14.2–18.2	16.21[3] —	8.6–11.5	9.88[3] —	10.0–14.1	12.50[3] —
—	—	10.0–14.2	11.70 —	—	
—	—	11.1–15.0	12.40 —	—	
16.2–21.1	18.88 ± 0.10	8.6–12.2	10.56 ± 0.07	11.8–15.9	13.91 ± 0.07
14.0–17.9	15.93 ± 0.08	8.0–10.6	9.41 ± 0.06	10.5–13.6	11.98 ± 0.07
13.1–17.7	15.18 ± 0.07	7.0–10.3	9.07 ± 0.05	10.0–13.0	11.49 ± 0.09
11.8–16.7	14.60 ± 0.16	7.6–11.0	9.69 ± 0.20	8.9–12.5	10.58 ± 0.15
12.8–17.2	14.61 ± 0.07	8.3–11.2	9.62 ± 0.05	9.5–12.8	11.21 ± 0.06
12.4–15.8	14.18 ± 0.13	8.0–11.1	9.63 ± 0.09	9.5–12.2	10.88 ± 0.10
12.6–17.0	15.03 ± 0.07	8.0–10.2	8.99 ± 0.04	9.6–12.8	11.06 ± 0.05
13.5–15.7	14.40 ± 0.15	8.0–10.4	9.59 ± 0.15	10.0–12.1	11.11 ± 0.15
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
15.5–18.8	17.25 ± 0.06	8.6–11.2	9.86 ± 0.05	11.9–14.7	13.47 ± 0.05
14.8–17.4	15.99 ± 0.10	8.8–11.5	9.94 ± 0.11	10.6–14.4	12.32 ± 0.10
13.4–18.0	15.70 ± 0.09	7.8–11.6	9.80 ± 0.07	9.6–13.9	11.92 ± 0.08

ctd. Table 3

No	Anal fin length		Pectoral fin length		Pelvic fin length	
	Range	$M \pm m$	Range	$M \pm m$	Range	$M \pm m$
1	16.8–22.6	19.65 ± 0.13	18.1–22.6	20.42 ± 0.08	13.2–16.8	15.09 ± 0.08
2	16.5–22.1	19.02 ± 0.16	16.7–20.8	19.06 ± 0.10	11.8–15.8	13.90 ± 0.09
3	15.2–20.4	17.91 ± 0.18	16.3–20.4	18.53 ± 0.10	11.4–15.2	13.39 ± 0.10
4	16.8–22.1	19.13 ± 0.09	17.6–21.1	19.26 ± 0.06	11.6–15.8	13.51 ± 0.05
5	17.5–22.1	19.42 ± 0.17	16.8–21.8	19.50 ± 0.14	13.0–15.5	14.16 ± 0.09
6	17.3–21.3	19.09 ± 0.15	17.4–20.7	18.95 ± 0.12	12.7–16.3	14.38 ± 0.09
7	16.3–23.3	19.44 ± 0.20	15.9–22.0	18.99 ± 0.13	12.4–17.0	14.75 ± 0.12
8	15.5–21.5	18.11 ± 0.21	15.5–21.5	19.06 ± 0.17	12.5–16.5	14.29 ± 0.08
9	—	—	—	—	—	—
10	17.5–24.5	20.64 —	16.0–23.0	18.55 —	11.1–16.0	13.90 —
11	16.2–23.0	19.14 —	17.0–23.0	20.29 —	13.0–19.0	15.59 —
12	16.9–22.8	19.70 —	17.0–22.4	19.85 —	13.0–16.3	14.80 —
13	16.3–21.8	18.50[3] —	17.1–21.5	19.04[3] —	12.9–16.4	14.56[3] —
14	15.9–21.7	17.92[3] —	18.4–23.1	20.11[3] —	13.5–17.3	15.10[3] —
15			18.2–21.6	20.10 —	12.8–16.8	15.00 —
16			17.0–22.7	19.40 —	13.2–17.7	15.10 —
17	14.5–21.5	18.33 ± 0.11	17.5–22.0	19.81 ± 0.09	12.5–16.1	14.66 ± 0.07
18	16.0–21.1	17.93 ± 0.11	17.0–20.6	18.46 ± 0.08	12.0–14.5	13.19 ± 0.06
19	15.0–20.5	18.01 ± 0.08	15.5–20.9	18.14 ± 0.07	10.7–14.8	13.12 ± 0.05
20	15.3–20.0	17.47 ± 0.21	17.0–20.7	18.68 ± 0.16	12.5–14.8	13.47 ± 0.10
21	15.2–20.7	17.79 ± 0.09	15.4–20.3	18.05 ± 0.07	11.2–14.8	12.84 ± 0.06
22	15.5–20.0	17.37 ± 0.16	15.5–20.6	18.38 ± 0.15	11.8–14.8	12.95 ± 0.10
23	15.5–21.0	18.38 ± 0.09	15.5–18.7	16.95 ± 0.06	10.9–13.7	12.10 ± 0.05
24	15.7–19.0	17.66 ± 0.20	17.0–20.0	18.48 ± 0.18	12.1–14.4	13.10 ± 0.16
25	—	—	—	—	—	—
26	15.1–21.1	18.22 —	—	—	12.1–14.6	14.38 —
27	—	—	—	—	—	—
28	15.5–19.8	17.60 ± 0.09	16.1–19.6	17.87 ± 0.06	12.3–14.8	13.54 ± 0.05
29	16.5–20.1	18.36 ± 0.14	17.2–20.6	18.67 ± 0.11	12.6–15.0	13.77 ± 0.08
30	16.1–20.2	18.14 ± 0.09	17.3–21.7	19.47 ± 0.09	11.5–15.3	13.85 ± 0.07

Distance P–V		Distance V–A	
Range	$M \pm m$	Range	$M \pm m$
20.9–26.6	23.41 ± 0.12	17.2–23.8	20.13 ± 0.12
20.1–26.0	23.14 ± 0.16	15.7–22.6	19.15 ± 0.18
20.6–25.8	23.26 ± 0.12	16.1–21.6	19.05 ± 0.18
18.4–24.6	22.20 ± 0.09	15.8–21.2	18.75 ± 0.08
21.8–24.8	22.39 ± 0.14	17.8–22.2	19.15 ± 0.17
20.1–24.4	22.63 ± 0.13	17.2–20.5	18.95 ± 0.13
18.3–26.7	22.91 ± 0.21	16.4–24.0	20.24 ± 0.19
18.5–26.5	22.87 ± 0.26	17.5–22.5	19.18 ± 0.21
—	—		—
19.0–25.0	22.29 —	—	—
19.0–28.0	23.12	—	—
23.0–24.7	23.77 —	—	—
—		—	—
—		—	—
21.8–26.5	24.1 —	—	—
22.2–26.2	24.2 —	—	—
20.7–26.1	23.27 ± 0.12	—	—
19.5–26.9	22.63 ± 0.14	16.4–21.7	18.55 ± 0.11
21.7–25.6	23.29 ± 0.08	17.2–22.1	19.07 ± 0.08
21.5–26.3	23.96 ± 0.20	17.4–22.0	20.05 ± 0.18
20.6–25.8	23.26 ± 0.12	16.1–21.6	19.05 ± 0.18
21.8–26.0	23.47 ± 0.14	16.8–20.5	18.89 ± 0.14
22.1–25.7	24.16 ± 0.01	16.8–21.5	19.18 ± 0.08
21.6–26.8	24.04 ± 0.35	17.2–22.1	19.68 ± 0.32
21.5–27.3	24.10 ± 0.15	—	—
—	—	—	—
—	—	—	—
20.5–25.8	23.37 ± 0.09	—	—
21.3–25.2	23.18 ± 0.05	17.3–22.7	19.89 ± 0.17
20.7–26.0	23.23 ± 0.11	17.1–23.8	20.09 ± 0.13

Others such as 1.4–5.2, 1.5–4.2, 4–5.2, 2.5–4.3, 5–4.2 were observed in 3 specimens at the very most, but usually in one specimen. Despite this variety of pharyngeal teeth not once the formula 3.5–5.3 was observed, which is mentioned by Banarescu (1946) for the bleak from the Timiş River.

MENSURAL CHARACTERS

The maximal body depth ratio of examined bleaks is 17.1–26.2 in percentages of the standard length. This character varies in particular types of the bodies of water. The bleak of our lakes have a slender body and the bleak from rivers is deeper-bodied. Still, in one type of the body of water we observe great differences in the maximal body depth, which is especially visible in the case of rivers. The bleak from the Warta River has $M = 23.63\,^0/_0$, whereas from the San River the $M = 20.65\,^0/_0$ (Tab. 3). Among the bleak from lakes not one specimen has been found out of the 600 ones examined of a depth ratio above $24\,^0/_0$, i.e. the value characterising the form *Alburnus alburnus* morpha *lacustris* (Berg, 1949 and Mihailova, 1963). Among the bleak from our rivers and firths specimens of a body depth $26.2\,^0/_0$ were recorded, but these were only single specimens and usually females.

Comparing our data on the bleak from rivers with the data from the neighbouring territory we see a great similarity with bleak from the Dnepr River and Zap. Dvina River in Byelorussia (Žukov, 1965). In case of the other eastern rivers (Vyčegda, Kama, Ural) we record a considerable differentiation of the bleak as concerns the maximal body depth. On this great distance ranging from the North to the South the maximal body depth ratio is the resultant of various environmental factors such as temperature, food resources and some differences of a genetic character simultaneously, if e.g. we will take into consideration the separateness of the bleak from the Kama River.

Comparing the data from the mentioned rivers of eastern Europe with corresponding data for the lakes on these areas (Syamozero, Onega, Pskov) similar relations are observed as in Polish waters. The bleak from the rivers is usually deeper-bodied (Tab. 3).

In the bleak from western Europe this character is similar. According to Manfredi (1916) the bleak *A. alborella* from the Ticino River is deeper-bodied than the bleak from Como Lake and Maggiore Lake. The mean body depth vertically above the pelvic fin (calculated by the method of the mentioned author) are in the percentages of standard length in the Ticino River — $M = 72.34$; in Como Lake — $M = 66.15$ and in Maggiore Lake — $M = 66.61$. These relations are confirmed by the data on the bleak from the Balkan Peninsula. The bleak from the Struma River and Marica River (Šiškov, 1941), Marica River (Mihailova, 1954) and Vardar River (Dimovski et Grupče, 1971b) are deeper-bodied than the bleak from Doiran Lake (Tab. 3).

The bleak from Polish firths have high maximal body depth ratio, which can be explained by the abundance of food. Some differences in this character in both firths are probably not due as much to the abundance but to the different of plankton composition, which is the main food of the bleak. According to Wiktorowie (1951) the freshwater species prevail in the zooplankton in the Firth of Szczecin, whereas in the Firth of Vistula Baltic and brackish species dominate. This zooplankton composition at a small density of competetive fish — smelt, *Osmerus eperlanus* (L.) — causes that even at smaller absolute food abundance in the Firth of Vistula the bleak is deeper-bodied than in the Firth of Szczecin.

The minimal body depth of examined bleaks is on the average 6–10 %. It reflects the maximal body depth and depends on the type of the body of water. This is visible looking at the mean values in Tab. 4.

The head length ratio of the bleak in Poland is 18.2–24.0 in percentages of the standard length. The longest head is that of the bleak from rivers, then from the firths and the shortest head length is of the bleak from lakes (Tab. 4). However, within one type of a body of water this character considerably varies. Such differentiation has been recorded for the bleak from our rivers e.g., the bleak from the Vistula River has a long head, and the one from the Muszynka River has a short one, $M_{diff} = 10.8$. This may be to some extent explained by the effect of the temperature of the environment and the current speed. Muszynka R. is a submontane river with a considerable gradient and the climate there is more severe than in the Vistula River region, which is a typical lowland river with a slow current. Also the warmer climate may be the reason why the head length of the bleak from Solinka River is longer as compared with the short one of the bleak from Muszynka River, $M_{diff} = 7.2$. The specific thermal conditions of the region of Solinka River are discussed in the chapter on the scales along the lateral line.

A further example of head elongation due to higher temperatures in the environment is the bleak from the Vyčegda River and Ural River. The first one is short-headed as it forms at low temperatures, in about 63° geographic latitude, whereas the second with a longer head forms at warmer temperature at 48° latitude. The bleak from the Kama River, which is on an intermediate geographical latitude as compared with the mentioned rivers, has a definitely short head which together with a large number of vertebrae and branched rays in the anal fin are an argument for the formation of these characters at low temperatures, and quite possibly in microclimate.

As regards the lakes, the differences in the head length are even greater. And so $M_{diff} = 10.03$ is between the long-head bleak from Licheń Lake and the short-head one from Hańcza Lake. In this case the thermal conditions of the environment are undoubtedly the dominant factor responsible for such proportions. Also the difference in the head length between the bleak from Dgał Lake and Hańcza Lake is considerable, $M_{diff} = 17.5$. Both these lakes stand in contrast as regards the surface, depth and hydrological type (acc. to Bernatowicz, 1965 the surface of Dgał Lake is 94 ha, max. depth 18.8 m, eutrophic type, 50.9 % of its surface is overgrown with vascular vegetation; acc. to Stangenberg, 1936 Hańcza Lake — surface 305.8 ha, max. depth 108.5 m, oligotrophic type). In these two contrastic biotopes the thermal conditions are undoubtedly different.

Milinskij (1946) has pointed out the shortness of the bleak's head from Syamozero Lake as compared with the bleak from Pskov Lake, $M_{diff} = 8.50$. In this case as in the previous ones the effect of the thermal factor is visible as Syamozero Lake lies in Karelia, which is in the range of lower temperature than Pskov Lake.

Some, although slight, differences in the head length are observed in the bleak from the Ticino River and Maggiore Lake. According to the method used by Manfredi (1916) the head length in the first case is on the average 69.47, and in the second — 68.91. It is also similar when comparing the head length of the bleak in the Vardar River ($M = 22.73$) and in Doiran Lake ($M = 21.47$), Dimovski et Grupče (1971b).

Also the thermal factor may be an explanation for the smaller head of the bleak from the Firth of Vistula, which is in the zone of more severe climate than the Firth of Szczecin, in which the bleak has a long head.

The caudal peduncle length of the bleaks in Poland is 16.0–24.4 in percentages of the standard length. When analysing this character in relation to the type of the body of water the longest caudal peduncle in the bleak from lakes recorded is $M = 20.90$, the mean length in the bleak from rivers — $M = 19.82$, and the least length in the bleak from firths — $M = 19.43$. The correlation: maximal body depth — caudal peduncle length, examined on the basis of arithmetic means shows that the great body depth is associated with short caudal peduncle (the bleak from rivers and firth), whereas the small body depth with long caudal peduncle (the bleak from lakes) — Tab. 4.

The example of the bleak does not confirm what has been said by Nikolskij, 1963: 33, "The forms of one species living in flowing and stagnant

Table 4. Comparison of the mean arithmetic values of some mensural characters of the bleak from rivers, lakes and firths in Poland

Character	River	Lake	Firth
Maximal body depth	22.30	20.28	22.98
Minimal body depth	8.43	7.94	8.38
Head length	21.79	20.40	20.60
Caudal peduncle length	19.82	20.90	19.43

water display an adaptation to the water cours; e.g. the grayling, *Thymallus arcticus* from Baikal, has greater body depth and longer caudal peduncle, while the representatives of this species in the Angara River have smaller body depth and shorter caudal peduncle, characteristic of good swimmers".

The bleak in lakes has usually a small body depth, its maximal body depth is smaller than the length of the caudal peduncle. However, in particular cases (Bimbinek Lake in Poland and Pskov Lake in USSR) where the bleaks are deeper-bodied their caudal peduncle is shorter than the maximal body depth (Tab. 3).

In rivers, the greatest body depth is greater than the caudal peduncle length as it can be seen on the example of rivers in Poland, USSR and the Balkans (Marica River, Struma River). The same is stated by Šiškov (1941) for the bleak from the south tributaries of the Danube (rivers: Iskăr, Vit, Jantra) Tab. 3.

The predorsal space is very similar in all types of the bodies of water and coresponds to the data on the bleak from other European areas. Only the bleak from Pskov Lake has this space slightly bigger. Some differentiation is observed in the size of the postdorsal space. And so, e.g., $M_{diff} = 14.0$ for the bleak from the Vistula River and San River, and also for the bleak from Mikołajskie Lake and Dgał Lake.

Passing onto an analysis of the height of unpaired fins: dorsal and anal, and the length of paired fins: pectoral and pelvic, quite significant differences are observed between the bleak from our rivers and lakes, and the middle values of the bleak from firths. This is illustrated in Tab. 5. However, it should be poin-

Table 5. Comparison of the mean arithmetic values of the heigth of unpaired fins and the length of paired fins in the bleak from rivers, lakes and firths in Poland

Character	Rivers	Firths	Lakes
Height of dorsal fin	16.31	15.85	14.85
Height of anal fin	12.40	12.12	11.19
Length of pectoral fin	19.25	19.07	18.32
Length of pelvic fin	14.05	13.81	12.97

ted out that only within one type of the body of water there are considerable differences, e.g. for the Vistula River and Warta River — $M_{diff} = 7.6$, and for the Vistula River and Muszynka River — $M_{diff} = 6.7$. Great differences are observed in the length of paired fins of the bleak from rivers and lakes. In the case of extreme values for the Vistula River and Hańcza Lake the difference in the length of pectoral fin is $M_{diff} = 34.7$, and for the pelvic fin $M_{diff} = 31.8$. The cited relations reflect the ways of species evolution in varying to the extreme environmental conditions.

The unpaired and paired fin as organ of propulsion, balancing and steering develop differently in various water courses. In rivers because of the necessity to overcome the water current, the fins will develop better in height and in length for better balance of fish body. In lakes, where there are no currents both the unpaired and paired fins do not attain such length as those of the bleak from rivers. In firths the situation is analogous as in lakes (Tab. 5).

A further confirmation of the mensural variability of the bleak due to the environment are the data on the eye diameter and the interorbital width as calculated by the standard length:

	Rivers	Firths	Lakes
eye diameter	6.05%	5.76%	5.60%
interorbital width	6.97%	6.18%	5.82%

SEXUAL DIMORPHISM

On the basis of literature data (Milinskij, 1946; Žukov, 1965 and others) pointing to the poorly developed sexual dimorphism in the bleak I would like to add something more. My observations are based on few mensural characters of specimens from two bodies of water — Vistula River and Hańcza Lake, (Tab. 6). We see in this table that the head length of males and females does not differ in both types of water. Predorsal distance is almost identical in both sexes in Hańcza Lake, whereas in the Vistula River this distance is slightly smaller in males. Postdorsal distance, caudal peduncle length, height of dorsal fin and length of pectoral fins are greater in the males of both these types of water.

Table 6. Comparison of the mean values of some mensural characters of 30 ♂♂ and 30 ♀♀ of the bleak from two different bodies of water

Locality	Wisła River		Hańcza Lake	
Character	♂♂	♀♀	♂♂	♀♀
Head length	22.50	22.50	19.36	19.44
Predorsal distance	55.00	55.50	54.40	54.50
Postdorsal distance	34.28	33.69	36.80	36.31
Caudal peduncle length	18.30	18.00	21.21	20.87
Height of dorsal fin	17.37	16.96	14.69	14.23
Length of pectoral fin	20.80	20.50	17.16	16.82

The sexual dimorphism is visible during the spawning season. The males acquire then the spawning tubercles on the head and on the back as far as the dorsal fin.

CONCLUSION

The variability of the bleak as seen from the review of the meristic and mensural characters is due to ecological and geographical factors.

The ecological variability of bleak is connected with the type of the body of water. In meristic characters it is mainly expressed by the number of lateral line scales. The bleak in Polish rivers has a smaller number of lateral line scales than the bleak in lakes. In the number of vertebrae this differentiation is expressed by greater frequency of occurrence in rivers of specimens with 41 vertebrae (7%), whereas in the lakes only 0.87% were recorded. This differentiation is even more striking in the case of *Alburnus alburnus alborella* (Northern Italy), where the bleak from the Ticino River has less vertebrae than the bleak from Como Lake and Maggiore Lake Tab. 2.

The mensural characters in the bleak from the Poland are clearly differentiated depending on the type of the body of water. The maximal and minimal body depth are greater in the bleak from rivers than lakes. The longer head of the bleak from rivers is connected with the water course, the shape of the head is adopted to conquer the friction with the surrounding water when the fish swims against the current. The length of the caudal peduncle is smaller in the bleak from rivers than lakes. This character is quite obviously correlated with the body depth. The greater is the maximal body depth, the shorter is the caudal peduncle, quite independently from the type of the body water. This correlation is observed also for other areas (Dnepr River and Pskov Lake, Vardar River and Doiran Lake) Tab. 3.

Due to swimming against the water current the bleaks from our rivers have longer pectoral and pelvic fins than the bleaks from lakes. This is confirmed by the example of the bleak from other localities (Vardar River and Doiran Lake).

The geographical variability is mainly due to the change of the temperature of the environment. In southern direction, due to the rise of temperature, the changes in meristic characters are: smaller number of vertebrae and branched rays in the anal fin. The diminishing number of lateral line scales in southern direction is not generally confirmed, as e.g. the lakes of the Balkan Peninsula, and especially the bleak from Prespa Lake with a remarkably high $M = 53.95$.

As long as the ranges of mentioned characters overlap we are dealing with interspecific variability. Therefore I am in favour of the opinion of Petrov (1930) and Šapošnikova (1964) that the bleak from the Ural River delta should be treated as the subspecific form *A.a. charusini* Herzenstein and not as the species *A. charusini* according to Berg, 1949.

As regards the bleak from the Balkan Peninsula the detailed studies initiated by DIMOVSKI et GRUPČE (1971 a, b) revealed controversial data with those of KARAMAN (1924, 1929, 1955) and that of OLIVA et ŠAFRANEK (1962), therefore the taxonomics of the bleak on these areas is an open matter.

The systematic position of the bleak from Italy is still not very clear. The data of MANFREDI (1916) on the bleak of the Ticino River, Como Lake and Maggiore Lake show that the bleak has a smaller number of vertebrae (36–40), whereas the typical form has 41–46. MANFREDI (1916) identified this bleak as *Alburnus alborella* (FILIPPI), whereas TORTONESE (1970) claim it is the subspecific form — *Alburnus alburnus alborella* (FILIPPI). However, Tortonese says that as long as the taxonomic character of the species *Alburnus albidus*, described for the first time by COSTA (1939) for Southern Italy, will not be revised and determined it will be impossible to classify the bleak from various localities in Italy and western part of the Balkan Peninsula.

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STRESZCZENIE

[Tytuł: Biometryczne i ekologiczne badania nad uklejąa *Alburnus alburnus* (Linnaeus) (*Pisces*, *Cyprinidae*) z różnych zbiorników wodnych w Polsce z uwzględnieniem zmienności geograficznej gatunku]

Biometryczne badania uklei, *Alburnus alburnus* (Linnaeus) z terenu Polski, odnoszące się do 17 stanowisk (rzeki, jeziora i zalewy), wskazują na różnicowanie się tego gatunku w zależności od typu zbiornika wodnego i od termiki środowiska. Różnice dotyczą zarówno cech merystycznych, jak i plastycznych.

Ukleje z rzek charakteryzują się mniejszą liczbą łusek na linii bocznej i pewną skłonnością do zmniejszania się także liczby kręgów, natomiast wykazują nieco większą liczbę miękkich promieni w płetwie odbytowej w porównaniu z uklejąa jezior. Reakcja uklei na wyższą temperaturę środowiska znalazła swój wyraz w zmniejszeniu liczby łusek na linii bocznej i liczby kręgów. Zmiany te zaszły w jeziorze Licheń, którego temperatura roczna znacznie wzrosła w wyniku dopływu gorących wód z elektrowni; w zimie nie spada poniżej +6°C.

W zakresie cech plastycznych ukleje rzek wyróżniają się większą maksymalną wysokością ciała od uklei z jezior i jednocześnie krótszym trzonem ogonowym. W przypadku uklei jeziorowej maksymalna wysokość ciała jest przeważnie niska a trzon ogonowy długi. Jednakże istnieje odchylenie od wymienionych stosunków. U uklei z jezior w przypadku dużej maksymalnej wysokości ciała (jezioro Bimbinek w Polsce, j. Pskowskie w ZSSR) wykształca się krótki trzon ogonowy, co wskazuje na dużą współzależność tych dwóch cech (tab. 3).

Długość głowy u uklei z rzek jest na ogół większa niż u uklei z jezior, co wiąże się prawdopodobnie z tokiem wody. Wydłużony kształt głowy ułatwia rybie pokonywanie oporu wody przy ustawianiu się pod prąd. Na długość głowy ma także pewien wpływ temperatura środowiska. Ukleja z rzeki Muszynki i jeziora Hańcza wyróżnia się krótką głową, jest to związane ze specyficznymi warunkami klimatycznymi tych stanowisk. Wymieniona rzeka i jezioro leżą w strefie niższych temperatur rocznych naszego terenu. Podobne stosunki obserwuje się przy zestawieniu danych tyczących się uklei z Zalewu Wiślanego, leżącego w klimacie ostrzejszym w porównaniu z cieplejszą strefą Zalewu Szczecińskiego.

Co się tyczy płetw nieparzystych i parzystych to istnieją wyraźne różnice w wysokości pierwszych i długości drugich między ukleją z rzek i jezior, co widać z zestawienia na tab. 3. Wiąże się to z tokiem wody i funkcją płetw jako narządów ruchu postępowego, balansowania i sterowania. Ukleje zalewów zajmują pod tym względem stanowisko całkowicie pośrednie.

Geograficzna zmienność uklei zarysowuje się w kierunku z północy ku południowi, co wiąże się z ociepleniem klimatu. W tym kierunku zaznacza się ubywanie liczby łusek na linii bocznej, liczby kręgów i miękkich promieni w płetwie odbytowej. W wyniku tych zmian wyodrębniono następujące podgatunki: *Alburnus alburnus charusini* Herzenstein 1889 w południowo-wschodniej Europie, *A. a. macedonicus* Karaman, 1929 na półwyspie Bałkańskim i *A. a. thessalicus* Stephanidis, 1950 w Grecji. Jednakże na półwyspie Bałkańskim wyraźnie wyodrębnia się ukleja z jeziora Prespa zarówno wysoką liczbą łusek na linii bocznej a zwłaszcza wysoką liczbą wyrostków filtracyjnych na pierwszym łuku skrzelowym, tab. 2. W wodach północnej Italii, gdzie według Tortonese, 1970 występuje *A.a. alborella* (Filippi) zarysowuje się wyraźna zniżka łusek na linii bocznej i liczby miękkich promieni w płetwie odbytowej w porównaniu z formą nominatywną rejonów północnych.

Inny kierunek zmienności geograficznej uklei zarysowuje się z zachodu ku wschodowi, co widać na przykładzie uklei z rzeki Kamy (dopływ Wołgi). W tym przypadku notuje się wyraźny wzrost liczby kręgów i pewien wzrost liczby miękkich promieni w płetwie odbytowej. Zmiany te stoją najprawdopodobniej w związku z oziębieniem się klimatu w miarę posuwania się ku wschodowi.

РЕЗЮМЕ

[Заглавие: Биометрическое и экологическое изучение уклейки, *Alburnus alburnus* (LINNAEUS) [*Pisces*, *Cyprinidae*] из различных водоемов Польши в связи с географической изменчивостью этого вида]

Биометрические исследования уклейки, *Alburnus alburnus* (LINNAEUS) с территории Польши, произведенные на материале из 17 станций (реки, озера и заливы — рис. 1), указывают на дифференциацию этого вида в зависимости от характера и температурного режима водоема. Различия наблюдаются как в меристических, так и в пластических признаках.

Речная уклейка характеризуется меньшим числом чешуй в боковой линии и некоторой тенденцией к уменьшению также числа позвонков, в то время, как численность мягких лучей анального плавника несколько увеличивается по сравнению с уклейкой из озер. Снижение числа чешуй в боковой линии и числа позвонков четко выразилось у уклейки из озера Лихень (Познанское воев.). в котором средняя годичная температура значительно возрасла в связи со сбросом теплых вод электростанции. В настоящее время температура воды в этом озере не снижается зимой ниже +6°C.

В пластических признаках наблюдаются следующие различия: у речной уклейки в большинстве случаев высота тела относительно больше, а хвостовой стебель короче, чем у озерных популяций, у которых тело обычно низкое, а хвостовой стебель длинный. Но наряду с этим встречаются также озерные популяции (оз. Бимбинек в Польше и оз. Псковское в СССР), у которых наблюдаются большие величины максимальной высоты тела и формируется при этом также короткий хвостовой стебель, что указывает на зависимость этих двух признаков (табл. 3).

Длина головы у речных популяций обычно больше, чем у озерных, что связано, по всей вероятности, с течением воды. Удлиненная форма головы облегчает рыбе преодолеть сопротивление воды при движении против течения. На длину головы оказывает также некоторое влияние температура окружающей среды. Уклейки из реки Мушинки и из озера Ганьча отличаются короткой головой, что связано со специфическими климатическими условиями этих водоемов. Находятся они в полосе наиболее низких годичных температур в Польше. Такое же соотношение наблюдается при сопоставлении данных касающихся Вислинского залива, находящегося в полосе более сурового климата и более теплого Щецинского залива.

Что касается непарных и парных плавников, то существуют четкие различия в высоте первых и длине вторых между популяциями из рек и озер (табл. 3). Это связано с движением воды и функцией плавников как органов движения. Популяции из заливов занимают в этом случае промежуточное положение.

Географическая изменчивость проявляется в клинальной изменчивости числа чешуй в боковой линии, позвонков и мягких лучей в анальном плавнике, количество которых уменьшается с севера на юг. На основании этих изменений выделены следующие подвиды: *Alburnus alburnus charusini* Herzenstein 1889 в юго-восточной Европе *A. a. macedonicus* Karaman 1929 на Балканском полуострове и *A. a. thessalicus* Stephanidis 1950 в Греции. Однако, на Балканском полуострове, в озере Преспа имеется уклейка, которая отличается высокой численностью чешуй в боковой линии и особенно высокой численностью жаберных тычинок на первой жаберной дуге (табл. 2). В водах северной Италии, где согласно данным Тортонезе (Tortonese 1970) встречается *A. a. alborella* (Filippi), наблюдается четкое снижение числа чешуй в боковой линии и мягких лучей в анальном плавнике по сравнению с номинативной формой северных районов Европы.

Иное направление географической изменчивости уклейки зарисовывается по направлению с запада на восток, что видно на примере уклейки из реки Камы (бассейн Волги). У этой популяции наблюдается четкое увеличение числа позвонков некоторый рост числа мягких лучей в анальном плавнике. Эти изменения связаны, по всей вероятности, с охлаждением климата по мере продвижения на восток.

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