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A PRELIMINARY BIOLOGICAL AND MORPHOMETRIC CHARACTERISTICS OF RIVER LAMPREY (*Lampetra fluviatilis* (L.)) FROM LAKE DABIE

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ABSTRACT

The river lamprey caught in Lake Dabie in the autumn seasons of 1997 (35 individuals) and 1998 (53 individuals) had mean individual weights of 145.1 and 139.3 g, respectively, their respective mean body lengths being 443.9 and 400.8 mm. The largest and the smallest individuals weighed 226.9 and 70.4 g, respectively. The post-dorsal lengths was the only plastic character, out of the 16 characters determined separately in females and males (sex ration of 2.1:1), which showed a substantial between-sexes difference.

Key words: river lamprey, autumn, length, weight, morphological variability.

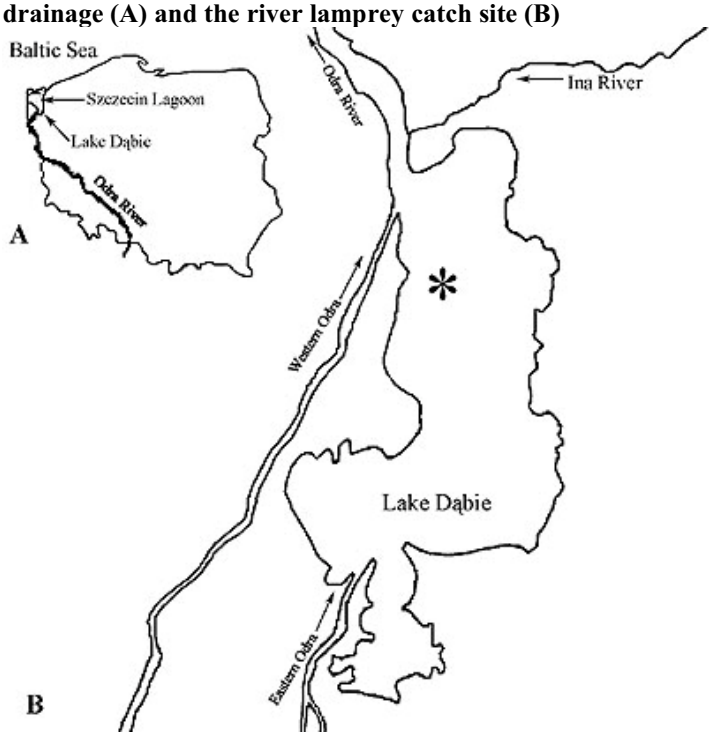
INTRODUCTION

The Polish inland waters harbour 4 cyclostomate species, the anadromous river lamprey being the best known of them [12]. Around mid-1880's, the lamprey was abundant in most rivers of the Odra, Vistula, Elbe, and Pomeranian basins. As late as in the 1930's, daily catches of up to 50 tonnes were not uncommon in the lower reaches of the Vistula [8]. According to Witkowski [15], sporadic records of the river lamprey are known at present from 13 water bodies, including the River Odra estuary consisting of, i.a., the Szczecin Lagoon and Lake Dabie. Prior to World War I, annual river lamprey landings amounted to 3200 kg [4], the 1990 Szczecin Lagoon catch being 450 kg only [1]. According to personal information supplied by professional fishermen operating in the Lagoon and the Lake, during the recent decade the river lamprey did occur in autumn catches, but the number of individual caught was gradually decreasing from year to year. The lack of detailed data on the river lamprey in the available literature has prompted this study, aimed at determining the basic biological (weight, length, sex ratio) and plastic characters in the river lamprey caught in Lake Dabie.

MATERIALS AND METHODS

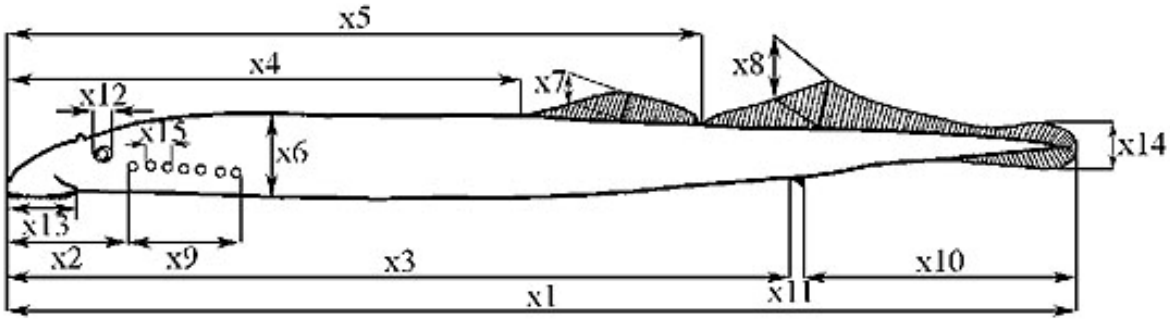
The analyses described in this paper were performed on two samples of river lamprey caught in autumn in Lake Dabie. The first sample, consisting of 35 individuals, was obtained on 5 November 1997, while the second sample of 53 individuals was collected on 16 October 1998. All the individuals were caught from the same site, 200 m away from the eastern shore of the lake, with traps deployed at 2.5 m depth (Fig. 1). The individuals caught were identified as river lamprey, based on a key published by Barus and Oliva [3] and on a set of criteria pertaining to the mouth sucker structure [14]. All the individuals were weighed to 0.1 g. In addition, two metric characters were determined on the individuals in the first sample: the total (x1) and pre-branchial (x2) lengths. The measurements were made on live individuals which were subsequently released back into the lake. The second sample consisted of dead individuals, for which reason it was possible to take 16 linear measurements from each, based on general principles described by Pravdin [11]. The lampreys were sexed after opening up the abdominal cavity.

Figure 1. Situation of Lake Dabie within the River Odra drainage (A) and the river lamprey catch site (B)



The measurements were taken, with electronic callipers, to 0.01 mm. The following plastic (metric) characters were determined: x1, body length; x2, pre-branchial length; x3, trunk length; x4, pre-dorsal length; x5, post-dorsal length; x6, body height; x7, DI height; x8, DII height; x9, branchial length; x10, tail length; x11, cloaca opening length; x12, eye diameter; x13, disc (sucker) diameter; x14, caudal fin height; x15, distance between gill apertures; x16, head width at the eye level (Fig. 2). The measurements were converted to per cent body length and treated statistically, for which purpose the mean ($\bar{x}$), standard deviation (SD), standard error of the mean (SE), and coefficient of variation (V) were calculated for each character. Correlations between the total length and body weight were determined and the regression coefficient was calculated. Statistical tests (STATISTICA computer package) were used to test for significance of differences in pre-branchial length (x2) between the samples. In the second sample, significance of differences in body proportions between males and females was tested for as well. Condition coefficients (Fulton coefficients, FC) were calculated for the two groups.

Figure 2. Linear measurements of the river lamprey. See text for explanations



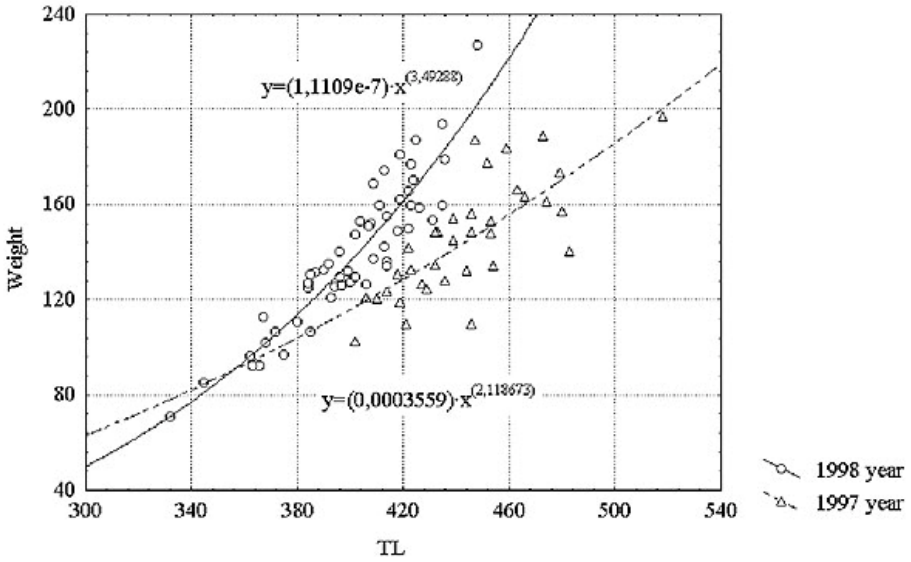
RESULTS

The data collected when measuring the lampreys, shown in Table 1 and Fig. 3, demonstrate rather considerable differences between the two samples. Those individuals caught in 1998 had a better condition as determined with the Fulton coefficient, their weights covered a broader range (the differences between the maximum and the minimum weights were 156.5 and 94.2 g in 1998 and 1997, respectively), and their mean total length was by 43.1 mm lower than in 1997.

Table 1. Length, weight, and correlation and condition coefficients for the river lamprey 1997 and 1998 samples

Item	1997				1998			
	TL (mm)	weight (g)	FC	n	TL (mm)	weight (g)	FC	n
Min	402.0	102.2	0.123	35	332.0	70.4	0.182	53
Max	518.0	196.4	0.209		448.0	226.9	0.252	
$\bar{x}$	443.9	145.1	0.165		400.8	139.3	0.213	
r	0.751				0.921			

Figure 3. The length-weight relationship in the two samples

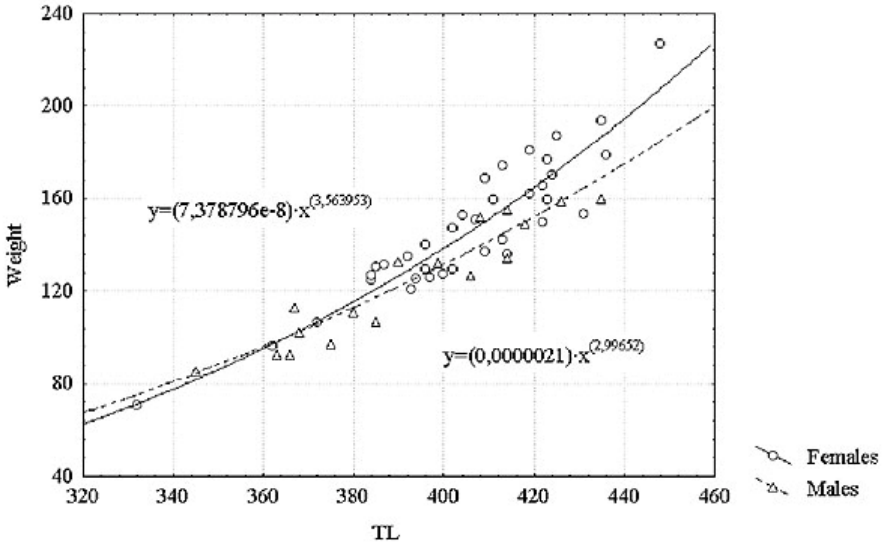


The sex (females to males) ratio in the 1998 group was 2.1:1. On the average, the females were by 19.2% heavier and by 13.4 mm longer than males, their condition coefficient being somewhat higher as well (Table 2, Fig. 4).

Table 2. Length, weight, and correlation and condition coefficients in the Lake Dabie river lamprey females and males

Item	Females				Males			
	TL (mm)	weight (g)	FC	n	TL (mm)	weight (g)	FC	n
Min	332.0	70.4	0.191	36	345.0	85.0	0.182	17
Max	448.0	226.9	0.252		435.0	159.5	0.227	
$\bar{X}$	405.1	146.9	0.218		391.7	123.2	0.202	
r	0.918				0.942			

Figure 4. The length-weight relationship in females and males caught in 1998



Of all the metric characteristics considered in the 1998 sample, it was the dorsal fin I and II heights (x7 and x8) only that showed high (>10) coefficients of variation, thus displaying a substantial plasticity (Table 3). Coefficients of variation calculated separately for the metric characters of males and females differed (Table 4). In the females, high coefficients of variation were recorded in the dorsal fin I height (x7) and the cloaca opening length (x11). On the other hand, the males were more variable in terms of their body proportions, as high values of V were recorded, in addition to the two character mentioned, also for the dorsal fin II height (x8), eye diameter (x12), caudal fin height (x14), and the distance between gill apertures (x15). On the other hand, the lowest V was recorded in both sexes in the trunk length (x3). Of the numerous non-parametric tests applied, the Wilcoxon and the Mann-Whitney U tests proved suitable for identifying characters which are most likely to aid in sex determination of the lamprey. Statistically significant between-sexes differences were detected in the following three metric characteristics: the post-dorsal length (x5), body height (x6), and tail length (x10) (Fig. 5).

Table 3. Metric characters of the Lake Dabie river lamprey 1998 sample

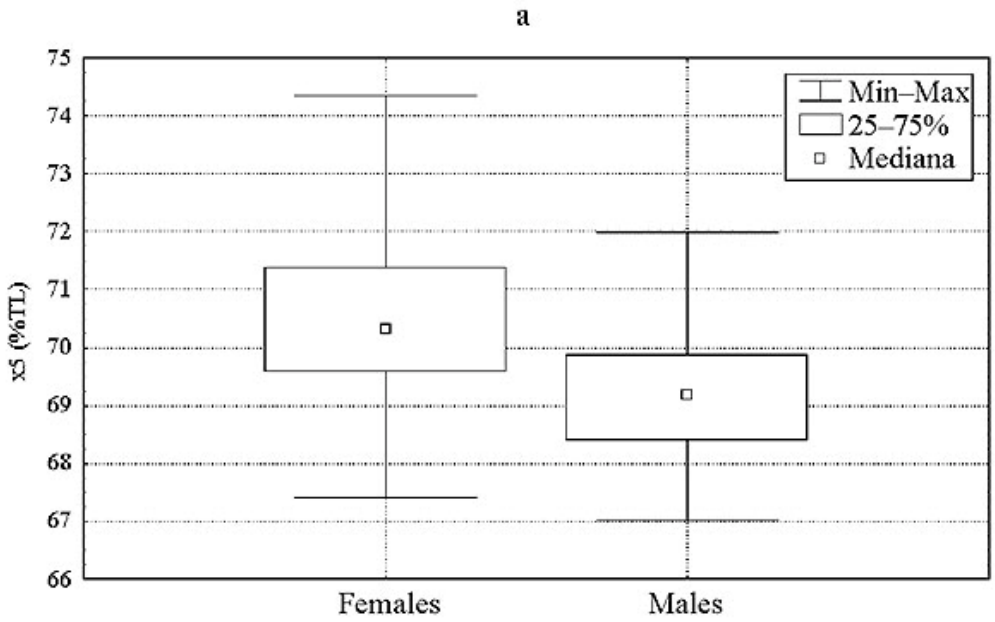
Character	% longitudo totalis (n = 53)					
	min	max	$\bar{x}$	SD	V	SE
x2	9.35	11.63	10.43	0.51	4.89	0.07
x3	71.23	76.47	73.89	1.19	1.62	0.16
x4	50.27	55.59	52.53	1.10	2.10	0.15
x5	67.01	74.35	70.12	1.65	2.36	0.23
x6	5.85	7.83	6.82	0.40	5.86	0.05
x7	1.30	2.33	1.76	0.22	12.69	0.03
x8	3.37	5.09	4.28	0.39	9.02	0.05
x9	8.84	10.67	9.78	0.40	4.08	0.05
x10	22.20	27.35	24.46	1.09	4.44	0.15
x11	0.96	2.11	1.40	0.24	17.50	0.03
x12	1.12	1.68	1.37	0.13	9.22	0.02
x13	3.55	4.92	4.16	0.35	8.32	0.05
x14	3.21	4.90	4.20	0.35	8.22	0.05
x15	1.28	1.81	1.55	0.13	8.62	0.02
x16	3.70	4.67	4.16	0.25	5.90	0.03

Table 4. Metric characters of the females and males found in the Lake Dabie river lamprey 1998 sample

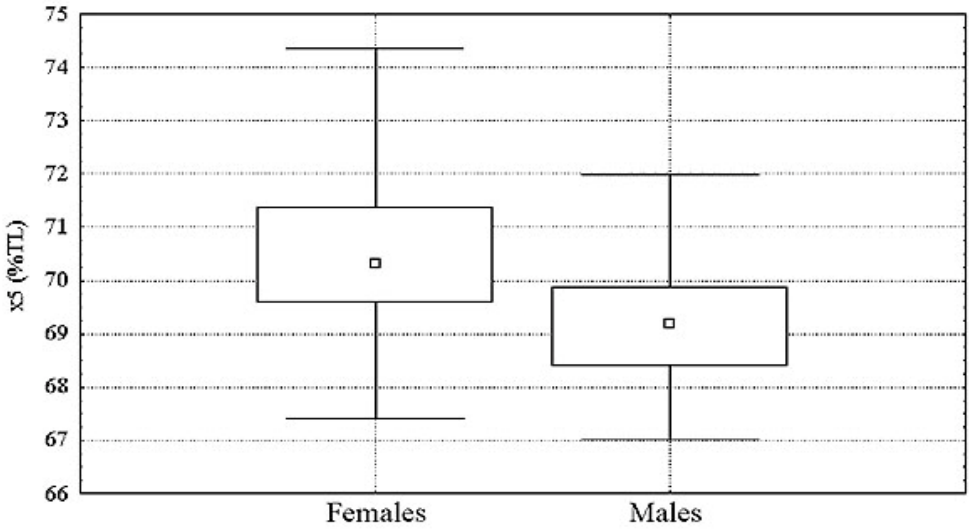
Cha-ra-cter	% longitudo totalis (n = 53)											
	females (n = 36)						males (n = 17)					
	min	max	$\bar{x}$	SD	V	SE	min	max	$\bar{x}$	SD	V	SE
x2	9.35	11.42	10.39	0.53	5.08	0.07	9.74	11.63	10.50	0.48	4.53	0.07

x3	71.23	76.47	74.04	1.13	1.53	0.16	71.26	75.62	73.58	1.29	1.75	0.18
x4	50.60	54.55	52.68	0.99	1.88	0.14	50.27	55.59	52.22	1.28	2.46	0.18
x5	67.41	74.35	70.52	1.62	2.30	0.22	67.01	71.98	69.27	1.42	2.05	0.19
x6	6.25	7.83	6.90	0.36	5.25	0.05	5.85	7.53	6.66	0.44	6.57	0.06
x7	1.34	2.33	1.77	0.20	11.18	0.03	1.30	2.26	1.75	0.28	15.82	0.04
x8	3.44	5.08	4.32	0.34	7.83	0.05	3.37	5.09	4.19	0.47	11.23	0.06
x9	9.16	10.67	9.83	0.37	3.79	0.05	8.84	10.51	9.70	0.45	4.64	0.06
x10	22.20	26.43	24.17	1.00	4.14	0.14	22.97	27.35	25.06	1.04	4.14	0.14
x11	1.02	2.11	1.44	0.27	18.64	0.04	0.96	1.51	1.31	0.16	11.95	0.02
x12	1.12	1.68	1.38	0.12	8.84	0.02	1.16	1.65	1.34	0.13	10.01	0.02
x13	3.66	4.92	4.19	0.35	8.38	0.05	3.55	4.91	4.10	0.34	8.22	0.05
x14	3.32	4.71	4.18	0.29	7.03	0.04	3.21	4.90	4.24	0.44	10.43	0.06
x15	1.28	1.76	1.55	0.12	7.78	0.02	1.31	1.81	1.55	0.16	10.45	0.02
x16	3.77	4.67	4.19	0.24	5.82	0.03	3.70	4.55	4.10	0.25	5.99	0.03

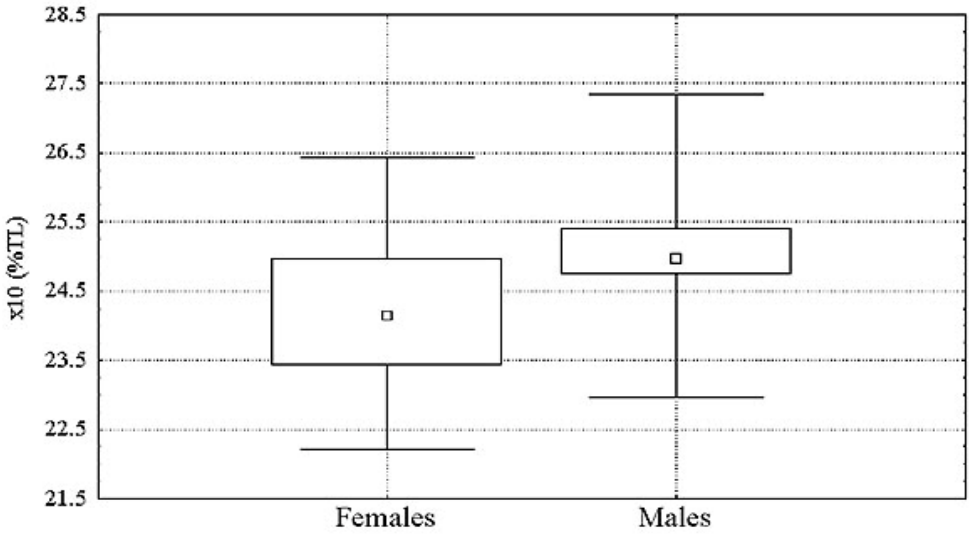
Figure 5. Statistically significant differences between males and females in: post-dorsal length, as found with the Mann-Whitney U test (a) and the Wilcoxon test (b); tail length, as found with the Mann-Whitney U test (c); and body height (Wilcoxon test)



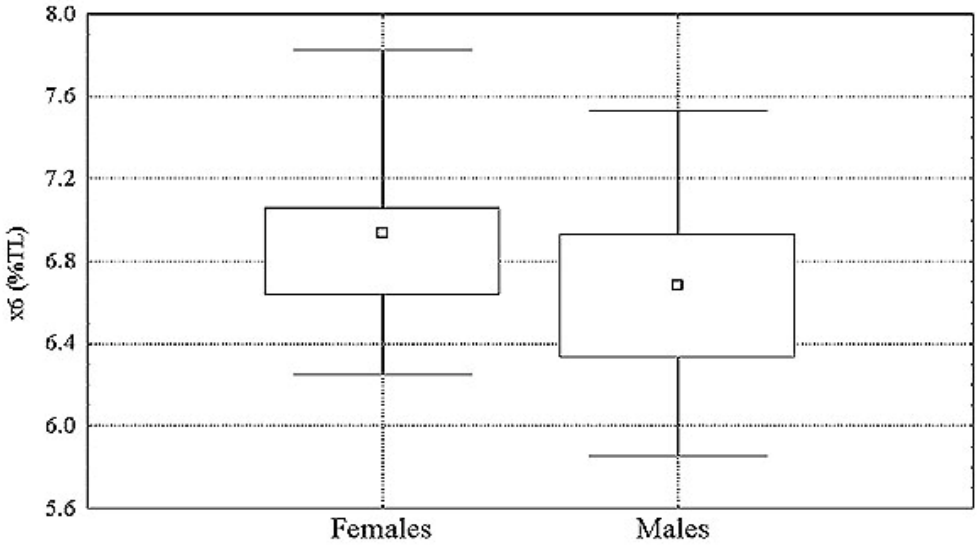
b


75
74
73
72
71
70
69
68
67
66
x5 (%TL)
Females
Males

c


28.5
27.5
26.5
25.5
24.5
23.5
22.5
21.5
x10 (%TL)
Females
Males

d

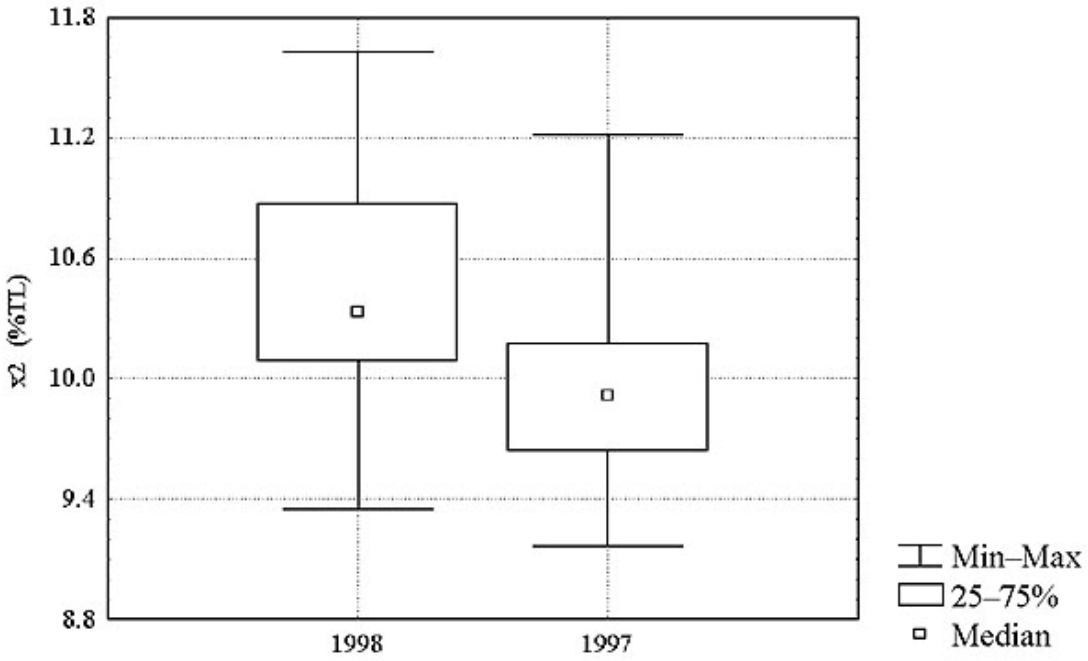

8.0
7.6
7.2
6.8
6.4
6.0
5.6
x6 (%TL)
Females
Males

One of the characters measured in 1997, i.e., the pre-branchial length (x2), showed a relatively low coefficient of variation (V=4.30). As demonstrated by the results of Student's t test, used to compare the 1997 and 1998 lamprey samples in terms of that character, the two samples differed significantly (Table 5; Fig. 6).

Table 5. Ranges of the pre-branchial length (x2) variability in the Lake Dabie river lamprey samples

Item	1998	1997
Min	9.35	9.16
Max	11.62	11.21
$\bar{x}$	10.42	9.92
SE	0.50	0.42
V	4.88	4.30
SD	0.07	0.07

Figure 6. Statistically significant difference between the 1997 and 1998 samples in the pre-branchial length (Student's t test)



DISCUSSION

The dates of capture indicate that the lampreys studied belonged to the so-called winter race [5]. Their gonads were advanced in development and occupied almost the entire abdominal cavity in females. That would suggest that the lampreys were caught while migrating to spawn, from the Baltic Sea upstream the River Odra estuary. As mentioned in the Introduction, the available Polish literature contains scant data on the basic size parameters of the river lamprey occurring in Polish waters. This has resulted, i.a., from the low abundance of the lamprey in Polish open waters, and from difficulties with catching the lamprey together with fish, the latter being most often caught with large-mesh gear of low selectivity towards

the former. Witkowski and Kuszewski [16] who worked in two Pomeranian rivers showed relatively large size differences between the autumn lamprey caught in River Grabowa (95 individuals) and River Drweca (37 individuals). Apart from differences in the total length (387.7 and 406.6 mm, respectively), the Drweca individuals were by 18%, on the average, heavier (139.8 g mean individual length). The Drweca lamprey mean individual weight was close to that of the 1998 Dabie individuals and lower than that of the 1997 Dabie lamprey.

The females studied in Lake Dabie and elsewhere were always longer (total length) and heavier than males. It is possible that the higher individual weight of the females resulted from their abdominal cavity being to a large extent filled with eggs.

Rolik and Rembiszewski [12] have stated, in rather general terms, that the river lamprey may grow up to 130 g individual weight and up to 428 mm body length. According to other authors [10, 13], the species may attain up to 450 mm and up to 150 g. However, as shown by the data obtained from Lake Dabie in 1997 as well as by some data on the Szczecin Lagoon lamprey, referred to by Bartel et al. [2], the species may grow to a size much larger than that described by the authors quoted (the largest individual measured 518 mm). According to Gaigalas and Matskevichus [6], the lamprey body size increases with salinity; the highest salinity is typical of the south-eastern Baltic where most probably the individuals caught in Lake Dabie originated from.

A comparison of mean values of several selected plastic characters (expressed as % l.t.) shows that the Lake Dabie lamprey body proportions were similar to the ranges given by other authors (listed in Table 6), the small differences found confirming the relatively high variability in body proportions of the lamprey caught in different areas. The only significant differences were those in the tail length (x10). The Dabie lampreys, particularly males, had shorter tails; the low coefficient of variation (V=4.14) of the tail length enhances the difference. A thorough analysis of the only paper dealing in detail with morphometry of the river lamprey in Poland [9] revealed two characters: the post-dorsal length (x5) and the DI height (x7), which were also definitely different in the Lake Dabie individuals: the latter characteristic was lower, while the former was higher. In addition, Kuszewski and Witkowski [9] found certain small differences in some characters (sucker diameter and the pre-dorsal, trunk, DII, and pre-branchial lengths) between lampreys caught from the Drweca, Grabowa, Parseta, and Wda. The authors quoted recorded also clear-cut sex-dependent differences in the post-dorsal length, which was also observed in the Lake Dabie individuals. It seems that the character in question may prove applicable when sexing live river lamprey, thus eliminating the need to open the abdominal cavity. According to Kuszewski and Witkowski [9], differences in some other characters (the pre-dorsal length, body height, and tail length) become more visibly sex-dependent just prior to spawning, that is in spring. It is interesting that those differences were visible in the Lake Dabie individuals as early as in autumn.

Table 6. Comparison of selected plastic characters between the Lake Dabie river lamprey population and populations from other areas

River Lake	Sex	n	Character							Author
			x2	x4	x8	x9	x10	x12	x13	
Arno	M	34	11.0	50.6	5.3	10.6	25.9	1.7	5.3	Zanandrea 1957
	F	26	11.1	51.2	5.0	10.7	25.1	1.7	5.4	
Ladoga	M	30	11.7	-	4.7	8.9	27.0	2.2	-	

	F	30	11.5	-	4.5	9.0	26.8	2.1	-	Ivanova-Berg 1966
Newa	M	30	10.2	-	4.2	10.2	27.6	1.2	-	Ivanova-Berg 1966
	F	30	10.3	-	4.2	10.3	27.2	1.2	-	
Drweca	M	51	10.5	52.0	6.0	10.3	27.8	1.6	4.1	Kuszewski, Witkowski 1995
	F	36	10.4	53.2	6.0	10.3	27.4	1.6	4.1	
Grabowa	M	24	9.7	53.3	6.0	10.0	27.1	1.6	4.5	Kuszewski, Witkowski 1995
	F	26	9.8	53.5	6.1	10.1	27.1	1.7	4.5	
Dabie Lake	M	17	10.5	52.2	4.2	9.7	24.2	1.3	4.1	this study 1999
	F	36	10.4	52.7	4.3	9.8	25.0	1.4	4.2	

The literature data on plastic characters as well as results of measurements taken on the Lake Dabie individuals point to a number of differences between different river lamprey populations, which is an evidence of the species displaying high plasticity in its body proportions. The plasticity is most likely an effect of wide variations of environmental conditions affecting the river lamprey.

CONCLUSIONS

1. A comparison of two populations of the river lamprey in Lake Dabie showed the individuals caught in autumn 1997 to have a higher mean total length and a higher individual weight.
2. The females to males ratio of 2.1:1, recorded in the 1998 sample, greatly exceeded that reported in the literature from other areas.
3. Morphometric analyses showed the females and males to differ in a number of characters, the difference in post-dorsal length being most conspicuous.

REFERENCES

1. Bartel R., 1993: Anadromous fishes in Poland. Bull. Sea Fish. Inst. Gdynia, 1: 3-15.
2. Bartel R., B. Bradauskas, F. Ikonen, A. Mitans, W. Borowski, A. Wesolowska, A. Witkowski, J. Blachuta, 1993: Comparison of length and weight of River lamprey from Finland, Latvia, Lithuania and Poland. Inter. Council Explor. Sea. Statutory meeting. Ref. J.
3. Baruš V., O. Oliva, 1995: Mihulovci a Ryby [Lampreys and fishes]. Academia, Praha, 9-90. (In Czech).
4. Elwertowski J., 1954: O minogu baltyckim – zapomnianej rybie [On river lamprey – a forgotten fish]. Gospodarka rybna, 6, 1: 10. (In Polish).
5. Erik V.A., 1957: Ob ozimych i jarovych rasach u rečnoj minogi *Lampetra fluviatilis* (L.) [On seasonal races of river lamprey *Lampetra fluviatilis* (L.)]. Vopr. Ichtiol., 9: 142-143. (In Russian).
6. Gaigalas G., A.P. Matskevichus, 1968: O nekotorych osobennostiach i vozmožnostiach promysla rečnoj minogi *Lampetra fluviatilis* (L.) v basseinie r. Niamunas [On some peculiarities and possibilities of fishing for river lamprey *Lampetra fluviatilis* (L.) in the basin of River Nyamunas]. Vopr. Ichtiol., 8:216-224. (In Russian).
7. Ivanova-Berg M.M., 1966: Morfologičeskie otličia ladožskoj minogi ot nevskoj. [Morphological distintions of Ladoga and Neva lampreys]. Vopr. Ichtiol., 6: 561-566. (In Russian).
8. Jokiel J., 1983: Lampreys in Poland. Bull. Sea Fish. Inst. Gdynia, 1-2: 18-22.
9. Kuszewski J., A. Witkowski, 1995: Morphometrics of the autumn spring run populations of the river lamprey, *Lampetra fluviatilis* (Linnaeus, 1758) from the Polish rivers. Acta Ichtiol. Pisc., 25, 1: 57-69.

10. Nikolski G., 1970: Ichtiologia szczegolowa [Detailed ichthyology]. PWRiL, Warszawa, 48-56. (In Polish).
11. Pravdin I.F., 1966: Rukovodstvo po izučeniju ryb [Guide to fish biometry]. Piszczevaja Promyslennost, Moskwa, 77-79. (In Russian)
12. Rolik H., J.M. Rembiszewski, 1987: Ryby i kraglouste [Fishes and cyclostomates]. PWN, Warszawa, 79-82. (In Polish).
13. Sterba G., 1952: Die Neunaugen [The Lampreys]. AVG, Leipzig, 1-40. (In German)
14. Vladykov V.D., 1967: The teeth of lampreys (*Petromyzonidae*): their terminology and use in a key to the holarctic genera. J. Fish. Res. Bd. Canada, 24, 5: 1067-1075.
15. Witkowski A., 1996: Zmiany rozsiedlenia oraz przyczyny zaniku minoga rzecznego, *Lampetra fluviatilis* (L.) w Polsce [Changes in distribution of the river lamprey, *Lampetra fluviatilis* (L.) in Poland and the reasons for the species decline]. Zoologica Poloniae, 41/supl.: 93-98. (In Polish)
16. Witkowski A., J. Kuszewski, 1995: Characteristics of the population of *Lampetra fluviatilis* (L.) entering the Drweca and Grabowa rivers (North Poland). Acta Ichtiol. Pisc., 25, 1: 49-56.
17. Zanandrea G., 1959: Esame critico e. comparativo delle lamprede catturata in Italia. Archiv. Zool. Ital., 42: 249-307.

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