AACL BIOFLUX

Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Morphological characteristics and variation of rudd *Scardinius erytrophthalmus* (L.) from the Łuknajno Lake, Poland

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Abstract. A total of 49 specimens of the rudd, *Scardinius erytrophthalmus*, were caught in the Łuknajno Lake, in 2005. For each fish, 24 morphometric features of the body and 20 features of the skull were measured. Selected meristic features (external and internal) were determined. Cephalic sensory canals were studied and their pores were counted. The coefficient of variation for the body proportion of rudd ranges from 3.88 to 31.55%. The meristic characters are as follows: *D* III 7–10, *A* III 10–14, *P* I 12–15, *V* I–II 8–9, *l.l.* 40–44, *ss* 6–8, *i* 3–4, *Vt* 38–41. The most common formula for the pharyngeal teeth is 3.5–5.3 (in 89.8% of the specimens), only in one specimen arrangement 2.5–5.2 was found. All the cephalic sensory canals are complete. The preoperculo-mandibular canal (CPM) has 12–24, commonly 19 pores. The supratemporal canal (CST) has 4–7, usually 6 pores. In the infraorbital canal (CIO) on the first infraorbital bone are 5–6 pores, commonly 5. The neurocranium of rudd is high and relatively wide. The smallest high of the neurocranium is noticed in the ethmoid region (13.47%) and the biggest in the supraoccipital.

Key words: fish, rudd, *Scardinius erytrophthalmus,* meristics, biometry, osteology

Streszczenie. Celem pracy była charakterystyka morfologiczna 49 osobników wzdręgi *Scardinius erytrophtalmus* pochodzącej z jeziora Łuknajno. Dla wszystkich ryb określono 24 cechy morfometryczne ciała i 20 pomiarów czaszki oraz wybrane cechy merystyczne (wewnętrzne i zewnętrzne). Policzono otwory kanałów linii bocznej głowy. Wartości względne analizowanych zewnętrznych cech biometrycznych charakteryzowały się zakresem zmienności wynoszącym 3.88–31.55%. Cechy merystyczne badanej próby ryb można zapisać następująco: *D* III 7-10, *A* III 10-14, *P* I 12-15, *V* I-II 8-9, *l.l.* 40-44, *s* 6-8, *i* 3-4, *Vt* 38-41. U większości osobników (89.8%) zaobserwowano dwuszeregowe zęby gardłowe o wzorze 3.5–5.3, tylko u jednego osobnika pojawił się układ 2.5–5.2. Wszystkie kanały linii bocznej głowy były kompletne. W CPM było 12-24 otworów, najczęściej 19. Na kości czołowej występowało 6-9 otworów. W CST było 4-7, zwykle 6 otworów. W CIO, na pierwszej kostce podoczodołowej było 5-6 otworów, najczęściej 5Czaszka wzdręgi była wysoka i stosunkowo szeroka. Najmniejszą wysokość mózgoczaszki (w % *L.bas.n*) zanotowano w okolicy regionu sitowego *H eth* (y_1) 13.47%, zaś największą przy przedniej krawędzi kości potylicznej górnej *H soc* (y_2) 39.43%.

Słowa kluczowe: wzdręga, *Scardinius erytrophtalmus,* merystyka, biometria, osteologia.

Rezumat. Un număr total de 49 exemplare de roșioară, *Scardinius erytrophthalmus*, au fost capturate din lacul Łuknajno, în anul 2005. La fiecare pește s-au măsurat 24 caractere morfometrice corporale și 20 ale craniului. Anumite caractere meristice alese (atât interne cât și externe) au fost, de asemenea, determinate. Canalele senzoriale cefalice au fost studiate, iar porii au fost numărați. Coeficientul de variație a proporțiilor corpului roșioarei au fost cuprinse între 3,88 și 31,55%. Caracterele meristice au fost după cum urmează: *D* III 7–10, *A* III 10–14, *P* I 12–15, *V* I–II 8–9, *l.l.* 40–44, *ss* 6–8, *i* 3–4, *Vt* 38–41. Cea mai frecventă formulă a dinților faringieni a fost 3.5–5.3 (la 89,8% dintre exemplare), doar la un singur specimen aranjamentul dentiției a fost identificat ca fiind 2.5–5.2. Toate canalele senzoriale cefalice au fost complete. Canalul preoperculo-mandibular (CPM) a avut 12–24 pori, cel mai frecvent 19 pori. Canalul supratemporal (CST) a avut 4–7 pori, cel mai frecvent 6 pori. În canalul infraorbital (CIO), pe primul os infraorbital există 5–6 pori, adesea 5. Neurocraniul roșioarei este înalt și relativ larg. Cea mai mică înălțime a neurocraniului a fost stabilită la nivelul regiunii etmoidului (13,47%), iar cea mare la nivelul supraoccipitalului.

Cuvinte cheie: roșioară, *Scardinius erytrophtalmus*, meristic, biometrie, osteologie.

Introduction. The family Cyprinidae contains more than 2000 species in almost 340 genera (Banarescu & Coad 1991). Cyprinid fishes have received much attention from evolutionary biologists, as they show a wide distribution around the world and occur in almost every freshwater environment. Its systematic relationships are still under debate (Zardoya & Doadrio 1998). Earlier classifications were based mainly on external features such as the presence, type and number of barbels as well as the structure and arrangement of the pharyngeal dentition (Howes 1991). More recently, osteological characters were also used (Doadrio 1990). Classifications based on the morphology and osteology first provided Chen et al (1984). Cavender & Coburn (1992) reanalysed their data and presented the phylogenetic analysis of the Cyprinidae. Despite these efforts, the interpretation of morphological data has proven to be difficult. The lack of valid and unambiguous morphological characters that define the different groups has prevented agreement among cyprinid systematists (Nelson 2006).

Recently, allozyme markers have been employed to study low-level phylogenetic relationships of European cyprinids (Coelho 1992; Berrebi et al 1995; Karakousis et al 1995). The molecular investigations resolved some, but not all groups of cyprinids (Gilles et al 2001). For these reasons, it is necessary to obtain additional data, both molecular and morphological.

Although cyprinid taxonomy and phylogeny have recently attracted much interest, particularly the genera *Leuciscus*, *Chondrostoma*, *Barbus* (Elvira 1997; Doadrio & Carmona 1998; Durand et al 1999; Durand et al 2003), and more recently *Scardinius* (Bianco et al 2001; Ketmaier et al 2003), little information is available, especially on the osteology.

The genus *Scardinius* Bonaparte, 1837 belongs to the family Cyprinidae, one of the largest families of vertebrates. This genus is widely distributed in Europe, being absent only in the Iberian Peninsula (Ketmaier et al 2003). It is represented by five species: *S. erythrophthalmus, S. scardafa, S. acarnanicus, S. graecus* and *S. racovitzai,* which inhabit lowland lakes and still waters of rivers and streams (Kottelat 1997). The rudd *S. erythrophthalmus* has the widest distribution; *S. acarnanicus* and *S. graecus* are endemic in Greece (Iliadou et al 1996); *S. scardafa*, endemic to Italy with a single relict population in Lake Scanno in Central Italy (Bianco & Ketmaier 2001). A nominal taxon *S. racovitzai* was also described from one thermal spring in Romania (Kottelat 1997 after Banarescu 1964), but its taxonomic status is still unclear, and it may represent a local ecophenotype of *S. erythrophthalmus* (Bianco et al 2004).

Figure 1. Map of Poland with the location of the sampling site.

In Poland the genus is represented by one species, *S. erythrophthalmus*, which is largely unaffected by fish management strategies as it is of little economic value.

A few papers (Klimczyk-Janikowska 1970, 1975; Iliadou & Anderson 1998) have given a thorough morphological description of this species.

The present paper describes morphology of the rudd, based on external and internal characters of the body and skeleton.

Material and Method. A total of 49 *S. erytrophthalmus* individuals (32 females and 17 males) were collected in 2005 from the population inhabiting the Łuknajno Lake (Fig. 1).

Sex of all specimens was determined according to the morphology of gonads. Twenty-one morphometric features were analyzed following the methodology of Szlachciak (2000) (except for some abbreviations) and measured (on the fresh specimens) to the nearest 0.1 mm on the left side of the body: head length (*lc*), preorbital distance (*prO*), eye diameter (*O*), postorbital distance (*poO*), head depth (*hc*), head width (*lac*), lower jaw length (*lmd*), standard length (SL) measured to the last scale in the lateral line), predorsal distance (*pD*), postdorsal distance (*poD*), maximum body depth (*H*), minimum body depth (*h*), caudal pedunle length (*lpc*), pectoral fin length (*lP*), pelvic fin length (*lV*), dorsal-fin base length (*lD*), anal-fin base length (*lA*), dorsal fin height (*hD*), anal fin height (*hA*), distance between pectoral and ventral fin (*P-V*), distance between ventral and anal fin (*V-A*). The measurements were expressed as a percentage of the standard length (*SL*) and head length (*lc*). The following meristic features (external and internal) were analysed: branched fin ray numbers of: dorsal- (*D*), anal- (*A*), pectoral- (*P*) and pelvic- (*V*) fins (two last branched dorsal and anal fin rays were counted as one); number of scales in the lateral line (*l.l.*), number of scales between lateral line and dorsal fin base (*ss*), number of scales between lateral line and ventral fin base (*i*), number of pharyngeal teeth (*PhF*); number of vertebrae in different portions of the vertebral column: predorsal vertebrae (*Vpd*) (i.e., lying anteriorly from dorsal fin insertion), abdominal vertebrae (*Va*), intermediate vertebrae (*Vi*), caudal vertebrae (*Vc*), hemal vertebrae (*Vh*) (caudal- plus intermediate ones with parapophyses connected by a bridge below the hemal canal); total number of vertebrae (*Vt*); the number of openings of cephalic sensory canals on particular bones in the neurocranium and visceral skeleton: preoperculo-mandibular canal (CPM) (dentary, articular, preoperculum, operculum); supraorbital canal (CSO) (nasal, frontal); supratemporal canal (CST) (parietal, posttemporal); infraorbital canal (CIO) (lacrimal, pterotic). Internal features were counted from dry skeleton preparations made by boiling in hot water. Pore counts were made from both the left and right side of the head; the number of canal openings of an individual bone included entry and exit.

On the skull 20 bone measurements were taken: ethmoid region depth on the level of the posterior margin of supraethmoid (*H eth)*, neurocranium depth on the level of the supraoccipital (*H soc*), neurocranium depth on the level of the parasphenoid (*H ps*), length of neurocranial base without pharyngeal process (*L. bas. n.*), cranial roof length (*L cr. r.*), ethmoid length (*L eth*), neurocranium width between lateral margins of lateral ethmoids (*Lt eth*), neurocranium width between lateral margins of sphenotic lateral processes (*Lt spho*), neurocranium width between lateral margins of pterotics on the level of the posterior pterotic process base (*Lt pto*), masticatory plate length (*Lt mas pl*), lacrimal bone length (*L iol*), opercular bone height (*H o*), opercular bone width (*L*), interopercular bone width (*L1*), subopercular bone width (*L2*), hyomandibular bone height (*H hyo*), palatine bone length (*L pal*). These measurements were expressed as a percentage of the cranial base length (*L.bas.n.*) (Bogutskaya 1994).

All the data were statistically processed, involving means (M), standard deviations (SD) and coefficient of variation (CV, %). To test for sexual dimorphism Student's t-test was applied.

The absolute values of body measurements were used to calculate correlation coefficients and linear regression to determine the relationships between the analysed elements with body and head length. Linear regression formula y = a + bx was used, where: y – analysed feature, x – standard length (*SL*) or head length (*lc*), b – regression coefficient, a – free equation factor. To determine the differences in body proportions along with the body length the hypothesis that the free factor of the equation equalled zero (H_o: a = 0) using a Student's t-test (α = 0.05) was verified. In cases when H_o hypothesis was accepted (P > 0.05) it was assumed that the body proportions were similar at different body length. The rejection of H_o hypothesis meant that differences in body proportions were statistically significant (Stanisz 1998).

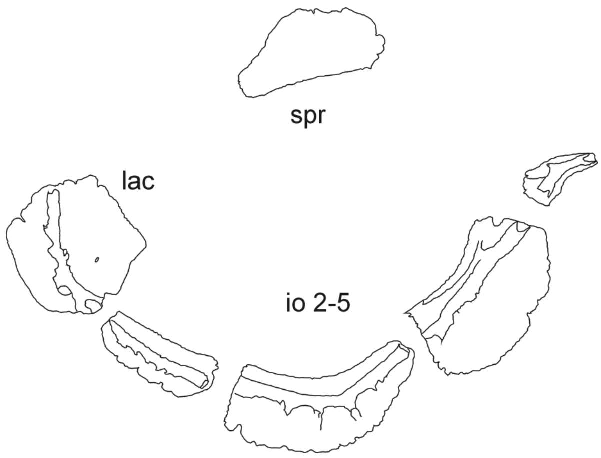

Figure 2. Infraorbitals of *S. erythrophthalmus* from the Łuknajno Lake. Abbreviations: io 2-5, infraorbitals 2-5; lac, lacrimal; spr, supraorbitale (drawn by J. Szlachciak).

Table 1

Relative values of biometric characters of *S. erythrophthalmus* from the Łuknajno Lake

Character	Range	M	SD	CV [%]
	in % of standard length (*SL*)			
head length *lc*	14.6–28.4	21.9	2.38	10.85
predorsal distance *pD*	52.4–63.2	58.5	2.27	3.88
postdorsal distance *poD*	29.0–62.7	34.5	4.61	13.38
maximum body depth *H*	19.2–41.1	35.6	4.00	11.23
minimum body depth *h*	9.2–27.4	11.1	2.48	22.28
caudal peduncle length *lpc*	6.4–31.6	15.6	3.73	23.89
pectoral fin length *lP*	2.8–17.9	17.9	4.43	24.77
ventral fin length *lV*	11.7–35.7	17.2	2.99	17.38
dorsal fin height *hD*	13.2–24.8	18.5	2.10	11.34
anal fin height *hA*	12.9–24.8	15.8	1.80	11.45
dorsal-fin base length *lD*	9.5–22.7	13.1	1.69	12.95
anal-fin base length *lA*	10.3–44.0	14.4	4.54	31.55
P-V distance	22.9–41.9	26.8	2.67	9.96
V-A distance	22.1–41.9	26.6	2.87	10.81
	in % of head length (*lc*)			
preorbital distance *prO*	21.0–42.2	27.2	4.24	15.60
eye diameter *O*	19.5–33.8	24.7	3.93	15.90
postorbital distance *poO*	46.4–76.8	52.1	6.44	12.38
head depth *hc*	69.0–127.5	91.6	13.23	14.44
head width *lac*	47.5–87.5	58.9	8.29	14.07
lower jaw length *lmd*	26.8–51.9	33.3	5.04	15.11

Results. The range of standard length *SL* of analysed fish was 130–260 mm, 201.5 mm on average. The lateral head length (*lc*) ranged from 28.6–61.6 mm, 45.4 mm on average.

Statistically significant differences between males and females were found in mean values of 4 metric indices. They were as follows: caudal peduncle length (P =

0.0085), pelvic fin length (P = 0.0189), anal fin height (P = 0.0125) and anal-fin base length (P = 0.0187). In the description of results both sexes were treated together.

Analysed biometric features were characterised by the coefficient of variation ranged from 3.88–31.55% (Table 1).

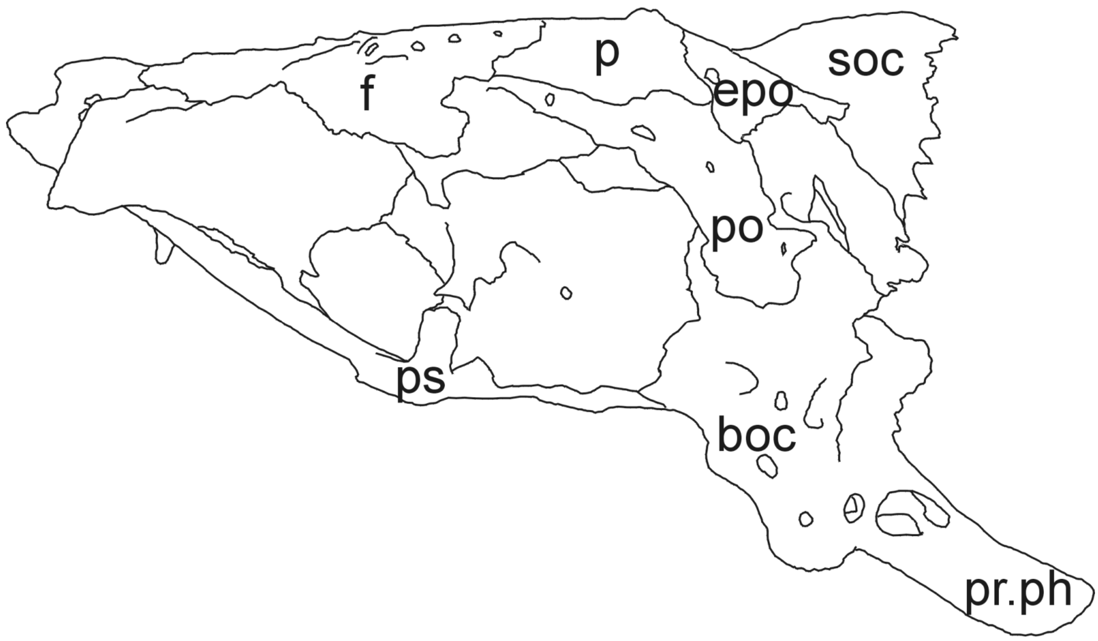

Figure 3. The neurocranium of *S. erythrophthalmus* from the Łuknajno Lake, leftlateral view. Abbreviations: boc, basioccipital; epo, epiotic; f, frontal; par, parietal; po, pterotic; pr.ph, pharyngeal process; ps, parasphenoid; soc, supraoccipital (drawn by J. Szlachciak).

The head of rudd is comparatively short. The head depth at nape is high, comprising almost 91.62% of *lc*. The head width is 58.89% of *lc* on average. The body is high. The dorsal fin is high (18.51% of *SL*, on average) with outer edge concave. Its base is short comprising 9.51–22.74% of *SL*.

The relationships between body measures and *SL* and *lc* are statistically significant (P < 0.05), correlation coefficients are positive and significant at the level 0.05, and their values range from 0.3687 to 0.8647. Two among 14 features increase proportionally to the fish *SL*: maximum body depth and pectoral fin length (Table 2). Relative values of these features do not change with the fish size. Among the head features only head width increases with the *lc*. The free factor in the regression equations do not differ significantly from zero (H_0: a = 0; P > 0.05). Other features related to fish size do not increase evenly with the fish length (H_0: a = 0; P < 0.05).

The results of external meristic features are given in Table 3. There was only one difference found between sexes. The females had more scales above the lateral line (*ss*) (P = 0.0413) than males. Therefore the results were given together for both sexes. The number of branched rays in the dorsal fin ranges from 7 to 10, 47% of the fish had 8 branched rays. Its outer margin is convex. The range of branched rays number in the anal fin varies from 10 to 13, 11.7 on average. The number of branched rays in the pectoral fin ranges from 11 to 15 (mean number 13.18 in the left and right fin). The rudd has from 8 to 9 rays in both pelvic fins, 8.75 on average. Most of the analyzed fishes (75.51%) have 9 rays.

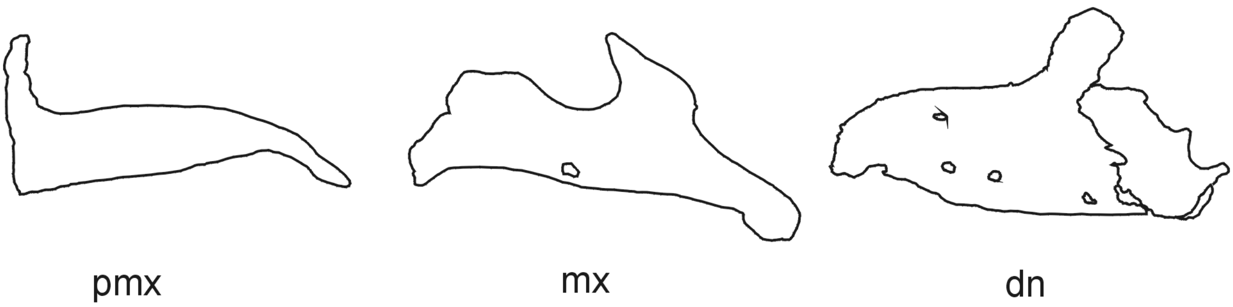

Figure 4. Jaws of *S. erythrophthalmus* from the Łuknajno Lake. Abbreviations: pmx, premaxilla; mx, maxilla; dn, dentary (drawn by J. Szlachciak).

Table 2

Linear regression equation for the relationships between biometric features (y) and *SL* (x) or *lc* of *S. erythrophthalmus* from the Łuknajno Lake. Abbreviation: R – correlation coefficient, a – free equation factor, b – regression coefficient, y – analysed feature

Trait	R	a	b	H_0: a=0	range
		y = a + b *SL*			
lc	0.7142	16.0555	0.1417	P < 0.05	16.55–25.53
pD	0.8647	35.5416	0.4202	P < 0.05	43.26–69.90
poD	0.8593	34.3989	0.1741	P < 0.05	27.40–38.43
H	0.8389	10.2278	0.3176	P > 0.05	24.69–44.83
h	0.8370	4.9286	0.0858	P < 0.05	7.71–13.15
lpc	0.3687	21.1483	0.0507	P < 0.05	13.33–16.55
lP	0.5815	9.1758	0.1364	P > 0.05	12.91–21.56
lV	0.7622	14.4608	0.0995	P < 0.05	13.16–19.46
hD	0.7523	13.1075	0.1232	P < 0.05	13.98–21.79
hA	0.7437	13.4009	0.0922	P < 0.05	12.19–15.63
lD	0.8158	9.8821	0.0822	P < 0.05	9.87–15.09
lA	0.7135	11.7308	0.0822	P < 0.05	10.76–15.98
P-V	0.8346	15.5581	0.1930	P < 0.05	19.50–31.74
V-A	0.8080	10.2756	0.2150	P < 0.05	18.33–31.96
		y = a + b *lc*			
prO	0.7691	3.3406	0.1950	P < 0.05	19.65–33.81
O	0.3852	6.8944	0.0889	P < 0.05	20.79–27.25
poO	0.8731	4.2748	0.4216	P < 0.05	35.97–66.63
hc	0.8131	9.1110	0.7068	P < 0.05	64.60–115.97
lac	0.8472	2.2258	0.5373	P < 0.05	38.74–77.80
lmd	0.7972	3.6783	0.2487	P < 0.05	23.77–41.85

Ranges were calculated taking extreme values of standard fish length SL and calculating the respective features from the regression equations. Than the results are given as percents of SL and *lc*.

The lateral line is complete. Below the lateral line all analysed specimens had from 3 to 4 rows of scales, 3.87 on average.

These features characterized low coefficients of variation ranged from 1.68 to 7.2.

The rudd has two rows of pharyngeal teeth. In 89.8% of the fish the pattern is 3.5–5.3, and sporadically 2.5–5.2. The teeth are laterally flattened and serrated. In the internal row are fine, whilst in the second, main row they are bigger and more massive.

The total number of vertebrae ranges from 38 to 41 (Table 4). All the specimens had 8–16 abdominal vertebrae. In the predorsal part the most common number of vertebrae is from 8 to 10 vertebrae, on average 9.61. Rudd from the analysed sample has from 2 to 4 intermediate vertebrae, in 63.3% of the fish is 3. The number of caudal vertebrae ranges from 13 to 15, on average 13.59. The analysis of the number of vertebrae in different regions of the vertebral column demonstrates that the lowest coefficient of variation (2.29%) is found in the case of the total number of vertebrae, whilst the highest (22.46%) for intermediate ones.

The number of pores on the bones of the skull is given in Table 5.

Table 3

Values of external meristic characters of *S. erythrophthalmus* from the Łuknajno Lake

Feature	Range	M	SD	CV [%]
Number of branched rays in *D*	7–10	8.7	0.69	8.02
Number of branched rays in *A*	10–13	11.7	0.81	6.91
Number of branched rays in left *P*	11–15	13.2	1.05	7.91
Number of branched rays in right *P*	11-15	13.2	1.01	7.61
Number of branched rays in *P* (overall)	11–15	13.2	1.00	7.57
Number of branched rays in *V*	8–9	8.8	0.43	4.96
Number of branched rays in *V*	8–9	8.8	0.43	4.96
Number of branched rays in V (overall)	8–9	8.8	0.42	4.82
Number of scales in *l.l.* (left side)	40–44	42.0	0.86	2.06
Number of scales in *l.l.* (right side)	40–44	41.8	0.87	2.09
Number of scales in *l.l.* (overall)	40–44	41.9	0.77	1.84
Number of scales between lateral line and dorsal fin base *ss*	6–8	7.0	0.25	3.57
Number of scales between lateral line and pelvic fin base *i*	3–4	3.9	0.33	8.54

The preoperculo-mandibular canal (CPM) begins on the dental bone. Most of the fishes analysed (49%) has 5 openings on this bone. On the articular predominantly are 2 openings (in 93.8% of the fishes). The preoperculum has the most numerous pores. All the examined specimens have 2 pores on the operculum. In the supraorbital canal (CSO) there are 6–9 openings in the frontal bone and in all fishes 2 pores on the parietal. In the supratemporal canal (CST) the parietal bone had 2–4 openings, whereas the posttemporal bone had 2 pores in all analysed specimens. The infraorbital canal (CIO) passes through 5 interorbital bones (Fig. 2) and the pterotic bone. On the first infraorbital bone, the lacrimal, most of the fishes analysed has 5 pores (98%). The pterotic bone has on average 5.257 pores, most often 5 (75.5%).

Osteological Description. The neurocranium (Fig. 3) is high in its posterior part and broad. Proportions of the neurocranium (% *L.bas.n.*) are shown in Table 6. The smallest width was noticed between lateral margins of lateral ethmoids, 40.79% *L.cr.r.* on average. The cranial roof is formed by the frontals and parietals.

The supraethmoid is short and broad, its average length is 15.24% *L.bas.n.* The medial anterior notch is shallow. The vomer is short and wide. The interorbital septum is formed entirely by the orbitosphenoid.

The supraoccipital crest is high, well pronounced. The pharyngeal process is long equipped with a masticatory plate, which length is 15.76% *L.bas.n*.

Rudd has five infraorbitals (Fig. 2). Two of them, the third and the fourth, are the biggest. The first, lacrimal is almost square in shape, its length is 19.55% *L.bas.n*. The fifth bone is the smallest, triangular in shape. The supraorbital is distinct and well formed.

The premaxilla is elongate, L-shaped. The premaxilla has a long medin process. The anterior portion of dentary is short and massive. Its coronoid process is quite long and oblique (Fig. 4). The lower jaw is not so long, only 41.23% *L.bas.n*. on average.

Opercular series (Fig. 5) consists of four bones. The opercular is the largest of the series and hasan articular process towards the hyomandibula. Its high is bigger than width, being 62.84 and 39.58% *L.bas.n.*, respectively. On the preopercular bone are present numerous pores of the preoperculo-mandibular canal (CPM). The length of the subopercular bone is bigger than interopercular one (59.50% *L.bas.n.* and 54.49% *L.bas.n.* on average, respectively).

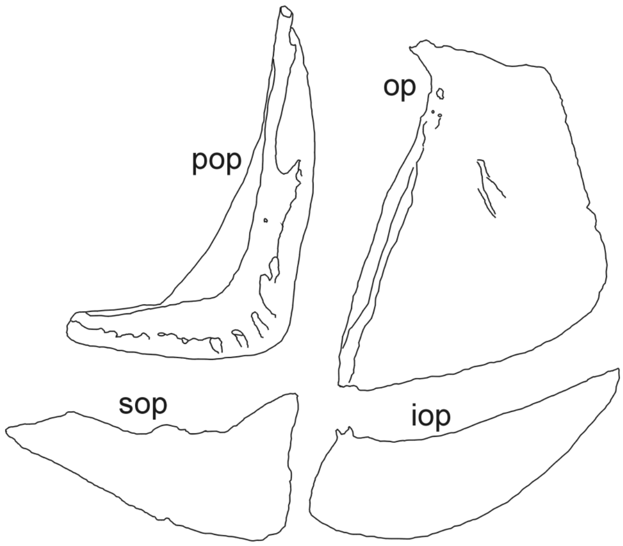

Figure 5. Opercular series of *S. erythrophthalmus* from the Łuknajno Lake. Abbreviations: iop, interoperculum; op, operculum; pop, praeoperculum; sop, suboperculum (drawn by J. Szlachciak).

Discussion. The rudd in polish waters does not rank among commercially important species. Very often it is caught together with the roach *Rutilus rutilus* (Linnaeus, 1758). It is consider as a very attractive angler fish. It is not a protected species (Załachowski 1997).

Among cyprinid fishes the occurrence of hybrids is very common. From the 17 species of cyprinids known to exist in the waters of the British Isles 10 different hybrids have been recorded (Wheeler 1969). The majority of these occur between members of the Leuciscinae subfamily and the most common appear to be among bream *Abramis brama* (Linnaeus, 1758), *R. rutilus* and *S. erytrophthalmus* (Wyatt et al 2006). As the papers about the rudd morphology are very scarce, some information can be found in papers about hybrids.

The biometric features analyzed by the authors were compared with the sample caught in the heated waters in Szczecin (Krzykawski et al 1997). These fishes differed statistically for all analyzed parameters ($P < 0.05$). Rud from heated waters had longer head, lower and narrower body, shorter predorsal and postdorsal distances.

The meristic characters of the analyzed sample were described by the following formula: *D* III 7–10, *A* III 10–14, *P* I 12–15, *V* I–II 8–9, *l.l.* 40-44, *s* 6–8, *i* 3–4, *Vt* 38–41. The number of scales in the lateral line is the feature characterized by the wide range and high variability. The range in rudd from the Łuknajno Lake was 40–44, the same as reported by Zaćwilichowska (1970), similar ranges, 40–43 gave Młyniec (in: Brylińska 1991), and 41–44 Wyatt et al (2006). Recently the occurrence of rudd was reported in some places in the United States (Easton et al 1993) as well as in Canada (Crossman et al 1992). The specimens caught in the St. Clair River (Canada) characterized the range 38–42. Fishes from the heated waters of Lake Dąbie had wider range of this feature, amounted 37–45 scales (Krzykawski et al 1997).

Few authors have given data for the number of vertebrae in the rudd. In the examined sample the total number of vertebrae amounted 38–41 (38.83 mean). Wheeler (1969) gave 36–39, Krzykawski et al (1997) 37-42. Kozhara et al (1997) has analyzed osteological collections concerning seven cyprinid species from the former Soviet Union. In the 19 samples of rudd he determined the range 36–41 (means of 37.50–39.77), 38 or 39 being the most frequent number. Wheeler (1969) was the only one who gave information about the number of the vertebrae in different parts of the skeleton. He reported 12–13 predorsal, 19–21 abdominal vertebrae and 17 caudal vertebrae.

The results of the present study indicate that the number of the pharyngeal teeth is the stable feature. In 89.8% of the analyzed fishes the pattern was 3.5 –5.3, the same as reported by Crossman et al (1992), Krzykawski et al (1997) and Iliadou & Anderson (1998).

No data are available in the literature concerning the number of pores in the lateral line system on the head in the rudd. The pattern is similar in all species from the subfamily Leuciscinae. There is no connection between the supraorbital (CSO) and infraorbital (CIO) canals (Bogutskaya 1989).

Traditionally, cyprinids were grouped in different subfamilies according to their morphological characters (Gosline 1978; Chen et al 1984). Depending on the authors, the number of subfamilies was very different. Bogutskaya (1990) divided the cyprinids into eight tribes with the genus *Scardinius* included to Leuciscini. Some of the osteological features of the rudd are typical for the subfamily Leuciscinae. The features which distinguish this species from others cyprinids are the superior mouth, the dorsal fin placed further towards the tail and serrated pharyngeal teeth. Anatomical features are as follows: the wide and high neurocranium, especially in its posterior part, a short ethmoidal region and high supraoccipital crest.

In the investigated sample neurocranium measurements were as follows: in the ethmoid region (*H eth*) 13.47%, in the occipital region (*H soc*) 39.43% and *H ps* 38.40%. The supraoccipital bone formed a high crest. The subfamily Leuciscinae is characterized by short and wide supraethmoid with a medial shallow notch (Howes 1981). In the rudd the length of this bone was 15.24% *L.bas.n.* on average. The interorbital septum was formed entirely by the orbitosphenoid. This feature is considered to be plesiomorphic for Leuciscinae.

Acknowledgements. The study was supported by grant No. 0208.805 from the University of Warmia and Mazury in Olsztyn.

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Received: 04 April 2010. Accepted: 15 May 2010. Published online: 16 May 2010.
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How to cite this article:
Szlachciak J., Strakowska E., 2010 Morphological characteristics and variation of rudd *Scardinius erytrophthalmus* (L.) from the Łuknajno Lake, Poland. AACL Bioflux **3**(2):91-101.