ACTA ICHTHYOLOGICA ET PISCATORIA
Vol. XXII Fasc 2 SZCZECIN 1992

Beata WIĘCASZEK

Ichthyology

BIOMETRIC CHARACTERISTICS OF BALTIC EEL-POUT *ZOARCES VIVIPARUS* (L.) FROM THE POMERANIAN BAY

CHARAKTERYSTYKA BIOMETRYCZNA BAŁTYCKIEJ WĘGORZYCY *ZOARCES VIVIPARUS* (L.) Z ZATOKI POMORSKIEJ

Department of Fish Systematics

The present paper describes biometric characters of eel-pout, *Zoarces viviparus* (L.) involving 28 metric and 12 meristic features. 208 specimens were examined with regard to both sexes. The materials studied was collected in May 1988, in the Pomeranian Bay. Furthermore, the problem of sex dimorphism in the species, as well as the degree of water salinity – vertebral count relationship were discussed.

INTRODUCTION

The eel-pout *Zoarces viviparus* (L.) belonging to the family *Zoarcidae* (ordo: *Perciformes*) is a common species inhabiting litoral and sublitoral zone of the Baltic Sea. The fish can be regarded as poorly known what is presumably associated with the lack of interest in the fish market. It is generally assumed that the eel-pout is not highly estimated food fish (Plorina, Ruus, 1972) owing to its specific appearance, mucus-covered body and green coloured bones.

The species is also parasitically infected in high degree, the nematoda *Thynnascaris adunca* being the most abundant (but not dangeorous for human (Graś-Wawrzyniak, 1977). The flesh of eel-pout is of a good taste demonstrating pretty high level of protein (16.3–18.4%) and fat (3.4–7%) (Plorina, Ruus, 1972).

Up to 1939 the eel-pout was being caught in the Puck Bay, the highest catches were noted for 1933 (111 t); then they were regularly decreasing to ca 10t in 1978–79 (Klimaj, Rutkowicz, 1970, Kuczyński, 1980). Nowadays there is a lack of fishery statistics concerned this species; as fishermen's reports showing an eel-pout as a by-catch of low value (due to low prices in the fish market) are thrown away overboard.

But the species, however, considering the over-catching of so far commercially exploited stocks, may soon become of big importance to fisheries of its mass occurence and good quality of flesh.

The literature on the eel-pout is scarce so far. Only the eel-pout parasitic fauna was dealt with (Graś-Wawrzyniak, 1977), as well as age and growth rate were investigated by Wójcik (1986) and Kłudczyńska (1989). Andrijašev (1954), Tanasijčuk (1970) and Kuczyński (1980) provided some data on the biology of the species. The eel-pout is also an object of physiological study with respect to its viviparous reproduction (Kristofferson, Oikari, 1975). The problem of metals and polychloric compounds' content in the eel-pout tissues was dealt with by Falandysz (1984). Ševcov and Kostromina (1983) gave the eel-pout fishing characteristics, while in Plorina, Ruus (1972) one can meet the technological description.

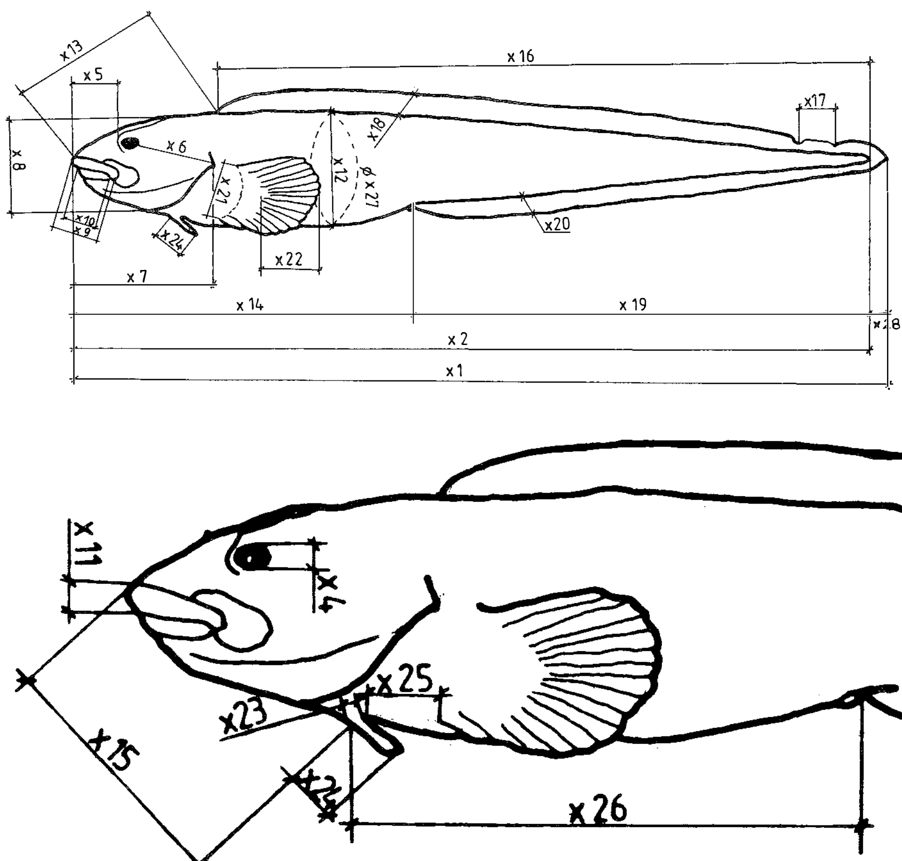


Fig. 1 and 1a. Diagram of metric character measurements

The issue of vertebral count in this species is discussed in some papers, too; the eel-pout shows a tendency to form local races, vertebrae number being belived as a race – differentiating character (Andrijašev, 1954; Meisner, 1948).

But a lack of full biomorphometric characteristics calls for more detailed one, the present paper being an attempt to gain more insight into the issue mentioned above.

MATERIALS AND METHODS

The materials under study consisted of 208 specimens of eel-pout (119 females and 88 males), caught in D2 sector of West Baltic, at the depth of 14 m (over the sandy ground), in May, 1988. The materials were collected by fishing vessel from the Cooperation of Fishery Work "Belona" in Dziwnów.

The biometric analysis was made involving 29 measurements (with the accuracy to 0.1 cm) and determination of 12 meristic features made on each fish. The measurements design shown in Fig. 1 given by Brylińska (1986) for perch-like fish was markedly modified.

In this paper the relationship between the characters examined and of body or head length is presented in terms of relative values expressed as per cent of the basic dimension. Such a treatment of results obtained was applied, because it must be remembered that proportions of fish body change with respect to fish age (what resulted from the change of fish diet and reaching sexual maturity).

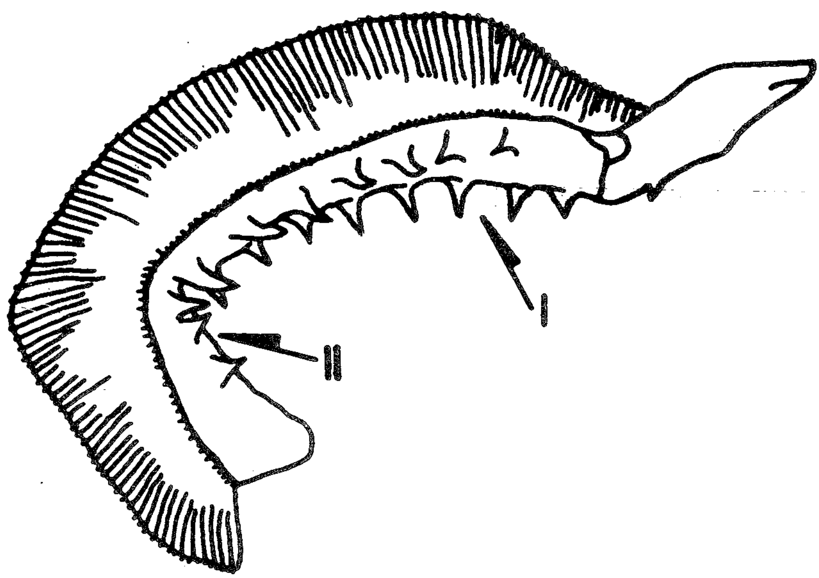


Fig. 2. Gill arch of the eel-pout with two rows of gill rakers. (Following a photograph by K. Radziun)

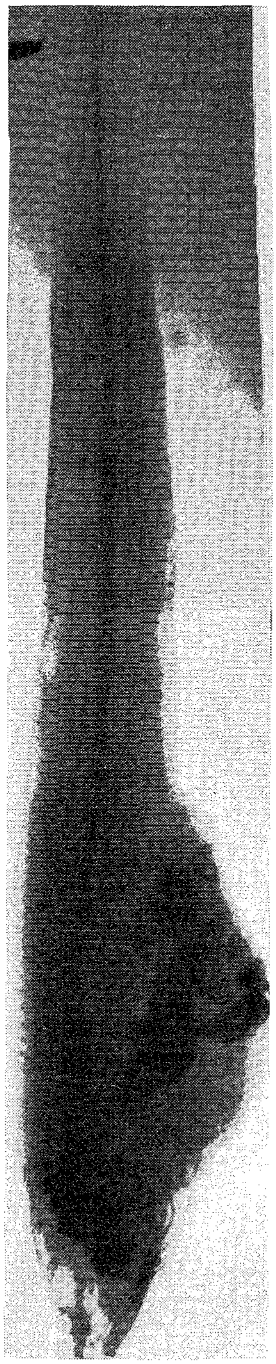


Fig. 3. X-ray radiogram of the eel-pout

The following meristic characters were determined: the vertebral count, rays count (in dorsal, anal, ventral and pectoral fins), number of gill rakers on the first gill arch (in first and second rows-Fig. 2), rays count in suboperculum membrane and the number of dark spots on the left side of fish body.

The eel-pout skin is provided with small scales, hidden deeply in the skin and counting them may be dismissed as highly improbable. In order to count the number of vertebrae and fin rays the X-ray radiograms were made; however all measurements were possible to make only on few of them (Fig. 3). Hence the thermal treatment was applied, making easy the determination of issues mentioned above.

Ruszczyc (1981) states that coefficients of variation are statistically significant when they amount to 8–10% only: thus characters yielding coefficient of variation below 10% are considered to be of low plasticity, within the range of 10–15 are considered to be of middle plasticity, while those of 15% up are of high plasticity.

In order to find out if an eel-pout possesses the caudal fin (or dorsal and anal fins are joined together), the treatment of caudal part with xylene was taken.

This method was found as feebly suitable, as the rays of fins became too much transparent (Fig. 4). The positive answer was given when the alizarin method was applied (Taylor, 1967), resulting purple coloured eel-pout skeleton with very well visible pattern of fins rays (included the caudal one) (Fig. 5).

The results obtained in biometric characters were treated statistically; standard deviation, coefficient of variation and standard error were estimated.

In order to determine the external sex dimorphism in this species, Student's t test (Greń, 1978) was used to verify the H_0 hypothesis assuming a lack of differences between males and females mean values.

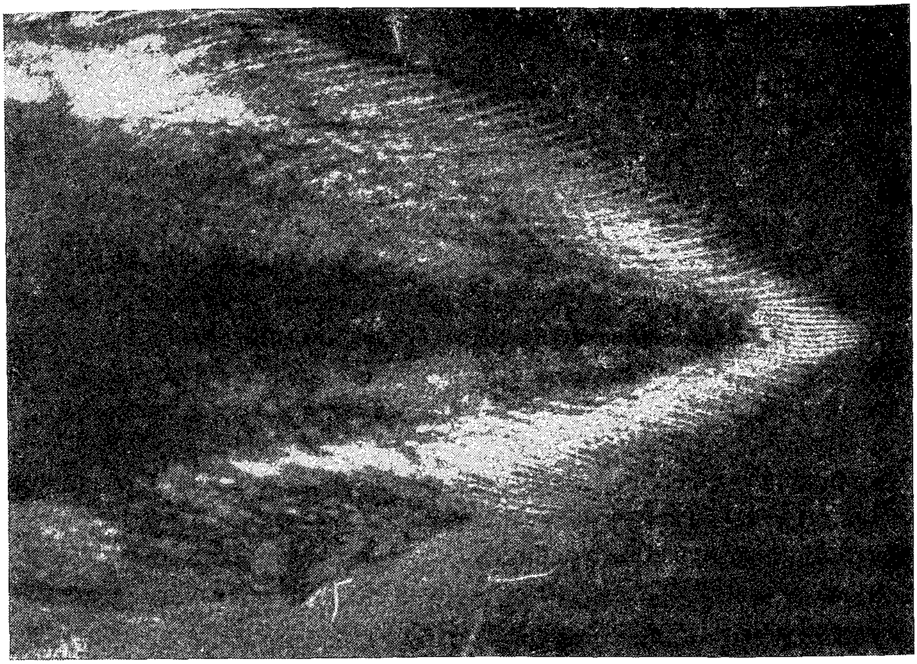
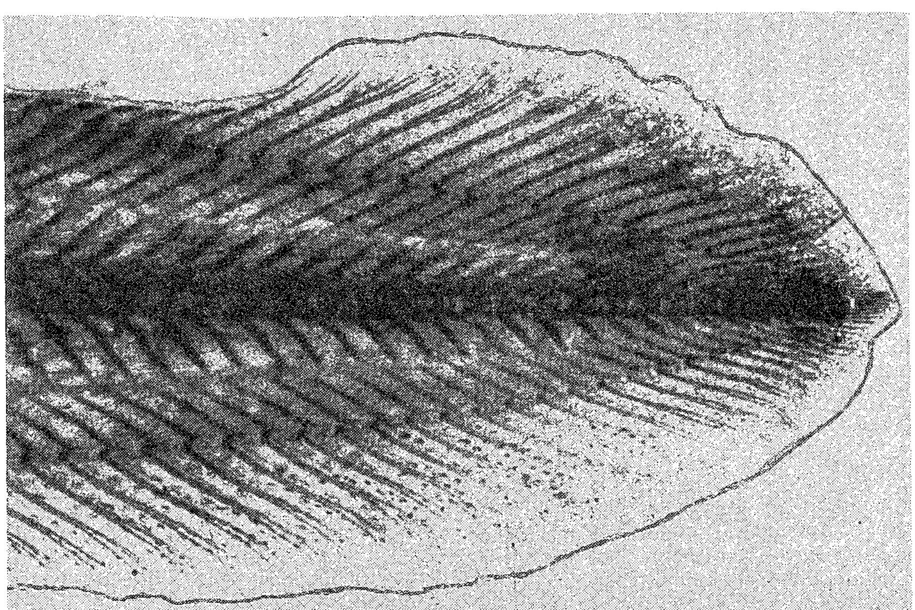


Fig. 4. Caudal part of the eel-pout body, treated with xylene (photo by K. Radziun)



Rys. 5. Caudal part of the eel-pout body alizarin-stained (photo by K. Radziun)

RESULTS

The materials studied consisted of 119 females (contributing 57.5% to whole sample) and 88 males (42.5%). The total length covered the range from 22.7 to 39.6 cm, both for whole sample and females, while in males from 25.2 to 39.0 cm; the mean was higher in males – 30.99 cm (females – 30.34 cm) (Fig. 6).

Table 1 summarises relative values of metric characters (i.e. to the body length – l. corporis) in the whole material. As seen from the table, values of coefficients of variation demonstrate most characters (55.6%) being low plastic. The value of coefficient of variation 10–15% was stated for the following characters: the vertical eye diameter, preorbital distance, upper and lower jaws length, base and length of ventral fin and distance between ventral and pectoral fins. Mentioned 8 characters contributing 29.6% to total features count. There are 4 characters (14.8%) only of high plasticity (i.e. coefficient of variation exceeding 15%), namely the length of "depression" base in dorsal fin, height of dorsal fin and caudal fin length.

The metric features pertinent to the cephalic part of body (expressed in % of head length) are presented in Table 2. As can be seen 50% of characters may be regarded as of low plasticity (preorbital and postorbital distance, height of head and lower jaw length), when 50% (vertical and horizontal eye diameter, length and width of upper jaws) are of a middle plasticity. In females (Table 3) seventeen biometric cha-

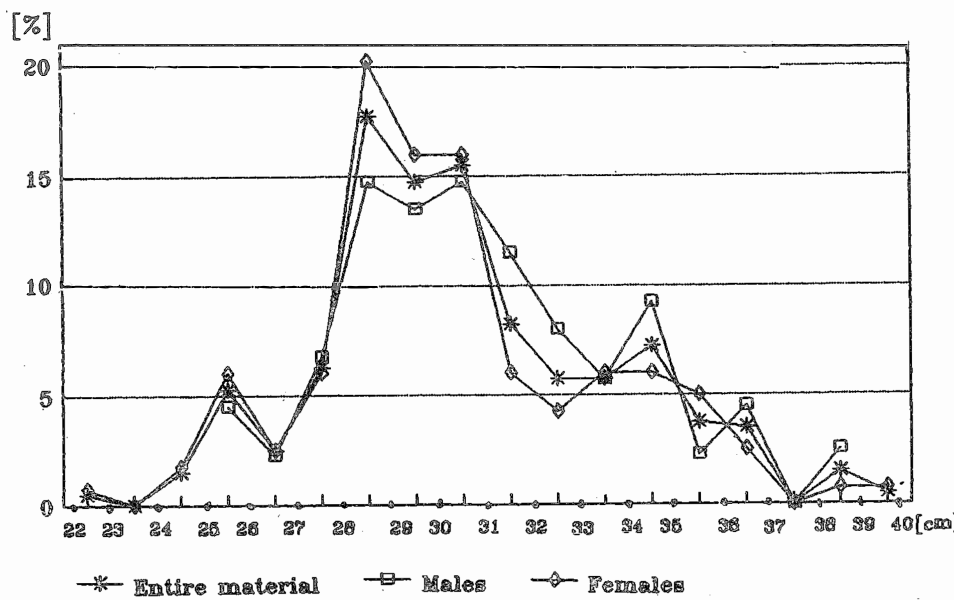


Fig. 6. Length distribution in the sample examined, with respect to both sexes

Table 1

Metric characters of eel-pout (*Zoarces viviparus* (L.)) from the Pomeranian Bay, in % of longitudo corporis (n = 208)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
x_1	98.8–104.3	100.97	0.03	0.45	0.44
x_2	100	100.00	0.00	0.00	0.00
x_3	2.2– 3.7	2.90	0.02	0.28	9.64
x_4	1.8– 3.2	2.50	0.02	0.26	10.53
x_5	3.3– 7.1	4.83	0.04	0.54	11.09
x_6	7.7–13.1	10.48	0.06	0.81	7.76
x_7	14.5–20.0	16.94	0.07	1.05	6.21
x_8	7.9–13.7	11.11	0.07	0.95	8.51
x_9	5.7–14.7	7.57	0.08	1.12	14.76
x_{10}	4.9–10.4	6.93	0.06	0.90	13.03
x_{11}	1.0– 2.3	1.61	0.02	0.22	13.79
x_{12}	11.9–18.1	14.81	0.09	1.24	8.37
x_{13}	12.6–20.0	15.82	0.08	1.13	7.14
x_{14}	31.1–46.3	40.25	0.13	1.92	4.77
x_{15}	9.6–16.1	12.38	0.08	1.17	9.46
x_{16}	64.8–89.8	82.35	0.18	2.55	3.10
x_{17}	2.5– 6.9	4.16	0.05	0.72	17.42
x_{18}	2.5– 6.4	4.54	0.05	0.71	15.69
x_{19}	44.2–61.8	57.22	0.14	1.96	3.42
x_{20}	2.0– 6.0	3.45	0.04	0.62	17.95
x_{21}	3.6– 7.4	5.28	0.03	0.48	9.00
x_{22}	9.2–14.3	10.84	0.05	0.71	6.58
x_{23}	0.5– 1.2	0.87	0.09	0.13	14.51
x_{24}	1.4– 4.7	3.55	0.03	0.44	12.48
x_{25}	2.6– 5.9	3.74	0.04	0.53	14.20
x_{26}	25.5–35.4	29.99	0.12	1.70	5.68
x_{27}	33.0–48.3	40.38	0.21	2.98	7.37
x_{28}	0.3– 2.2	0.94	0.02	0.28	29.24

Table 2

Metric characters of eel-pout (*Zoarces viviparus* (L.)) head in % of longitudo capitis lateralis (n = 208)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
x_3	12.1–21.8	17.14	0.12	1.78	10.41
x_4	9.7–19.3	14.82	0.12	1.73	11.68
x_5	21.0–36.7	28.52	0.17	2.50	8.78
x_6	43.9–74.4	61.92	0.26	3.76	6.07
x_7	100	100	0.00	0.00	0.00
x_8	45.6–84.0	65.74	0.40	5.76	8.76
x_9	35.9–90.0	44.60	0.36	5.12	11.48
x_{10}	28.8–54.8	40.84	0.27	3.94	9.64
x_{11}	6.4–14.6	9.50	0.09	1.26	13.24

racters (expressed in % in relation to the body length) showed the coefficient of variation values lower than 10% (62.9% of all characters studied). Characters of a middle plasticity are as follows: the vertical eye diameter, length and width of upper jaw, height of dorsal and ventral fins and distance between pectoral and ventral fins (22.2% of total features studied). The following features (14.8%) were considered as to be of high plasticity: the length of "depression" base in dorsal fin, height of anal fin, length of ventral fin base and length of caudal fin.

Females showed, like in the entire material studied (Table 4), the same metric characters pertinent to the head (expressed as the per cent indices – relative values) belonging to the group of low and middle plasticity.

When discussing metric characters of eel-pout males (Table 5) expressed in relative values, as low plastic 15 characters (53.6%) are found out. There were 8 (28.6%) features regarded to be of middle plasticity: the preorbital distance, length and height of upper jaw, length of lower jaw, preventral distance, height of dorsal fin, base length and height of ventral fin. The analysis showed 4 characters (14.3%) being of high plasticity: base length of "depression" in dorsal fin, height of anal fin, distance between ventral and pectoral fins and length of caudal fin.

Table 6 summarises the metric characters pertinent to cephalic part in relation to the head length in males. Five of features mentioned can be regarded as low plastic, while 3 (the horizontal and vertical eye diameter, width of upper jaw) being of middle plasticity.

Table 3

Metric characters of eel-pout (*Zoarces viviparus* (L.)) females in % longitudo corporis
(n = 120)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
x_1	98.8–102.3	100.96	0.03	0.35	0.35
x_2	100	100.00	0.00	0.00	0.00
x_3	2.2– 3.7	2.86	0.03	0.28	9.86
x_4	1.9– 3.2	2.47	0.02	0.26	10.64
x_5	3.3– 5.9	4.86	0.04	0.45	9.53
x_6	8.2–13.1	10.37	0.07	0.74	7.12
x_7	14.5–20.0	16.55	0.08	0.93	5.63
x_8	9.2–13.4	11.09	0.08	0.88	7.97
x_9	5.7–14.7	7.10	0.09	0.96	13.57
x_{10}	4.9– 8.5	6.51	0.06	0.65	9.92
x_{11}	1.0– 2.3	1.56	0.02	0.22	13.91
x_{12}	11.9–18.1	14.89	0.12	1.26	8.47
x_{13}	13.4–20.2	15.73	0.09	0.98	6.20
x_{14}	31.3–47.0	40.78	0.19	2.10	5.15
x_{15}	9.7–14.9	12.12	0.08	0.92	7.59
x_{16}	66.2–90.5	83.45	0.23	2.56	3.07
x_{17}	2.5– 7.0	4.27	0.07	0.77	18.07
x_{18}	2.5– 5.9	4.38	0.06	0.65	14.94
x_{19}	44.6–63.1	57.56	0.20	2.15	3.74
x_{20}	2.0– 6.1	3.43	0.06	0.67	19.58
x_{21}	4.0– 7.4	5.28	0.04	0.49	9.23
x_{22}	9.2–12.7	10.81	0.06	0.64	5.90
x_{23}	0.5– 1.2	0.86	0.01	0.13	15.04
x_{24}	2.6– 4.8	3.57	0.04	0.39	10.88
x_{25}	2.7– 5.6	3.76	0.05	0.50	13.38
x_{26}	27.2–35.9	30.83	0.14	1.57	5.09
x_{27}	34.5–48.8	40.97	0.27	2.93	7.15
x_{28}	0.4– 2.3	0.98	0.03	0.30	30.79

Table 4

Metric characters of eel-pout (*Zoarces viviparus* (L.)) females head in % of longitudo capitis lateralis
(n = 120)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
x_3	12.1–21.8	17.30	0.17	1.83	10.56
x_4	11.4–19.3	14.87	0.16	1.72	11.49
x_5	21.0–36.4	28.29	0.22	2.46	8.68
x_6	48.3–74.4	62.69	0.31	3.44	5.48
x_7	100	100.00	0.00	0.00	0.00
x_8	56.3–84.0	67.14	0.49	5.33	7.94
x_9	35.9–90.0	42.94	0.49	5.37	12.51
x_{10}	28.8–47.7	39.34	0.30	3.28	8.34
x_{11}	6.5–14.6	9.46	0.12	1.32	14.00

Table 5

Metric characters of eel-pout (*Zoarces viviparus* (L.)) males in % of longitudo corporis
(n = 87)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
1	2	3	4	5	6
x_1	100.3–104.3	101.02	0.06	0.56	0.56
x_2	100	100.00	0.00	0.00	0.00
x_3	2.3– 3.5	2.90	0.03	0.27	9.66
x_4	1.8– 3.0	2.52	0.03	0.26	9.79
x_5	3.3– 7.1	4.96	0.06	0.55	11.33
x_6	7.7–13.0	10.67	0.09	0.87	7.31
x_7	14.5–19.6	17.35	0.11	1.00	5.81
x_8	9.2–13.4	11.15	0.09	0.88	8.10
x_9	6.0–11.7	8.05	0.11	1.06	13.89
x_{10}	5.9–10.4	7.41	0.10	0.92	13.44
x_{11}	1.2– 2.2	1.63	0.02	0.21	14.88
x_{12}	12.1–17.4	14.65	0.12	1.09	7.26
x_{13}	12.7–19.5	16.35	0.13	1.22	7.24
x_{14}	32.9–47.0	40.69	0.22	2.02	4.69
x_{15}	10.2–16.2	12.98	0.14	1.36	11.65
x_{16}	65.2–88.7	82.89	0.28	2.63	3.15

continued tabl. 5

1	2	3	4	5	6
x_{17}	2.5– 5.6	4.12	0.07	0.66	20.44
x_{18}	2.8– 6.5	4.86	0.08	0.70	14.46
x_{19}	52.5–62.4	57.97	0.18	1.72	3.04
x_{20}	2.0– 4.9	3.54	0.06	0.58	17.96
x_{21}	3.7– 6.4	5.36	0.05	0.44	7.75
x_{22}	9.3–14.5	11.07	0.09	0.80	7.14
x_{23}	0.6– 1.2	0.90	0.01	0.12	11.65
x_{24}	1.4– 4.8	3.60	0.05	0.51	11.50
x_{25}	2.6– 5.1	3.83	0.06	0.58	19.40
x_{26}	27.0–35.9	30.04	0.18	1.72	5.51
x_{27}	33.2–48.7	40.26	0.31	2.92	6.78
x_{28}	0.3– 2.3	0.94	0.03	0.29	24.06

Table 6

Metric characters of eel-pout (*Zoarces viviparus* (L.)) males head in % of longitudo capitis lateralis
(n = 87)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (±s)	Coefficient of variation (V)
x_3	12.3–20.6	16.77	0.18	1.68	10.34
x_4	9.7–17.8	14.57	0.18	1.73	11.43
x_5	22.7–36.7	28.56	0.26	2.44	8.74
x_6	43.9–68.6	61.54	0.43	4.00	5.83
x_7	100	100.00	0.00	0.00	0.00
x_8	50.9–78.4	64.40	0.60	5.59	8.90
x_9	36.5–60.3	46.24	0.44	4.12	9.32
x_{10}	36.0–54.8	42.66	0.42	3.94	9.98
x_{11}	6.7–12.8	9.40	0.12	1.12	13.75

Symbols used in measurements design as well as in Tables 1,2,3,4,5,6.
x_1 – total length, x_2 – body length, x_3 – horizontal eye diameter, x_4 – vertical eye diameter, x_5 – preorbital length, x_6 – postorbital length, x_7 – head length, x_8 – head height, x_9 – length of upper jaw, x_{10} – length of lower jaw, x_{11} – width of upper jaw, x_{12} – maximal body height, x_{13} – antedorsal length, x_{14} – preanal length, x_{15} – preventral length, x_{16} – length of the base of dorsal fin, x_{17} – length of the base of "depression" in dorsal fin, x_{18} – height of dorsal fin, x_{19} – length of the base of anal fin, x_{20} – height of anal fin, x_{21} – length of the base of pectoral fin, x_{22} – height of pectoral fin, x_{23} – length of the base of ventral fin, x_{24} – height of ventral fin, x_{25} – distance between pectoral and ventral fin, x_{26} – distance between ventral and anal fin, x_{27} – body length in the circle, x_{28} – length of caudal fin.

Analysis of meristic characters

Meristic characters of eel-pout studied are presented in Tables 7, 8 and 9 (in the entire material, females and males respectively).

Table 7

Meristic characters of eel-pout (*Zoarces viviparus* (L.)) from the Pomeranian Bay. (n = 208)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
SN	12–23	17.99	0.14	2.04	11.31
D'	58.0–85.0	71.59	0.38	5.54	7.74
D''	9.0–20.0	13.39	0.15	2.12	15.86
D	69.0–102.0	84.94	0.45	6.54	7.70
D'''	VI–XII	8.76	0.09	1.24	14.14
A	60.0–89.0	71.82	0.38	5.42	7.55
P	16.0–21.0	18.53	0.07	1.00	5.37
V	3.0	3.0	0.00	0.00	0.00
sp. branch I rz.	10.0–18.0	14.02	0.11	1.60	11.39
sp. branch II rz.	8.0–15.0	11.84	0.08	1.17	9.85
r. branch	4.0– 8.0	5.59	0.04	0.62	11.10
vt.	105–125	116.42	0.22	3.25	2.79

Table 8

Meristic characters of eel-pout (*Zoarces viviparus* (L.)) females (n = 120)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (±s)	Coefficient of variation (V)
SN	12–23	17.90	0.22	2.05	11.44
D'	58.0–85.0	71.46	0.60	5.55	7.77
D''	10.0–20.0	13.44	0.20	2.17	16.14
D	69.0–102.0	84.84	0.60	6.58	7.76
D'''	VI–XI	8.76	0.12	1.28	14.55
A	60.0–85.0	71.81	0.51	5.56	7.75
P	16.0–21.0	18.47	0.09	0.94	5.10
V	3.0	3.0	0.00	0.00	0.00
sp. branch I rz.	11.0–17.0	14.05	0.13	1.46	10.39
sp. branch II rz.	8.0–15.0	11.68	0.13	1.22	10.40
r. branch	4.0–7.0	5.54	0.06	0.63	11.42
vt.	105.0–125.0	116.27	0.33	3.66	3.15

Table 9

Meristic characters of eel-pout (*Zoarces viviparus* (L.)) males

(n = 87)

Character	Character range (%)	Arithmetic mean (M)	Standard error (±m)	Standard deviation (± s)	Coefficient of variation (V)
SN	12–23	18.07	0.22	2.06	12.84
D'	60.0–85.0	72.56	0.59	5.47	7.50
D"	9.0–18.0	13.28	0.21	2.00	15.37
D	70.0–98.0	85.84	0.70	6.50	7.55
D'''	VI–XII	8.77	0.13	1.20	15.04
A	62.0–89.0	72.55	0.57	5.29	8.02
P	16.0–21.0	18.58	0.11	1.03	5.42
V	3.0	3.0	0.00	0.00	0.00
sp. branch I rz.	10.0–18.0	14.02	0.18	1.68	13.99
sp. branch II rz.	9.0–15.0	12.15	0.11	1.06	8.84
r. branch	4.0– 8.0	5.65	0.07	0.62	12.45
vt.	110.0–124.0	116.63	0.30	2.82	2.52

Symbols used in Tables 7, 8, 9

SN – spots' number in the first row, D' – number of soft rays in dorsal fin (before "depression"), D" – number of soft rays in dorsal fin (behind "depression"), D – total number of soft rays in dorsal fin, D''' – number of hard rays in dorsal fin, A – number of rays in anal fin, P – number of rays in pectoral fin, V – number of rays in ventral fin, Sp. branch. I rz. – number of gill rakers on the first gill arch, in the first row, Sp. branch II rz. – number of gill rakers on the first gill arch, in the second row, vt – number of vertebrae.

The dark spots count in the first line (on the left side of eel-pout body) ranged within 12–23, both in the whole sample, as well as in males and females. The mean amounting to 18.07 was higher in males. Range of coefficient of variation (11.31–12.84%) indicates the character being of middle plasticity.

The soft rays count in dorsal fin before the "depression" covered the range from 58 to 85 (in males: 60–85 in females: 58–85). Males showed the higher mean (72.56). This character is low plastic, as the coefficient of variation shows value below 8%. The range of variation in the dorsal fin behind "depression" is very wide and amounted 9–20 rays (males showing the range 9–18, while females 10–20). Coefficient of variation reached values over 15%. The mean count for females exceeding that for males. The total soft rays count in the dorsal fin ranged within 69–102 (in males 70–98, in females 69–102), mean in males (85.84) was higher. The character (value of coefficient of variation below 8%) appeared to be low variable.

The number of hard rays found in the "depression" of dorsal fin was 6–12 in all the fish and in males, 6–11 being found in females. The means for each sex were close to each other, 8.77 and 8.76 respectively. The character is of middle plasticity.

The number of soft rays detected in the anal fin covered the range from 60 to 89, in males being 62–89, in females 60–85 (males showing higher mean value amounting to 71.82). The feature is of a low variability, values coefficient of variation are ca 8%.

The pectoral fin number of rays in the whole sample and both sexes ranged from 16 to 21. The mean count in the population examined amounted to 18.53, females demonstrated a higher mean (18.58). The coefficient of variation (ca 5%) shows a low plasticity of the character.

The ventral fin number of rays was constant and amounted to 3.

The gill rakers are situated in two rows on the first gill arch. The number of rakers found in the first row covered the range 10–18 (in males 10–18 as well, in females 11–17). The mean count of gill rakers for all fish studied amounted to 14.02; the mean being slightly higher in females. The character is of middle plasticity, with the coefficient of variation varying from 10.14 to 13.99%. The gill rakers count in the second row on the first gill arch ranged from 8–15 (males 9–15, females 8–15); the mean value for the entire materials amounted to 11.84, in males (12.15) exceeding that of females.

The character is low plastic (only in females the coefficient of variation exceeding 10%).

The ray count in the suboperculum membrane covered the range from 4 to 8 (both for the whole sample, males and females); the higher mean count (5.65) was found in males. The character is of low variability.

The vertebral count was found to cover the range from 105 to 125 (for the entire material and females), in males being slightly narrower, namely 110–124. The mean value for the fish investigated was 116.42, while in males 116.63, females showing feebly lower value (116.27).

Student's t test results

The hypothesis H_0 was taken assuming the lack of significant differences between characters in both sexes. In twelve metric characters (42.9%) (expressed in relative values) the hypothesis was rejected showing statistically significant differences between males and females. In eleven characters the mean value of characters is higher in males. The features are as follows: the preorbital and postorbital distance, lateral head length, length of upper and lower jaws, width of upper jaw, predorsal and preventral distance, height of dorsal and pectoral fin, length of ventral fin base. In case of one character – the distance between ventral and anal fin, mean value in females exceeding that of males.

When considering meristic characters, the H_0 hypothesis was rejected in one feature only – the gill rakers count in the second row on the first gill arch. The mean count of gill rakers was higher in males.

DISCUSSION

The biometric characteristics of eel-pout was dealt with in few papers only. No one work was found providing detailed description, particularly with respect to metric characters. Some data on a few meristic features were presented in Meisner (1948), Berg (1949), Andrijašev (1954), Gąsowska (1962), Klimaj, Rutkowicz (1970) and Kuczyński (1980). As a rule, however, neither region investigated nor sample size was given in papers mentioned.

The materials obtained for the study included fishes of total length from 22.7 to 39.6 cm, the most numerous being 28–29 cm (17.8%) and 30–31 cm (15.4%) length classes. Gąsowska (1962) reported 30–33 cm as maximum total length of the eel-pout from the Baltic fishing grounds, while Kuczyński (1980) obtained higher length range for that region (21–40 cm), with 29 cm class prevailing. Wójcik (1986) investigated the growth rate of this species, stating the length ranging from 26.4 cm to 37.0 cm. Males to females sex ratio established by him amounted to 1.77, while in present paper 0.74 only. The difference may have stemmed from different age structure of sample studied; in older fish groups females usually prevail markedly. According to the authors citied above, the females predominated in 32–33 cm length class (in present paper – in 28–29), while males in 31–32 cm class (in present work there are two equal-numerous groups: 28–29 cm and 30–31 cm).

Workers carried out studies on eel-pout from the White Sea and Murmansk Sea, like Altuhov et al. (1958) reported the maximum total length in this species up to 36 cm (in the age of 12). Andrijašev (1954) found the maximum fish length 33 cm, in the age 9, when Berg (1949) and Plorina, Ruus (1972) estimated length up to 60 cm, with predominating value of 30 cm. According to authors citied above females exceeding males in length, what was confirmed by this investigation, too.

The base of dorsal and anal fin in the eel-pout is extremely long. Ray counting is difficult, resulted from thick skin covering both fins; in order to count rays, skin should be removed. Gąsowska (1962) and Klimaj, Rutkowicz (1970) reported the soft ray count in the dorsal fin ranging within 72–85 (before the "depression" in this fin); the identical value is given by Andrijašev (1954) for Baltic Sea; for Barents Sea and White Sea he indicated, however, the range from 76 to 84. Berg (1949)found it as 71–85. In the present work it was obtained a wider range of soft ray count in the dorsal fin being 58–85 (mean value amounting to 71.59), 30% of individuals had less than 70 rays.

A peculiar dorsal fin in this species is worthy of mention, because, although the greater part of it being supported by soft rays in the usual manner, in a small section near the tail they been converted into stiff spines, next following again by soft rays. The fin-fold connecting these spines is considerably shorter than remaining part, hence in present study was used a term – "depression" in dorsal fin. This case is very rarely indeed, what is mentioned in Norman (1963). According to some authors the stiff spines count may cover the range from 0 to 17 (Gąsowska 1962, Klimaj, Rutkowicz 1970); Berg (1949) and Andrijašev (1954) reported the same range finding fish with 5–6 to 10–11 to be most abundant. It corresponds with results given by Altuhov et al. (1958), showing 10 as maximum count of spines. In the sample studied they covered the range from 6 to 12, with mean amounting to 8.76.

The soft ray count behind the "depression" in dorsal fin ranged, by authors quoted, to 24–27. In the sample examined the count ranging from 9 (in some cases only) to 20, the mean being 13.40.

Total soft ray count in the dorsal fin in the entire material covered the range from 69 to 102; no comparison can be made, as in hitherto-published papers nobody gave any data on it.

Berg (1949), Andrijašev (1954), Gąsowska (1962), Klimaj-Rutkowicz (1970) reported the range of ray count in the anal fin from 80 to 95, while in the present study the range was estimated as 60–89.

Discrepancies in dorsal and anal fin ray count may have stemmed from different sample size as well as from different region under study. No one of authors mentioned above gave the number of fish and area examined.

Further, it seemed questionable if an eel-pout posseses the caudal fin. Berg (1949) and Klimaj, Rutkowicz (1970) found out no caudal fin in this species, dorsal and anal fin being, by them, connected along in the end of the tail. On the other hand, Andrijašev (1954), Gąsowska (1962), Kowalska et al.(1973) stated the presence of caudal fin in eel-pout. Still the description of its shape is different according to different workers; Kowalska et al. (1973) describes a fin as small an oval, while Suvorov (1954) and Nikolski (1970) regarded that caudal fin begins just behind the "depression" in dorsal fin and being of pointed shape (it means soft rays behind the "depression" belonged to the caudal fin).

In the present work the presence of the the caudal fin in the eel-pout was proved, its shape was qualified as pointed. Basing on results obtained, it was found that the caudal fin is situated just in the end of fish tail.

The caudal fin differs from dorsal and anal ones owing to its cluster arrangment of rays (Fig. 5).

In the present study the pectoral fin ray count covered the range form 16 to 21, what is confirmed by other authors (Gąsowska, 1962, Klimaj, Rutkowicz, 1970). Andrijašev (1954) reported the prevailing range as 18–20; in this study the mean count obtained amounting to 18.53.

The ventral fin in the eel-pout possesses a constant ray count – 3. It is found out in available literature, too.

The problem of vertebral count in this species appeared to be quite important, Schmidt (after Meisner, 1948) stated, that number of vertebrae in the eel-pout is salinity – depending character. He higher is salinity, the larger is vertebral count. The constructed a map of Danish fiords showing salinity of water – vertebral count relationship, with isohalines and vertebrae count placed on them. As can be seen, for example, salinity of 20.5‰ indicates the mean of 114.6 vertebrae, while 11.9‰ – 108 vertebrae. Schmidt carried out the experiment, in which he proved the vertebral count is a genetically determined character. In the material examined in this study the vertebral count covered the range within 105–125, with the mean of 116.42 (the mean count was negligible higher in males – 116.63). In the region of capture of sample examined (D2 in West Baltic Sea), salinity of water is ca 7 ‰. Such a considerable discrepancy might resulted from many factors, as different region under study, as well as different period of investigation (Schmidt was working on the problem in 1920s and 1930s), what is clearly associated with different water condition. It is important, when making comparison, the number of individuals studied, too.

Gąsowska (1962) reported higher range of vertebral count – from 101 to 129, while Berg (1949) and Klimaj, Rutkowicz (1970) found the vertebrae number as 101–126. A very close data are given by Andrijaŝev (1954), but for Barents Sea and White Sea he reported 114–118 range.

Gaumiga (1981) found the salinity and temperature of water in the bottom–coat may have affected the distribution and concentration the eel-pout, which are clearly reflected in results of study by him. Basing on the investigation during 1974–1978 in Ryska Bay he showed the biggest concentrations of the eel-pout existing in relatively low temperature (0.7–3.2°C) and salinity of water (5.2–6.6%).

The insight into reports of Cooperation of Fishery Work confirmed the occurence of large concentration of the species in bottom coat of Pomeranian Bay (salinity fluctuating to 7‰).

As Kuczyński (1980) stated, the lack of any detailed eel-pout statistics of catching and population studies unable to assess an optimal catch. So every efforts should be made to broaden the knowledge on the eel-pout, being the pretty important source of fish protein from the Baltic Sea.

CONCLUSION

1. The fish studied ranged within 22.7 to 39.6 cm of total length (l.t.), with the mean value of 30.59 cm. The total length in females covered the same range (mean value – 30.34 cm), while in males it was ranged from 25.2 to 39.0 cm (mean value – 30.99 cm).

2. The eel-pout from the area examined showed relatively small range of coefficient of variation; both in metric characters (expressed in relative values) as well as in meristic.

3. Sexual dimorphism was found showing statistically significant differences in 12 metric characters (42.9% of total characters investigated) and in 1 meristic feature

(8.3%), the mean values in female and male characters being analysed with an aid of Student's t test.

4. Meristic characters of the eel-pout population from the Pomeranian Bay can be expressed with the following formula: D (58) 60–83 (85)–VI–XI(XII)–9(10)–19(20) A 60–85(89) P 16–21 V–3; number of rays in suboperculum membrane 4–8.

5. The vertebral count in the fish studied ranged within 105–125 (the mean count – 116.42). As the material examined was derived from one region only it calls for carry out the investigation again, as well as from the Pomeranian Bay and other regions of different water salinity, in order to find out salinity – vertebral count relationship.

6. The gill rakers on the first gill arch were placed in two rows; in the first one they ranged from 10 to 18 (the mean value of 14.02) being bigger and more numerous than in the second row, in which they covered the range from 8 to 15 (with the mean amounting to 11.84). The significant difference between sexes was found out in the count of gill rakers in the second row-females being characterised by 11.68, when males 12.15.

7. With the aid of alizarin – staining of fish skeleton it was detected the presence of caudal fin in this species.

REFERENCES

Althuhov K.A., A.A. Mihajlovskaja, F.B. Muhomiegijarov, 1958: Ryby Bielovo Moria. Gosudarstviennoje Izdatielstvo Karielskoj ASSR, Pietrozavodsk. (in Russian)

Andrijašev A.P., 1954: Ryby severnyh morej SSSR. Izd. A.N. SSSR, Moskwa – Leningrad. (in Russian)

Berg L.S. (editor), 1949: Promyslovyje ryby SSSR. Wsiesojuznyj Naučno-Issliedovatelskij Institut Morskovo Rybnovo Hozjajstva i Okieanografii (BWNIRO), Piščepromizdat. (in Russian)

Bylińska M. (editor), 1986: Ryby słodkowodne Polski. [Freshwater fishes of Poland]. Państwowe Wydawnictwo Naukowe, Warszawa.

Falandysz J., 1984: Metale i związki polichlorowe w tkance mięśniowej węgorzycy z Zatoki Gdańskiej. [Metals and the polychloric compounds in the muscular tissue of the eep-pout from Gdańsk Bay]. Biuletyn MIR Nr 3–6 (83–86), Gdynia.

Gaumiga R.J., 1981: Osobiennosti rozpriedielenia i sostava zapasa bieldugi v Rižskom Zalivie. Rybohazjastviennyje Issliedovania. (Balt. NIIRH), vypusk 16 (39–45), Riga.

Gąsowska M. (editor), 1962: Krągłouste i ryby, Cyclostomi et Pisces. Klucz do oznaczania kręgowców Polski. Cz. 1 [Cyclostomates and fishes. A guide for determination vertebrates of Poland. Part1] . Państwowe Wydawnictwo Naukowe, Warszawa-Kraków.

Graś-Wawrzyniak B., 1977: Parazytofauna węgorzycy Zoarces viviparus (L.). [Parasitic fauna of the eel-pout Zoarces viviparus (L.)]. (M. Sc. degree). Inst. Ichtiologii AR. Szczecin.

Greń J., 1978: Statystyka matematyczna, modele i zadania [Mathematical statistics, models and expercises]. PWN, Warszawa.

Klimaj A., S. Rutkowicz, 1970: Atlas ryb Północnego Atlantyku [Atlas of North Atlantic fishes]. Wydawnictwo Morskie, Gdańsk.

Kłudczyńska B., 1989: Wiek i tempo wzrostu węgorzycy (Zoarces viviparus (L.)) z Zatoki Pomorskiej [Age and growth rate of the eel-pout from the Pomeranian Bay]. (M. Sc. Degree.) Instytut Ichtiologii, AR Szczecin.

Kowalska K., J.M. Rembiszewski, H. Rolik, 1973: Mały słownik zoologiczny – Ryby. [A small zoological quide-Fi]. Wiedza Powszechna, Warszawa.

Kristofferson R., A. Oikari, 1975: Notes on the biology of the eel-pout in the brackish water of Tvärminne. Gulf of Finland. Ann. Zool. Fennici ; 12 (143—147).
Kuczyński J., 1980: Mniej popularne gatunki ryb bałtyckich-węgorzyca. [Less common of Baltic fish species — eel-pout]. Biul. MIR, nr 5—6 (29—33), Gdynia.
Meisner W., 1948: Ichtiologia stosowana. [Ichthyology in practise]. Wyd. 2 Drukarnia Pomorska Spółdz. Wydawn. „Wiedza" nr 7 w Grudziądzu. Gdynia.
Nikolski G., 1970: Ichtiologia szczegółowa [Ichthyology in details]. PWRiL, Warszawa.
Norman J.R., 1963: A history of fishes. British Museum (Natural History). London.
Plorina A.P., W.W. Ruus, 1972: Pročije ryby. Rybohazjastviennyje Issliedovania. (Balt. NIIRH), vypusk 9 (111—125), Riga. (in Russian).
Ruszczyc Z., 1981: Metodyka doświadczeń zootechnicznych. [Methodology of experiments in animals husbandry]. Państwowe Wydawnictwo Rolnicze i Leśne, Warszawa.
Suvorov E., 1954: Podstawy ichtiologii [Foundations of ichthyology]. PWN, Warszawa.
Ševcov S.E., E. Kostromina, 1983: O selektivnom promysle bieldugi v Rižskom Zalivie. Rybohozjastviennyje Issliedovania (Balt. NIIRH), vypusk 18 (81—86), Riga. (in Russian).
Tanasijčuk W.S., 1970: Biologia bieldugi Zoarces viviparus (L.) z Rižskovo Zaliva. Tr. Balt. NIIRH t. IV (161—170), Riga, (in Russian).
Taylor W.R., 1967: An enzyme method of clearing and staining small vertebrates. Proc. U.S. nant. Mus. 122 (3596): (1—17).
Wójcik I., 1986: Wiek i tempo wzrostu węgorzycy (Zoarces viviparus (L.)) z Zatoki Pomorskiej. [Age and growth rate of eel-pout (Zoarces viviparus (L.)) from the Pomeranian Bay]. (M. Sc. degree.) Zakład Biologii AR, Szczecin.

Beata WIĘCASZEK

CHARAKTERYSTYKA BIOMETRYCZNA WĘGORZYCY BAŁTYCKIEJ *ZOARCES VIVIPARUS* (L.) Z ZATOKI POMORSKIEJ

STRESZCZENIE

W niniejszej pracy przedstawiono charakterystykę morfometryczną węgorzycy *Zoarces viviparus* (L.), złowionej w rejonie Zatoki Pomorskiej w maju 1988 r.

Przebadany materiał węgorzycy mieścił się w zakresie długości całkowitej (l.t.) od 22,7 do 39,6 cm (z wartością średnią 30,59 cm). Samice osiągnęły długość średnią równą 30,34 cm, natomiast samce 30,99 cm.

Dymorfizm płciowy wyraża się u tego gatunku różnicami istotnymi statystycznie w przypadku 12 cech wymierzalnych i 1 cechy merystycznej.

Cechy merystyczne populacji węgorzycy z rejonu Zatoki Pomorskiej można ująć w następującą formułę: D/58/60—83/85/— VI — XI/XII/ — 9/10/ — 19/20/ A 60—85/89/ P 16—21, V3, pr. w błonie podskrzelowej 4—8. Wyrostki filtracyjne występowały w dwóch rzędach na łuku skrzelowym; w pierwszym było ich od 10 do 18 i były one wyższe niż w rzędzie drugim, w którym było ich od 8 do 15.

Liczba kręgów dla zbadanej węgorzycy wahała się od 105 do 125 (średnia liczba — 116,42). Ponieważ materiał ten pochodził tylko z jednego rejonu, wskazane byłoby powtórzenie badań ryb tego gatunku z obszaru Zatoki Pomorskiej oraz z rejonów o innym zasoleniu, w celu stwierdzenia zależności pomiędzy wysokością zasolenia a liczbą kręgów.

Za pomocą wybarwienia szkieletu ryby metodą alizarynową stwierdzono, że węgorzyca posiada jednak płetwę ogonową, trudną do wyodrębnienia, połączoną z płetwami: grzbietową i odbytową.

Authors' address: Received: 1991.05.22

Mgr Beata Więcaszek
Zakład Systematyki Ryb
Akademia Rolnicza
ul. K. Królewicza 4
71-550 Szczecin,