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Systematics

MORPHOLOGY OF *PHOXINUS PHOXINUS* (L. 1758) (*PISCES, CYPRINIDAE*) FROM THE RIVER SKAWA

MORFOLOGIA *PHOXINUS PHOXINUS* (L., 1758) – *PISCES, CYPRINIDAE* – Z RZEKI SKAWY

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The paper deals with morphological characters of *Phoxinus phoxinus* (L., 1758) from the river Skawa near Jordanów and Sucha Beskidzka. According to Berg's (1949) taxonomic criteria, the population studied should be assigned to the nominal subspecies *Phoxinus phoxinus phoxinus* (L.).

INTRODUCTION

Phoxinus phoxinus (L., 1758) attains small size (Fig. 1). An average body length (*longitudo totalis*) of the species' representatives in Poland ranges within 8–10 cm (Staff, 1950). The species inhabits highland and lowland rivers of a fast current and clean water. The species has been found in all major rivers of Poland (Rembiszewski and Rolik, 1975), its main centre of distribution being, however, brook trout-inhabited streams up to their springs. Owing to its abundance in upper parts of rivers, the species seems to play an important role in fish communities, mainly as a food supply for older salmonids (pers. observations).

According to Staff (1950) and Gąsowska (1962), Poland is inhabited by two species of the genus *Phoxinus* Agassiz., 1935: *Phoxinus phoxinus* (L., 1758) and *Ph. percnurus* (Pallas, 1811), with a number of local forms. There isaconsiderable discrepancy of opinions as to the systematics of the genus. Based on osteological analyses, Gąsowska (1979) proposes to assign the Euro-Asian representatives of the genus *Phoxinus* sensu Bănărescu (1964) to the followign genera: *Phoxinus* Rafinesque, 1920 and *Moroco* Jordan et Hubbs, 1925. The first would contain *Ph. phoxinus* (L., 1758), while the other *Maroco percnurus* (Pallas, 1811) = *Ph. percnurus* sensu Berg, 1949 along with its related forms. It seems purposeful in this context to collect more data on morphology of the genus from various parts of its range.

The present study was aimed at examining the morphology of *Ph. phoxinus* from the river Skawa, an upstream tributary of the Vistula. Studies on *Ph. phoxinus* morphology in the Vistula catchment area were based on numerous observations in the streams of Mszanka (Starmach, 1963) and Sowlinki (Kulamowicz and Jażdżewski, 1970), and in the river Sufraganiec (Kulamowicz and Korkuć, 1971).

Fig. 1. ***Phoxinus phoxinus*** **from the river Skawa (longitudo corporis 78 mm), female**

MATERIALS AND METHODS

Ph. phoxinus occurs along almost the whole of the Skawa. The accompanying species in upper parts of the river are *Nemachilus barbatulus* (L., 1758) and younger age groups

of brook trout; in lower parts numerous are *Leuciscus cephalus* (L., 1758), *Gobio gobio* (L., 1758), and *Barbus meridionalis petynyi* (Heckel, 1847). 20 km off the Skawa's opening into the Vistula *Cottus poecilopus* Heckel, 1836 was localised.

The materials were collected within the period of 6–15 July, 1979 as a part of a project carried out by the members of the Students Ichthyological Society at the Institute of Ichthyology, Academy of Agriculture, Szczecin. The catches were effected with a 5-mm mesh size net mounted on a 2.5 x 1.5 m rectangular frame; dip nets and rods were used as well.

Age of the specimens caught as determined on the operculum ranged from 1+ to 7 years, the longitudo corporis ranging within 36–80 mm. The morphological analyses involved examining 21 metric and 8 meristic characters. The morphometric characters studied were measured according to the cyprinid formula given by Opuszyński (1978). The measurements were made with a calliper to the nearest 0.5 mm. The meristic characters were studied on 63 individuals, the morphometric ones on 50 fishes, males and females contributing 25 each. In order to study the sexual dimorphism, the extent of variability (d) was assessed with a formula

$$d = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}$$

where M_1 and M_2 = arithmetic means for the groups compared,
m_1 and m_2 = standard errors of the respective means.

DISCUSSION OF RESULTS

Scales of the individuals examined were fine, oval, enlarged towards the tail. Circuli on scales well-marked, radii few, less conspicous; annuli almost identical with circuli. The ventral side of the body naked, scales occurring only near the ventral and pectoral fins. The lateral line extends along the body slightly winding and may disappear in the caudal part. The number of scales along the lateral line is 82–94. The arrangement of scales conforms with the previous observations (Berg, 1949; Kulamowicz and Jażdżewski, 1970).

Fin ray ratios are given in Table 1. The *Ph. phoxinus* sample studied shows a considerable variability in the caudal fin radii ratios (Table 1), which is worth noticing as the observations made so far have revealed either very slight variations (Kulamowicz and Jażdżewski, 1970) or none at all (Starmach, 1963; Kulamowicz and Korkuć, 1971).

Filtration processes (counted in the external row on the first gill arch at the right-hand side of the head) numbering (5) (6) 7–10 (11) (mean of 8.6) are arranged in groups of two or three on the epibranchiale, the remaining ones being placed on the ceratobranchiale.

The Skawa sample individuals demonstrated a considerable variability in their pharyngeal teeth patterns: 2.5–4.2 (55%); 2.2–4.2 (26%); 2.5–4.1 (5%); 2.5–4.3 (3%); 1.5–4.1 (3%); 2.4–3.2 (2%); 2.5–5.1 (2%); 1,5–5.2 (2%); 1.4–4.1 (2%). A similarly high variability in the *Ph.phoxinus* pharyngeal teeth pattern was described by Starmach (1963), Kulamowicz and Jażdżewski (1970), Klimczyk-Janikowska (1970), and Kulamowicz and Korkuć (1971); on the other hand, numerous observations point out to a low degree of variability in this character in some *Ph.phoxinus* populations (Tack, 1941; Staff, 1950; Horoszewicz, 1960; Gąsowska, 1962; Żukov, 1965). Additionally, the pharyngeal teeth arch width index was calculated after Horoszewicz (1960); the index value for the Skawa *Ph.phoxinus* was found to amount: $M \pm m = 63.45 \pm 0.69$; $\delta = 4.1$ ($n = 17$). The result approaches that obtained by Horoszewicz (1960) for the Vistula *Ph.phoxinus* ($M = 62.9$, $\delta = 5.18$; $n = 10$).

A detailed analysis of the Skawa *Ph.phoxinus* morphometry is to be found in Table 2.

The principal external feature of the sex dimorphism in *Ph. phoxinus* (Fig. 2) is the appearance of pectoral and ventral fins; the fins are larger and more robust in males. This character almost always permits sexing before any anatomical examination is made. Previous research on the sexual dimorphism yielded unequivocal results with respect to certain characters only, such as the structure of pectoral and ventral fins, respective lengths of these, and P-V spatium. The nature of the most significant differences ("d" close to or exceeding 3) in the appearance of the body is presented in Table 3. Additionally, the Skawa *Ph.phoxinus* males have their dorsal and anal fins higher than females and shifted forwards. The river Sufraganiec males were distinguished by their

Table 1

Fin ray relations in the Skawa *Phoxinus phoxinus*

		Lepidotrichium non-branched			Lepidotrichium branched					
D	no of rays	III			7			8		
	(%)	100			92			8		
A	no of rays	III			7			8		
	(%)	100			93			7		
V	no of rays	I		II	6		7			8
	(%)	97		3	3		90			7
P	no of rays	I			13	14	15	16	17	18
	(%)	100			5	5	18	52	18	2
C	no of rays	I–I	I–II	II–II	13	14	15	16	17	18
	(%)	82	15	3	2	3	11	20	61	3

Table 2

Characteristics of metric characters of *Ph. phoxinus* in the Skawa; n = 25 males and 25 females

Signum	*Dispersio empirica*	M±m	δ	V (%)
longitudo corporis in mm	44.0–80.0	65.58±0.84	6.68	10.2
longitudo corporis = 100				
longitudo capitalis lateralis	20.8–25.0	22.72±0.13	1.00	4.4
longitudo pedunculi caudae	24.0–30.9	29.00±0.16	1.30	3.4
distantia praedorsalis	50.1–55.9	52.95±0.55	4.26	8.1
distantia postdorsalis	31.3–40.2	37.76±0.16	1.32	3.4
distantia praeanalis	57.1–66.2	62.81±0.22	1.71	2.7
spatium P–V	21.3–29.2	24.35±0.23	1.81	7.3
spatium V–A	15.3–21.0	18.12±0.17	1.30	7.2
longitudo basis D	9.3–12.7	10.72±0.10	0.76	7.1
longitudo basis A	8.7–12.7	10.83±0.11	0.86	8.0
summa longitudo P	14.4–19.3	17.02±0.16	1.28	7.6
summa longitudo V	11.0–16.4	13.49±0.17	1.32	10.0
summa longitudo capitis	13.0–16.4	15.20±0.10	0.76	5.0
summa altitudo corporis	18.1–25.4	21.65±0.23	1.82	8.3
minima altitudo corporis	7.6–10.9	9.13±0.09	0.70	8.9
summa altitudo D	15.7–21.2	18.46±0.17	1.32	7.2
summa altitudo A	13.2–20.8	18.19±0.18	1.38	7.7
summa latitudo capitis	12.5–16.4	14.66±0.11	0.89	6.1
latitudo basis pedunculi caudae	8.1–10.9	9.85±0.16	0.85	7.7
latitudo basis pinna caudalis	3.8– 6.8	4.73±0.07	0.53	11.2
distantia praeocularis	6.3– 7.8	7.16±0.06	0.48	6.9
diameter oculi	4.0– 6.6	5.26±0.07	0.53	10.0
minima altitudo corporis = 100				
latitudo basis pedunculi caudae	96.0–128.0	117.02±1.80	9.51	7.9
longitudo pedunculi caudae = 100				
minima altitudo corporis	24.7–38.3	29.79±0.28	2.19	9.2
spatium P–V = 100				
summa longitudo P	52.4–90.0	70.67±1.17	9.15	13.4
spatium V–A = 100				
summa longitudo V	60.0–100.0	75.21±1.12	8.72	7.7

Table 3

Diversity in metric characters of *Ph. phoxinus* in the Skawa with a particular reference to sex dimorphism

Signum	♂♂ (n = 25)	♀♀ (n = 25)	d
	M ±m		
longitudo corporis = 100			
spatium P– V	23.07±0.27	25.63±0.28	6.6
summa longitudo P	17.89±0.24	16.15±0.19	5.7
distantia praedorsalis	51.97±0.29	53.93±0.24	5.2
summa longitudo V	14.29±0.33	12.70±0.16	4.3
summa altitudo A	18.91±0.28	17.47±0.20	4.2
distantia praeanalis	61.94±0.42	63.68±0.22	3.7
summa altitudo D	19.12±0.30	17.81±0.21	3.6
longitudo pedunculi caudae	29.60±0.39	28.40±0.22	2.7
minima altitudo corporis = 100			
latitudo basis pedunculi caudae	120.94±1.11	113.10±2.37	3.0
spatium P– V = 100			
summa longitudo P	78.17±1.63	63.18±1.07	7.7
spatium V–A = 100			
summa longitudo V	80.45±2.29	69.98±1.19	4.1

longer and higher tail base (Kulamowicz and Korkuć, 1971). In some samples, this diversification was limited to qualitative characters of fins, and sometimes to a numerical ratio between them (Tack, 1941; Starmach, 1963; Żukov, 1965; Klimczyk-Janikowska, 1970).

TAXONOMIC ANALYSIS

Within the species of *Phoxinus phoxinus*, Berg (1949) differentiates three subspecies: *Ph.phoxinus phoxinus* (L.), the nominal one, *Ph. phoxinus ujmonensis* Kaschtschenko, 1900, and *Ph.phoxinus colchicus* Berg, 1910. The characters which, according to Berg (1949), divide the species into the three subspecies are summarised in Table 4. Basically, the *Ph.phoxinus phoxinus* (L.) characters as in Table 4 are in agreement with those observed in the sample examined. However, the variability range of the minima altitudo corporis: longitudo pedunculi caudae ratio for the Skawa sample reaches the upper limit of the criterion for *Ph.phoxinus ujmonensis*. Similar results were obtained by

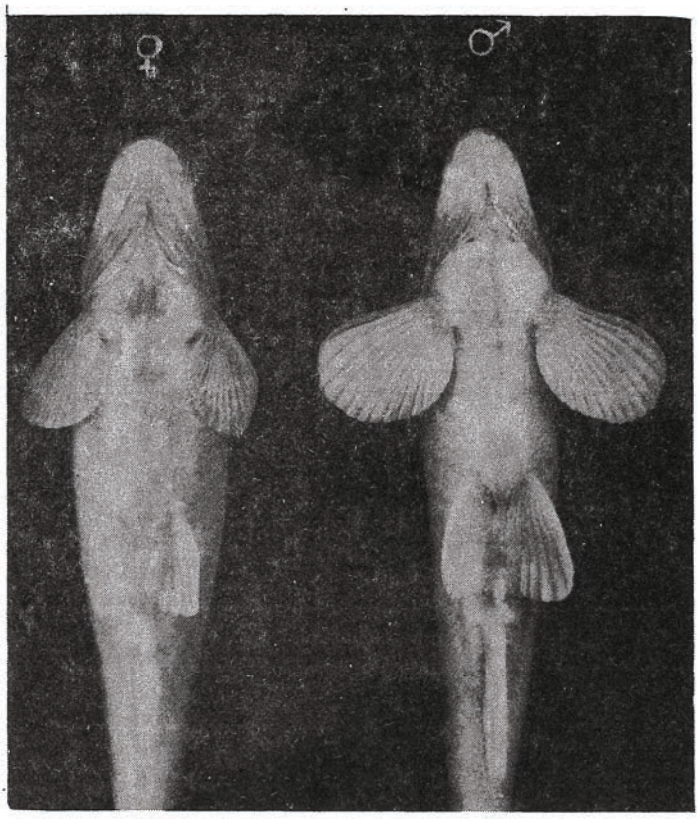

Fig. 2. *Phoxinus phoxinus*, female and male ventral viev

Kulamowicz and Jażdżewski (1970) as well as by Kulamowicz and Korkuć (1971) who studied samples from the Vistula catchment area. The observations indicate that the minima altitudo corporis: longitudo pedunculi caudae criterion for *Ph.phoxinus phoxinus* should be corrected; the criterion does not seem to be useful for defining *Ph.phoxinus ujmonensis.*

When compared to other Polish studies, the Skawa sample differs from that of the Sowlinka (Kulamowicz and Jażdżewski, 1970) and the Sufraganiec one (Kulamowicz and Korkuć, 1971) in the Skawa fishes having a shorter head; the ratios of summa longitudo P/P-V spatium and summa longitudo V/V-A spatium are different as well. Additionally, the Skawa fish caudal base is slightly higher and longer.

Worth mentioning is the fact of finding, in 18% of the Skawa *Ph.phoxinus* individuals, an increased number of hard rays (1 or 2 additional ones) in the caudal fin (Table 1). No similar observation is recorded in the available literature. It could be speculated that this

Table 4

Systematic characters relevant to subspecies of *Ph. phoxinus* as given by Berg (1949)

Subspecies / character	*Phoxinus phoxinus phoxinus* (Berg, 1910)	*Phoxinus phoxinus ujmoniensis* (Kaschtschenko, 1900)	*Phoxinus phoxinus colchicus* (Berg, 1910)
number of lateral line scales	80–92	88–102	–
dorsal fin	7 usually branched rays	7–7 branched rays	–
filtration processes	5–11	9–10	–
Abdomen scales	no scales		abdomen whole or almost whole covered with scales
longitudo corporis = 100			
summa altitudo corporis	17.0–24.5	–	21.0–26.0
minima altitudo corporis = 100			
latitudo basis pedunculi caudae	>100	= 100	<100
longitudo pedunculi caudae = 100			
minima altitudo corporis	25–34	28–38	42–46
geographical distribution	Europe and northern Asia	Altay Region in the Obi catchment area	Black Sea basin

strengthening of the caudal fin is associated with an adaptation to life in harsh environmental conditions in shallow water of a strong current. The anomaly was observed in both the females (55%) and males (45%).

CONCLUSIONS

1. The river Skawa *Phoxinus phoxinus* should be assigned to the nominal subspecies *Ph.phoxinus phoxinus* (L.).

2. The minima altitudo corporis/longitudo pedunculi caudae ratio in Berg's definition of *Ph.phoxinus phoxinus* (L.) should be corrected.
3. The Skawa sample fish show a considerable individual variability in the number of filtration processes and numerical relations in the pharyngeal teeth and caudal fins.
4. Morphological examinations should be carried out on equal numbers of females and males since, in view of the sexual dimorphism occurring, sex ratio can influence mean values of some characters.
5. When compared to other Polish populations of *Ph.phoxinus*, the Skawa sample shows no basic morphometric differences; some discrepancy being recorded in numerical relations in the filtration apparatus, pharyngeal teeth, and fins.

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MORFOLOGIA *PHOXINUS PHOXINUS* (L., 1758) (*PISCES, CYPRINIDAE*) Z RZEKI SKAWY

Streszczenie

Materiał zebrano w rzece Skawie w lipcu 1979 roku. Zbadano 21 cech wymierzalnych 50 osobników (25 samców i 25 samic) – tabela 2. Badając dymorfizm płciowy, stopień zróżnicowania oceniono przy pomocy wzoru:

$$d = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}$$ (tabela 3)

U samców płetwy piersiowe i brzuszne są dłuższe i silniej zbudowane (Ryc. 2). Samce mają ponadto wyższą i przesuniętą bardziej ku przodowi płetwę grzbietową i odbytową.

Analizę cech policzalnych wykonano w oparciu o 63 osobniki *Ph.phoxinus.* Stwierdzono następujące układy zębów gardłowych: 2.5–4.2 (55%), 2.4–4.2 (26%), 2.5–4.1 (5%), 2.5–4.3 (3%), 1.5–4.1 (3%), 2.4–3.2 (2%), 2.5–5.1 (2%), 1.5–5.2 (2%), 1.4–4.1 (2%). Liczba wyrostków filtracyjnych charakteryzowała się znaczną zmiennością i wynosiła (5) (6) 7–10 (11), średnio = 8,6. Liczebność promieni w płetwach jest następująca (Tabela 1.): D III 7(8), A III 7(8), V I(II) (6) 7 (8), P I (13) 14–17 (18), C I (II) (13) 14–17 (18) (II) I.

Ph. phoxinus z rzeki Skawy kwalifikuje się według kryteriów taksonomicznych Berga (1949) do podgatunku nominatywnego *Phoxinus phoxinus phoxinus* (L.). Porównując próbę ze Skawy z innymi populacjami *Ph. phoxinus* z obszaru Polski nie dostrzega się zasadniczych różnic w morfometrii, a jedynie stosunki ilościowe w aparacie filtracyjnym, zębach gardłowych i płetwach wykazują pewne różnice.

T. Хеесе

МОРФОЛОГИЯ PHOXINUS PHOXINUS (L.,1758) (PISCES, CYPRINIDAE) ИЗ РЕКИ СКАВЫ

Р е з ю м е

Материал собрали в реке Скаве в июле 1979 года. Исследовали 21 черт у 50 особей (25 самок и 25 самцов) - таб.2. Исследуя половой диморфизм степень дифференциации определяли по формуле:

$$d = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}$$

У самцов грудные и брюшные плавники длиннее и более сильно построены (рис.2). Кроме того, у самцов спинный и анальный плавники выше и более продвинуты вперёд. Анализ меристических признаков провели на 63 особъях Ph. phoxinus. Нашли следующую систему глоточных зубов: 2.5-4.2 (55%), 2.4-4.2

(26%), 2,5-4.1 (5%), 2,5-4.3 (3%), 1.5-4.1 (3%), ?,4-3.2 (2%), 2.5-5.1 (2%), 1,5-5.2 (2%), 1,4-4.1 (2%). Количество фильтрационных тычинок характеризовалось большей изменчивостью и составляло: (5) (6) 7-10(11), в среднем 8,6. Количество лучей в плавниках (таб.1): D III 7(8), A III 7(8), V I/II)(6)7(8), P I (13)14-17(18, C I(II) (13)14-17(18) (II) I.Ph. phoxinus из реки Скава можно зачислить по таксономическим критериям Берга(1949) как номинативный подвид Phoxinus phoxinus phoxinus (L.) . Сравнивая рыб из реки Скавы с другими популяциями Ph. phoxinus рек Польши нашли, что нет основных морфометрических различий а только количественные отношения в фильтрационном аппарате, глоточных зубах и плавниках показывают некоторые отличия.

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