Arch. Pol. Fish. (2011) 19: 37-49
DOI 10.2478/v10086-011-0005-8

RESEARCH ARTICLE

Contributions to the morphological variation of the common gudgeon, *Gobio gobio* complex (Teleostei: Cyprinidae), in the upper Vistula drainage (southeast Poland)

Michał Nowak, Jan Mendel, Paweł Szczerbik, Artur Klaczak, Tomasz Mikołajczyk, Konrad Ozga, Barbara Fałowska, Włodzimierz Popek

Received – 09 November 2010/Accepted – 10 February 2011. Published online: 30 March 2011;

Abstract. Recent molecular research indicates that several distinct species have been confused under the name *Gobio gobio* (L.); thus, comparative investigations of numerous local populations are urgently needed. The present study presents and discusses detailed morphometric characteristics of 82 individuals from the *G. gobio* complex of nine tributaries of the upper Vistula River (southeast Poland) within the context of the known variability of this species. The specimens analyzed generally resemble *G. gobio* s. stricto in a number of morphometric and meristic characters. The results are rather consistent with previous literature data on Polish populations of the "common gudgeon"; however, as long as molecular analyses are not available, precise identification is impossible.

Keywords: biometrics, Gobioninae, ichthyofauna, traditional morphometrics, Vistula drainage

M. Nowak [✉], P. Szczerbik, A. Klaczak, T. Mikołajczyk, K. Ozga, B. Fałowska, W. Popek
Department of Ichthyobiology and Fisheries
University of Agriculture in Kraków
Spiczakowa 6, 30-199 Kraków-Mydlniki, Poland
Tel./Fax: +48 12 637 51 76, +48 12 638 59 79;
e-mail: michal.nowak@ur.krakow.pl

J. Mendel
Department of Fish Ecology
Institute of Vertebrate Biology
Academy of Sciences of the Czech Republic v.v.i.
Květná 8, 603 65, Brno, Czech Republic

Introduction

Gobioninae are a subfamily of the family Cyprinidae comprising small, bottom-dwelling fishes of practically no commercial importance (Kottelat and Freyhof 2007, Mendel et al. 2008a, 2008b, Nowak et al. 2008a). This is why they have long been disregarded as a subject of ichthyological investigations in Poland, as well as in Europe in general. Nevertheless, they have been investigated extensively by taxonomists. It was Bănărescu (1961) who divided the genus *Gobio* into the three subgenera, namely *Gobio* sensu stricto, *Romanogobio*, and *Rheogobio*. Naseka (1996) later elevated them to the rank of distinct genera. Naseka and Freyhof (2004) joined the genera *Romanogobio* and *Rheogobio* as they judged the latter to be a junior synonym of the former. Presently, the genera *Gobio* and *Romanogobio* are well established among fish taxonomists; however, some authors still consider *Rheogobio* to be a valid genus (e.g., Nalbant 2003, also Nalbant, pers. comm.).

Due to conceptual changes in modern systematics regarding mainly the shift from biological to phylogenetic and evolutionary species concepts and the abandonment of the subspecific category (Kottelat 1997, Wiley and Mayden 2000, Kottelat and Freyhof 2007), many former subspecies or local forms have been recognized as valid species. Thus, some former "catch-all" species considered to be highly polymorphic and to consist of a number of subspecies, were divided into distinct species (Naseka et al. 2006, Mendel et al. 2008a, Nowak et al. 2008a). The type species for the genus *Gobio*, the common gudgeon, *Gobio gobio* (L.), was redescribed by Kottelat and Persat (2005).

In Poland, the taxonomy of this group of fishes has never been thoroughly clarified (Nowak et al. 2008b). Since the series of works by Rolik (1959, 1965a, 1965b, 1965c, 1967), it has been widely accepted that the territory of Poland is inhabited by three gudgeon species. In addition to *G. gobio*, Kessler's (sand) gudgeon, *Gobio kessleri* Dybowski, currently *Romanogobio kesslerii* (Rolik 1959), and the whitefin gudgeon, *Gobio albipinnatus* Lukasch, currently *Romanogobio albipinnatus* (Rolik 1965b), are recorded. In the past, another species, the stone (longbarbel) gudgeon, *Gobio uranoscopus* Agassiz, currently *Romanogobio uranoscopus*, was also reported from the upper Vistula drainage (e.g., Staff 1950); however, Rolik (1959, 1965c) clearly showed that this was the result of confusion with *R. kesslerii*. Recent studies show, however, that all these names have been applied for species groups comprising of a number of distinct species (Mendel et al. 2006, 2008a, 2008b, Kottelat and Freyhof 2007, Nowak et al. 2009a).

Beside the "nominative form" of the common gudgeon, *G. gobio gobio*, the occurrence of two other subspecies was presumed. In the Czarna Orawa River system within the Danube River drainage, Balon and Holčík (1964) identified *Gobio gobio obtusirostris* (Valenciannes), whereas in the Strwiąż River system within the Dniestr River drainage Rolik (1967) found *Gobio gobio sarmaticus* (Berg). The latter two taxa are currently considered valid species (Kottelat and Freyhof 2007, Mendel et al. 2008a, b); however, they are considered in a slightly different manner than in the 1960s, so this does not necessarily infer their occurrence on Polish territory. A detailed re-examination of the material from the both river drainage is needed.

Rolik (1965a) examined the *G. gobio* material from a number of rivers in Poland and discussed the results obtained in reference to data from adjacent countries, mainly those from the works of Berg (1949) and Bănărescu (1954, 1961). Following the latter, Rolik (1965a) tried to explain the observed variability in certain morphometric traits placing Polish populations "somewhere between" *G. gobio gobio* and *G. gobio obtusirostris*, and applying the terms of "lotic" and "lentic" ecological forms. Very recently it was hypothesized that what is thought in the Vistula River drainage to be *G. gobio* could indeed consist of a group of very similar species (Nowak et al. 2008b). Molecular data showed that this idea was generally true, and at least two evolutionary lineages of the "common gudgeon" were identified on Polish territory (Nowak et al. 2009a, Mendel and Nowak, unpubl. data). The first is Lineage_I that refers to *G. gobio* sensu stricto and the second is Lineage_V (*Gobio* sp. 2, a probable undescribed species) according to Mendel et al. (2008a, 2008b).

In their rediscription of *G. gobio*, Kottelat and Persat (2005) emphasized the fact that, although there have been a number of reviews concerning the taxonomy of the genus *Gobio* (e.g., Bănărescu 1954, 1961, 1962, 1992, Bănărescu et al. 1999), they have been based mainly on a restricted number of populations and the results have been generalized over a wide range. Thus, Kottelat and Persat (2005) postulated the need for intensified efforts to compare numerous populations from adjacent drainage using similar methodology. Naseka et al. (2006) did this to review some populations from Turkey, and designated certain new species. Surprisingly, in recent years, beside some significant exceptions (e.g., Vasil'eva et al. 2004, 2005, Freyhof and Naseka 2005), only scant attention has been paid to the issue of morphological diversity and the identification of gudgeons of the genus *Gobio*. A number of questions regarding the taxonomy and identification of some local populations have not been answered definitively.

In the current study, molecular analysis was unavailable for a vast majority of specimens examined; thus, the paper deals solely with the *G. gobio* complex consisting of individuals representing at least two lineages according to Mendel et al. (2008a, 2008b), Lineage_I and Lineage_V, but disregarding their genetic identity (Mendel and Nowak, unpubl. data). The main goal of the present study was to contribute to knowledge of the morphological variation of the *G. gobio* complex in the drainage area of the upper Vistula River system.

Material and methods

Study area and sampling methods

Fish were collected from 2006 to 2009 during ichthyological surveys in the upper Vistula River drainage. The study was performed on material collected from nine rivers within the upper Vistula drainage: Hoczewka, Krzyworzeka, Mleczka, upper San, Sanoczek, Solinka, Tarnawka, Wiar, and Wisłoka (Fig. 1). A total of 82 specimens were used in the study. The material was collected occasionally during monitoring surveys in the upper Vistula system. The fish were caught by electrofishing using a battery-powered portable electroshocker (IG-600T, Hans Grassl GmbH). The fish were anaesthetised with a lethal dose of 2-phenoxyethanol and fixed in a 4% formaldehyde solution. The material was stored at the Department of Ichthyobiology and Fisheries, University of Agriculture in Kraków under catalog numbers KIR 209 (Hoczewka, 3 specimens), KIR 210 (Krzyworzeka, 12 spec.), KIR 211 (Mleczka, 8 spec.), KIR 212 (upper San, 11 spec.), KIR 213 (Sanoczek, 5 spec.), KIR 214 (Solinka, 8 spec.), KIR 215 (Tarnawka, 7 spec.), KIR 216 (Wiar, 5 spec.), and KIR 217 (Wisłoka, 23 spec.).

Methods for measurements and counts

In the laboratory, the gudgeons were measured for 35 distances usually considered in taxonomic studies of this group of fishes (e.g., Bănărescu 1954, 1961, Naseka and Freyhof 2004, Naseka et al. 2006, Nowak et al. 2008, 2009b, 2010, Nowak 2010) (Fig. 2). The measurements were performed generally according to Hubbs and Lagler (1947), with some adaptation from Naseka et al. (2006) and Nowak et al. (2008b, 2009b). Standard length (SL), body length (L) and head length (HL) were measured from the tip of the snout (upper jaw) to the end of the hypural complex, the end of the last perforated scale in the lateral line, and the most backward extending point of the opercular membrane, respectively. Caudal peduncle length (pl) was taken as a straight line from

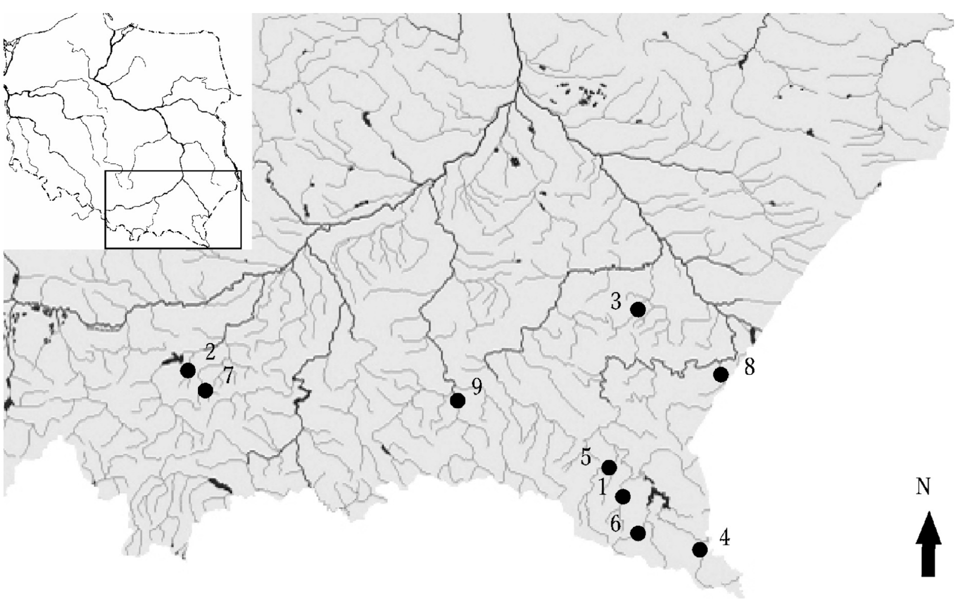

Figure 1. Study area with sampling sites marked in rivers: 1 – Hoczewka; 2 – Krzyworzeka; 3 – Mleczka; 4 – upper San; 5 – Sanoczek; 6 – Solinka; 7 – Tarnawka; 8 – Wiar; 9 – Wisłoka.

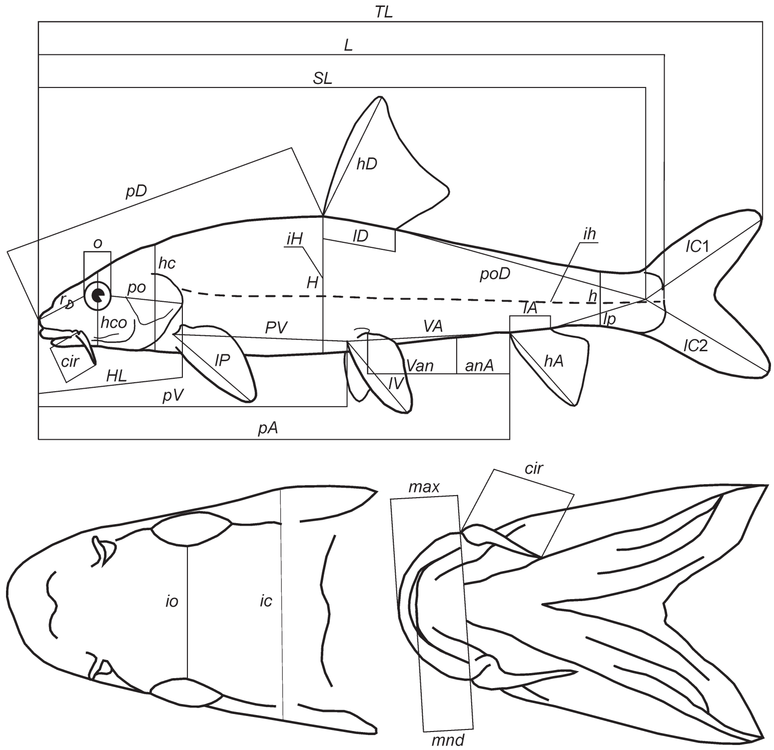

Figure 2. Methods for measurements. Abbreviations: TL, total length; L, body length; SL, standard length; H, body depth; h, caudal peduncle depth; iH, body width at dorsal fin origin; ih, caudal peduncle width at anal fin insertion; pD, predorsal length; poD, postdorsal length; pV, prepelvic length; pA, preanal length; PV, distance between pectoral and pelvic fin origin; VA, distance between pelvic and anal fin origin; pl, caudal peduncle length; hD, dorsal fin depth; lD, dorsal fin base length; hA, anal fin depth; lA, anal fin base length; lP, pectoral fin length; lV, pelvic fin length; lC_1, caudal fin upper lobe length; lC_2, caudal fin lower lobe length; Van, distance between pelvic fin insertion and anus; anA, distance between anus and anal fin origin; HL, head length; hc, head depth at nape; hco, head depth at eye center; r, snout length (preorbital distance); o, horizontal eye diameter; po, postorbital distance; ic, head width at opercles; io, interorbital width; cir, barbel length; max, upper jaw length; mnd, lower jaw length. Drawing by M. Nowak.

the anal-fin insertion to the end of the hypural complex. All the measurements were taken by hand, using a dial caliper and the results were recorded to the nearest 0.05 mm. In the text, all subunits of the head are expressed in percentages of HL, and all subunits of the body are expressed percentages of SL, unless otherwise stated. It should be noted that SL was used as the main reference length, in contrast to the vast majority of Eastern European publications, in which it has been confused with body length (abbreviated herein as L; see the discussion in Kottelat and Persat 2005, Nowak et al. 2009b). In addition, 14 meristic characters were examined in each specimen. The methods applied for the counts were taken from Hubbs and Lagler (1947), Naseka et al. (2006), and Nowak et al. (2008a, 2009b). The last two branched rays in the dorsal and anal fins were counted as 1½ according to Kottelat and Freyhof (2007).

Data processing

Because the material from certain localities was collected occasionally (usually during ichthyofaunistic monitoring), there were small numbers of specimens which meant that no statistical analyses were possible. Thus, only descriptive statistics were calculated, including: range, arithmetic mean of morphometric characters, and frequency distributions and mode for meristic characters.

Results

The morphometric data for each group are expressed traditionally in percentages of SL or HL and are summarized in Tables 1-3. The body was elongated, with a relatively long head (HL was on average from 26.04

Table 1
Morphometrics of *Gobio gobio* complex from Hoczewka, Krzyworzeka and Mleczka Rivers. Arithmetic mean is in parentheses. Trait abbreviations explained in the text

Trait	Hoczewka (N = 3)	Krzyworzeka (N = 12)	Mleczka (N = 8)
TL (mm)	111.90-126.00 (118.59)	79.50-132.00 (109.06)	104.40-132.80 (118.83)
L (mm)	94.25-107.15 (100.19)	67.50-114.30 (93.33)	87.25-112.75 (100.48)
SL (mm)	91.05-102.05 (96.19)	65.00-108.65 (90.32)	84.16-109.50 (97.25)
In % SL			
H	20.30-20.73 (20.47)	16.81-22.77 (19.89)	19.70-21.64 (20.76)
h	8.13-9.16 (8.56)	8.05-9.43 (8.83)	8.30-9.78 (9.07)
iH	12.15-13.76 (13.04)	11.78-14.53 (13.52)	14.44-16.34 (15.43)
ih	7.27-8.66 (7.86)	7.18-9.31 (8.25)	8.41-10.17 (9.16)
pD	48.00-49.40 (48.89)	45.42-50.79 (48.17)	46.75-49.64 (48.29)
poD	41.61-43.69 (42.89)	39.53-44.94 (42.40)	40.71-43.81 (42.19)
pV	49.81-50.74 (50.16)	47.84-51.37 (49.39)	47.94-55.38 (50.01)
pA	70.96-74.01 (72.34)	68.64-74.55 (71.62)	69.71-74.16 (71.29)
PV	24.02-26.07 (25.07)	22.77-26.62 (24.12)	21.30-25.29 (23.72)
VA	22.02-24.66 (23.40)	20.22-23.52 (21.76)	20.07-24.29 (21.70)
pl	20.09-21.75 (20.93)	19.20-22.75 (20.92)	19.16-23.16 (21.56)
hD	20.97-21.73 (21.32)	19.69-23.86 (21.80)	19.56-22.50 (20.78)
lD	11.91-12.97 (12.37)	11.06-14.43 (13.12)	12.30-14.28 (13.10)
hA	15.98-17.59 (16.69)	15.80-18.66 (17.12)	15.04-17.59 (16.41)
lA	8.19-8.30 (8.25)	7.18-9.39 (8.43)	7.66-9.55 (8.50)
lP	19.15-19.75 (19.43)	19.23-23.31 (20.74)	16.83-22.18 (20.45)
lV	15.77-16.75 (16.22)	15.93-18.65 (16.75)	14.94-17.23 (16.26)
lC_1	21.68-23.21 (22.45)	21.16-24.75 (22.78)	20.85-24.55 (22.42)
lC_2	20.80-22.20 (21.41)	19.71-23.53 (21.12)	18.40-22.62 (20.46)
Van	10.87-11.80 (11.43)	8.76-10.64 (9.59)	9.01-10.74 (9.85)
anA	6.97-9.02 (8.11)	6.47-9.97 (7.80)	6.16-9.44 (7.94)
HL	25.57-26.56 (26.04)	26.44-28.23 (27.06)	24.94-27.99 (26.72)
In % HL			
hc	58.19-60.37 (59.39)	51.67-58.52 (56.25)	56.27-66.07 (60.98)
hco	49.38-51.66 (50.35)	45.56-51.99 (48.94)	47.08-55.73 (51.14)
r	45.33-46.57 (45.95)	39.11-47.76 (42.87)	41.31-44.96 (43.21)
o	19.57-19.73 (19.64)	16.79-23.91 (19.57)	17.87-21.85 (19.79)
po	41.55-45.78 (43.92)	40.56-46.35 (43.35)	39.33-45.46 (41.67)
ic	57.13-60.05 (58.77)	48.89-53.89 (51.05)	51.95-61.33 (56.48)
io	27.45-29.16 (28.38)	25.46-30.00 (27.69)	25.79-30.10 (28.24)
cir	25.27-28.58 (26.40)	21.94-27.78 (25.21)	20.92-26.52 (23.71)
max	26.39-28.43 (27.17)	22.59-26.94 (24.80)	24.88-27.81 (26.52)
mnd	18.22-19.27 (18.67)	17.07-22.45 (18.84)	16.88-19.75 (18.39)

Table 2
Morphometrics of *Gobio gobio* complex from Rudawa, Sanoczek and Solinka Rivers. Arithmetic mean is in parentheses. Trait abbreviations explained in the text

Trait	San (N = 11)	Sanoczek (N = 5)	Solinka (N = 8)
TL (mm)	122.40-137.00 (130.05)	81.95-105.10 (93.56)	116.50-131.15 (122.11)
L (mm)	103.20-118.70 (108.71)	69.15-88.35 (78.16)	98.20-109.60 (102.74)
SL (mm)	101.00-115.20 (106.04)	66.75-85.82 (75.47)	95.05-105.80 (99.42)
In % SL			
H	18.12-23.18 (20.89)	19.45-21.19 (20.12)	20.25-22.53 (21.03)
h	8.47-10.07 (9.37)	8.82-9.10 (8.92)	8.44-9.31 (9.01)
iH	13.90-16.15 (14.97)	15.63-18.01 (16.28)	15.30-17.08 (16.23)
ih	7.33-9.08 (8.59)	8.01-9.86 (9.28)	8.10-9.86 (9.32)
pD	48.45-50.78 (49.54)	47.30-48.58 (48.07)	47.42-49.46 (48.38)
poD	38.04-42.34 (40.76)	42.05-44.65 (43.13)	40.45-43.89 (42.14)
pV	49.45-53.05 (50.63)	48.21-50.04 (48.85)	48.67-50.74 (49.49)
pA	71.04-75.49 (72.92)	69.54-70.64 (70.13)	70.51-72.78 (71.87)
PV	23.62-26.87 (24.75)	23.02-24.99 (24.13)	23.44-26.29 (24.76)
VA	21.14-23.70 (22.41)	16.80-20.84 (19.60)	21.20-23.96 (22.20)
pl	19.28-21.46 (20.70)	20.99-22.57 (21.92)	18.35-23.26 (20.94)
hD	19.58-23.56 (22.05)	21.67-23.86 (22.83)	20.38-21.94 (21.17)
lD	12.30-13.63 (13.03)	12.75-13.65 (13.10)	12.78-13.97 (13.31)
hA	15.48-17.90 (16.48)	15.81-17.62 (16.77)	15.95-17.12 (16.42)
lA	7.74-8.77 (8.32)	8.07-9.02 (8.36)	8.01-10.49 (8.74)
lP	18.76-23.00 (21.03)	20.15-22.38 (21.53)	17.22-21.45 (19.81)
lV	15.12-19.55 (16.81)	15.91-17.68 (17.05)	15.53-17.09 (16.47)
lC_1	19.79-24.30 (22.04)	21.92-24.70 (23.30)	21.24-22.81 (22.03)
lC_2	19.44-23.18 (20.86)	20.48-22.81 (21.56)	19.97-22.22 (20.77)
Van	8.19-10.38 (9.35)	7.84-9.62 (8.73)	8.59-10.81 (9.56)
anA	6.28-8.86 (7.43)	6.33-8.18 (7.36)	6.99-9.49 (8.18)
HL	26.78-28.49 (27.68)	26.71-28.69 (27.75)	25.63-26.79 (26.17)
In % HL			
hc	56.71-62.54 (59.46)	56.61-62.06 (59.48)	59.94-66.06 (62.61)
hco	45.96-52.84 (48.44)	48.93-51.48 (50.26)	49.84-55.18 (52.05)
r	42.66-47.65 (45.39)	39.95-44.90 (41.83)	43.62-47.18 (45.74)
o	18.18-20.07 (18.83)	21.07-26.72 (22.86)	18.11-20.81 (19.41)
po	39.79-44.67 (41.25)	39.11-40.85 (39.85)	40.80-42.42 (41.53)
ic	55.03-59.97 (57.38)	53.73-58.80 (55.94)	56.78-61.53 (58.42)
io	24.16-28.36 (26.44)	25.27-30.08 (27.74)	26.59-30.03 (28.13)
cir	25.35-34.49 (28.30)	22.09-27.40 (25.44)	22.19-27.96 (25.64)
max	26.17-20.79 (28.30)	24.54-28.71 (26.87)	24.03-30.10 (27.31)
mnd	18.06-21.95 (20.29)	14.62-19.63 (17.62)	15.80-20.11 (18.33)

Table 3
Morphometrics of *Gobio gobio* complex from Tarnawka, Wiar and Wisłoka Rivers. Arithmetic mean is in parentheses. Trait abbreviations explained in the text

Trait	Tarnawka (N = 7)	Wiar (N = 5)	Wisłoka (N = 23)
TL (mm)	108.60-131.85 (115.97)	101.75-113.85 (108.88)	91.35-136.35 (105.37)
L (mm)	92.75-112.45 (98.13)	85.65-96.70 (91.44)	76.80-116.55 (87.68)
SL (mm)	89.05-108.90 (94.96)	82.95-93.50 (88.48)	73.10-113.80 (84.61)
In % SL			
H	20.39-22.99 (21.53)	19.10-21.03 (20.00)	17.80-21.76 (20.08)
h	8.17-9.06 (8.60)	8.15-9.46 (8.90)	8.07-9.25 (8.59)
iH	12.45-13.44 (12.88)	12.16-12.58 (12.35)	11.29-15.48 (12.97)
ih	7.34-8.32 (7.87)	7.73-8.16 (7.96)	6.42-8.67 (7.51)
pD	47.88-50.61 (49.01)	49.01-51.00 (49.69)	46.89-51.38 (49.22)
poD	39.94-42.67 (41.57)	40.33-41.35 (40.79)	38.88-45.47 (42.28)
pV	47.29-51.99 (49.69)	49.29-51.05 (50.10)	47.45-52.61 (50.23)
pA	70.80-74.13 (72.17)	69.49-72.63 (71.54)	68.46-74.45 (72.25)
PV	22.15-26.27 (24.39)	21.89-26.44 (23.74)	22.17-26.82 (24.32)
VA	20.54-24.40 (22.73)	20.45-22.47 (21.58)	18.70-23.96 (21.78)
pl	19.49-21.12 (20.38)	20.13-21.71 (21.04)	19.65-23.31 (21.23)
hD	20.02-22.72 (21.63)	21.03-23.91 (22.18)	19.20-23.77 (22.16)
lD	12.48-13.55 (13.09)	12.55-13.99 (13.24)	11.86-14.65 (13.10)
hA	14.89-17.46 (16.63)	15.97-17.58 (17.07)	15.59-18.61 (17.12)
lA	7.98-9.19 (8.45)	8.02-8.92 (8.40)	7.39-9.63 (8.42)
lP	18.47-21.14 (19.42)	19.17-22.07 (21.23)	18.77-23.49 (20.90)
lV	16.20-17.45 (16.83)	16.23-18.30 (17.48)	15.95-19.36 (17.55)
lC_1	20.33-23.97 (22.29)	22.55-24.53 (23.51)	21.20-26.98 (23.90)
lC_2	18.31-21.99 (20.35)	21.24-22.58 (21.96)	18.91-24.57 (22.51)
Van	9.56-11.85 (10.49)	8.91-10.68 (9.67)	7.52-11.07 (10.00)
anA	6.82-8.53 (7.94)	7.03-8.48 (7.66)	5.79-10.01 (7.93)
HL	26.26-28.25 (27.32)	26.53-28.84 (27.89)	26.86-30.11 (28.41)
In % HL			
hc	54.97-59.37 (57.45)	53.13-57.04 (55.64)	51.70-62.13 (55.69)
hco	44.52-50.30 (47.80)	45.01-49.89 (47.48)	43.16-48.85 (46.56)
r	39.55-44.18 (41.20)	40.74-45.40 (43.24)	39.01-45.83 (42.40)
o	18.16-22.56 (19.73)	18.71-21.96 (20.40)	19.20-24.63 (21.37)
po	41.84-44.45 (43.13)	40.31-44.49 (42.30)	38.98-43.60 (41.27)
ic	50.16-53.83 (52.55)	49.00-53.78 (51.30)	46.23-54.14 (50.46)
io	23.81-28.59 (26.89)	24.52-26.43 (25.71)	23.62-29.04 (26.07)
cir	21.00-25.14 (22.72)	23.70-27.63 (25.51)	20.94-27.76 (24.25)
max	23.82-26.34 (25.25)	23.71-27.76 (25.68)	22.59-28.60 (25.41)
mnd	17.57-19.80 (18.27)	16.71-20.94 (18.46)	15.63-21.88 (18.82)

Table 4
Frequency distributions of scale counts in lateral line (to the end of hypural complex) and lateral row in *Gobio gobio* complex from the upper Vistula drainage

River	N	38	39	40	41	42	43	44	45
Number of scales in the lateral line to the end of the hypural complex									
Hoczewka	3				1	2			
Krzyworzeka	12		3	3	2	4			
Mleczka	8	1		5	2				
San	11		5	6					
Sanoczek	5	1	3	1					
Solinka	8		1	3	4				
Tarnawka	7		2	4	1				
Wiar	5		1	4					
Wisłoka	23		8	9	5	1			
Total number of scales in the lateral line									
Hoczewka	3						3		
Krzyworzeka	12				2	4	2	4	
Mleczka	8			1		5	2		
San	11				5	6			
Sanoczek	5				1	3		1	
Solinka	8				1	3	3	1	
Tarnawka	7				2	4	1		
Wiar	5				1	3	1		
Wisłoka	23				9	8	5	1	

to 28.41% of SL), and a laterally compressed and elongated caudal peduncle (pl 20.38-21.92% SL, h 8.56-9.37% SL, ih 7.52-9.32% SL). The pectoral fins were long, lP reached, on average, from 19.42 to 21.53% of SL. The dorsal fin was placed slightly behind the middle of the body, and the predorsal distance was longer than postdorsal distance (on average, pD and poD were 48.07-49.69% SL and 40.76-43.13% SL, respectively). The anus was placed closer to the anal fin origin than the pelvic fin insertion (on average, Van and anA distances were 8.73-11.43% SL and 7.36-8.18% SL, respectively). The snout was usually longer than the postorbital distance (in seven of total nine groups the mean value of r ranged from 41.83 to 45.95% of HL, whereas po varied from 39.85 to 43.92% HL; however, in two groups, Krzyworzeka and Tarnawka, the snout was notably shorter than the postorbital distance: 42.87 vs. 43.35% HL and 41.20 vs. 43.13% HL, respectively).

Regarding the meristic characters, the gudgeons analyzed in the study had three unbranched and 7½ (6½ in a single specimen) branched rays in the dorsal fin, and three unbranched and 6½ branched rays in the anal fin. Along the lateral line they had 40-44 (41-43 in most specimens; 42 on mode) perforated scales, 38-42 (usually 39-41; 40 modally) on the body (to the end of the hypural complex), and 1-3 (2 modally) scales on the caudal fin base (Table 4). Usually the gudgeons had 6 (occasionally 5 or 7) transverse rows of scales between the lateral line and the dorsal fin origin, and 4 (rarely three 3) rows between the lateral line and the pelvic fin origin. On the dorsum between the head and the dorsal fin origin there were 13-18 (16 modally) scales, very irregular in shape and size (Table 5). Around the caudal

Table 5
Frequency distributions of predorsal and circumpeduncular scale counts in *Gobio gobio* complex from the upper Vistula drainage

River	N	11	12	13	14	15	16	17	18
Predorsal scales									
Hoczewka	3					1	1	1	
Krzyworzeka	12					2	4	4	2
Mleczka	8					1	4	2	1
San	11				3	1	5	2	
Sanoczek	5					4	1		
Solinka	8					2	5	1	
Tarnawka	7				1	2	2	2	
Wiar	5					2	2	1	
Wisłoka	23			1	3	7	10	2	
Circumpeduncular rows of scales									
Hoczewka	3			3					
Krzyworzeka	12			1	8	3			
Mleczka	8		3	1	3	1			
San	11		3	4	1	3			
Sanoczek	5			1	2	2			
Solinka	8		1	2	3	1	1		
Tarnawka	7		2	2	2	1			
Wiar	5		2	3					
Wisłoka	23		5	12	5	1			

peduncle at its lowest part 12-16 (13 on mode) transverse rows of scales were counted (Table 5). Between the anus and the anal fin origin there were 4-6 (2 and 8 in single specimens, 5 modally) irregular scales. The distance from the tip of pectoral fin to origin of pelvic fin was equal from ½ o 4 scales (2 modally; in 4 specimens pectoral fin reached pelvic fin origin).

Discussion

In general, the specimens analyzed in this study resemble populations from other Polish rivers, described elsewhere in the literature (Rolik 1965a, 1967, Skóra and Włodek 1966, 1969, 1971, Danilkiewicz 1997, Nowak et al. 2008, Nowak 2010) as is shown in Table 6. Morphometric and meristic traits have been recognized as useful tools for the identification of particular species of the both genera of European gudgeons, *Gobio* and *Romanogobio*, by numerous authors for a very long time (Berg 1949, Bănărescu 1954, 1961, 1962, Bănărescu et al. 1999, Vasil'eva et al. 2004, 2005, Freyhof and Naseka 2005, Kottelat and Persat 2005, Naseka et al. 2006, Kottelat and Freyof 2007, Nowak et al. 2008b, 2009b, Nowak 2010). Conversely, other ichthyologists find that ranges of most of the morphometric characters usually overlap, and thus question the validity of some taxa designated on this basis (e.g., Bănărescu 1961, 1962, Koščo 1997, Bănărescu et al. 1999, Mendel et al. 2008a, 2008b). Very recently serious difficulties were encountered in distinguishing newly described species *Gobio volgensis* Vasil'eva, Mendel, Vasil'ev, Lusk et Lusková from *G. gobio*

Table 6

Certain morphometric features expressed in per cents of body length (*L*) of *Gobio gobio* complex from Vistula drainage according to various authors (range of the mean values for different localities are given)

Trait	River drainage					
	Vistula[1]	Soła[2]	Dunajec[3]	Wieprz[4]	Upper Vistula[5]	Upper Vistula[6]
H	18.65-19.90	18.3-20.6	19.5-23.9	19.35-22.23	19.0-21.3[a]	19.29-20.83
h	8.70-9.34	7.7-8.3	8.0-9.3	8.31-8.98	8.2-8.7[a]	8.22-9.01
pl	22.62-23.60	21.9-23.8	21.1-26.8	20.87-23.45	21.3-21.8[a]	19.72-21.17
pD	46.73-47.43	47.0-48.6	45.5-47.3	46.48-49.01	47.5-47.6[a]	46.41-48.09
poD	42.19-43.85	42.7-44.1	42.8-44.4	-	-	39.48-41.65
lP	18.77-20.80	16.8-17.4	15.5-20.5	-	19.1-20.5[a]	18.65-20.79
lV	15.87-16.98	14.9-15.6	14.8-16.3	-	15.6-17.0[a]	15.57-16.94
hD	20.38-21.53	19.5-20.8	19.0-22.2	17.68-19.29	20.3-21.3[a]	20.10-22.04
hA	14.47-15.07	15.0-15.7	15.5-16.7	13.49-14.57	14.9-15.9[a]	15.88-16.54
lC_1	19.50-21.43	20.6-22.0	18.9-21.0	-	-	21.32-23.05
HL	25.87-26.71	25.7-27.7	24.6-26.6	25.09-26.56	25.5-26.4[a]	25.01-27.36
r	11.48-12.14	10.4-11.7	-	10.70-12.75	10.02-11.09[b]	10.89-12.03
o	5.86-6.55	4.9-5.6	-	5.07-6.20	5.89-5.97[b]	4.91-6.12
po	10.50-11.27	11.2-12.2	-	-	11.25-11.43[b]	10.52-11.42
io	7.33-7.79	-	-	6.95-7.48	7.29-7.83[b]	6.94-7.43
cir	6.30-7.26	5.2-5.9	-	5.15-6.27	6.73-7.01[b]	6.00-7.60

Source of data: [1]Rolik (1965), [2]Skóra and Włodek (1966), [3]Skóra and Włodek (1969), [4]Danilkiewicz (1997), [5]Nowak et al. (2008b), [6]currently reported study; [a] in % SL (L not measured), [b]values calculated from the data given in the publication

sensu stricto (Mendel et al. 2008a), as well as the molecularly identified *G. gobio* from its hybrids with *Gobio* sp. 2 (Nowak and Mendel, in prep.). Recently, Kottelat and Persat (2005) and Kottelat and Freyhof (2007) indicated that *G. gobio* can be distinguished from all other *Gobio* species in Europe by the following combination of external characters: 4-5 scales between the anus and the anal fin origin, the naked breast between the pectoral fins, 39-42+2 scales along the lateral line, 12-14 circumpeduncular rows of scales, barbels reaching beyond the anterior margin and usually to the middle of the eye, the snout longer than the postorbital distance, HL being 26-30% of SL, eye diameter 5-7% of SL, 1.0-1.4 times in interorbital width (in specimens larger than 60 mm SL), 2.4-2.8 times in head depth at the nape, the latter character being 15-17% of SL, head depth at the eye center 43-51% of HL, body depth 19-23% of SL, head width 14-16% of SL and 49-57% of HL, caudal peduncle depth 30-34% of HL. Unfortunately, this description might refer, at least in a part, to a number of different species of *G. gobio* complex (see Mendel et al. 2008a, 2008b). Mendel et al. (2008a, 2008b) found that at least three distinct evolutionary lineages are still confused under the name *G. gobio*. These include *Gobio* sp. 1 (unresolved question, if the name *Gobio muresia* Jaszfalusi or *Gobio carpathicus* Vladykov are available), *Gobio* sp. 2 (maybe referring to the name *Gobio bulgaricus* Drensky) and *G. gobio* s. stricto. This problem is encountered especially within the Danube drainage (Mendel et al. 2008a, 2008b), but it was also encountered recently in the Vistula drainage (Nowak et al. 2009a, Mendel and Nowak, in prep.).

The results obtained in this study are generally consistent with the description given by other authors (Kottelat and Persat 2005, Kottelat and Freyhof 2007). On the other hand, it was noted that in a significant number of specimens (53 out of 82), the snout was shorter than the postorbital distance (Tables 1-3; however, on average in seven out of nine river groups the postorbital distance was longer than the snout), which contradicts both Kottelat and Persat (2005) and Kottelat and Freyhof (2007). On the other hand, Nowak et al. (2008b) reported gudgeons with much shorter snouts (in the Rudawa River snout length was on average of 39.3% of HL). The short snout was considered by a number of authors to be a key character of the former subspecies *G. gobio obtusirostris* or intrasubspecific *G. gobio* morpha *obtusirostris* (Berg 1949, Bănărescu 1954, 1961, Rolik 1965, 1967), which is currently accepted to be a valid species. Skóra and Włodek (1966) also found numerous gudgeons with snouts shorter than the postorbital distance, contrary to Rolik (1965a), who noted a prevalence of specimens with longer snouts (Table 6). Morphological comparisons performed by the latter author led to the conclusion that Polish populations of *G. gobio* are "somewhere between" *G. gobio gobio* and *G. gobio obtusirostris* (Rolik 1965a).

Bănărescu (1954) introduced the terms of "lotic" and "lentic" to the ecological forms of *G. gobio*. This author expected the former form to be characterized by a somewhat shallower body and caudal peduncle, longer barbels, paired fins and caudal peduncle in comparison to the latter forms. According to Bănărescu (1954) lotic forms occur in upper stretches of large rivers, whereas lentic ones in lower stretches of large rivers, as well as in small streams with fast water currents. When trying to apply this distinction to Polish populations, Rolik (1965a) concluded that nearly all the populations examined conformed to the terms of the lotic form, regardless of water current or size of the river where they had been caught. Such inconsistency and imprecise definitions of both forms led Kottelat and Persat (2005) to perform thorough critiques of the concept by Bănărescu (1954).

The results obtained in the current study are consistent with data from other authors from Poland (Table 6). The specimens studied in the current work did not vary noticeably from the specimens investigated by Rolik (1965a), Skóra and Włodek (1966, 1969), or Danilkiewicz (1997). The only one visible deviation from data in the literature is the shorter postdorsal length, not seen in the previous investigations (Table 6). At present, very few populations from the territory of Poland have been thoroughly studied, which is why no simple pattern of variability can be identified now. In the current study, morphological variation was described using very few samples, as was mentioned previously. Nonetheless, the authors think it is important to report even such limited material, and make the results available for a wide audience as a departure point for further studies. Without any doubt, it is urgent to continue research on the variability of the gudgeons of the genus *Gobio* in Poland. Further investigations need to cover both the molecular and morphological approaches. Special attention should be paid to explaining even very slight differences, some of which are identified in the present study, which could be crucial for the identification of cryptic evolutionary lineages (e.g., see the case of *G. volgensis* in Mendel et al. 2008 b).

Acknowledgments. All the procedures applied in the study were accepted by the First Local Ethics Committee in Kraków (no. 81/2008). Jan Mendel was supported by a project of the Grant Agency of the Czech Republic no. 206/09/P608.

References

Berg L.S. 1949 – Fishes of the USSR and adjacent countries. Vol. 2 – Izd. Akademii Nauk SSSR, Moskva-Leningrad (in Russian).

Balon E.K., Holčík J. 1964 – Lampreys and fishes new to Poland from the Danube Basin (Black Orava) – Fragm. Faun. 11: 189-206 (in Polish).

Bănărescu P. 1954 – Biometrische und systematische Studien an *Gobio gobio* aus Rumänien – Věst. čs. spol. zool. 18: 6-40 (in German).

Bănărescu P. 1961 – Weitere systematische Studien über die Gattung *Gobio* (Pisces, Cyprinidae), insbesondere im Donaubecken – Věst. čs. spol. zool. 25: 318-346 (in German).

Bănărescu P. 1962 – Phylletische Beziehungen der Arten und Artbildung bei der Gattung *Gobio* (Pisces, Cyprinidae) – Věst. čs. spol. zool. 26: 38-64 (in German).

Bănărescu P. 1992 – A critical updated checklist of Gobioninae (Pisces, Cyprinidae) – Trav. Mus. Hist. Nat. "Grigore Antipa" 32: 303-330.

Bănărescu P., Sorić V.M., Economidis P.S. 1999 – *Gobio gobio* (Linnaeus, 1758) – In: Bănărescu P. (Ed.), The freshwater fishes of Europe. Vol. 5/I. Cyprinidae 2. Part 1. Rhodeus to Capoeta. AULA Verlag, Wiebelsheim.

Danilkiewicz Z. 1997 – Distribution and variability of the gudgeon – *Gobio gobio* (L.) in Wieprz river-basin – Ann. UMCS Lublin, Sectio C, 52: 169-182 (in Polish).

Freyhof J., Naseka A.M. 2005 – *Gobio delyamurei*, a new gudgeon from Crimea, Ukraine (Teleostei: Cyprinidae) – Ichthyol. Explor. Freshwat. 16: 331-338.

Hubbs C.L., Lagler K.F. 1947 – Fishes of the Great Lakes Region – Bull. Cranbrook Inst. Sci. 26: 1-186.

Koščo J. 1997 – Biometric characters of *Gobio gobio* (L.) from the Tisa Basin – In: Abstracts of the Third Session of the Symposium "Systematics and phylogenesis of the animal world: Systematics of the fishes from the Cyprinidae". Olsztyn-Kortowo, Poland (in Polish).

Kottelat M. 1997 – European freshwater fishes. An heuristic checklist of the freshwater fishes of Europe (exclusive former USSR), with an introduction for non-systematists and comments on nomenclature and conservation – Biologia (Bratislava), Section Zoology 52 (Suppl. 5): 1-271.

Kottelat M., Freyhof J. 2007 – Handbook of European freshwater fishes – Kottelat, Cornol and Freyhof, Berlin.

Kottelat M., Persat H. 2005 – The genus *Gobio* in France, with redescription of *G. gobio* and description of two new species – Cybium 29: 211-234.

Mendel J., Lusk S., Lusková V., Koščo J., Papoušek I., Halačka K., Vetešník L. 2006 – Molecular biological analyses of sand gudgeon (*Romanogobio kesslerii*) in the waters of the Czech Republic and Slovakia – Biodiverzita ichtyofauny ČR VI: 95-101 (in Czech).

Mendel J., Lusk S., Lusková V., Koščo J., Vetešník L., Halačka K. 2008a – The species diversity of gudgeon of the genera *Gobio* and *Romanogobio* in the territory of the Czech Republic and Slovakia – Biodiverzita ichtyofauny ČR VII: 17-24 (in Czech).

Mendel J., Lusk S., Vasil'eva E.D., Vasil'ev V.P., Lusková V., Erk'akan F., Ruchin A., Koščo J., Vetešník L., Halačka K., Šanda R., Pashkov A.N., Reshetnikov S.I. 2008b – Molecular phylogeny of the genus *Gobio* Cuvier, 1816 (Teleostei: Cyprinidae) and its contribution to taxonomy – Mol. Phylogenet. Evol. 47: 1061-1075.

Nalbant T. 2003 – Checklist of the fishes of Romania. Part one: freshwater and brackishwater fishes – Stud. Cercet. Biol. B: 122-127.

Naseka A.M. 1996 – Comparative study on the vertebral column in the Gobioninae (Cyprinidae, Pisces) with special reference to its systematics – Publ. Espec. Inst. Esp. Oceanogr. 21: 149-167.

Naseka A.M., Erk'akan F., Küçük F. 2006 – A description of two new species of the genus *Gobio* from Central Anatolia (Turkey) (Teleostei: Cyprinidae) – Zoosyst. Rossica 15: 185-194.

Nowak M. 2010 – Morphological variability of the common gudgeon *Gobio gobio* (L.) in the Nida River drainage – MSc thesis, University of Agriculture in Kraków (in Polish).

Nowak M., Koščo J., Popek W. 2008a – Review of the current status of systematics of gudgeons (Gobioninae, Cyprinidae) in Europe – AACL Bioflux 1: 27-38.

Nowak M., Popek W., Drąg-Kozak E., Epler P. 2008b – Morphology of the common gudgeon, *Gobio gobio* (L.) sensu lato, from the Vistula River drainage in the context of recent literature data (Teleostei: Cyprinidae) – Arch. Pol. Fish. 16: 37-48.

Nowak M., Mendel J., Koščo J., Drąg-Kozak E., Popek W., Epler P. 2009a – Morphological and genetic variability of the genus *Gobio* in Poland – In: Abstract book of the 13th European Congress of Ichthyology, Klaipeda, Lithuania.

Nowak M., Petrescu-Mag I.V., Mierzwa D., Popek W. 2009b – On some interesting Romanian gudgeons (Cyprinidae: *Romanogobio*) found in the collection of Museum and Institute of Zoology PAS – AES Bioflux 1: 81-88.

Nowak M., Klaczak A., Szczerbik P., Popek W. 2010 – Notes on the sexual dimorphism of common gudgeon *Gobio gobio* (L.) – Komun. Ryb. 6(119): 2-5 (in Polish).

Rolik H. 1959 – The Kessler's gudgeon (*Gobio kessleri* Dyb.) in Poland – Fragm. Faun. 8: 207-221 (in Polish).

Rolik H. 1965a – Contribution to the knowledge of the geographical and ecological variability of *Gobio gobio* (L.) in Poland – Fragm. Faun. 12: 15-29 (in Polish).

Rolik H. 1965b – *Gobio albipinnatus* Luk. – a new species to the Polish fauna – Fragm. Faun. 12: 177-181 (in Polish).

Rolik H. 1965c – Remarks on the systematic position of the *Gobio kessleri* Dyb. from River San – Fragm. Faun. 11: 455-465 (in Polish).

Rolik H. 1967 – Contributions to the ichthyofauna of Strwiąż (a tributary of Dniestr) with special reference to *Gobio gobio* (L.) and *Cobitis* (*Sabanejewia*) *aurata* (Fil.) – Fragm. Faun. 14: 133-151 (in Polish).

Skóra S., Włodek J.M. 1966 – The common gudgeon (*Gobio gobio* L.) from the Soła River – Acta Hydrobiol. 8: 25-40 (in Polish).

Skóra S., Włodek J. M. 1969 – The gudgeon (*Gobio gobio* [L.]) from the Dunajec River basin – Věst. čs. spol. zool. 33: 351-368.

Skóra S., Włodek J.M. 1971 – The gudgeon (*Gobio gobio* L.) from the basins of the rivers Czarna Staszowska and Kamienna – Acta Hydrobiol. 13: 87-105.

Staff F. 1950 – The freshwater fishes of Poland and adjacent countries – Trzaska, Evert and Michalski, Warszawa (in Polish).

Vasil'eva E.D., Vasil'ev V.P., Kuga T.I. 2004 – On the taxonomy of gudgeons of the genus *Gobio* (Gobioninae, Cyprinidae) of Europe: a new gudgeon species *Gobio kubanicus* sp. nova from the Kuban' River drainage – Vopr. Ichtiol. 44: 766-782 (in Russian).

Vasil'eva E.D., Vasil'ev V.P., Boltachev A.R. 2005 – Taxonomic relationships of gudgeons (*Gobio*, Gobioninae, Cyprinidae) of Crimea – J. Ichthyol. 45: 730-743.

Wiley E.O., Mayden R.L. 2000 – The Evolutionary Species Concept – In: Wheeler Q. D., Meier R. (Eds), Species concepts and phylogenetic theory. A debate. Columbia University Press, New York: 70-89.

Streszczenie

Zmienność morfologiczna kiełbia krótkowąsego *Gobio gobio* (L.) w dorzeczu Górnej Wisły (południowo-wschodnia Polska)

W świetle najnowszych badań molekularnych pod nazwą kiełb krótkowąsy, *Gobio gobio* (L.), kryje się cały szereg odrębnych linii ewolucyjnych, które według ewolucyjnej koncepcji gatunku należy uznać za odrębne gatunki. Dlatego tak ważne jest opisanie zmienności morfologicznej kiełbi z rodzaju *Gobio*. W niniejszej pracy zestawiono cechy morfometryczne (tab. 1-3) i merystyczne (tab. 5-6) opracowane na materiale 82 kiełbi pozyskanych z 9 rzek w dorzeczu Górnej Wisły (rys. 1). Zgodnie z oczekiwaniami, obserwowana zmienność cech przeliczalnych nie była wysoka. Przebadane kiełbie posiadały następującą charakterystykę merystyczną: D III.(6)7, A III.6, l.l. (38)39-41(42)+(1)2(3), sq_1 (5)6(7), sq_2 (3)4, (13,14)15-16(17,18) łusek przedgrzbietowych, (12)13-14(15,16) łusek dookoła trzonu ogonowego, (2)4-6 łusek pomiędzy odbytem a podstawą płetwy odbytowej oraz (0,1)2(3,4) łusek pomiędzy końcem płetwy piersiowej a podstawą płetw brzusznych (tab. 5-6). Pod względem zróżnicowania cech morfometrycznych kiełbie z przebadanych dopływów Górnej Wisły nie odbiegały znacząco od danych literaturowych (tab. 4). Jedyną cechą odróżniającą omawiane populacje od pozostałych kiełbi z terenu Polski jest wyraźnie dłuższa odległość zagrzbietowa (poD; tab. 4). W związku z niskimi liczebnościami poszczególnych grup jakakolwiek analiza statystyczna nie była możliwa. Niniejsza praca jest przyczynkiem do poznania zmienności morfologicznej relatywnie słabo poznanej grupy ryb, jaką są kiełbie rodzaju *Gobio*. Pewne dyskretne różnice wskazane przez autorów mogą się stać punktem wyjścia do dalszych analiz porównawczych, najlepiej morfologiczno-molekularnych, umożliwiających w przyszłości identyfikację poszczególnych gatunków z tego zespołu.