ACTA HYDROBIOL.	14	2	173—204	KRAKÓW 1972

STANISŁAW SKÓRA

Piekielnica (*Alburnus bipunctatus* Bloch) z dorzeczy górnego Sanu i Dunajca

The cyprinid *Alburnus bipunctatus* Bloch from the basins of the rivers Upper San and Dunajec

Mémoire présenté le 10 mai 1971 dans la séance de la Commission Biologique de l'Académie Polonaise des Sciences, Cracovie

Abstract — The following data were studied: length of body, weight of body, growth, age, shape of body, colouring of body, variability of 25 morphological features of the trunk, 5 features of the head, and variability of meristic features of 424 specimens of the cyprinid *Alburnus bipunctatus* Bloch caught in the upper part of the River San and in the River Dunajec and their confluents. Analysis of the contents of the alimentary canal of this fish was also made. The linear growth of cyprinid was similar in the two investigated basins. As was the case with other fish, decrease and equalization of the relative variability of morphological features was observed. In comparison with the results of works of other authors, no great differences were found. This holds true for the means, the variability of the investigated morphological features, and the meristic features of the species discussed, which would show that this is the nominal form *Alburnus bipunctatus* Bloch.

The cyprinid *Alburnus bipunctatus* Bloch, occurs in fairly large numbers in our rivers, but in spite of this fact it is a little known fish. The Polish literature on the morphology and biology of this cyprinid is very scarce or incidental, based on material which is not clearly defined geographically, or it even is based on the works of authors from neighbouring countries, especially on those of Berg (1949). A few sentences on the structure of the pharyngeal teeth arches and the shape and the system of teeth were found in the paper of Horoszewicz (1960). They were written on the basis of a special examination of 6 specimens of this fish (length 3.3—7.2 cm) caught in the Vistula.

The following foreign authors whose papers discuss the morphology or biology of *Alburnus bipunctatus* Bloch on the basis of the geographically

clearly defined material should be mentioned: Balon (1952, 1962), Banarescu (1957), Berg (1949), Kossatkin (1958), Maksunov (1966), Spillmann (1961), Tusnádi (1963), and Żukov (1960, 1965).

Materials and method

The material collected for the purposes of the present paper comes from the rivers whose sources are in the Carpathian Mountains (the San and Dunajec) and their confluents. For the study of *Alburnus bipunctatus* from those two large geographical regions 504 specimens of this fish were caught of which 424 specimens were preserved in alcohol or formalin and used for detailed examination (Table I).

The *Alburnus bipunctatus* caught had the body a little less extended and more spiny than the bleak, and their sides were compressed. The body height of the investigated species was 3.3 to 4.3 times less than the body length (without the tail-fin), this being 3.8 on the average, which is to some extent in agreement with the data given by Gąsowska (1962), who states that the maximum height of the body of this cyprinid is 3 to 4 times less than the body length. Żukow (1965) states that the maximum height of the body of *Alburnus bipunctatus* occurring in White Russia is 3.7 to 4.9 times less than the body length, this being 4.2 times on the average.

The mouth was obtuse and truncate and the mouth aperture was final. The mouth intersection was slightly shifted. The jaws were equal, which is a distinct feature differentiating it from the bleak.

The dorsal fin was shifted more to the front than in the bleak, and the anal fin begins at the end of it, being much higher in front.

The colour of the body of the *Alburnus bipunctatus* described in the present paper was not always identical. The back of most of the specimens was blue-green or olive-green or even grey. In the basin of the River Dunajec some specimens with a brown colour of the back were encountered, but this was not observed in the San basin. The sides of the body were shining and silvery. Two rows of dark pigment spots run over and under the lateral line and frame it along its whole length with a double line. Over the lateral line and along the body runs a distinct violet strip with a golden lustre. The lateral line and the two rows of pigmented spots which encircle it was curved in most of the investigated specimens and in many cases even disconected. Over the lateral line of some specimens a few rows of dark spots were found, which were a little bigger than those running along the lateral line. The dorsal and caudal fins were grey and the pectoral, ventral, and anal fins were bright, and at the base yellow or orange. During the spawning period the colour of the body of *Alburnus bipunctatus* (males) is especially intensive and the pectoral, ventral and anal fins become orange of even bright red at the base.

Tabela I. Miejsca połowu piekielnicy (stanowiska) na rzekach dwóch dorzeczy Sanu i Dunajca
Table I. Cyprinid fishing points on the rivers of the San and Dunajec Basins

Dorzecze Basin	Rzeka River	Miejscowość Locality	Liczba złowionych piekielnic Number of cyprinids caught	Liczba złowionych ryb Number of fish caught	% piekielnicy do ryb z danego stanowiska Percentage of cyprinids among fish from the given points	Liczba ryb wykorzystanych w badaniach Number of examined fish
San	Wołosaty	Stuposiany	16	191	8,4	16
	San I	Dwerniczek	16	97	16,5	14
	San I	Rajskie	24	196	12,2	24
	San I	Zabrodzie	28	87	32,2	28
	Solinka	Dołżyca	9	238	3,8	9
	Solinka	Wołkowyja	18	88	20,4	18
	Solinka	Solina	9	214	4,2	9
	Wetlina	Kalinica	5	72	6,9	5
	San II	Łączki	14	69	20,3	14
	San II	Wola Postołowa	8	80	10,0	8
	San II	Załuż	36	96	37,5	35
	San II	Dolina	11	63	17,5	11
	Osława	Tarnawa Dolna	31	131	22,0	31
	San III	Międzybrodzie	14	138	10,1	14
	San III	Dobra Szlachecka	14	167	8,4	14
	San III	Niewiastka	7	87	8,1	7
	San III	Dynów	7	46	15,2	7
	Hoczewka	Hoczew	49	235	20,9	40
	Razem - Total		316	2305	13,7	304
Dunajec	Czarny Dunajec	Nowy Targ	1	98	1,0	
	Rogoźnik	Ludźmierz	1	138	0,7	
	Dunajec I	Łopuszna	1	107	0,9	1
	Dunajec I	Dębno	4	70	5,7	2
	Dunajec I	Nidzica	4	83	4,8	3
	Dunajec I	Szczawnica Dolna	2	75	2,7	2
	Dunajec I	Krościenko	2	97	2,1	2
	Dunajec I	Tylmanowa	8	124	6,5	5
	Dunajec I	Zabrzeż	7	99	7,1	2
	Dunajec I	Jazowsko Dolne	3	138	2,2	1
	Dunajec I	Kadcza	8	132	6,1	3
	Dunajec I	Podegrodzie	5	90	5,6	2
	Grajcarek	Szczawnica Niżna	2	441	0,5	-
	Poprad	Muszyna Folwark	3	99	3,0	3
	Poprad	Żegiestów	1	121	0,8	1
	Poprad	Piwniczna	3	113	2,7	3
	Poprad	Rytro	5	139	3,6	5
	Poprad	Stary Sącz	6	125	4,8	6
	Biała T.	Biała Niżna	2	115	1,7	2
	Biała T.	Ciężkowice	4	57	7,0	2
	Biała T.	Gromnik	74	261	28,4	47
	Biała T.	Tuchów	19	131	14,5	10
	Biała T.	Tarnów	11	196	5,6	6
	Dunajec II	Czchów	7	125	5,6	7
	Dunajec II	Zawada Lanckorońska	1	60	1,7	1
	Dunajec II	Zgłobice	4	233	1,7	4
	Razem - Total		188	3467	5,4	120

The fishing was carried out exclusively by means of an electric aggregate with a direct current of 4.5 A and 220 V. During the operation the current intensity as well as voltage were changed according to the conductivity of water (e.g. depth, pollution, etc.). At the points where the

water was shallow the aggregate stood on the bank and the fishing team moved on foot in the bed of river against the stream. At the points where the water was deep the fishing was carried out with the help of a boat, which held the aggregate and the fishing team.

The River San: fishing was carried out on the San and its basin from the locality of Bóbrki to Dynów from 24 August to 29 August 1959 and in the upper basin of the San from 22 August to 25 August 1960.

The River Dunajec: fishing was carried out on the upper Dunajec and its confluents up to Nowy Sącz from 3 September to 13 September 1963. The middle and lower Dunajec from Czchów to its mouth to the Vistula in the neighbourhood of the locality Ujście Jezuickie and its confluents flowing to the Dunajec below Czchów was fished from 20 May to 27 May 1964.

More accurate data concerning the materials found and preserved for further studies are given in Table I.

For the characteristics of plastic and meristic features only well-preserved specimens without any deformations were used.

The specimens were measured with accuracy to one milimetre by means of a slide caliber according to the scheme for the family *Cyprinidae* accepted in the author's previous work (Skóra 1969).

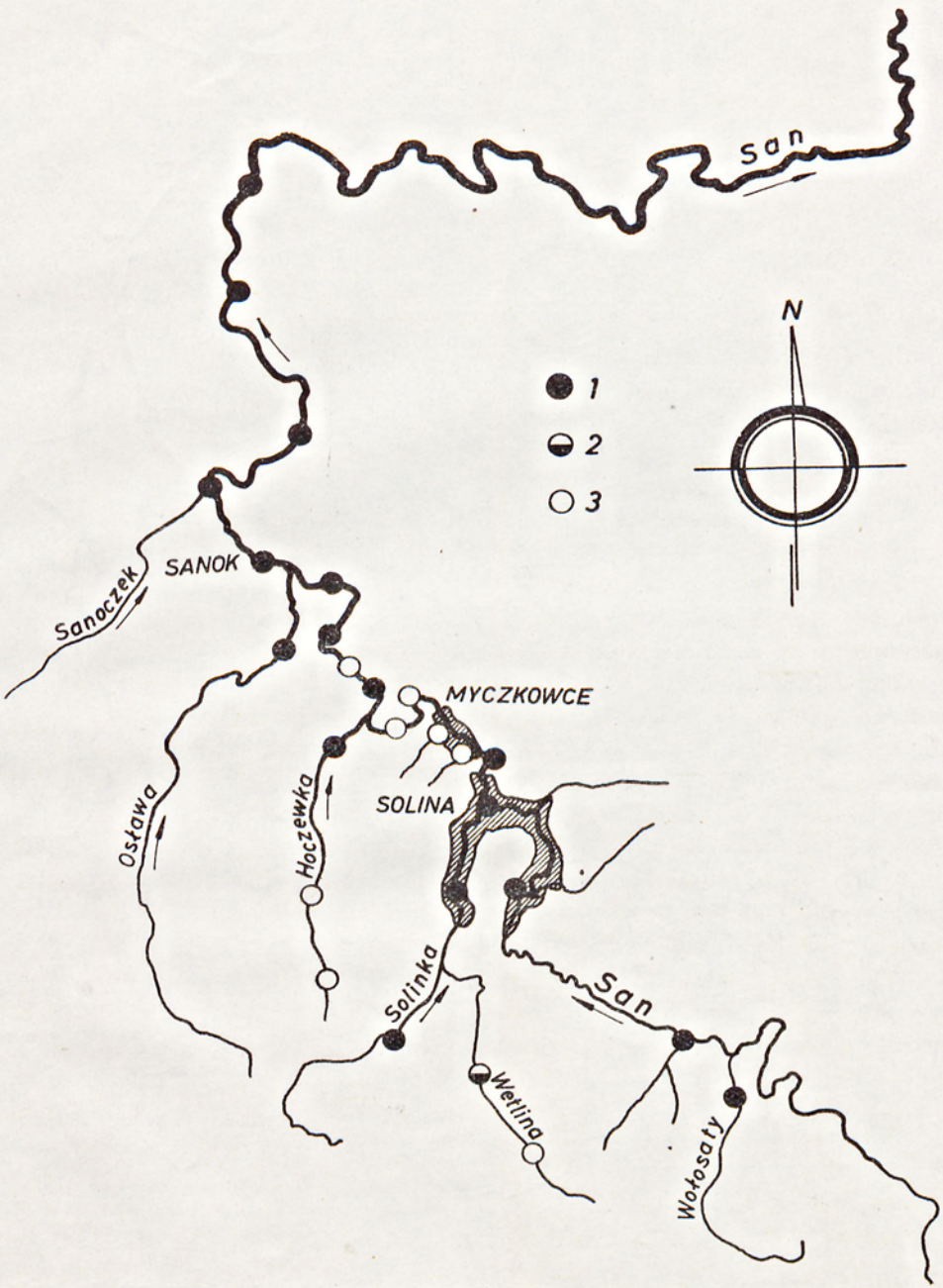
The gill rakers on the first branchial arches, the vertebrae in the spinal column, and the number of rays in the fins were counted with the aid of a magnifying glass. The pharyngeal teeth were macerated after skeletonizing with 4% sodium-lye, the remains of the tissues being removed with the aid of a needle and a magnifying glass in order not to miss the growing new teeth or the old ones, undergoing absorption.

In order to establish sex affiliation, each time the abdominal cavity was opened and this being followed by microscopic and macroscopic observation.

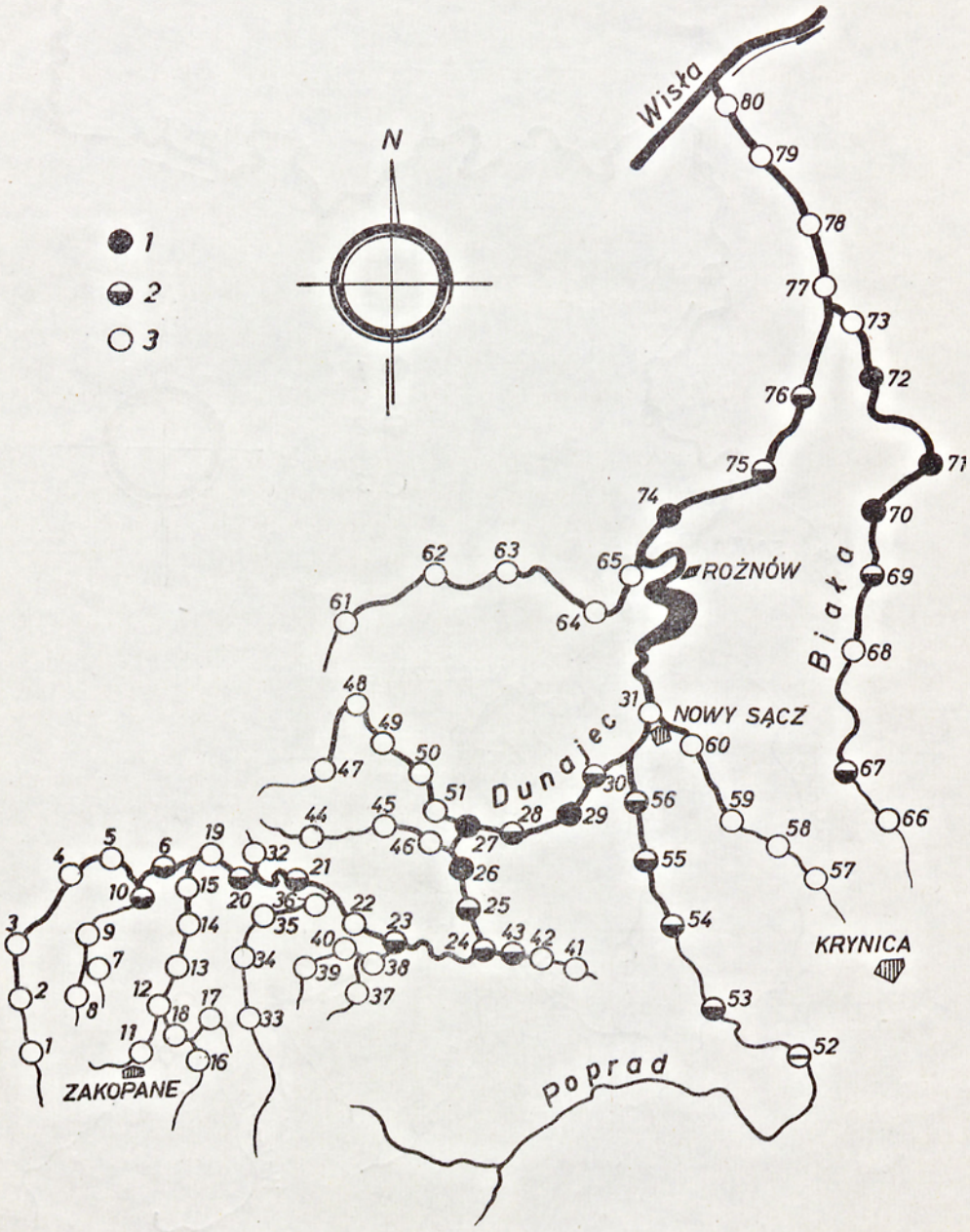
The age of fish was assumed on the basis of the annual increments on the scales and the growth and annual increase were measured on the basis of the direct measurements of the investigated fish (Table II).

Habitat of *Alburnus bipunctatus Bloch*

The characterization of the biotope of this cyprynid given by various authors is not always identical. Gąsowska (1962) states that *Alburnus bipunctatus* inhabits all Polish rivers along their whole length. Strojnowski (1860) and Wałecki (1864), similarly to Schindler (1956), have the opinion that it inhabits swift running waters. Nowicki (1889) and Żukov (1960, 1965) are of similar opinion, but they state that this fish also inhabit quiet, deep parts of the rivers (e.g. under mill-dams). Nikolski (1950) asserts that this fish inhabits stagnant waters and slowly run-



Ryc. 1. Szkic dorzecza Sanu z naniesionymi stanowiskami połowu ryb, 1 — piekielnice wystąpiły licznie, 2 — piekielnice wystąpiły nielicznie, 3 — piekielnic nie stwierdzono
Fig. 1. Sketch of the basin of the River San with marked fishing points. 1 — *Alburnus bipunctatus* Bloch occurred in large numbers, 2 — *A. bipunctatus* occurred singly, 3 — no *A. bipunctatus* were found



Ryc. 2. Szkic dorzecza Dunajca z naniesionymi stanowiskami połowu ryb. 1 — piekielnice wystąpiły licznie, 2 — piekielnice wystąpiły nielicznie, 3 — piekielnic nie stwierdzono

Fig. 2. Sketch of the basin of the River Dunajec with marked fishing points. 1 — *Alburnus bipunctatus* Bloch occurred in large numbers, 2 — *A. bipunctatus* occurred singly, 3 — no *A. bipunctatus* were found

ning rivers. Staff (1950) states that it lives in clear running waters, but avoids rapid and cool streams and lives collectively. This last opinion is confirmed by the present investigations as regards the lack of *Alburnus bipunctatus* in cool mountain streams and its collective life.

The exact geological and pedological characterization and the chemical characterization of water of the catchment area of the Dunajec can be found in Pasternak's paper (1968). A list of the algae living at the bottom of the river (excepting its Tatra part) is given by Chudybowa (1965) and Dratnal and Szczęsny (1965) write about the invertebrates found in the Dunajec. According to Kołder (1965) 32 species of fish occurred in the basin of the Dunajec (including the reservoirs) besides *Alburnus bipunctatus*.

In the San, Dunajec, and the larger confluents of these rivers *Alburnus bipunctatus* occurred in its greatest numbers in the lower regions of the trout zone and upper regions of the barbel zone (figs. 1, 2).

In the San between the localities Dwerniczek and Zabrodzie (the trout zone) *Alburnus bipunctatus* occupies the 2nd position (with regard to quantity) after the minnow (*Phoxinus phoxinus* L.) in the stock of fish and down river from the locality Bóbrka to Sanok this species occupies at the particular fishing points positions from 1 to 4, being surpassed only by the barbel, the cyprinid *Chondrostoma nasus*, the bleak and the gudgeon. In the lower parts of the San from Sanok to Dynów at all the fishing points *Alburnus bipunctatus* occupied 3rd or 4th position, surpassed mainly by *Chondrostoma nasus*, bleak, chub, and gudgeon.

In the left confluent of the San, the River Wołosaty, at its mouth at Stuposiany (the trout zone) *Alburnus bipunctatus* occupied the 5th position

Tabela II. Długość, ciężar i współczynnik kondycji Fultona obliczony dla piekielnicy z dorzecza Sanu i Dunajca

Table II Length, weight and Fulton coefficient estimated for cyprinids of the San and Dunajec Basins

Rzeka River	Liczba badanych ryb Number of examined fish	Longitudo totalis in cm		Longitudo corporis in cm		Pondus in g		g.x 100 / L³
		Granice Range	x̄	Granice Range	x̄	Granice Range	x̄	
San I	56	8,0 - 13,7	10,2	6,6 - 11,0	8,4	4,9 - 21,0	9,1	0,85
San II	68	6,7 - 13,2	10,0	5,3 - 10,6	8,2	2,0 - 16,5	8,4	0,84
San III	42	7,0 - 13,5	9,7	5,7 - 11,1	8,0	2,5 - 19,6	7,9	0,87
Wołosaty	16	7,4 - 12,3	10,8	6,0 - 10,2	8,9	4,5 - 16,5	11,9	0,93
Solinka	36	8,0 - 12,9	10,3	6,6 - 10,5	8,4	3,5 - 16,0	9,0	0,83
Wetlina	5	9,0 - 11,5	10,3	7,6 - 9,4	8,5	7,0 - 12,0	9,8	0,90
Hoczewka	40	6,6 - 14,0	10,1	5,7 - 11,5	8,3	2,7 - 16,5	8,5	0,82
Osława	31	7,8 - 13,9	10,9	6,2 - 11,4	8,9	3,0 - 22,5	10,9	0,84
Ogółem dorzecze Sanu Total San Basin	304	6,6 - 14,0	10,2	5,3 - 11,5	8,4	2,0 - 22,5	9,0	0,85
Dunajec I	23	10,1 - 16,1	13,1	8,2 - 13,3	10,8	6,8 - 33,6	18,5	0,83
Dunajec II	12	5,2 - 13,4	10,3	4,3 - 11,1	8,5	0,9 - 17,7	9,6	0,87
Poprad	18	8,7 - 15,3	12,0	7,1 - 12,6	9,8	4,7 - 29,7	14,3	0,83
Biała Tarnowska	67	5,7 - 13,4	10,3	4,6 - 11,1	8,5	1,2 - 22,4	10,2	0,94
Ogółem dorzecze Dunajca Total Dunajec Basin	120	5,2 - 16,1	11,1	4,3 - 13,3	9,1	0,9 - 33,6	12,4	0,91

(quantitatively) after the barbel, minnow, stream trout, and miller's-thumb, in the stock of fish of this river.

Also in the left-bank confluent of the San, in the River Solinka, (the trout zone) fish were caught from 3 fishing points. At the upper fishing point *Alburnus bipunctatus* occupied 6th position (quantitatively), at the middle one 2nd, and at the lower one 5th, being surpassed by the stream-trout and accompanying species such as: minnow, barbel, loach, miller's-thumb, *Cottus poecilopus,* or gudgeon.

In the River Wetlina, the right confluent of the River Solinka (the left confluent of the San) fish were caught at two fishing points (the trout zone); at the upper one near the locality Wetlina where *Alburnus bipunctatus* was not found at all, and at the lower one near the locality Kalenica, where this fish occupied the 4th position.

At the two fishing points on the upper confluent of the San, the River Hoczewka (the trout zone), no *Alburnus bipunctatus* were found but at the lower fishing point near the village Hoczwa, 5 km above the mouth of the Hoczewka to the San, this fish occurred fairly numerously, occupying the 2nd position after the barbel.

In the next confluent of the upper San, the River Osławia, 9 km above its mouth to the San, near the village Tarnawa Dolna (the trout zone) *Alburnus bipunctatus* occupied the 2nd position after the barbel in the stock of this river.

In the Dunajec *Alburnus bipunctatus* occurred between the town of Nowy Targ and the locality Zgłobice, but did not appear either above Nowy Targ or below Zgłobice up to mouth of the river to the Vistula. In the section between Nowy Targ and Nowy Sącz (the lower trout zone and the upper barbel zone) *Alburnus bipunctatus* occupied the 8th position in the stock of the Dunajec. In the sector between the localities Czchów and Zgłobice (the barbel zone) the *Alburnus bipunctatus* occupied quantitatively the last position among the fish caught in this sector.

Alburnus bipunctatus were most numerous in the barbel zone of the River Biała Tarnowska (the right confluent of the Dunajec) between the Gromnik and Tarnów, and in smaller quantities in the lower regions of the trout zone; it was not found in the upper part of the River Biała. As far as the stock of the whole region of the river is concerned *Alburnus bipunctatus* occupied the 4th position after the barbel, chub, and *Chondrostoma nasus.*

In the River Poprad (the barbel zone) *Alburnus bipunctatus* occurred in the whole sector from the Czechoslovakian border to its confluence with the Dunajec. It occupies the 7th position in the stock of this river.

Single specimens of *Alburnus bipunctatus* were also found in the sectors near the mouth of the following rivers: Czarny Dunajec, Rogoźnik, and Grajcarek.

In many confluents of the Dunajec which are typical troutstreams such

as: Biały Dunajec, Cicha Woda, Poroniec, Łopuszanka, Biała Tatrzańska, Koćwinianka, Łapszanka, Ochotnica, Kamienica Łącka, Kamienica Nawojowska, and Łososina no *Alburnus bipunctatus* were found.

From the available literature and from the data quoted above it follows that *Alburnus bipunctatus* occurs most numerously in the upper regions of the barbel zone and in the lower regions of the trout zone. On the whole it is not found in small streams, brooks, or even in smaller rivers which are characterized by gradients greatly exceeding 8‰, by a rocky bottom, or even stony — gravel bottom, this being confirmed by the investigations of the upper Vistula (Żarnecki, Kołder 1956), where the presence of this fish was not noted. This species occurs most numerously in rivers of medium size, with gradients from 1, 1.5‰ to 4.0‰, with gravel or sandy bottom, from 10 to 30 m wide and from 0.3 to 2.0 m in depth, this being confirmed by a fairly abundant occurrence of this fish in the middle part of the River Biała.

Alburnus bipunctatus lives collectively in the river-bed, in the middle parts of rivers, in streams with gravel or sandy bottom with clear water, this being in agreement with the opinions of Strojnowski (1860) and Staff (1950). According to Jaśkowski (1962) and Żukov (1965), shoals of *Alburnus bipunctatus* are found below mill-dams and weirs.

In winter this species gathers in hollows and deep parts of rivers with gravel and sandy bottom, where it stays till the ice breaks up. According to Wałecki (1864), *Alburnus bipunctatus* is in constant motion during the melting of ice and spring rise of the water, and it is then easily caught. This cyprinid also avoids waters which are becoming overgrown as well as large deep rivers with muddy water (the bream zone).

Growth, age and condition coefficient

When assembling *Alburnus bipunctatus* for the purposes of the present paper, the author collected all the specimens of this species which had been caught but in the material from the basin of the River San, the first age group was not found; this was probably due to the fact that the meshes of the landing-net used were too big.

Comparing the data gathered by Żukov (1965) on the rate of growth of *Alburnus bipunctatus* in the River Dvina in White Russia for the first and the second age group, we note that this species grows there less well in youth than in Poland, this refering to body length as well as to body weight. The full body length (*longitudo totalis*) of *Alburnus bipunctatus* studied by Bauch (1966) was slightly smaller for the first three age groups than that of the specimens studied by the present author, but as far as the other age groups are concerned it was more or less on the same level.

The growth of males and females of *Alburnus bipunctatus* was fairly regular, reaching its maximum in the 6th year of life in the San basin (18.0 g) and in the 9th year of life in the Dunajec basin (30.4 g). In the

older age groups only a few specimens were found and these were all females. The majority of *Alburnus bipunctatus* died off after the 5th and the 6th year of life and only a few females from the Dunajec basin managed to live to the age of 8 and 9 years. No great differences in growth between the sexes are visible either in the San or Dunajec basins (Table III). Evident differences in body weight of males and females were observed only in the 5th and 6th age groups in the San basin, and this was probably caused by the greater weight of the female gonads. In the Dunajec basin *Alburnus bipunctatus* grew slightly better than in that of the San. According to Nowicki (1889), *Alburnus bipunctatus* sometimes grows up to 11 cm but, on the other hand, Gąsowska (1962) and Staff (1950) agree that it reaches up to 10 or 12 cm in length. According to Staff (1950), specimens of the species reaching 15 cm of length are sometimes found. A similar length for this fish is mentioned by authors from other countries, such as: Banarescu (1957), Bauch (1966), Berg (1949), Kossatkin (1958), Schindler (1953) and Żukov (1960, 1965). *Alburnus bipunctatus* caught by Spillmann (1961) in the rivers of France reached 9.06 cm (females) in length and 13.83 g in weight. The specimens caught by Balon (1952) in the River Olza were approx. 11.2 cm in body length and one caught by the same author in the Danube (Balon 1962) was only 6.05 cm in body length and 3.92 g in body weight.

The data concerning body length and body weight of *Alburnus bipunctatus* from the San and Dunajec basins are assembled in Table II, from which it follows that *Alburnus bipunctatus* caught in the basin of the upper San weighed on the average about 9.0 g, the mean body length being about 8.8 cm. *Alburnus bipunctatus* from the basin of the Dunajec River was distinctly larger, its mean body weight being about 12.4 g, and body length 9.1 cm. The average specimen among 424 which were studied from both basins weighed 10 g, its body length being 8.6 cm. The mean body weight of nine-years-old *Alburnus bipunctatus* from the basin of the River Dunajec (Table III) was 30.4 g, its mean body length being 12.9 cm. These values were similar to maximum body weight and length cited in the literature.

The condition coefficient of *Alburnus bipunctatus* from the San and Dunajec basins, estimated according to Fulton's formula, showed fairly low values and in no case did it exceed the value 1 (Table II). The specimens caught in the River Wołosaty (0.93), the San basin, and the River Biała (0.94), in the Dunajec basin had the highest condition coefficient, and those from the River Hoczewka (0.82) in the San basin had the lowest. As follows from Table II, the differences in the condition coefficients, in spite of the fact that they were measured for fish from various rivers of the two basins, were very small. Data on this subject were not found either in the Polish or foreign literature.

Tabela III. Tempo wzrostu piekielnicy z rzek i dorzeczy Sanu i Dunajca
Table III. The rate of growth of the cyprinids from the rivers of the San and Dunajec Basins

Wiek Age	Liczba badanych ryb Number of examined fish	Longitudo totalis in cm		Longitudo corporis in cm			Pondus in g		
		Granice Range	$\bar{x}$	Granice Range	$\bar{x}$	Roczne przyrosty Annual increase	Granice Range	$\bar{x}$	Roczne przyrosty Annual increase
Dorzecze Sanu - The San Basin									
2	42	6,6 - 9,0	8,0	5,3 - 7,9	6,6		2,0 - 6,5	4,1	
3	92	8,2 - 11,4	9,6	6,6 - 9,3	7,9	1,3	4,2 - 9,5	7,2	3,1
4	93	9,6 - 11,7	10,5	7,7 - 9,8	8,6	0,7	6,5 - 12,5	9,5	2,3
5	60	9,7 - 12,9	11,6	8,5 - 10,5	9,5	0,9	9,5 - 16,5	12,7	3,2
6	16	11,3 - 13,9	13,0	9,3 - 11,4	10,6	1,1	12,5 - 22,5	18,0	5,3
Dorzecze Dunajca - The Dunajec Basin									
1	5	5,2 - 6,0	5,8	4,3 - 5,4	4,8		0,9 - 2,7	1,5	
2	4	7,2 - 8,8	8,2	5,8 - 7,2	6,7	1,9	2,6 - 5,2	4,3	2,8
3	29	9,2 - 10,6	9,9	7,3 - 8,7	8,0	1,3	5,5 - 9,2	7,5	3,2
4	57	10,1 - 11,6	10,7	8,2 - 9,4	8,8	0,7	6,8 - 11,9	10,2	2,7
5	14	11,2 - 12,6	11,9	9,2 - 10,4	9,8	1,0	12,0 - 16,4	14,0	3,8
6	13	12,1 - 13,4	12,9	9,8 - 11,2	10,7	0,9	15,3 - 19,7	17,9	3,9
7	10	12,5 - 14,2	13,4	10,3 - 11,8	11,0	0,3	18,4 - 22,6	21,3	3,4
8	3	14,3 - 15,0	14,6	11,9 - 12,3	12,2	1,2	22,4 - 26,2	24,4	3,1
9	5	15,3 - 16,1	15,7	12,4 - 13,3	12,9	0,7	28,2 - 33,6	30,4	6,0
Średnie dla całego materiału - Arithmetical means of the whole material									
1	5	5,2 - 6,0	5,8	4,3 - 5,4	4,8		0,9 - 2,7	1,5	
2	46	6,6 - 9,0	8,1	5,3 - 7,9	6,4	1,6	2,0 - 6,5	4,1	2,6
3	121	8,2 - 11,4	9,6	6,6 - 9,3	7,9	1,5	4,2 - 9,5	7,2	3,1
4	130	9,6 - 11,7	10,5	7,7 - 9,8	8,7	0,8	6,5 - 12,5	9,6	2,4
5	74	9,7 - 12,9	11,7	8,5 - 10,5	9,6	0,9	9,5 - 16,5	12,9	3,3
6	29	11,3 - 13,9	12,7	9,3 - 11,4	10,4	0,8	12,5 - 22,5	17,1	4,2
7	10	12,5 - 14,2	13,4	10,3 - 11,8	11,0	0,6	18,4 - 22,6	21,3	4,2
8	3	14,3 - 15,0	14,6	11,9 - 12,3	12,2	1,2	22,4 - 26,2	24,4	3,1
9	5	15,3 - 16,1	15,7	12,4 - 13,3	12,9	0,7	28,2 - 33,6	30,4	6,0

Tabela IV. Współczynniki zmienności (v) wymiarów liniowych i ciężarów

Table IV. The coefficients of variability (v) of linear measurements

Dorzecze - Basin	Wiek - Age	Liczba badanych ryb Number of examined fish	Płeć - Sex	Longitudo totalis	Longitudo corporis	Longitudo praeanalis	Longitudo praeventralis	Longitudo pedunculi caudae	Longitudo trunci	Longitudo capitis lateralis	Longitudo spatii postorbitalis	Diameter oculi	Longitudo spatii praeorbitalis	Longitudo P	Longitudo V	Summa altitudo A	Longitudo pinnae C superior
San	II	32	♂	7,26	6,85	7,58	8,72	10,71	7,81	8,85	11,92	10,30	18,57	11,45	16,05	12,19	8,74
		10	♀	8,57	10,33	11,53	12,07	11,30	9,39	9,94	12,93	13,40	11,78	11,18	12,82	8,54	10,32
		42	♂♀	7,48	7,66	8,59	9,46	10,71	8,18	8,97	12,19	11,20	16,87	11,29	15,75	11,30	8,75
	III	45	♂	5,44	5,39	6,13	8,31	10,79	6,83	5,74	9,66	10,88	11,27	8,04	10,76	9,01	7,93
		47	♀	6,34	5,94	7,96	7,39	9,33	7,06	6,68	12,61	9,49	11,27	7,78	9,45	9,02	7,38
		92	♂♀	5,93	5,76	7,53	8,07	10,12	7,06	6,53	11,33	10,34	11,27	7,91	10,23	9,08	8,82
	IV	51	♂	4,69	4,95	6,36	5,64	9,39	5,09	6,18	10,32	10,68	8,81	7,31	8,10	7,87	7,42
		42	♀	4,20	5,52	7,07	6,33	10,97	7,09	7,36	9,30	12,52	12,07	9,94	8,35	9,49	6,03
		93	♂♀	5,00	5,26	6,88	6,14	10,22	6,09	6,80	9,90	11,80	10,52	8,72	9,57	8,91	6,97
	V	16	♂	5,04	3,49	5,09	5,96	7,98	4,79	8,44	6,51	11,27	13,28	7,75	10,00	15,16	8,16
		44	♀	5,27	5,24	6,68	6,29	8,83	5,68	6,91	7,39	11,47	12,27	9,27	8,19	10,23	8,06
		60	♂♀	5,75	5,59	7,37	7,62	9,45	6,56	7,77	8,61	11,79	12,77	9,47	8,58	12,24	8,57
	VI	7	♂	4,48	4,97	3,77	6,73	10,86	5,70	5,84	7,36	11,97	11,90	7,31	7,32	4,04	8,29
		9	♀	5,19	5,00	5,80	7,57	9,82	5,50	6,83	7,03	6,39	6,76	7,06	7,95	9,35	8,61
		16	♂♀	6,42	8,07	6,80	8,48	10,23	6,31	7,61	7,81	9,86	9,55	8,73	8,61	10,96	11,18
	Razem Total	151	♂	12,37	12,27	12,36	12,83	14,52	12,54	13,96	14,78	13,16	14,46	13,54	14,44	15,45	13,64
		152	♀	12,85	12,69	12,94	13,17	13,26	13,67	12,26	14,75	13,97	15,42	14,20	13,93	15,51	13,80
		303	♂♀	13,25	14,32	13,66	13,93	15,54	13,81	12,81	15,74	14,67	15,26	14,55	14,28	14,77	14,49
Dunajec	I	5	♂♀	8,75	8,74	11,32	15,41	13,57	8,33	9,82	14,20	11,84	14,06	10,46	13,64	5,77	10,00
	II	4	♂	8,88	9,56	13,33	13,43	17,38	10,84	10,56	13,24	16,40	11,76	18,04	11,50	8,97	11,44
	III	21	♂	3,74	3,82	6,27	8,03	11,88	7,91	4,81	5,95	6,90	10,00	5,60	7,59	7,09	7,35
		8	♀	4,17	4,71	4,26	10,47	13,50	4,68	3,63	6,62	9,82	11,30	8,39	7,10	5,18	5,18
		29	♂♀	3,95	4,22	5,80	8,66	12,26	7,30	5,11	6,41	8,08	10,69	6,91	8,84	6,64	5,76
	IV	24	♂	3,70	3,81	5,79	6,26	8,39	3,96	3,68	8,47	5,97	8,80	6,39	7,73	7,39	6,64
		13	♀	2,82	2,78	3,79	4,05	7,37	3,26	4,97	8,54	4,75	5,49	5,37	6,79	7,74	5,41
		37	♂♀	3,46	3,48	5,06	5,58	8,18	3,96	4,37	8,46	5,50	8,06	6,19	6,19	7,42	6,17
	V	3	♂	4,86	5,41	4,68	6,84	2,60	5,73	5,07	5,63	7,94	10,94	5,26	6,66	5,26	6,74
		11	♀	3,95	4,18	7,11	8,84	6,60	3,84	5,83	8,00	8,46	7,47	4,28	4,87	6,51	5,92
		14	♂♀	3,92	4,24	6,74	8,78	8,55	3,60	5,43	7,24	9,94	12,11	4,89	5,09	5,86	5,83
	VI	3	♂	3,75	3,44	3,19	7,85	12,96	5,03	2,29	4,96	7,53	0,00	2,99	10,81	5,56	2,35
		10	♀	3,06	3,81	5,16	6,60	3,50	4,75	6,36	10,84	10,42	12,92	9,50	7,87	5,91	6,21
		13	♂♀	3,27	3,69	5,15	7,10	6,19	5,08	6,11	10,27	10,09	12,06	8,24	7,68	5,67	5,53
	VII	3	♂	2,75	1,35	2,14	7,96	5,82	5,18	4,00	4,96	7,95	9,21	5,50	5,88	2,86	13,13
		7	♀	4,60	3,53	5,66	3,70	7,57	4,88	7,29	9,82	6,49	8,28	5,38	4,82	6,53	2,77
		10	♂♀	4,41	4,76	5,19	4,92	10,21	5,90	6,25	8,51	6,84	8,13	5,03	5,06	5,97	7,01
	VIII	3	♀	2,41	1,93	2,99	3,92	11,86	1,80	2,12	4,57	7,53	8,66	4,76	3,27	7,18	7,14
	IX	5	♀	2,50	3,02	4,47	7,03	4,53	2,99	5,84	9,15	8,87	8,51	8,97	4,37	5,30	4,03
	Razem Total	58	♂	14,51	15,02	16,32	15,32	21,93	15,93	11,49	13,85	12,46	12,12	11,99	11,62	14,54	11,08
		57	♀	14,88	15,31	16,61	15,14	21,17	15,31	9,78	18,85	13,88	17,46	15,60	15,00	16,08	14,00
		120	♂♀	19,34	18,56	19,52	18,28	23,94	19,73	17,93	24,79	16,35	19,07	18,30	18,58	20,37	17,34

ciała piekielnicy z dorzecza Sanu i Dunajca (wg wieku)

and of body weight of cyprinids from the San and Dunajec Basins (according to age)

Longitudo pinnae C inferior	Longitudo pinnae C media	Summa altitudo D	Longitudo basis D	Distantia praedorsalis	Distantia postdorsalis	Spatium inter P et V	Spatium inter V et A	Longitudo basis A	Summa altitudo capitis	Summa altitudo corporis	Altitudo analis	Minima altitudo corporis	Distantia inter oculos	Summa latitudo corporis	Summa longitudo in circuitu	Pondus
8,03	16,67	9,80	13,37	7,24	11,20	11,15	11,46	11,38	12,37	9,76	10,00	13,49	10,98	11,45	11,09	20,65
8,65	7,16	9,73	16,82	8,62	10,00	16,23	16,14	13,42	9,47	9,82	9,06	11,56	4,08	12,78	9,75	27,95
8,17	16,71	9,66	14,05	7,54	10,83	12,48	12,58	11,79	12,05	9,70	9,71	12,86	12,00	11,67	10,75	22,15
9,14	10,43	9,72	12,31	6,67	8,74	10,35	8,67	11,07	7,79	9,32	9,30	9,87	8,17	10,46	9,52	17,61
9,20	12,47	8,96	12,42	7,02	6,56	8,93	11,99	11,37	9,58	8,26	8,21	10,71	9,69	9,00	8,39	12,59
8,56	11,63	8,96	12,52	6,96	7,71	9,88	10,72	11,28	8,75	8,95	8,78	10,26	9,18	9,78	9,03	15,25
8,20	13,54	8,66	10,43	6,00	6,39	8,13	8,33	8,00	8,43	6,04	7,75	8,43	11,54	9,49	8,17	12,19
6,03	11,90	8,00	11,81	6,49	6,75	9,90	10,29	11,08	7,63	8,82	6,53	8,21	10,00	6,80	6,25	12,21
7,38	12,93	8,40	11,12	6,33	6,58	9,16	9,64	9,69	8,18	7,84	7,24	8,33	10,76	8,37	7,42	13,90
7,36	13,17	12,34	10,57	4,72	5,89	7,19	11,92	10,70	7,96	5,92	6,75	8,59	11,16	6,47	5,84	10,95
8,25	12,29	7,53	9,77	6,19	5,04	7,41	8,70	8,29	7,87	7,26	8,76	7,08	7,63	7,03	6,80	14,68
8,40	12,31	9,10	9,77	6,88	6,60	8,69	10,15	9,51	8,48	5,62	8,51	8,30	9,32	7,80	7,43	15,62
6,19	9,09	6,36	8,85	5,01	6,69	4,89	6,83	10,40	4,08	5,67	4,89	5,64	5,35	6,33	5,54	7,18
9,25	9,57	9,80	9,65	5,68	6,91	6,44	8,90	7,29	8,21	4,16	5,69	8,48	8,55	7,10	6,61	16,73
9,75	9,56	11,25	10,00	6,29	7,91	6,88	10,61	8,49	8,09	5,11	5,81	9,00	10,64	9,66	6,52	17,92
16,44	17,31	14,32	15,87	12,63	13,56	15,52	14,21	17,50	13,61	15,28	16,38	15,13	14,75	15,56	15,22	35,70
13,93	15,00	13,91	15,98	13,27	13,31	14,98	15,79	16,54	13,89	14,43	15,13	14,94	15,37	14,74	13,41	36,71
15,79	16,08	14,58	16,28	13,72	14,02	16,22	16,32	17,32	14,40	15,67	16,32	15,61	15,78	15,68	15,04	38,58
7,50	16,07	10,78	14,48	9,06	10,55	8,14	15,25	13,57	8,87	10,00		10,71	10,71	16,67	17,04	46,87
12,61	6,90	13,07	17,38	10,20	12,81	27,82	12,30	25,24	10,00	8,57		8,70	9,62	10,25	6,24	26,93
7,50	8,00	6,63	11,39	5,37	5,95	9,33	10,20	9,74	8,76	7,09		6,89	8,71	7,81	9,41	14,21
4,00	6,24	6,09	8,16	5,29	7,43	8,65	11,27	11,69	7,91	7,43		7,78	8,93	11,19	6,02	16,87
5,77	7,40	7,15	12,41	5,34	6,51	9,67	10,61	10,87	8,37	7,01		6,64	8,75	9,05	8,72	14,84
6,49	10,00	4,62	7,82	4,61	6,73	7,43	8,02	10,60	5,66	7,23		7,36	7,75	8,50	5,18	7,54
8,37	6,96	3,98	7,01	2,55	5,74	7,23	4,80	10,50	5,35	4,92		8,10	6,71	9,91	3,04	9,28
7,19	9,50	4,90	7,61	3,96	5,15	6,87	7,91	8,95	5,46	6,49		7,53	7,59	8,74	4,43	8,17
6,74	11,85	2,60	8,39	3,85	7,96	16,48	6,89	7,93	6,25	6,92		6,24	6,99	9,06	4,14	12,49
5,97	14,38	5,63	7,48	5,70	4,74	5,38	8,01	8,19	4,75	6,83		7,47	9,82	7,98	6,03	8,88
5,91	13,94	5,31	7,74	5,22	5,25	8,02	10,11	8,14	4,77	7,06		6,90	10,03	9,20	5,54	9,32
4,73	14,10	5,07	16,30	3,57	3,85	8,70	13,25	12,62	0,00	5,54		6,24	7,53	7,69	3,90	10,77
6,36	14,15	8,97	12,26	4,60	5,04	6,96	11,69	9,02	7,87	4,82		9,39	7,22	9,40	3,68	5,50
5,57	14,38	7,84	10,22	4,32	4,67	8,36	11,89	9,84	6,69	4,82		8,77	7,01	8,88	3,91	6,86
6,19	5,63	2,39	6,67	2,56	2,27	11,11	7,21	7,52	3,00	1,83		5,42	6,67	3,93	3,29	6,68
3,98	6,33	4,08	8,19	5,45	7,14	7,08	5,23	5,79	3,65	7,00		7,84	6,67	5,17	3,97	6,86
4,39	6,36	4,11	7,38	4,40	7,57	8,16	6,99	7,67	3,53	4,68		8,20	6,24	4,63	3,90	6,54
7,14	13,07	2,25	9,75	3,66	2,22	13,39	2,45	2,60	5,71	4,68		5,42	6,66	10,69	5,66	7,81
2,88	11,75	1,99	4,88	3,66	2,78	4,38	5,98	6,23	2,55	10,92		3,81	5,85	0,00	7,99	7,45
10,92	12,13	12,21	17,43	12,92	12,67	15,49	16,98	18,48	14,03	16,85		14,30	13,94	15,90	14,38	40,28
14,04	14,90	14,72	20,95	16,03	13,71	16,00	19,10	18,42	16,29	15,69		15,87	15,20	16,80	14,34	43,20
17,23	17,45	17,82	23,22	19,35	18,16	21,33	22,78	21,94	19,47	20,95		24,58	17,97	21,77	19,92	53,22

Tabela V. Zestawienie cech morfologicznych
Table V. Morphological features of cyprin

Dorzecze - Basin	Wiek - Age	Liczba badanych ryb Number of examined fish	Płeć - Sex	Longitudo totalis	Longitudo praeanalis	Longitudo praeventralis	Longitudo pedunculi caudae	Longitudo trunci	Longitudo capitis lateralis	Longitudo P	Longitudo V	Summa altitudo A	Longitudo pinnae C superior	Longitudo pinnae C inferior	Longitudo pinnae C media
				in % longitudo corporis											
San	II	32	♂	120,9	62,7	44,9	21,2	79,0	24,8	19,8	17,1	17,2	22,7	23,0	11,7
		10	♀	122,2	64,6	45,6	21,0	77,5	25,2	20,7	16,7	17,6	23,7	23,7	12,3
		42	♂♀	121,2	63,1	45,0	21,2	78,7	24,9	20,0	17,0	17,3	22,9	23,1	11,9
	III	45	♂	122,9	62,5	45,0	21,2	77,9	24,4	20,3	17,0	18,2	24,1	24,0	11,8
		47	♀	120,9	64,2	45,9	20,6	78,2	24,7	20,0	16,2	18,1	23,6	23,7	11,7
		92	♂♀	121,9	63,3	45,5	20,9	78,0	24,5	20,1	16,6	18,1	23,8	23,8	11,7
	IV	51	♂	121,1	61,9	44,9	21,0	78,4	23,8	20,0	16,5	18,1	23,2	23,3	11,5
		42	♀	121,8	63,1	45,5	21,4	77,6	24,0	20,0	16,0	18,2	23,5	23,5	11,5
		93	♂♀	121,4	62,4	45,2	21,2	78,1	23,9	20,0	16,3	18,2	23,3	23,4	11,5
	V	16	♂	122,5	61,6	43,6	20,8	77,8	24,1	19,6	16,9	17,3	23,3	23,7	11,5
		44	♀	121,9	63,1	45,4	21,3	79,5	24,1	19,8	16,1	18,0	23,4	23,6	11,3
		60	♂♀	122,0	62,7	44,9	21,2	79,1	24,1	19,8	16,3	17,8	23,4	23,7	11,3
	VI	7	♂	121,5	62,7	45,0	21,3	79,6	23,6	19,7	16,0	17,5	22,1	23,0	11,2
		9	♀	122,3	63,4	46,1	20,6	78,5	23,8	20,2	16,1	18,8	23,8	23,8	11,0
		16	♂♀	122,0	63,1	45,6	20,9	79,0	23,7	20,0	16,1	18,3	23,1	23,4	11,1
	Razem Total	151	♂	121,8	62,2	44,8	21,1	78,3	24,2	20,0	16,8	17,8	23,3	23,4	11,6
		152	♀	121,6	63,5	45,6	21,1	78,5	24,3	20,0	16,1	18,1	23,5	23,6	11,5
		303	♂♀	121,7	62,9	45,2	21,1	78,4	24,2	20,0	16,4	18,0	23,4	23,5	11,5
Dunajec	I	5	♂♀	122,7	63,9	46,6	17,6	76,9	23,5	18,1	13,9	16,4	23,9	23,5	11,8
	II	4	♂	122,2	62,2	42,6	21,5	77,8	24,1	18,1	14,8	15,9	23,7	24,4	10,7
	III	21	♂	122,4	64,1	45,7	20,4	79,1	23,3	19,3	16,4	17,4	24,1	24,1	10,5
		8	♀	123,1	64,7	45,8	20,0	78,7	22,7	18,9	15,1	17,5	24,3	24,2	10,8
		29	♂♀	122,5	64,2	45,7	20,3	79,0	23,1	19,4	16,0	17,4	24,2	24,1	10,6
	IV	24	♂	122,5	62,4	44,4	20,2	77,9	22,9	19,2	15,5	17,9	23,7	23,7	10,4
		13	♀	121,4	62,3	45,6	19,6	78,5	22,3	18,6	15,3	17,8	23,7	23,2	10,5
		37	♂♀	122,1	62,3	44,8	20,0	78,1	22,7	19,0	15,5	17,9	23,7	23,5	10,5
	V	3	♂	121,1	65,3	45,6	22,8	77,6	23,1	19,4	15,3	17,7	23,1	23,1	9,9
		11	♀	121,5	62,8	42,5	19,8	78,5	22,8	18,4	15,5	17,9	23,8	23,6	10,8
		14	♂♀	121,4	61,9	43,1	20,5	78,3	22,9	18,6	15,5	17,9	23,7	23,5	10,6
	VI	3	♂	120,3	62,2	42,5	21,3	76,5	24,1	18,7	15,2	17,1	23,5	23,2	9,5
		10	♀	121,3	64,1	44,5	20,8	78,9	22,3	18,7	15,4	17,4	22,4	22,3	9,9
		13	♂♀	121,1	63,7	44,0	20,9	78,3	22,7	18,7	15,4	17,3	22,7	22,5	9,8
	VII	3	♂	121,1	63,0	41,9	23,2	80,4	22,0	17,6	15,0	17,9	20,5	21,7	9,1
		7	♀	121,2	62,8	44,7	20,7	77,9	22,7	18,2	15,1	17,7	22,8	22,5	10,0
		10	♂♀	121,2	62,9	43,8	21,5	78,6	22,5	18,0	15,0	17,8	21,1	22,3	9,7
	VIII	3	♂♀	120,3	64,7	44,7	22,5	78,9	22,5	17,3	14,5	17,5	23,0	23,0	9,6
	IX	5	♀	121,4	65,7	43,1	22,9	78,4	22,2	18,8	14,9	17,8	23,1	22,6	9,3
	Razem Total	58	♂	122,0	63,3	44,9	20,7	78,6	23,0	19,0	15,7	17,5	23,6	23,5	10,0
		57	♀	121,5	63,6	44,3	20,6	78,5	22,7	18,5	15,2	17,7	23,3	23,1	10,2
		120	♂♀	121,4	63,4	44,5	20,6	78,5	22,8	18,8	15,4	17,6	23,5	23,4	10,3

piekielnicy z dorzeczy Sanu i Dunajca (wg wieku)
ids from the San and Dunajec Basins (according to age)

Summa altitudo D	Longitudo basis D	Distantia praedorsalis	Distantia postdorsalis	Spatium inter P et V	Spatium inter V et A	Longitudo basis A	Summa altitudo corporis	Altitudo analis	Minima altitudo corporis	Summa altitudo corporis	Longitudo in circuitu	Longitudo spatii postorbitalis	Diameter oculi	Longitudo spatii praeorbitalis	Summa altitudo capitis	Distantia inter oculos
												in % longitudo capitis				
22,5	13,7	51,1	36,5	20,9	18,6	17,5	25,2	20,7	9,5	10,9	63,5	44,1	30,5	29,7	71,8	30,7
22,6	13,4	50,8	36,5	22,2	19,3	18,2	25,4	21,0	9,7	10,9	66,3	45,2	30,1	27,1	68,7	29,5
22,5	13,4	51,0	36,5	21,2	18,7	17,7	25,3	20,8	9,6	10,9	64,2	44,4	30,4	29,1	71,0	30,4
23,4	13,9	51,3	37,6	21,8	19,3	19,2	26,4	22,0	9,9	11,2	67,0	46,8	30,1	29,1	75,4	31,8
22,9	13,4	51,5	37,0	22,3	19,6	18,4	26,9	21,9	9,7	13,7	67,4	46,1	30,0	28,1	73,5	31,6
23,1	13,6	51,4	37,3	22,0	19,5	18,8	26,7	21,9	9,8	11,3	67,2	46,4	30,1	28,6	74,4	31,7
22,6	13,5	51,0	37,2	21,8	18,9	19,3	26,5	22,3	9,7	11,5	66,8	46,4	29,0	28,7	75,0	32,0
22,5	13,4	51,5	36,9	22,3	19,6	18,1	27,4	22,3	9,7	11,2	67,3	46,8	30,1	27,6	74,8	31,7
22,6	13,4	51,2	37,1	22,0	19,2	18,8	26,9	22,3	9,7	11,4	67,0	46,6	29,5	28,2	74,9	31,8
22,5	13,5	50,7	36,4	21,7	18,4	19,0	26,9	23,0	9,8	11,2	66,6	45,4	28,9	28,0	74,0	31,7
22,2	13,5	51,7	37,5	22,7	19,8	19,3	27,1	22,5	9,9	11,5	67,8	47,5	29,2	28,2	74,7	32,4
22,3	13,5	51,4	37,2	22,4	19,4	19,2	27,1	22,6	9,9	11,4	67,5	47,0	29,1	28,2	74,5	32,2
22,1	13,2	51,8	36,2	22,6	18,6	20,4	27,5	23,1	9,6	11,1	67,0	47,5	28,4	27,2	72,8	30,9
23,6	13,3	51,3	36,5	22,5	19,8	18,7	26,5	22,5	9,8	11,7	65,1	46,7	28,6	26,9	73,1	33,0
22,7	13,3	51,5	36,4	22,5	19,3	19,4	26,9	22,8	9,7	11,4	65,9	47,0	28,5	27,0	73,0	32,1
22,8	13,6	51,1	37,0	21,7	18,9	19,0	26,4	22,0	9,7	11,2	66,3	46,1	29,5	22,8	74,3	31,6
22,6	13,4	51,5	37,9	22,4	19,7	18,6	27,0	22,2	9,8	11,4	67,3	46,7	29,7	27,9	74,0	31,9
22,7	13,5	51,3	37,1	22,1	19,3	18,8	26,7	22,1	9,8	11,3	66,8	46,4	29,6	28,3	74,1	31,7
21,4	12,2	53,4	38,2	21,8	16,8	17,6	23,9		8,8	11,3	63,9	44,6	33,9	28,6	71,4	37,5
20,7	10,7	52,2	38,5	24,4	18,1	15,6	25,9		8,5	11,9	65,6	44,6	30,8	26,2	69,2	32,3
23,0	12,5	52,0	38,1	22,0	18,4	19,0	25,4		9,2	11,8	62,7	44,4	30,8	26,3	72,7	33,1
22,1	11,1	52,5	37,7	24,5	20,0	17,3	27,2		9,2	12,9	67,7	44,8	32,2	25,9	70,8	33,6
22,8	12,1	52,1	38,0	22,6	18,9	18,5	25,9		9,2	12,1	64,1	44,5	31,2	26,2	73,3	33,2
22,6	12,5	52,0	37,8	22,6	18,6	19,0	26,5		9,1	12,2	66,0	45,7	30,0	26,3	70,3	32,7
21,9	12,3	52,5	37,4	23,6	20,3	18,3	27,2		9,1	12,4	68,2	45,8	30,4	26,1	73,9	34,0
22,4	12,5	52,2	37,7	22,9	19,2	18,8	26,8		9,1	12,3	66,8	45,8	30,2	26,2	71,9	33,2
22,8	13,9	52,9	37,1	21,8	17,0	19,7	25,5		9,5	12,9	65,3	45,6	32,4	23,5	70,8	36,8
22,0	13,0	52,9	38,0	22,8	20,1	18,6	27,2		9,7	12,2	65,8	47,3	29,0	26,5	72,7	32,7
22,1	13,2	52,9	37,8	22,6	19,4	18,9	26,8		9,6	12,4	65,7	47,0	29,7	25,9	72,2	33,9
21,6	12,1	53,3	37,8	21,9	19,0	20,0	26,3		8,9	12,4	64,8	46,1	30,3	23,7	71,7	30,3
21,8	12,4	53,3	37,5	24,0	20,1	18,0	26,5		9,2	12,4	66,0	44,8	29,7	27,2	75,1	33,1
21,7	12,3	53,3	37,5	23,5	19,8	18,5	26,5		9,1	12,4	65,7	45,1	29,8	26,3	73,7	32,4
21,4	13,2	52,4	38,7	23,8	21,1	20,2	27,9		9,4	12,9	67,2	46,7	29,3	25,3	77,3	34,7
21,4	13,6	52,8	36,6	23,6	20,2	19,1	27,3		8,9	13,5	67,9	45,7	31,2	26,0	76,3	34,1
21,4	13,5	52,7	37,2	23,6	20,5	19,5	27,4		9,1	13,3	67,7	46,0	30,6	25,8	76,6	34,3
21,1	12,9	53,7	37,0	23,3	19,5	18,4	26,8		8,8	11,8	65,5	46,3	28,0	24,4	74,4	31,7
21,4	13,3	53,2	36,3	23,7	19,7	18,9	26,8		9,1	12,4	64,5	49,6	28,8	25,9	75,5	32,9
22,3	12,5	52,4	37,6	22,7	19,1	18,8	26,3		9,1	12,2	65,1	45,3	30,7	25,7	72,9	33,0
21,7	12,7	52,9	37,3	23,6	19,9	18,4	26,9		9,2	12,5	66,6	45,9	29,7	26,0	73,9	33,0
22,1	12,6	52,6	37,6	23,0	19,3	18,7	26,5		9,1	12,3	66,0	45,0	30,2	26,0	73,0	33,2

Morphological features

A basic statistical analysis was carried out by calculating the following paramaters: the arithmetical means ($\bar{x}$), the standard deviation (σ), the coefficients of variability (v %), and the proportions of the body in relation to body length (*longitudo corporis*) and the lateral length of the head (*longitudo capitis lateralis*). Altogether 31 morphological features were measured and the weight of individual fishes was determined. The investigated morphological features concerned the trunk (25 features) and the head (6 features).

Some slight differences in absolute magnitude of variability (σ) between males and females of *Alburnus bipunctatus* from the two basins were observed. Females of the studied species were distinguished by a slightly greater absolute variability of body size than males. The absolute variability measured by means of the standard deviation showed some tendencies towards increase with the growth of the fishes in time, both in the Dunajec and San basins but this does not prove that the variability of shoals as a whole also grows. The course of variability in the shoals of the individual age groups is shown in Table IV in which the relative variability of shoals is shown by means of the coefficient of variability.

As follows from Table IV, in all the features measured there occurs with increasing growth a decrease in the relative variability (v %) in both the basins studied. It is particularly strongly marked between the second and third year of life, mainly with *Alburnus bipunctatus* from the basin of the Dunajec. This concerns body weight, in which a rapid decrease in variability followed by its stabilization can also be observed. This phenomenon is also known from carp culture (Włodek 1966), from gudgeon (Skóra, Włodek 1969), from tench (Skóra 1964), and from bream (Skóra 1969).

The differences in the relative variability of body size between males and females of the studied species were small and did not show any regularity. The population from the Dunajec basin treated as a whole showed greater relative variability for all the features studied than that from the San basin. Nevertheless, it must be understood that all the age groups which were caught in the given basin (Table IV) were studied together and here there was a significant difference. The population from the San basin consisted of five age groups only (from the 2nd to the 6th), whereas that from the Dunajec basin consisted of 9 age groups, i.e. from the 1st to the 9th and this was probably the cause of the final greater variability of all the morphological features of *Alburnus bipunctatus* from the Dunajec basin.

On the basis of Table V one can observe that the described species of fish showed a considerable stability in the mean proportions of the body, irrespective of age. The differences observed in the body proportions of

males and females did not exceed 1% except in one case where the proportion of the body circumference of females from the basin of the Dunajec was 1.5% greater than that of males this being connected with the size of the gonads of individual fish.

On the basis of the data collected in Table VI it can be seen that the variability of *Alburnus bipunctatus* from the San and the Dunajec basins was subject to the same phenomenon as gudgeon from the Dunajec basin (Skóra, Włodek 1969), i.e., a decrease in relative variability with age followed by a certain stabilization. In the morphological features of the trunk the stabilization of variability was more marked than in those of the head.

In examining the biometrical data according to the fishing points, it was found that the mean linear measurement of the body of *Alburnus bipunctatus* was very similar to each other in spite of the fact that these fishes came not only from various stands but also from various rivers and even from various basins, that is to say from different environmental conditions. Greater differences were found only in body weight, this being caused by an environmental factor. Probably at points which were more fertile larger specimens with better condition were caught.

Relative variability (v %) shows considerable differences between the rivers. The greatest variability was found with *Alburnus bipunctatus* from the Dunajec, from the area denoted Dunajec II, i.e., from the sector from Czchów to Ujście Jezuickie. All the data concerning the variability of body size of *Alburnus bipunctatus* caught along this sector remain almost all the time over 20% (with the exception of one feature, the diameter of eye). In fishes from other regions of the rivers variability of the morphological features, with the exception of body weight, very rarely rose above 20% and in most cases only reached 15%. *Alburnus bipunctatus* from the Biała Tarnowska river (Dunajec basin) also showed fairly high variability but not as high as that of Dunajec II. Populations of *Alburnus bipunctatus* from the San basin showed on the whole smaller variability than those caught in the Dunajec basin (Table VII). The specimens caught in the River Hoczewka, which within the population from the San basin, showed the greatest variability of the measured features, had only one body feature out of the 30 studied whose variability rose slightly above 21% (the base of the anal fin), but the variability of 29 features ranged from 13.28 to 19.13%. These distinct differences in variability of fishes from the San and Dunajec basins are stressed by the measured standard deviation of the linear size of the bodies of the fishes.

In Table VIII the plastic features of *Alburnus bipunctatus* from the rivers or from particular sectors of them are shown in percentage of body length or length of the head. It was found that the total length expressed in percentage of body length is similar in the two populations investigated, i.e. those of the San and of the Dunajec. This would show that *Alburnus*

Tabela VI. Zbiorcze średnie arytmetyczne ($\bar{x}$)proporcji dla 24 cech ciała pielielnicy odniesionych do długości ciała i 5 cech głowy odniesionych do długości bocznej głowy oraz ich średnie współczynniki zmienności (v%) według wieku i płci

Table VI. Summary arithmetical means ($\bar{x}$) of proportions for 24 features of the cyprinid body relating to body weight and 5 features of the head relating to its lateral length; mean coefficients of variability (v%) according to age and sex

Dorzecze Basin	Wiek Age	Średnie proporcje tułowia i ich zmienność Mean proportions of the trunk and their variability									Średnie proporcje głowy i ich zmienność Mean proportions of the head and their variability								
		Samce Males			Samice Females			Razem Total			Samce Males			Samice Females			Razem Total		
		n	$\bar{x}$	v%	n	$\bar{x}$	v%	n	$\bar{x}$	v%	n	$\bar{x}$	v%	n	$\bar{x}$	v%	n	$\bar{x}$	v%
San	2+	32	32,3	10,49	10	32,8	11,03	42	32,4	10,67	32	41,4	12,83	10	40,1	10,32	42	41,1	12,86
	3+	45	33,0	8,80	47	33,0	8,71	92	33,0	8,87	45	42,6	9,55	47	41,9	10,53	92	42,2	10,17
	4+	51	32,7	7,62	42	32,8	8,05	93	32,8	8,04	51	42,2	9,96	42	42,2	10,30	93	42,2	10,23
	5+	16	32,6	7,97	44	33,0	7,64	60	32,9	8,32	16	41,6	10,04	44	42,4	9,33	60	42,2	10,19
	6+	7	32,8	6,47	9	32,9	7,37	16	32,8	8,41	7	41,4	8,13	9	41,7	7,39	16	41,5	9,19
Dunajec	1+	-	-	-	-	-	-	5	32,5	11,48	-	-	-	-	-	-	5	43,3	11,94
	2+	4	32,6	12,75	-	-	-	-	-	-	4	42,6	12,21	-	-	-	-	-	-
	3+	21	33,1	7,47	8	33,4	7,19	29	33,2	7,61	21	41,7	8,06	8	41,5	8,92	29	41,7	8,46
	4+	24	33,0	6,60	13	32,7	5,73	37	33,1	6,22	24	41,1	7,33	13	42,0	6,17	37	41,5	7,01
	5+	3	33,1	6,59	11	33,1	6,49	14	33,0	6,72	3	41,8	7,55	11	41,6	7,70	14	41,7	8,82
	6+	3	32,7	6,91	10	33,0	7,04	13	32,9	6,96	3	40,4	4,00	10	42,0	9,85	13	41,5	9,24
	7+	3	33,1	5,09	7	33,1	5,58	10	33,1	6,04	3	42,7	6,36	7	42,7	6,98	10	42,7	6,65
	8+				3	32,9	5,51							3	41,0	6,63			
	9+				5	33,0	5,01							5	42,5	6,99			

Tabela VII. Zbiorcze średnie arytmetyczne ($\bar{x}$) proporcji 24 cech piekielnicy odniesionych do długości ciała oraz 5 cech głowy odniesionych do długości bocznej głowy i ich współczynniki zmienności (v%) (według stanowisk)

Table VII. Summary arithmetical means ($\bar{x}$) of proportions of 24 features of cyprinid relating to body length and of 5 features of the head relating to its lateral length and their coefficients of variabilty (v%) (according to fishing points)

Dorzecze Basin	Rzeka lub potok River or stream	Liczba badanych ryb Number of examined fish	Proporcje Proportions		Współczynniki zmienności Coefficients of variability		
			Średnie dla 24 cech tułowia Means for 24 features of the trunk	Średnie dla 5 cech głowy Means for 5 features of the head	Średnie dla 24 cech tułowia Means for 24 features of the trunk	Średnie dla 5 cech głowy Means for 5 features of the head	Średnie dla ciężaru ciała Means for body weight
San	San I	66	33,0	42,3	12,44	12,33	34,82
	San II	68	33,0	42,5	14,34	14,59	35,01
	San III	42	32,2	40,9	16,61	16,49	49,30
	Wołosaty	16	33,2	42,2	12,62	13,21	26,88
	Solinka	36	32,9	42,2	14,59	15,05	37,10
	Wetlina	5	32,4	41,5	9,63	10,17	19,73
	Hoczewka	40	32,5	41,3	16,27	15,70	39,36
	Osława	31	33,0	42,5	13,74	13,65	35,46
	Średnio - Average	304	32,8	42,0	14,90	15,14	38,67
Dunajec	Dunajec I	23	33,1	41,2	15,07	15,01	42,68
	Dunajec II	12	32,8	41,6	25,30	20,93	51,66
	Poprad	18	33,0	42,1	14,58	14,82	43,32
	Biała Tarnowska	67	33,1	41,6	16,97	16,58	47,27
	Średnio Average	120	33,0	41,5	19,93	19,53	53,22
San + Dunajec	Średnio Average	424	32,2	41,9	16,94	16,56	49,76

Tabela VIII. Zestawienie cech morfologicznych
Table VIII. Morphological features of cyprin

Dorzecze - Basin	San					
Rzeka - River	San I	San II	San III	Wołosaty	Solinka	Wetlina
Ilość badanych ryb Number of examined fish	66	68	42	16	36	5
					in % longitudo	
Longitudo totalis	122,3	121,6	121,2	121,6	121,8	121,2
Longitudo praeanalis	62,7	62,9	62,9	62,9	63,1	64,2
Longitudo praeventralis	44,6	45,1	44,6	45,3	45,4	44,9
Longitudo pedunculi caudae	20,9	21,5	20,1	22,0	21,2	20,5
Longitudo trunci	78,2	78,4	76,0	79,4	79,8	77,4
Longitudo capitis lateralis	24,2	24,4	24,2	23,7	24,4	24,1
Longitudo P	20,1	20,1	20,0	19,3	19,6	20,5
Longitudo V	17,0	16,6	16,0	16,4	16,9	16,7
Summa altitudo A	17,9	18,3	17,3	18,0	18,4	19,3
Longitudo pinnae C superior	23,2	23,8	23,1	24,2	23,4	23,8
Longitudo pinnae C inferior	23,5	24,1	23,3	24,2	23,5	23,5
Longitudo pinnae C media	12,0	11,5	11,2	11,9	11,6	12,0
Summa altitudo D	22,8	23,1	21,9	22,8	22,9	23,8
Longitudo basis D	14,0	13,7	13,4	13,3	13,3	12,2
Distantia praedorsalis	51,2	51,6	50,9	51,2	51,3	52,7
Distantia postdorsalis	36,9	37,5	36,2	37,0	37,1	36,9
Spatium inter P et V	22,2	21,8	21,7	22,5	22,1	21,9
Spatium inter V et A	19,7	19,4	19,2	19,3	19,1	18,1
Longitudo basis A	19,2	18,8	18,2	18,7	18,5	17,6
Summa altitudo corporis	26,9	26,6	26,0	28,8	26,1	25,2
Altitudo analis	22,7	22,1	21,7	23,0	21,9	20,2
Minima altitudo corporis	9,9	9,9	9,4	10,0	9,8	8,9
Summa latitudo corporis	11,6	11,3	11,0	11,2	11,2	10,8
Summa longitudo in circuitu	68,4	67,0	63,9	69,5	67,0	62,3
					in % longitudo	
Longitudo spatii postorbitalis	46,9	45,9	45,2	47,0	46,7	46,8
Diameter oculi	29,7	30,1	29,7	28,7	30,2	29,4
Longitudo spatii praeorbitalis	27,8	29,0	28,1	28,1	28,6	29,4
Summa altitudo capitis	75,1	75,5	71,9	75,1	74,1	70,6
Distantia inter oculos	31,8	32,1	29,8	32,2	31,3	31,2

bipunctatus from the San basin had a caudal fin of similar length to that of *Alburnus bipunctatus* from the Dunajec basin. This is supported by the relative values of the sizes of the lower and upper lobes of caudal fin. The differences were observed, however, during comparison of the mean values of the sizen of the middle ray of caudal fin, and this difference is 1.2% in favour of the population from the San basin. Some differences for the above discussed features were also observed within the two populations.

In analizing the mean values it can be stated that *Alburnus bipunctatus* from the San basin had a longer head (24.2%) than those from the Dunajec basin (22.8%). In the San basin *Alburnus bipunctatus* from the stream Wołosaty had the smallest head (23.7%). But it was still larger than the largest head of *Alburnus bipunctatus* from the River Biała Tarnowska (a confluent of the Dunajec) (23.1%). Thus it follows that the head length

piekielnicy z dorzeczy Sanu i Dunajca (wg stanowisk)

ids from the San and Dunajec Basins (according to fishing points)

			Dunajec					Ogółem Total
Hoczewka	Osława	Razem Total	Dunajec I	Dunajec II	Poprad	Biała T.	Razem Total	San + Dunajec
40	31	304	23	12	18	67	120	424
corporis								
120,9	122,1	121,7	121,2	121,7	121,8	121,3	121,4	121,6
62,8	62,4	62,8	64,3	62,7	63,0	63,4	63,4	63,0
46,1	45,8	45,2	45,0	44,3	40,5	45,5	44,5	45,0
20,6	21,6	1,1	21,1	18,7	20,8	20,7	20,6	20,9
79,6	78,0	9,4	80,3	78,1	78,7	78,0	78,5	78,3
24,1	24,0	,2	22,7	22,6	22,3	23,1	22,8	23,8
19,4	20,2	19,9	18,0	18,4	19,1	19,1	18,8	19,6
15,5	16,3	16,4	15,3	15,2	15,5	15,5	15,4	16,1
17,4	18,5	18,0	17,4	18,2	18,1	17,4	17,6	17,9
23,0	23,5	23,4	23,0	23,7	23,1	23,7	23,5	23,4
23,2	23,5	23,6	23,1	23,8	23,0	23,5	23,4	23,5
11,1	11,2	11,5	10,2	10,4	9,8	10,5	10,3	11,2
21,8	23,2	22,7	21,7	22,3	21,9	22,3	22,1	22,5
12,9	13,3	13,5	12,9	13,1	12,9	12,2	12,6	13,2
51,6	50,8	51,3	52,3	52,1	53,3	52,6	52,6	51,7
37,1	37,9	37,2	37,4	37,5	38,1	37,6	37,6	37,3
22,0	22,5	22,1	23,7	23,0	22,7	22,9	23,0	22,4
18,5	19,3	19,3	20,2	19,7	19,1	19,0	19,3	19,3
18,4	19,4	18,8	18,7	18,9	19,5	18,3	18,7	18,7
26,5	27,2	26,8	26,9	26,3	27,6	26,1	26,5	26,6
21,6	22,2	22,1						
9,5	9,9	9,8	9,4	9,0	9,4	9,0	9,1	9,5
11,3	11,4	11,3	11,8	12,4	12,2	12,6	12,3	11,6
64,3	68,7	66,8	65,3	63,0	66,9	66,6	66,0	66,6
capitis lateralis								
45,8	48,0	46,4	45,1	47,0	47,7	45,1	45,3	46,1
29,0	29,1	29,6	28,8	28,7	29,5	31,2	30,2	29,8
28,7	27,3	28,3	26,8	25,6	25,5	25,9	26,0	27,6
71,3	74,8	74,0	73,2	73,0	74,0	72,6	73,0	73,7
31,8	33,3	31,7	32,3	33,5	33,6	33,4	33,2	32,2

of *Alburnus bipunctatus* from the Dunajec basin was closer to that of *Alburnus bipunctatus* from the French rivers (Spillmann 1961) and the head length of this species from the San basin was closer to that of *Alburnus bipunctatus* from Persia (Spillmann 1961) and Dvina (Žukov 1965). The sizes of mouth length and postorbitalis length given in percentage of the lateral length of the head (*longitudo capitis lateralis*) were consequently greater in fishes from the San basin. The diameter of the eye did not show any great differences either within the groups themselves or between one group of fishes and another; nor did this feature differ from that in the same species studied by Spillmann (1961), or in that described by Žukov (1965). The head height showed very considerable variations among fishes from the individual rivers of the San basin. The smallest head height was observed in *Alburnus bipunctatus* from the River Wetlina (70.6% of head length) and the greatest in

those from the sector San II (75.5% of head length). Much smaller variations were observed in the fishes caught in the Dunajec basin. Head height of the specimens of *Alburnus bipunctatus* from the San basin was smaller by 1% than that of *Alburnus bipunctatus* from the Dunajec basin. Head height measured in comparison with head length by Žukov (1965) for *Alburnus bipunctatus* from the River Dvina was distinctly smaller than that of the *Alburnus bipunctatus* studied in the present paper, though the range of variation was similar.

Width of forehead was greater for the fishes from the Dunajec basin and only *Alburnus bipunctatus* from the River Osława, from the sector San II, and from River Wołosaty had a width of forehead similar to that of the fishes from the Dunajec basin.

The fishes from the River Wołosaty in the San basin were distinguished by the greatest body height (28.8% of body length) and those from the River Wetlinka, from the same basin, by the smallest. Body heights of *Alburnus bipunctatus* (in % of body length) are similar in the two studied basins and correspond with those of *Alburnus bipunctatus* grom some French rivers (Spillmann 1961) and from the Rumanian rivers (Banarescu 1957). On the other hand they are sligthly higher in comparison with the mean height of *Alburnus bipunctatus* from some regions of Bulgaria studied by Banarescu (1957). The proportion of the smallest body height to length was similar in all cases within the basins as well as in comparison between one basin and another. *Alburnus bipunctatus* from the River Dvina studied by Žukov (1965) had a similar smallest body height.

Specimens from the Dunajec basin had a slightly greater width than those from the San basin, this being more interesting because it was not connected with the increase in the proportion of body circumference to length. In the San basin *Alburnus bipunctatus* from the River Wołosaty had the greatest body circumference (69.5% of body length), and in the Dunajec basin, those from the River Poprad (66.9%). In the San basin *Alburnus bipunctatus* in the River Wetlina had the smallest circumference (62.3%) and in the Dunajec basin those from the Dunajec II sector (63.0%). Thus the relative values of this feature displayed considerable variations.

The proportion of the predorsal distance and post-dorsal distance to body length displays moderate variation within the basins but in comparing the two basins a slightly longer anterior of the body of *Alburnus bipunctatus* from the Dunajec basin was observed. Similar measurements of the predorsal distance were obtained for this species by Banarescu (1957), Spillmann (1961), and Žukov (1965) and by Žukov (1965) of the post-dorsal distance.

The mean preanal and preventral distances were similar for *Alburnus bipunctatus* from two basins and almost identical with the means calculated by Žukov (1965) for *Alburnus bipunctatus* from the River Dvina.

In the San basin specimens from the River Wołosaty had the longest caudal stem and those from the sector Dunajec II the shortest. The mean trunk length of *Alburnus bipunctatus* from the studied basins was sligthly greater than mean trunk length given by Žukov (1965) for *Alburnus bipunctatus* from the Dvina basin.

The distance between the pectoral and ventral fins was longer in fishes from the Dunajec basin but the distance between the ventral and anal fins was identical for the two populations studied and similar to the measurements obtained by Žukov (1965) for the same species from the Dvina basin.

The length of the base of the dorsal and anal fins was shortest for *Alburnus bipunctatus* from the River Wetlina in the San basin. Fishes from the sector San I had the greatest length of the base of dorsal fin and those from the River Poprad in the Dunajec basin had the longest base of the anal fin. Similar means for these two features in the same species are given by Žukov (1965) from the Dvina basin.

The length of the fins of the studied cyprinid was similar to that of the fins of the same species from some French described by Spillmann (1961), but according to Žukov (1965) the fins of *Alburnus bipunctatus* from the Dvina basin were somewhat shorter.

It follows from the calculations assembled in Table VIII that there are some distinct differences in the plastic features of *Alburnus bipunctatus* from the individual rivers, or from their different sectors. These differences are to great extent conditioned by individual variability and trophicity of the rivers or their sectors.

Meristic features

Arithmetical means of the number of scales on the lateral line of the body calculated for the investigated fish (Table IX) are on the whole in agreement with those calculated by Banarescu (1957) for *Alburnus bipunctatus* from the rivers of Rumania and Bulgaria and with those given by Spillmann (1961) for this species living in some French and Persian rivers. The same is true of the standard deviation, hence there is a certain similarity in the variability of the number of scales of this species occurring in Rumania, Bulgaria (Banarescu 1957), France, and even in Persia (Spillmann 1961).

Moreover, a kind of anomaly in the structure of the lateral line of the studied cyprinid was noticed. It was found that the majority of specimens of both populations had larger or smaller repeatedly recurring bends and curves of the lateral line on the level of the ventral fins. In the case of 14 specimens from the San basin and 3 from that of the Dunajec, the

lateral line ended on the level of the base of the ventral fins and its continuation was seen in a higher or lower row of scales. In 9 cases rows of scales overlapped, perforated by small canals, over a length of 2 to 4 scales (never more). In all such cases the lateral line ended normally on the caudal trunk. The number of scales perforated by the apertures of the lateral line on the right and the left sides of the body was not always the same and the asymmetry observed ranged from 1 to 5 scales. The scales were always counted in the line on the left side of body. With many specimens the course of the lateral line on one side of the body of the first did not correspond to that on the other side. This asymmetry was found in 35% of specimens. Some individuals were found in which the lateral line on one side of the body ran very regularly, while on the other it was curved or even broken.

The number of rays (Table IX) in the dorsal, ventral, and anal fins refers to the branched rays. It should be noted that the last ray, which is sometimes divided till the base in the dorsal and anal fins, was always counted as one. Single, hard rays (2—3 in the dorsal fin and always 3 in the anal and ventral fins) were omitted.

In general, in the fins of the studied cyprinid the following number of supple and stiff rays occurred: D II—III/6—9, P 11—16, V II/6—9, A III/11—17, C 19.

Gill rakers on the first branchial arches were short and sparcely set in the studied *Alburnus bipunctatus*. The number of gill rakers (7—13) given in Table X was always counted on the left side of gill-cover on the edge of the first branchial arch. Asymmetry in the number of gill rakers was quite often observed on the outer edge of the first branchial arch on the left and the right side of the head. This asymmetry amounted most often to 1 to 2 rakers, occasionally 3, more on the left or on the right branchial arch.

The number of vertebrae in the spinal column of the discussed *Alburnus bipunctatus* ranged from 37 to 42 (Table X) with a predominance of specimens with 39 vertebrae.

The pharyngeal teeth of *Alburnus bipunctatus* occur in two rows and in 11 arrangements. Hence it follows that the variability of the arrangement of the lower pharyngeal teeth was in this fish very great (Table X). The following arrangements of the lower pharyngeal teeth were observed most frequently: 2.5—5.2, 2.5—5.2, 2.5—5.3, 2.4—5.2, this being observed in 404 out of 424 of the examined fishes, i.e. 95.3% of the whole material studied. On the basis of the obtained results, it can be stated that the arrangements of the lower pharyngeal teeth typical for this species are those mentioned above, the remaining 7 arrangements encountered in single individuals being atypical. This is supported by the investigations of other authors, such as Banarescu (1957), Horoszewicz (1960), Spillmann (1961), Žukov (1960, 1965), and others.

Tabela IX. Zestawienie cech merystycznych piekielnicy z trzech środowisk rzecznych

Table IX. Meristic features of cyprinids from 3 fluvial environments

Nazwa rzeki lub dorzecza Name of river or basin	San			Dunajec			Dźwina (Żukov 1965)		
Liczba badanych ryb Number of examined fish	304			120			49-99		
	$\bar{x}$	σ	v	$\bar{x}$	σ	v	$\bar{x}$	σ	n
Squamae, linea lateralis	48,0 (44-54)	1,74	3,69	47,2 (44-54)	1,82	3,86	46,9 (44-51)	2,21	95
Numerus radiorum pinnae D	II-III / 7,3 (6- 9)	0,65	8,86	II-III / 7,3 (6- 9)	0,56	7,67	II-III / 8,1 (7- 9)	0,35	94
Numerus radiorum pinnae P	13,7 (11-16)	0,92	6,73	13,6 (11-16)	0,86	6,32	13,6 (12-16)	0,90	49
Numerus radiorum pinnae V	II / 7,6 (6- 9)	0,53	7,08	II / 7,4 (6- 8)	0,53	7,23	8,0 (8)	0,00	49
Numerus radiorum pinnae A	III / 14,2 (11-17)	1,04	7,30	III / 13,9 (11-17)	1,03	7,37	III / 16,1 (14-17)	0,86	85
Numerus radiorum pinnae C	19,0	-	-	19,0	-	-			
Numerus spinarum branchialium	11,0 (7-13)	1,11	10,07	11,5 (8-14)	1,11	9,64	11,0 (10-13)	0,97	99
Numerus vertebrarum	39,0 (37-42)	0,91	2,33	39,1 (37-42)	0,39	2,55	40,7 (38-43)	1,28	99

Tabela X. Liczba i układy zębów gardłowych piekielnicy z dorzeczy Sanu i Dunajca
Table X. Number and system of pharyngeal teeth of cyprinids from the San and Dunajec Basins

Dorzecze Basin	Rzeka River	Układ zębów gardłowych - System of pharyngeal teeth												n
		2.5-4.2	2.5-5.2	2.5-5.3	2.4-5.2	2.4-4.2	1.4-5.2	1.4-4.1	2.4-4.1	2.5-5.1	2.5-4.1	1.5-5.2	1.5-4.2	
San	San I	26	24	7	6	1				1	1			66
	San II	35	18	6	5	2	1					1		68
	San III	17	14	4	7									42
	Wołosaty	7	5	2	2									16
	Solinka	16	11	2	2	1	1		1		1		1	36
	Wetlina	2	2	1										5
	Hoczewka	21	13	3	2					1				40
	Osława	11	10	4	3		1	1		1				31
	Razem - Total	135	97	29	27	4	3	1	1	3	2	1	1	304
Dunajec	Dunajec I	8	8	5		1			1					23
	Dunajec II	5	3	2	2									12
	Poprad	7	6	1	1	1				2				18
	Biała Tarnowska	40	17	6	2	2								67
	Razem - Total	60	34	14	5	4			1	2				120
San + Dunajec	n	195	131	43	32	8	3	1	2	5	2	1	1	424
	%	46,0	30,9	10,1	7,5	1,9	0,7	0,2	0,5	1,2	0,5	0,2	0,2	100,0

Reproduction

Strójnowski (1860) states that spawning of *Alburnus bipunctatus* takes place in May. Gąsowska (1962), Nikolski (1950), Schindler (1953), Staff (1950), and Žukov (1965) give a broader time-limit, namely from May till June. Kossatkin (1958) establishes the spawning time of *Alburnus bipunctatus* observed by him as the beginning of the third decade of June.

In the San basin *Alburnus bipunctatus* was caught in the third decade of August, after earlier spawning, similarly as in the upper confluent of the Dunajec, i.e., till the town of Nowy Sącz where fishes were caught from 5 to 13 September. The diameter of the eggs ranged from 0.20 to 0.65 mm, 0.38 mm on the average. In the material caught from the lower Dunajec and in its right confluent the Biała Tarnowska between 20 and 27 May, two females partly spawned from the 5th age group were found, this supporting Žukov's observations (1965) about the staggered character of spawning of *Alburnus bipunctatus*. The remaining females from this period aged from 3 to 9 years, in spite of the fact that the temperature of the water at that time reached 19 °C, did not spawn, but they were already in the IV and V phase of sexual maturity, which means that they were capable of immediate spawning.

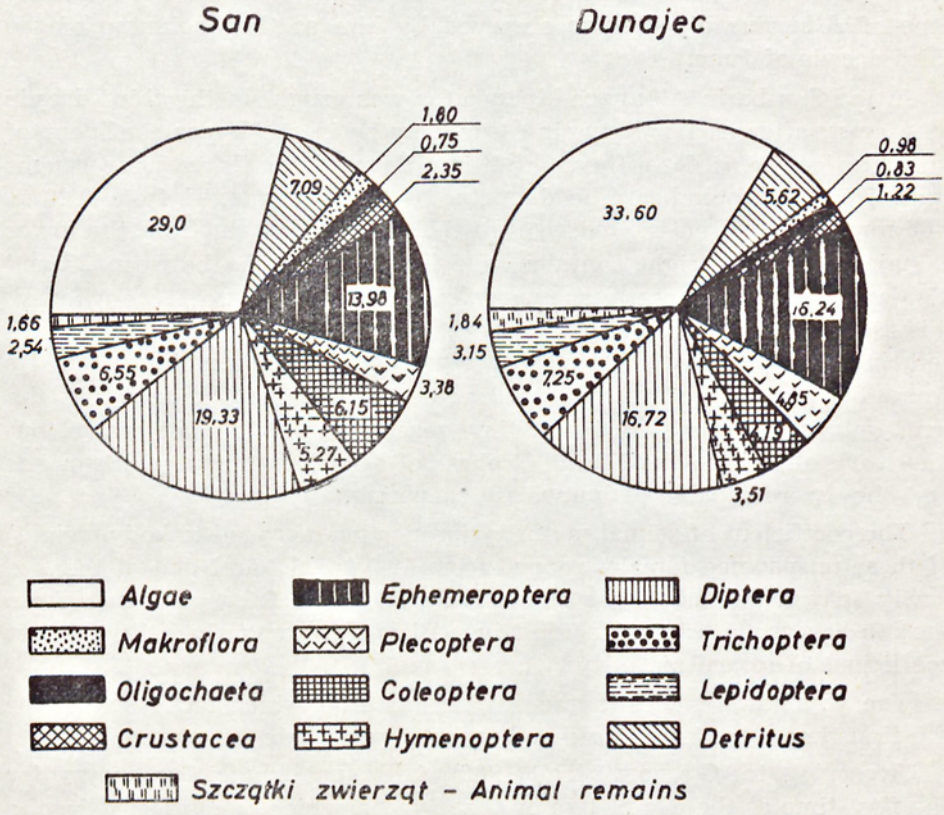
The coefficient of sexual maturity (proportion of gonad to body weight) of these unspawned females ranged from 10.0 to 26.3 and that of the two partly spawned females was respectively 8.0% and 9.3%. A female from the 5th age group, caught in the River Biała Tarnowska had the greatest coefficient of sexual maturity.

The youngest females in the studied material which could spawn for the first time were 3 years old and males 2 years old.

According to Gąsowska (1962) *Alburnus bipunctatus* spawn for the first time at the age of two or three years, which is confirmed by the present observations. Gąsowska (1962) also states that this species spawns in rivers with sandy bottom, but Schindler (1953) and Staff (1950) state that females of *Alburnus bipunctatus* spawn on a gravel bottom. Nikolski (1950), and Žukov (1960, 1965) consider a stony bottom to be the one on which females of *Alburnus bipunctatus* can spawn. Observing the course of spawning of *Alburnus bipunctatus* in the rivers of Southern Poland, namely in the basins of the Rivers San, Dunajec, Raba, Czarna Staszowska and Nida, it was possible to establish exactly that this fish is not so very fastidious and that it spawned in every kind of river bottom, only an appropriate flow of water being needed. All the authors mentioned above, in discussing this problem, point out the need of an appropriate flow of water for spawning.

Nutrition

The composition of the content of the alimentary tract of *Alburnus bipunctatus* from the San basin as well as from that of the Dunajec (fig. 3) was somewhat varied, as was the case with the specimens analysed by the Rumanian authors (G y u r k ó, N a g y, W i l h e l m 1967).



Ryc. 3. Procentowy udział poszczególnych składników zwierząt i roślin w pokarmie piekielnicy (*Alburnus bipunctatus* B l o c h) z dorzeczy Sanu i Dunajca
Fig. 3. Proportional participation of the particular components of animals and plants in the food of *Alburnus bipunctatus* B l o c h from the San and Dunajec basins

The analysis of the contents of alimentary tracts of *Alburnus bipunctatus* caught in May as well as in August or September showed that invertebrates were the main ingredient and then lower plants. In the food of *Alburnus bipunctatus* caught in the San basin invertebrates formed about 62% of the food mass, and lower plants 29.1%. In the Dunajec basin invertebrates formed about 60% and lower plants about 34% of the food mass. The remains of higher plants had some importance in the food of

Alburnus bipunctatus caught in the Dunajec basin but zooplankton was rather additional or incidental food.

Of the animal food the smallest forms of *Tendipedidae* had the greatest importance in nutrition, followed by the may-flies (*Ephemeroptera*), case-worms (*Trichoptera*), and *Hymenoptera*. Not only fragments of the organisms living in the rivers were contained in the alimentary tracts of *Alburnus bipunctatus*, but also fragments of riverside leaves, plants, bushes, and trees. *Alburnus bipunctatus* also catches food from the air, this being evidenced by the remains of the wings of insects found in its alimentary tracts; this finding supports Nikolski's opinion (1950).

According to Nikolski (1950), Schindler (1953), Staff (1950), and Strojnowski (1960), the basic food of *Alburnus bipunctatus* are invertebrates and, as was mentioned above, Gąsowska (1962) states that it feeds on plankton. Żukov (1960) puts zooplankton in the first place in the food of *Alburnus bipunctatus* before invertebrates, but the same author in a paper from 1965 states that the larvae of insects are its main food.

In comparing the results of the analysis of the contents of the alimentary tract of *Alburnus bipunctatus* from the San and Dunajec basins with the results of those from *Alburnus bipunctatus* living in the waters of Rumania (Gyurkó, Nagy, Wilhelm 1967), a similarity with regard to both quality and quantity of food is clearly visible.

Conclusions

In analysing the mean growth of the fish separately for each basin, it may be stated that *Alburnus bipunctatus* grows similarly in the two regions. As far as the linear growth of the body is concerned (*longitudo totalis* and *longitudo corporis*), it is best in the first year of life, after which a rather sudden collapse in growth occurs. Diminution and equalization of the relative variability for the morphological features were observed similarly as in the case of other fish, e.g., gudgeon (Skóra, Włodek 1966, 1969).

In comparison with the results of the works of other authors no great differences were found. This holds true for the means, for the variability of the above-mentioned morphological features, and for the meristic features of the species discussed, which signifies that this is the nominal form of *Alburnus bipunctatus* Bloch.

STRESZCZENIE

Badania oparto na 424 okazach piekielnicy złowionych przy pomocy agregatu elektrycznego na prąd stały w górnym Sanie i Dunajcu oraz ich dopływach (tabela I).

W porównaniu z ukleją badane piekielnice miały ciało nieco mniej wydłużone i bardziej wygrzbiecone, z boków ściśnione, a obydwie szczęki jednakowo równe.

tępo zakończone, ścięte. Otwór ustny końcowy. Przecięcie ust nieco skośne. Płetwa grzbietowa bardziej przesunięta do przodu; płetwa odbytowa zaczyna się za końcem płetwy grzbietowej, a w przodzie jest znacznie wyższa. Wysokość ciała mieściła się w długości ciała od 3,3 do 4,3 razy. Barwa ciała piekielnic nie zawsze była identyczna. W przeważającej liczbie miały one ubarwienie grzbietu niebiesko-zielone lub oliwkowozielone, a nawet szare. Boki ciała srebrzysto błyszczące. Powyżej i poniżej linii bocznej biegną dwa szeregi ciemnych plam pigmentu, ujmujące linię boczną na całej jej długości jakby podwójną kreską. Nad linią boczną wzdłuż ciała biegnie smuga fioletowa z połyskiem złotawym. Linia boczna, a z nią dwa szeregi pigmentowych plamek obejmujących ją, była u większości osobników powyginana, a nawet poprzerywana.

Piekielnica występowała najliczniej w dolnych rejonach krainy pstrąga i górnych rejonach krainy brzany (ryc. 1, 2). Nie spotykano jej w małych strumieniach, potokach, a nawet mniejszych rzekach o dużych spadkach jednostkowych przekraczających wartość 8‰ i o dnie skalistym lub kamienisto-żwirowym. W korycie rzeki przebywa gromadnie, szczególnie w środkowych partiach i w prądzie. Lubi dno żwirowe lub piaszczyste i wodę przezroczystą. Piekielnica unika wód zarastających, jak również dużych głębokich rzek o mętnej wodzie.

Przeciętna piekielnica łowiona w dorzeczu górnego Sanu była średnio mniejsza niż piekielnica z dorzecza Dunajca. Współczynnik kondycji piekielnicy z dorzecza Sanu i Dunajca wykazywał dość niskie wartości i w żadnym przypadku nie przekraczał jedności (tabela II).

Wzrost piekielnicy w poszczególnych grupach wieku dla obydwu dorzeczy był podobny. Najlepszy przyrost w długości ciała piekielnica osiąga w pierwszym roku życia, później następuje dość gwałtowne jego załamanie (tabela III).

W obydwu rozpatrywanych dorzeczach i we wszystkich mierzonych cechach (tabela IV) istnieje z wiekiem ryb zmniejszanie się względnej zmienności (v%). Uwydatnia się to zwłaszcza pomiędzy pierwszym a drugim rokiem życia. U opisanych populacji piekielnicy istniała duża stabilność wśród średnich proporcji ciała niezależnie od wieku ryb. W cechach morfologicznych tułowia wystąpiła stabilizacja zmienności (tabela V) bardziej wyraźnie niż w cechach morfologicznych dotyczących głowy. Populacja piekielnicy z dorzecza Sanu odznaczała się nieco mniejszą zmiennością niż ryby złowione w dorzeczu Dunajca (tabela VI i VII).

Notuje się pewne różnice w cechach plastycznych piekielnicy pomiędzy poszczególnymi rzekami czy nawet odcinkami rzek. Różnice te w znacznym stopniu są uwarunkowane zmiennością indywidualną i troficznością poszczególnych rzek lub ich odcinków (tabela IX).

Liczbę łusek w linii bocznej, liczbę promieni twardych i miękkich w płetwach, liczbę wyrostków filtracyjnych na zewnętrznej krawędzi pierwszych łuków skrzelowych i liczbę kręgów w kręgosłupach oraz układy zębów gardłowych piekielnicy przedstawiono w tabeli IX i X.

Piekielnica w dorzeczu Sanu i Dunajca trze się od trzeciej dekady maja do końca czerwca. Ikrę składa na dnie piaszczystym, żwirowym, a nawet kamienistym, byle tylko był odpowiedni przepływ wody. Najmłodsze piekielnice przystępujące pierwszy raz do tarła miały dwa (samce) lub trzy lata (samice).

Podstawowym pokarmem piekielnicy są zwierzęta bezkręgowe oraz rośliny niższe, natomiast rośliny wyższe i zooplankton stanowiły raczej pokarm dodatkowy, a nawet przypadkowy (ryc. 3).

REFERENCES

B a l o n E., 1952. Ryby reky Olzy. Zvlaštni otisk Přirodovědeckého sborniku Ostravskěho kraje, 13, 517—548.

B a l o n E., 1962. Okologische Bemerkungen über die Standorten der Donaufische mit

einer Beschreibung des Fundes des *Carassius auratus gibelio* (Bloch, 1783) und *Alburnoides bipunctatus* (Bloch, 1782). Vestnik Československ. Spol. Zoolog., 26, 333—351.

Bănărescu P., 1957. Die Rassiale Zugehöringkeit einiger Rumänischer Süsswasserfischarten Izd. Inst. de Pisciculture de la RP Macédoine, 2, 59—80.

Bauch G., 1966. Die einheimischen Süsswasserfische. Radebeul und Berlin. Neumann Verlag.

Berg L.S., 1949. Ryby presnych vod SSSR i sopredelnych stran. Cast. 2. Moskva-Leningrad. Izdat. Akademii Nauk. SSSR.

Chudybowa D., 1965. Benthic Algae in the River Dunajec. Limnological Investigations in the Tatra Mountains and Dunajec River Basin, Kom. Zagosp. Ziem Górskich PAN, 11, 153—159.

Dratnal E., B. Szczęsny, 1965. Benthic Fauna of the Dunajec River. Limnological Investigations in the Tatra Mountains and Dunajec River Basin. Kom. Zagosp. Ziem Górskich PAN, 11, 161—214.

Gąsowska M., 1962. Klucze do oznaczania kręgowców Polski. I. Krągłouste i ryby — Cyslostomi et Pisces. Warszawa-Kraków. PWN.

Cyurkó S., Z.I. Nagy, A. Wilhelm, 1967. Dinamica nutritiel la belditá (*Alburnoides bipunctatus bipunctatus* Bloch), Bul. Inst. de Cercetări si Proiectări Piscicole. 26, 2, 59—67.

Horoszewicz L., 1960. Wartość kości gardłowych dolnych (Ossa pharyngea inferiora) jako kryteriów gatunkowego oznaczenia ryb karpiowatych (*Cyprinidae*), Roczn. Nauk Roln., I, 75, B-2, 237—258.

Jaśkowski J., 1962. Materiały do znajomości ichtiofauny Warty i jej dopływów. Fragmenta Faunistica. 9, 28, 450—499.

Kołder W., 1960. Badania składu ichtiofauny górnego dorzecza Sanu. Kraków. Zakład Biologii Wód PAN (rękopis).

Kołder W., 1965. Fisch productivity of the river Dunajec in its historical and actual aspect. Along the Dunajec river. 16 Limnologorum Convetus in Polonia, Cracov.

Kossatkin V., 1958. Tippviidikas — Eesis haruldane kala, Loodusuurijate Seltsi Aastaraamat, 51, 249—262.

Maksunov V. A., 1966. O polosatoi bastrjanke *Alburnoides taeniatus* (Kessl.) verchovev r. Syr-Dari. Voprosy Ichtiologii. Akad. Nauk SSSR. 6, 20—25.

Nikolski G.V., 1950. Častnaja ichtiologija, Moskva, Gos. Izdat. Sov. Nauka.

Nowicki M., 1889. O rybach dorzeczy Wisły, Styru, Dniestru i Prutu w Galicyi. Kraków. W drukarni „Czasu" Fr. Kulczyńskiego i Sp.

Pasternak K., 1964. Geologiczna i gleboznawcza charakterystyka dorzecza rzeki San — Geological and pedological characteristics of the basin of river San. Acta Hydrobiol., 6, 3, 289—307.

Pasternak K., 1968. Charakterystyka podłoża zlewni rzeki Dunajec — Characteristics of the substratum of the river Dunajec catchment basin, Acta Hydrobiol. 10, 3, 299—317.

Schindler O., 1953. Unsere Süsswasserfische, Kosmos Gesellschaft der Naturfreunde. Stuttgart, Franc. Verlagshandlung.

Skóra S., 1964. Charakterystyka lina (*Tinca tinca* L.) ze Zbiornika Goczałkowickiego — Characteristics of the tench (*Tinca tinca* L.) in the reservoir of Goczałkowice. Acta Hydrobiol., 6, 2, 97—118.

Skóra S., 1969. Leszcz (*Abramis brama* L.) ze Zbiornika Goczałkowickiego — Der Brassen (*Abramis brama* L.) aus dem Staubecken von Goczałkowice. Acta Hydrobiol., 11, 3, 377—406.

Skóra S., J. M. Włodek, 1966. Kiełb krótkowąsy (*Gobio gobio* L.) z rzeki Soły — Der Gründling (*Gobio gobio* L.) aus Soła-Fluss. Acta Hydrobiol., 8, 1, 25—40.

Skóra S., J.M. Włodek, 1969. The Gudgeon (*Gobio kobio* L.) from the Dunajec river basin. Vestnik Československ. Spol. Zoolog., 33, 4, 351—368.

Spillmann J., 1961. Observations sur la variation d'une petite espéce de poissons de la famille des Cyprinidae: *Spirlinus bipunctatus* (Bloch). Bull. Mus. Hist. nat. Paris, 33, 2, 161—168.

Staff F., 1950. Ryby słodkowodne Polski i krajów ościennych, Warszawa, Trzaska Evert i Michalski.

Strojnowski S., 1860. Opisanie porządku stawowego. W Krakowie Bazyli Skalski drukował. Wznowione wydanie przez Gawareckiego i Kohna w książce Polskie stawowe gospodarstwo. Warszawa.

Tusnádi G., 1963. Allometriche untersuchung n an populationen von *Alburnoides bipunctatus* Bloch aus dem Karpatenbecken. Acta Zoolog., Acad. Scient. Hungar., 9, 199—207.

Wałecki A., 1864. Materiały do fauny ichtiologicznej Polski. 2, Systematyczny przegląd ryb krajowych. Warszawa, Drukarnia Gazety Polskiej.

Włodek J.M., 1966. Studies on the variability of carp populations in ponds. Verh. int. Ver. Limnol., 16, 1435—1439.

Żarnecki S., W. Kołder, 1956. Ichtiofauna Wisły Śląskiej. Biul., Zakład Biologii Stawów PAN, 3, 19—45.

Żukov P.J., 1960. Opredelitel ryb Beloruskoj SSSR. Min'sk. Izdat. Akademii Nauk BSSR.

Żukov P.J., 1965. Ryby Belorussii. Min'sk, Izdat. Nauka i Technika.

Adres autora — Author's address

Mgr inż. Stanisław Skóra

Zakład Biologii Wód, Polska Akademia Nauk, Kraków, ul. Sławkowska 17.