MORPHOLOGICAL CHARACTERISTICS AND VARIATION OF GUDGEON, GOBIO GOBIO (ACTINOPTERYGII: CYPRINIDAE), FROM THE Odra RIVER DRAINAGE, POLAND

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INTRODUCTION

Gudgeon, Gobio gobio (Linnaeus, 1758) belongs to the genus Gobio, subfamily Gobioninae, one of the major subfamilies in the Cyprinidae (cf. Nelson 2006). Gobionines typically include many bottom dwellers of small to medium sized fish and are abundant in East Asia. General characteristics of species of this subfamily are: the elongate- or rather oblong cylindrical bodies, an inferior mouth, and a pair of barbels (Hosoya 1986).

Their morphological and ecological diversity caused a debate about which genera should be included in the Gobioninae and whether this subfamily constitutes a monophyletic group within the Cyprinidae (cf. Yang et al. 2006).

The subfamily Gobioninae consists of two major pycletic lineages. The first one includes semi-bottom dwellers such as Hemibarbus, Squalius, Gobio, and Mesogobio, the second one including true bottom dwellers such as Gobiobotta, Pseudogobio, Saurogobio, Microphysogobio, and Biwia (cf. Hosoya 1986).

Gobionins include approximately 130 species in about 30 genera that are widely distributed throughout northern and eastern Eurasia from Spain east to Japan and south to central Vietnam. The genus Gobio is a small fish of low economic importance, and therefore has hitherto received little attention (Callejas et al. 2004).

For a long time gudgeons were thought to belong to a frequently found, polymorphic species Gobio gobio (cf. Bănărescu 1992, Naseka 1998, Bănărescu et al. 1999). This diversity has led to the misidentification of Central Europe gudgeons for many years (Freyhof et al. 2000).

At present, approximately 20 Gobio species is distributed through Europe and Asia (Doadrio and Madeira 2004), nine species only in Europe (Naseka and Bogutskaya 1998, Ruchin and Naseka 2003). Three species, G. gobio, G. kessleri, and G. albiplnatus, occurring in Poland, have been traditionally assigned to this genus.

The gudgeon, G. gobio is widely distributed in Europe except some parts of Spain, southern Italy, and Greece as...
G. gobio is considered to be an eurybiontic species inhabiting creeks, rivers, lakes, and ponds of different sizes and preferring slowly flowing waters (Ruchin and Naseka 2003). Some of the morphometric characters show the high variability. Bănărescu (1954), based on his own studies, demonstrated the existence of two ecological forms, rheophilus and limnophilus. Rheophilus morphotypes have a longer tail peduncle, more deeply forked caudal fins, longer paired fins and barbels, and are darker than the limnophilus forms from the same general area, which have a higher body shape and rounded caudal fins (Bănărescu et al. 1999).

Recently published taxonomic revisions (Vasil’eva et al. 2004, 2005, Naseka et al. 2006) revealed that some of the presently known subspecies or local forms should be regarded as separate species.

There are few papers dealing with the accurate information about Polish populations of gudgeon. Biometric studies were carried out on gudgeon, G. gobio, from the rivers of southern Poland (Skóra and Włodek 1966, 1969, 1971), from the Vistula drainage (Rolik 1965), and from two small rivers in the Vistula River drainage (Nowak et al. 2008). Kirtiklis et al. (2005) studied the karyotype of G. gobio from the Odra River.

The aim of this contribution is to describe the morphology of gudgeon from the Odra River drainage, based on its meristic and metric characters, with special emphasis on some osteological features. A comparison with specimens and populations from other regions of Poland could provide new data on the intraspecific variability and help to identify characteristic differences among the populations.

**MATERIALS AND METHODS**

A total of 46 G. gobio individuals were collected in October 2002 from the population inhabiting the Zimnik Stream, the Skóra River System in the Odra River drainage (Fig. 1). Twenty-four metric features were analyzed following the methodology of Szlachciak (2000) (except for some abbreviations) and measured 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 (lmld), barbel length (lb), standard length (SL), predorsal distance (pdD), postdorsal distance (poD), maximum body depth (H), minimum body depth (h), preanal distance (Pa), caudal peduncle length (lpc), body width (lacO), pectoral fin length (IP), ventral fin length (IV), dorsal fin length (ID), anal fin length (A), 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 analyzed: soft (branched) fin ray numbers of: dorsal- (D), anal- (A), pectoral- (P), and ventral (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 (s), 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: preoperculomandibular 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 paraphyseal (H ps), length of neurocranial base without pharyngeal process (L.bas.n.), cranial root 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), dentary bone length (L dent), premaxilla bone length (L pmx), maxilla bone length (L mx), premaxilla bone length (L pmx), opercular bone width (L), interopercular bone width (L1), subopercular bone width (L2), hyomandibular bone height (H hyo), palatine bone length (L pal), dentary bone length (L dent), premaxilla bone length (L pmx), maxilla bone length (L mx). These measurements were expressed as a percentage of the cranial baselength (L.bas.n.) (Bogutskaya 1994). In order to estimate the degree of “wideness” or “narrowness of crania the ratio Lt pto to cranial roof length L.cr.r. was counted.

All the data were statistically processed, involving means (x), standard deviations (s), and coefficient of variation (CV, %).

RESULTS

Biometric features. The range of body length SL of analysed fish was 87.40–116.10 mm, 101.12 mm on average. The lateral head length (lc) ranged from 21.20–30.50 mm, 25.08 mm on average.

Relative values of biometric features in gudgeon are given in Table 1. Analysed biometric features were characterised by the coefficient of variation ranged from 3.35% to 14.69%.

The head is comparatively short. Mouth inferior with a pair of maxillary barbels.

The body is low and elongate. The caudal peduncle is considerably long, comprising 16.55%–26.30% of SL. It is laterally compressed with depth much greater than width.

The dorsal fin is high with outer edge concave. Its base is short.

External meristic features. The results are given in Table 2. In the dorsal fin 78% of the fish had 8 soft rays. The gudgeon has short anal fin. More than half (55.6%) of the analysed fish had 7 rays. Its outer margin is slightly convex or almost straight.

The number of soft rays in the pectoral fin ranges from 11 to 15, with 12 and 13 being the most common results, found in 41.4% and 44.8% of the fish, respectively.

Table 1

| Character          | Range     | x       | s        | CV [%] |
|--------------------|-----------|---------|----------|--------|
| Head length lc     | 22.6–26.8 | 24.8    | 1.06     | 4.28   |
| Predorsal distance pD | 43.6–51.6 | 47.7    | 1.60     | 3.35   |
| Postdorsal distance poD | 35.3–47.2 | 41.1    | 3.01     | 7.33   |
| Maximum body depth H | 16.8–23.4 | 20.3    | 1.90     | 9.37   |
| Preamal distance pA | 52.5–70.5 | 61.6    | 4.16     | 6.75   |
| Minimum body depth h | 6.4–10.6  | 8.4     | 1.03     | 12.33  |
| Caudal peduncle length lpc | 16.6–26.3 | 19.9    | 2.22     | 11.17  |
| Pectoral fin length IP | 13.2–23.0 | 18.8    | 2.07     | 11.01  |
| Ventral fin length IV | 13.4–19.6 | 16.5    | 1.28     | 7.75   |
| Dorsal fin height hD | 17.3–25.76 | 21.6    | 1.84     | 8.53   |
| Anal fin height hA  | 12.5–18.8 | 21.6    | 1.47     | 6.81   |
| Dorsal fin length ID | 8.8–14.7  | 12.5    | 1.19     | 9.51   |
| Anal fin length lA  | 5.7–9.8   | 7.5     | 0.99     | 13.23  |
| P–V distance       | 22.6–32.5 | 26.6    | 2.40     | 9.04   |
| V–A distance       | 18.2–28.1 | 21.7    | 2.15     | 9.92   |

| Character          | Range     | x       | s        | CV [%] |
|--------------------|-----------|---------|----------|--------|
| Preorbital distance prO | 34.7–49.4 | 42.0    | 3.45     | 8.21   |
| Eye diameter O     | 12.1–25.0 | 18.6    | 2.73     | 14.69  |
| Postorbital distance poO | 34.0–47.8 | 40.0    | 3.23     | 8.07   |
| Head depth hc      | 48.1–63.3 | 54.0    | 3.40     | 6.30   |
| Head width lac     | 38.4–50.5 | 45.0    | 2.71     | 6.03   |
| Lower jaw length lmd | 18.0–30.7 | 22.4    | 2.78     | 12.40  |
| Barbel length lb   | 14.4–28.0 | 22.0    | 3.89     | 17.72  |

x, mean; s, standard deviation; CV, coefficient of variation.
The gudgeon has 7 soft rays in the ventral fin (58% of the fish). The lateral line is complete.

**Internal meristic features.** The gudgeon has two rows of pharyngeal teeth. In 58.1% of the fish the pattern is 3.5–5.3, and in 25.8% of them 2.5–5.2. The teeth in the internal row are fine. In the second, main row they are bigger and more massive. All teeth are cylindrical with pointed, hooked tips and reduced grinding surface.

The total number of vertebrae ranges from 38 to 41 (Table 3). In 36% of the fish 39 vertebrae were found, whilst in 33% of fish the vertebral number reached 40. The analysis of the number of vertebrae in different regions of the vertebral column demonstrates that the lowest coefficient of variation, CV = 2.13% is found in the case of the total number of vertebrae, whilst the highest, CV = 12.64%, is found for predorsal vertebrae number (Table 3).

The number of pores on the bones of the skull is given in Table 4. The preoperculo-mandibular canal (CPM) most commonly has 15–20 pores. The preoperculum has the most numerous pores. All the examined specimens had 2 pores on the preoperculum. In the supraorbital canal (CSO) there are 8–11 pores. This canal does not extend onto the parietal bone. 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 show 6 pores (66%), its number ranges from 5 to 8. The pterotic bone has, most often, 4 or 5 pores.

**Osteological description.** The neurocranium (Fig. 2) is low and moderately broad. Proportions of the neurocranium (% L.bas.n.) are shown in Table 5. The ratio of Ltpto cranial roof length L.c.r.r. ranges within 44.14–56.72, assuming 50.13 on average. This means that the skull of gudgeon is rather slender and narrow. The cranial roof is formed by two paired bones, the frontals and the parietales. The lateral concavities of both frontals are

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**Table 2**

| Feature                                      | Range | $\bar{x}$ | $s$  | CV [%] |
|----------------------------------------------|-------|-----------|------|--------|
| Number of soft rays in dorsal fin D          | 7–9   | 8.0       | 0.23 | 2.99   |
| Number of soft rays in anal fin A            | 6–7   | 6.7       | 0.47 | 6.98   |
| Number of soft rays in pectoral fin P1       | 11–15 | 12.5      | 0.81 | 6.46   |
| Number of soft rays in pectoral fin P2       | 11–15 | 12.7      | 0.83 | 6.56   |
| Number of soft rays in pectoral fin P        | 11–15 | 12.6      | 0.72 | 5.69   |
| Number of soft rays in ventral fin V1        | 7–8   | 7.1       | 0.25 | 3.48   |
| Number of soft rays in ventral fin V2        | 6–8   | 7.0       | 0.25 | 3.63   |
| Number of soft rays in ventral fin V         | 6.5–7.5 | 7.0 | 0.18 | 2.60   |
| Number of scales in the lateral line l.l.1   | 37–41 | 39.3      | 0.91 | 2.33   |
| Number of scales in the lateral line l.l.2   | 38–41 | 39.2      | 0.76 | 1.94   |
| Number of scales in the lateral line l.l.    | 38–40.4 | 39.3 | 0.63 | 1.60   |
| Number of scales between lateral line and dorsal fin base ss | 5–6 | 5.9 | 0.39 | 6.60   |
| Number of scales between lateral line and ventral fin base i | 5 | 5.0 | 0.00 | 0      |

$\bar{x}$, mean; $s$, standard deviation; CV, coefficient of variation; numbers 1 and 2 denote left and right side of the body.

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**Table 3**

| Feature                                      | Range | $\bar{x}$ | $s$  | CV [%] |
|----------------------------------------------|-------|-----------|------|--------|
| Predorsal vertebrae Vpd                      | 7.8   | 6–9       | 0.98 | 12.64  |
| Abdominal vertebrae Va                       | 11.5  | 10–13     | 0.91 | 7.93   |
| Intermediate vertebrae Vi                   | 4.5   | 4–5       | 0.51 | 11.33  |
| Abdominal and intermediate vertebrae Vai     | 16.0  | 14–17     | 0.86 | 5.38   |
| Caudal vertebrae Vc                         | 16.4  | 15–18     | 0.76 | 4.62   |
| Hemal vertebrae VH                          | 17.5  | 16–19     | 0.91 | 5.21   |
| Total vertebrae Vt                          | 39.4  | 38–41     | 0.84 | 2.13   |

$\bar{x}$, mean; $s$, standard deviation; CV, coefficient of variation.
deep so the minimum width of the bone is approximately half of the greatest width.

The supraethmoid is short and broad; its average length is 19.53% of L. bas.n. The medial anterior notch is shallow. The posterior margin of the supraethmoid is firmly connected with the frontals only in the corners forming small gape in the middle (Fig. 2). The depth of mesethmoid determines the entire depth of the ethmoid region, which is comparatively low. The lateral ethmoid contains the entire olfactory foramen. The vomer is short but wide. The interorbital septum is formed by the orbitosphenoid. The pterosphenoid is elongate and is longer than the orbitosphenoid.

The posterior pterotic process is long, pointed, and directed caudally. The supraoccipital crest is low, weekly pronounced. The pharyngeal process has a masticatory plate, which is pentagonal in shape. Its mean width is 10.87% L. bas.n.

Gudgeon has five infraorbitals (Fig. 3). The first, lacrimal and the third are the longest. The lacrimal length in the sample is 36.54% L. bas.n. The supraorbital is distinct and well formed.

The premaxilla and maxilla are elongate. The premaxilla has a short median process. The anterior portion of the dentary is rather narrow and elongated. Its coronoid process is almost vertical (Fig. 4). The lower jaw is relatively short, only

| Canal               | Bone                      | Range | $\bar{x}$ | $s$  | CV [%] |
|---------------------|---------------------------|-------|-----------|------|--------|
| preoperculo-mandibular | d-dentary                | 4–5   | 4.1       | 0.34 | 8.25   |
|                     | d1                        | 4–5   | 4.1       | 0.34 | 8.25   |
|                     | d2                        | 4–5   | 4.1       | 0.34 | 8.25   |
|                     | a-articular               | 1–3.5 | 3.0       | 1.12 | 37.33  |
|                     | a1                        | 2–3   | 2.8       | 0.42 | 15.11  |
|                     | a2                        | 2–3   | 2.8       | 0.37 | 13.03  |
| p-preoperculum      | p1                        | 7–10  | 8.6       | 0.76 | 8.85   |
|                     | p2                        | 7–9   | 8.4       | 0.61 | 7.25   |
| o-operculum         | o1                        | 2     | 2         | 0    | 0      |
|                     | o2                        | 2     | 2         | 0    | 0      |
| n-nasal             | n1                        | 3–4   | 3.5       | 0.52 | 15.07  |
|                     | n2                        | 3     | 3         | 0    | 0      |
| f-frontal           | f1                        | 5–7   | 6.0       | 0.52 | 8.67   |
|                     | f2                        | 5–7   | 5.8       | 0.55 | 9.48   |
| p-parietal          | p1                        | 2–4   | 3.1       | 0.47 | 15.02  |
|                     | p2                        | 2–4   | 3.2       | 0.59 | 18.61  |
| pt-posttemporal     | pt1                       | 2–2.5 | 2.0       | 0.12 | 5.91   |
|                     | pt2                       | 2–2.5 | 2.0       | 0.18 | 8.87   |
| l-lacrimal          | l1                        | 5–7   | 6.1       | 0.45 | 7.43   |
|                     | l2                        | 5–8   | 6.2       | 0.68 | 11.04  |
| p-pterotic          | p1                        | 3–5.5 | 4.8       | 0.44 | 9.22   |
|                     | p2                        | 4–6   | 4.8       | 0.47 | 9.73   |

$\bar{x}$, mean; $s$, standard deviation; CV, coefficient of variation; numbers 1 and 2 denote left and right side of the body.
Table 5

Skull and bone measurements of gudgeon, *Gobio gobio*, from the Odra River drainage

| Feature                                                                 | Range   | \( \bar{x} \) | s    | CV [%] |
|------------------------------------------------------------------------|---------|---------------|------|--------|
| Length of neurocranial base without pharyngeal process \( L_{bas.n.} \)| 19.5–25.9 | 23.0          |      |        |
| Ethmoid region depth \( H_{eth} \)                                      | 13.1–21.0 | 17.3         | 1.92 | 11.07  |
| Neurocranium depth on the supraoccipital level \( H_{soc} \)            | 24.5–31.9 | 27.7         | 1.74 | 6.29   |
| Neurocranium depth on the parasphenoid \( H_{ps} \)                     | 23.4–29.0 | 26.1         | 1.48 | 5.68   |
| Cranial roof length \( L_{cr.r.} \)                                     | 82.6–95.8 | 90.4         | 3.03 | 3.35   |
| Ethmoid length \( L_{eth} \)                                           | 15.9–24.0 | 19.5         | 2.20 | 11.26  |
| Neurocranium width between lateral margins of lateral ethmoids \( L_{te} \) | 31.9–46.4 | 43.3         | 2.71 | 6.23   |
| Neurocranium width between sphenotics \( L_{spho} \)                    | 41.6–52.1 | 46.0         | 2.19 | 4.76   |
| Neurocranium width between pterotics \( L_{pto} \)                     | 44.1–56.7 | 50.2         | 2.48 | 4.95   |
| Masticatory plate length \( L_{mas.pl} \)                              | 8.6–12.9  | 10.9         | 0.93 | 8.55   |
| Lacrimal bone length \( L_{tol} \)                                      | 30.0–45.6 | 36.5         | 3.49 | 9.55   |
| Hyomandibular bone height \( H_{hyo} \)                                 | 33.6–47.2 | 39.0         | 3.61 | 9.27   |
| Opercular bone width \( L_{op} \)                                       | 29.1–50.3 | 38.6         | 5.86 | 15.18  |
| Interopercular bone width \( L_{i} \)                                   | 31.7–52.3 | 39.6         | 3.82 | 9.65   |
| Subopercular bone width \( L_{s} \)                                     | 41.0–53.8 | 47.4         | 3.11 | 6.57   |
| Hyomandibular bone height \( H_{hyo} \)                                 | 33.0–44.81 | 39.0       | 2.85 | 7.30   |
| Palatine bone length \( L_{pal} \)                                      | 24.5–38.5 | 31.3         | 2.93 | 9.37   |
| Dentar bone length \( L_{dent} \)                                       | 32.6–43.1 | 37.6         | 2.81 | 7.48   |
| Premaxilla bone length \( L_{pmx} \)                                    | 22.8–32.3 | 28.0         | 2.34 | 8.36   |
| Maxilla bone length \( L_{max} \)                                       | 26.1–37.0 | 31.3         | 2.57 | 8.21   |

\( \bar{x} \), mean; s, standard deviation; CV, coefficient of variation.
46.02% \textit{L. bas.n.} on average. The opercular series (Fig. 5) consists of four bones. The operculum is the largest of the series and has an articul ar process towards the hyomandibula.

**DISCUSSION**

The species that belong to the genus \textit{Gobio} are morphologically similar to each other, and this has led to misidentifications for many years (Freyhof et al. 2000). In particular, the \textit{G. gobio} complex is a taxonomically difficult species, which shows an extraordinary phenotypic diversity, but the validity of many of its nominal species is still controversial (Bănărescu et al. 1999, Schreiber 2000). The common gudgeon is one of the most variable fish species in Europe. Two morphotypes were distinguished: lotic (rheophilic) and lentic (limnophilic). They differ in colour, some biometric features (Bănărescu et al. 1999), and in some meristic features, especially the number of scales in the lateral line (Kux and Libosvarsky 1981).

Bănărescu (1954) has made an extensive taxonomic study of the genus \textit{Gobio} in Romanian waters. According to the results for \textit{Gobio gobio} five morphometric characters were chosen: length of barbels, eye diameters, maximum and minimum body depth, and caudal peduncle length. The rheophilus form, inhabiting upper reaches of rivers, showed lower maximum and minimum body depth, smaller head and eye diameter but longer barbels, and caudal peduncle than the limnophilus form. The same five characters were chosen by Libosvarsky and Kux (1982). Kux and Libosvarsky (1981) used four of them (without the caudal peduncle length) and the number of scales in the lateral line.

Rolik (1965) tried to classify several populations from Vistula drainage into lotic and lentic forms and consider to be lotic form of \textit{G. gobio gobio} (cf. Nowak et al. 2006). The present authors’ data and other populations studied by Jarzynowa and Rechulicz (1997), Nowak et al. (2008) were riverine, so the differences could not be explained in terms of these ecological forms.

The type locality of the species is England. The English populations of \textit{G. gobio gobio}, both rheophilic and limnophilic, are characterized by longer heads, averaging 27.3, 28.5, and 28.1% SL for different groups (Bănărescu et al. 1999).

Kottelat and Persat (2005) criticised this classification as inconsistent and insufficiently defined (Nowak et al. 2006).

Bănărescu (1954) has stated that the eye diameter \((O)\) was a good parameter in discriminating between \textit{G. gobio} and its congeners. The eye diameters and head length of gudgeons from the Elbe and the Odra River systems are

**Figs. 3–5.** Bones of the viscerocranium and circumorbital series of gudgeon, \textit{Gobio gobio}, from the Odra River drainage (95.7 mm in SL) **Fig. 3.** Infraorbitals (io 2–5, infraorbitals 2–5; lac, lacrimal; spr, supraborbitale) **Fig. 4.** Jaws (pmx, premaxilla; mx, maxilla; dn, dentary) **Fig. 5.** Opercular series (iop, interoperculum; op, operculum; pop, praeperculum; sop, suboperculum)
more similar to those of specimens from the Danube. Gudgeons from the Vistula system are more similar to the English ones (Rolik 1965). The eye diameter in the analysed specimens varies from 12.1% to 25.0% of head length \( lc \) and is characterized by high coefficient of variation (CV = 14.7%), while in another Polish sample the range is 18.8%–25.7% \( lc \) (Nowak et al. 2008). Vasil’eva et al. (2005) demonstrated the great morphological similarity between the Crimean gudgeons with certain Bulgarian populations. The eyes of these gudgeons were very small. It is necessary to take into consideration that this feature is subject to the size variability (Bănărescu et al. 1999, Vasil’eva et al. 2005) and implies a comparison of specimens only of similar size.

Other characters used in comparisons by different authors are head length, snout length and postorbital distance (Rolik 1965, Skóra and Włodek 1966, Nowak et al. 2008). According to them gudgeons in the Vistula River drainage visually differed from these in the Odra River drainage in shorter head, a bit longer snout and deeper body. Specimens from the Bukowa River (Jarzynowa and Rechulicz 1997) were characterized by long head (25.0%–30.4% SL). They are more similar to those from the Soła River (Skóra and Włodek 1966) compared to the San River (Rolik 1965).

The meristic characters although, having a taxonomic importance are not stable and are characterized by certain variability, which is likely to be characteristic for a given population or species. In the analysed sample the principal meristic features are as follows: \( D III 7–9; A III 6–7; P I 11–15; F I 6–8; l l. 37–41. \) According to Skóra and Włodek (1971), who analysed samples from the rivers of southern Poland, those meristic features that show a small variability are extremely good diagnostic features. In their study, these were the number of scales on the lateral line of the body and the number of vertebrae (CV = 2.96% and 2.92%, respectively). The sample under study showed the lowest variability for the same features, 1.60% for the number of scales and 2.13% for the total number of vertebrae (CV = 14.7%), while in another Polish sample the same range of the abdominal vertebrae amounted to 18–22, whilst in the caudal region 15–18.

In 1946 Tretyakov was the first to use the features of the cephalic lateral line system for understanding cyprinid phylegony (Hensel 1978). The general pattern in the Gobionine is that the infraorbital canal connects the supraorbital- (CSO), the preoperculo-mandibular- (CPM), and the supratemporal- (CST) canals (Hosoya 1986). All of the cephalic canals are complete (Bănărescu et al. 1999). In the Gobio species the supraorbital canal (CSO) run only through nasal and frontal bones. On the frontal it is divided into two branches. Rarely, this canal extends onto the parietal bone. There is no information’s about pore numbers for Polish populations. The CIO has greater number of pores than \( G. albibrinnatus \), designated by the formula (15–17) 18, 19 (20, 21) (Bănărescu et al. 1999). Specimens from the present study had 16–19 pores. Vasil’eva et al. (2005) gave some data about the number of pores on particular elements of the skull in “short-barbeled Crimean gudgeon, Gobio krymensis”—until recently regarded a junior synonym of Gobio gobio gobio by Kottelat (1997) and Froese and Pauly (2008). These results are very similar to the common gudgeon, \( G. gobio \). In the majority of specimens of the “Crimean gudgeon” on the frontal bone in most specimens is eight pores (in the common gudgeon, seven), on pterotic three–fives pores (in the common gud-
The infraorbital series is composed of the lacrimal and su-
mericotypes. The ventral margin of the lacrimal. This morphotype can be
ceeding bones. Hosoya (1986) divided the series into two
specimens of gudgeon, have a pair of supraorbital bones.
also observed in
Vandewalle (1974), Hosoya (1986), Bănărescu et al. (1999),
brae; l.l. = number of scales in the lateral line; ss = number of scales between lateral line and dorsal fin base; i = number of scales
between lateral line and ventral fin base.

### Table 6
Comparison of selected meristic character of gudgeon, *Gobio gobio*, with the data from the literature
(mean value in brackets)

| Water body                             | D    | A    | P    | V    | Vt   | l.l. | ss  | i    |
|----------------------------------------|------|------|------|------|------|------|-----|------|
| Odra River drainage (present study)    | 7−9  | 6−7  | 11−15| 6−8  | 38−41| 37−41| 5−6 | 5    |
| (8)                                    | (6.7)| (12.6)| (7)  | (39.4)| (39.2)| (5.9)|     |      |
| Wieprz River drainage (Danilkiewicz 1997) | 7    | 6    | 12−17| 7    | —    | 39−44| 5−6 | 4−6.5|
|                                         | (14.9)| (7)  |      |      | (41.80)| (5.79)| (4.8)|      |
| Sola (Skóra and Włodek 1966, 1971)    | 7    | 5−6  | —    | —    | 38−41| 39−45| 5−6 | 3−4  |
|                                         | (39.6)|      |      |      |      |      |     |      |
| Strwiąż (Rolik 1967)                   | 7    | 5−7  | (6)  | —    | 35−38| 39−44| 5−6 | 3−4  |
| Berg (1949)                            | 7    | 6    | —    | —    | 40−45| 5−6  | 3−4 |      |
| Bănărescu (1962)                       | —    | —    | —    | —    | —    | —    | —   |      |
| Kux and Libovarsky (1981)              | —    | —    | —    | —    | 40−45| —    | —   |      |
| Rudawa River (Nowak et al. 2008)       | 7    | 5−6  | (7.0)| (6.0)| —    | 38−44| 5−6 | 3−4  |
|                                         |      |      | (40.8)| (5.8)|      | (3.9)|     |      |
| Silnica River (Nowak et al. 2008)      | 7    | 5−6  | (7.0)| (6.0)| —    | 38−42| 5−6 | 4−5  |
|                                         |      |      | (40.5)| (5.9)|      | (4.1)|     |      |

*D, A, P, V = soft (branched) fin ray numbers of dorsal-, anal-, pectoral- and ventral fins, respectively; *Vt* = total number of verte-
brae; *l.l.* = number of scales in the lateral line; *ss* = number of scales between lateral line and dorsal fin base; *i* = number of scales
between lateral line and ventral fin base.

Gobio usually there are five pores), on praecoperculum the
number of pores varies from seven to eleven (in the common gudgeon, seven–eight).

Some elements of the head anatomy were described by
Vandewalle (1974), Hosoya (1986), Bănărescu et al. (1999),
and Vasil’eva et al. (2004).

All the genera of Gobioninae, including the analysed
specimens of gudgeon, have a pair of supraorbital bones.
The infraorbital series is composed of the lacrimal and suc-
ceeding bones. Hosoya (1986) divided the series into two
morphotypes. *Gobio* belongs to the first morphotype char-
acterized by the infraorbital canal running backward along
the ventral margin of the lacrimal. This morphotype can be
also observed in *Hemibarbus, Squalidus*, and *Mesogobio*.

The general appearance of the neurocranium, including
bone measurements, is described in details for
*G. albipinnatus*, widely distributed and abundant species
that was formerly confused with its congeners, especially
*G. gobio* (cf. Bănărescu et al. 1999). The skull depth in
the ethmoid region of *G. gobio* is similar to *G. albipinnatus*,
being on average 13.1%–21% and 15.7%–20.0%,
17.3%, and 17.5% *L.bas.n.* respectively. In the sphenotic
region, the range is 23.4%–29.0% *L.bas.n.* for *G. gobio
and 24.3%–29.6% *L.bas.n.* for *G. albipinnatus*. The depth of
the occipital part is 24.5%–31.9% *L.bas.n.* and
25.2%–30.5% *L.bas.n.*, respectively. The width of the
neurocranial of *G. albipinnatus*, between the lateral margins
of the lateral ethmoids, is 38.6% to 44.8% *L.bas.n.*, that
between the margins of the sphenotics ranges from
42.9% to 52.3%, and between the lateral margins of the
pterotics varies from 50.0% to 57.3% of *L.bas.n.* These
values for analysed sample of *G. gobio* are as follows:
31.9%–46.4%, 41.6%–52.1%, and 44.1%–56.7% of *L.bas.n.* These figures indicate that the neurocranium of
*G. albipinnatus* is a little deeper and wider than that of
*G. gobio*. According to Vasil’eva et al. (2004) the skull depth
of *G. gobio* (% *L.bas.n.*) are as follows: *H eth* 17.1%–20.1%,
*H soc* 27.0%–28.9%, and *H ps* 24.9%–28.1%. These measure-
ments were made for the first time for a Polish sample.

Although knowledge on how to distinguish between
*Gobio* species has improved in recent years (Bănărescu et
al. 1999, Vasil’eva et al. 2004, 2005), their identification
is still not easy because of extraordinary phenotypic
diversity. There is still too little comparative material
available for Polish populations.

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