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Biological Invasions
Research Article

The Alien Peipsi Whitefish *Coregonus maraenoides* Polyakov, 1874 (Actinopterygii: Salmoniformes) in Iskar Reservoir, Danube River basin, Bulgaria

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Abstract: In the 1960–1970s, three coregonid fishes (*Coregonus albula, Coregonus maraenoides* and *Coregonus peled*) were imported from the former Soviet Union and introduced to some reservoirs in Bulgaria. Irregular import, hatching in local fish-farms and stocking continued until the 1990s. The aim of our study was to examine the occurrence of the alien coregonid species in one of the stocked reservoirs, Iskar Reservoir, and to identify the species recorded based on their morphology. A total of 54 coregonid specimens were collected at five stations in the period from October to March in 2015 and 2016. According to the studied morphometric and meristic data, all the coregonid specimens collected were identified as the Peipsi whitefish, *Coregonus maraenoides*. The morphology of *C. maraenoides* from Iskar Reservoir revealed some differences from the native population (Peipus Lake, Estonia and Russia), being most likely a result of adaptation of this species to the local environmental conditions or related to the brood stock management in the fish farms. Our results showed that *C. maraenoides* has successfully established in the reservoir. The existence of self-sustaining population has been supported by the following: a long period from the last stocking of *C. maraenoides* to the reservoir up to our study (>15 years); presence of specimens of different size classes in the catches; and presence of sexually mature female and male specimens.

Key words: Non-native fish, *Coregonus maraenoides,* morphology, Iskar Reservoir

Introduction

Coregonid fishes (genus *Coregonus* L., 1758) are cold-water adapted, resident or migratory freshwater fishes common throughout the Holarctic in North America, Europe and Asia (Kottelat & Freyhof 2007). A total of 59 coregonid species have been described to date, but much more than this have been suggested to occur by many authors (Berg 1923, Reshetnikov 1968, 1980, Himberg & Lehtonen 1995, Kottelat & Freyhof 2007). The diversity and phylogeny of the coregonid species is complex and the genus includes many endemic and sympatric species (Svärdson 1998, Schulz et al. 2006, Kottelat & Freyhof 2007). Some of the species are of high conservation concern and vulnerable to anthropogenic impact, such as overfishing, water pollution and stocking with non-native coregonids (Kottelat & Freyhof 2007, Mehner et al. 2018). The species identification of the coregonids is difficult due to the

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lack of clearly pronounced morphological differences, probably as a result of their relatively recent evolutionary divergence (Mehner et al. 2018). It is considered that the number of gill rakers on the first arc is one of the most prominent meristic characters (Amundsen et al. 2004). However, the number of gill rakers may undergo modifications when environmental conditions change (Bittner et al. 2010). In general, most of the coregonid species are extremely plastic and able to adapt quickly to new environments (Reshetnikov 1980, Pereskokov & Rogozin 2001, Kottelat & Freyhof 2007). Due to the high commercial value of the coregonid fisheries, their translocation and introductions have been carried out continuously (Karpevich et al. 1975, Mamcarz 1992, Falkowski & Wołos 1998). However, the stockings of coregonids from multiple origins in lakes with native coregonids have created serious difficulties in the identification of local populations because of the formation of hybrids (Falkowski & Wołos 2007, Mehner et al. 2018).

The Bulgarian ichthyofauna did not include coregonid fishes until the 1960–1970s, when the vendace (*Coregonus albula*), Peipsi whitefish (*Coregonus maraenoides*, reported as *C. lavaretus maraenoides*), and peled (*Coregonus peled*) were introduced from the former Soviet Union. These species were imported at the stage of eyed eggs, hatched in local fish-farms, and released as post-larvae in some reservoirs. The introduction was made with the purpose of utilisation of the large resources of zooplankton by the coregonid species, as well as with the aim of diversification of the commercial and recreational fisheries in some semi-mountain reservoirs, such as Iskar, Dushantsi, Batak, and Dospat (Zivkov 1987, Karapetkova & Zivkov 1995, Uzunova & Zlatanova 2007). Available information shows that until 1979 the Bulgarian Union of Hunters and Fishermen had released 15,000,000 coregonid larvae (Dachev 1979). There is no information on the exact number of each species. In the 1990s, the import of eyed eggs and stocking with locally produced coregonid species in the Bulgarian water bodies has ceased. However, in the following two decades, information about regular capture of the coregonid species of different sizes from some of the stocked reservoirs, including Iskar Reservoir, has been provided by sport fishermen and fishery control officers. Current scientific information about the presence and status of the three coregonid species introduced into the Bulgarian reservoirs is lacking.

Data about the ichthyofauna of Iskar Reservoir are very scarce. Pehlivanov et al. (1989) reported on the abundance and behaviour of juvenile perch (*Perca fluviatilis*) in the littoral zone of the reservoir. Raikova-Petrova et al. (2017) published on the heavy metal content in nine fish species from the ecotone zone. The only data on the coregonids were included in the works of Dachev (1979) and Staneva (1993). Dachev (1979) studied and compared the age and growth rate of *C. maraenoides* (reported as *C. lavaretus maraenoides*), and peled (*C. peled*) from Iskar Reservoir with those from Dushantsi Reservoir. Staneva (1993) investigated the ichthyofauna of Iskar Reservoir based on anglers' catches and reported the presence of single specimens of *C. peled* (1990) and *C. maraenoides* (1991).

The aim of the present study was to examine the occurrence of the alien coregonid species in Iskar Reservoir and to identify the species recorded on the basis of the external and internal morphological characteristics.

Materials and Methods

Study area

Iskar Reservoir is located in the western part of Bulgaria at an altitude of 817.5 m a.s.l. The reservoir was built in 1955 and it is formed by the waters of the Iskar

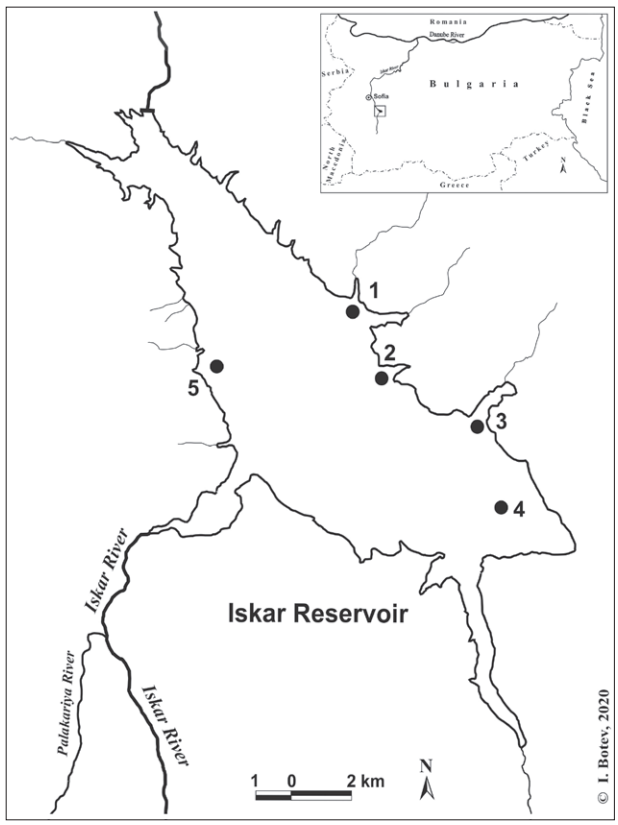

Fig. 1. Map of Iskar Reservoir and fish sampling sites (black dots): 1. Lesnov Dol Site; 2. Parakladenets Site; 3. Borishki Zaliv Site; 4. Ichtimanski Zaliv Site; and 5. The Boat Station.

River, one of the right tributaries of the Danube River. The catchment area is 1,046 km². The reservoir has a maximum length of 13.5 km, maximum width of 5.5 km, and a maximum depth of about 70 m. The water volume of Iskar Reservoir is 673x10⁶ m³, and its maximum surface area is 30 km² (Ivanov et al. 1964).

In summer, the water temperature reaches from 22 to 26°C at the surface area (0–1 m), 20°C at 10 m, and 8°C at the water depths between 20 and 60 m. In winter, the temperature at the surface is in the range from 0 to 4°C, and ice cover is formed that varies from days to months (Ivanov et al. 1964, Panova 2009). The dissolved oxygen is in the range from 7 to 12 mg/l at the surface, and decreases up to 1–2 mg/l at the bottom (Ivanov et al. 1964). The oxygen saturation at the surface is the lowest in August (62%) and the highest in May (104%) (Panova 2009). Distinct stratification is observed in the reservoir with respect to oxygen and temperature, with a clearly located thermocline (Ivanov et al. 1964, Panova 2009). The reservoir is defined as mesotrophic (Kalchev et al. 1993).

The water of the reservoir is used for drinking water supply, production of electricity, irrigation, and recreational activities.

Fish sampling

The fish sampling was conducted between October 2015 and March 2016, at five stations in Iskar reservoir (Fig. 1). The coregonids were caught with bottom-set monofilament gill nets, which were 8–10 m deep and 200–400 m long, and included panels of 60, 80, 120, and 140 mm stretch mesh sizes. Gill nets with smaller mesh sizes were not used in order to prevent catching and injuring smaller fish species. Each fishing session lasted for approximately 10 hours.

All collected fish were frozen individually in plastic bags at -20°C and stored at the laboratory of the Department of General and Applied Hydrobiology, the Faculty of Biology, Sofia University, Bulgaria, prior to conducting all the analyses.

Fish measurements and data analyses

A total of 45 morphological features (morphometric and meristic characters) were studied according to Pravdin (1966) (Fig. 2). The morphometric measurements were taken using digital callipers with an accuracy of 0.01 cm. The meristic characters included: the number of unbranched and branched fin rays, the number of scales in the lateral line (LL), and the number of scales above and below of the lateral line.

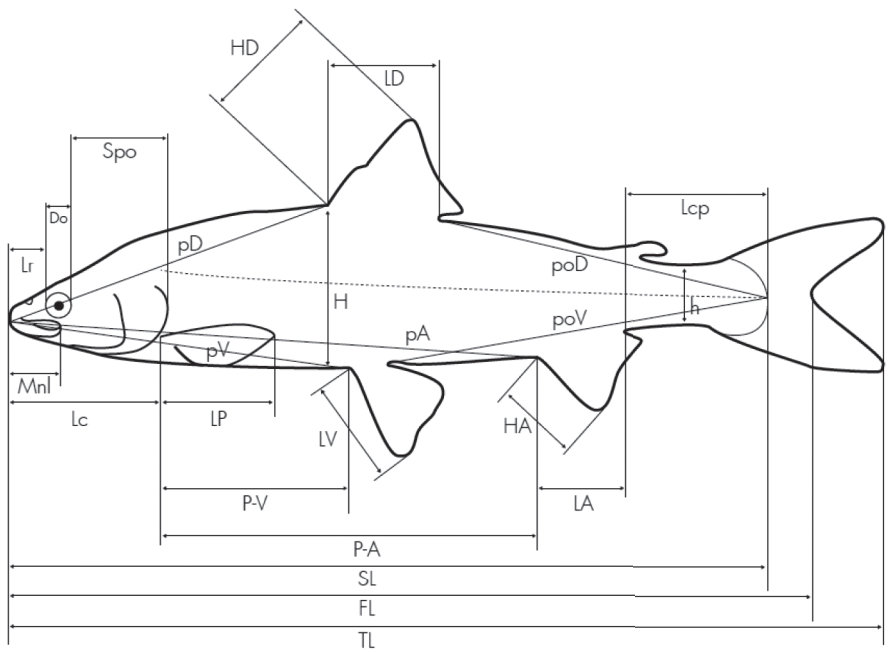

Fig. 2. Scheme of the morphometric measurements of the coregonid specimens in the present study. The following abbreviations are used: length of head (Lc), maximum body height (H), minimum body height (h), predorsal distance (pD), preventral distance (pV), postdorsal distance (poD), postventral distance (poV), prepectoral distance (pP), preanal distance (pA), length of caudal peduncle (Lcp), length of dorsal fin base (LD), height of dorsal fin (HD), length of anal fin base (LA), height of anal fin (HA), length of pectoral fin (LP), length of ventral fin (LV), pectoral – ventral distance (P–V), pectoral – anal distance (P–A), preorbital distance (length of rostrum) (Lr), postorbital distance (Spo), horizontal diameter eye (Do), maxilla length (Mxl), maxilla width (Mxw), mandibula length (Mnl), head height (Hc), inter orbital distance (Iod), and ratio depth to width of rostral plate.

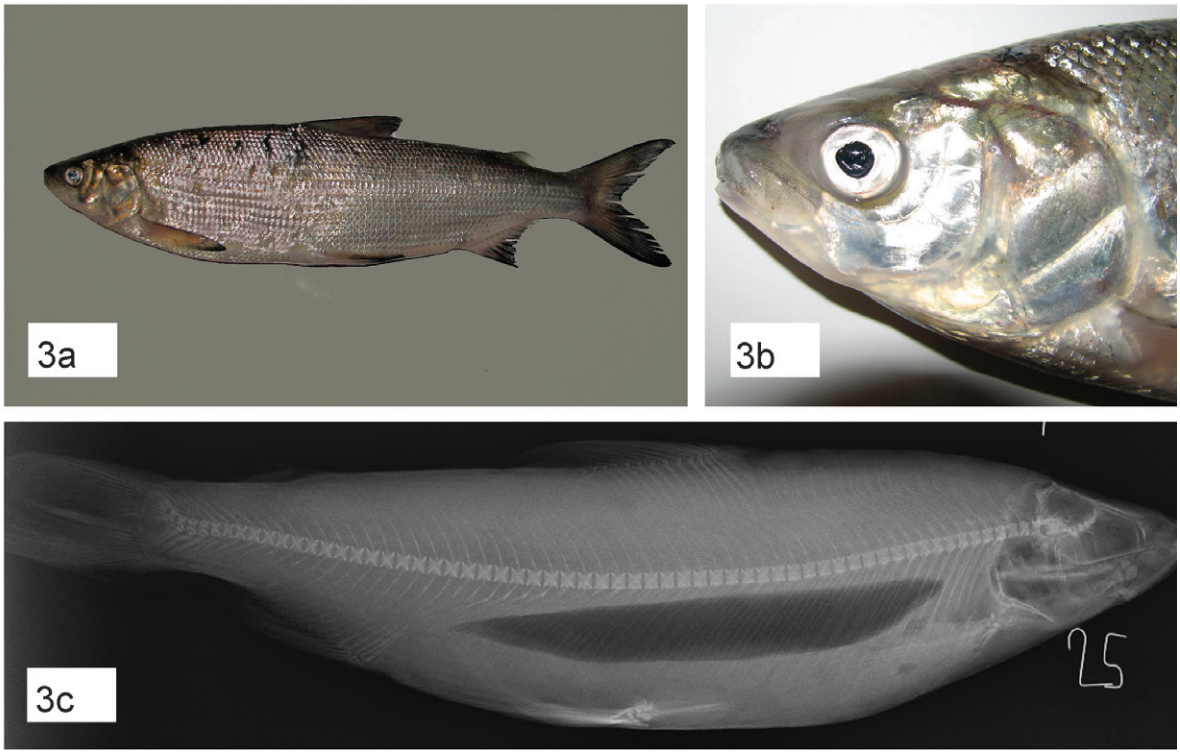

Fig. 3. Specimen of *Coregonus maraenoides* (TL: 332 mm; W: 897 g) captured in Iskar Reservoir, Bulgaria, in December 2015: Body (3a), head (3b) and an X-ray image (3c).

The number of first gill rakers on the first arc was counted under a binocular stereo zoom microscope. The number of vertebrae was counted using X-ray images. All specimens were weighted (W) with an accuracy of 0.1 g. The eviscerated weight (We ± 0.1 g) and gonad weight (Wg ± 0.1 g) were measured. The gonad-somatic index (GSI) was calculated from the equation GSI%=100 (Wg/We).

All the plastic characteristics except the standard length (SL), fork length (FL) and total length (TL) were expressed in percentage of the standard length (SL), fork length (FL) and head length (Lc). The main descriptive statistics were calculated for all morphological characters and they were presented by means, standard errors of means (SE), standard deviations (SD), and minimum and maximum values.

The species identification was made according to Pravdin (1931), Berg (1948), and Kottelat & Freyhof (2007).

After the species identification, the morphometric characteristics of the specimens from Iskar Reservoir were compared with those of coregonids from the native range (Krause & Palm 2000). Student's *t*-test was used for this purpose. For the statistical inference, two-tailed probability *p*-values less than 0.05 were considered significant.

The SigmaStat 4.0 software was used for the statistical analyses.

Results

A total of 54 coregonid specimens were caught. All collected fishes had elongated, silvery bodies without any spots or bars on them. All fins had a black margin, the caudal fin was nearly black (Fig. 3a). The rostral plate was well developed. Its depth was 1.3–1.8 times the width. The lower jaw extended to the front end of the eye. The mouth was subterminal (Fig. 3b). The mean head length was 21.5% of the SL. The body depth varied from 20 to 30% of the SL (mean 26%). The mean number of the fin rays was: IV+11 for dorsal fin rays; III+13 for anal fin rays; I+14 for pectoral fin rays; and I+11 for pelvic fin rays. The lateral line scales were 93 (87–102); the rows above the lateral line were from 10 to 11; and the rows below the lateral line – from 8 to 9. The number of gill rakers was 37 (33–41). The total number of vertebrae varied from 59 to 64 (mean 61) (Fig. 3c, Tables 1 and 2). The standard length (SL) was from 265 mm to 452 mm, the total length (TL) – from 316 mm to 520 mm (Table 1). The total body mass ranged from 289 g to 1,756 g. The biggest specimen was a male with a total length of 520 mm, and a body weight of 1,756 g.

A total of 24 fishes were determined as males and 10 fishes as females. The average GSI for the female fishes was 12.42% and varied between 3.46%

Table 1. Morphometric characters of the specimens of *Coregonus maraenoides* (N=54) from Iskar Reservoir, Bulgaria. Max – maximum value (cm); Min – minimum value (cm); Mean – mean value (cm); SD – Standard deviation; SE – Standard error

Character	Code	Mean	SE	SD	Min	Max
Total body length	TL	37.50	0.60	4.72	31.60	51.90
Fork body length	FL	33.80	0.60	4.56	27.90	48.40
Standard body length	SL	31.76	0.58	4.27	46.50	45.20
in % of SL						
Length of head	Lc	21.52	0.14	0.90	17.84	25.39
Maximum body height	H	26.21	0.25	1.80	20.00	30.50
Minimum body height	h	8.24	0.06	0.47	7.06	9.08
Predorsal distance	pD	48.31	0.29	2.16	44.48	52.84
Preventral distance	pV	51.02	0.28	2.06	46.38	57.74
Postdorsal distance	poD	43.03	0.25	1.81	39.62	47.11
Postventral distance	poV	51.52	0.30	2.10	45.70	55.90
Prepectoral distance	pP	20.74	0.17	1.24	18.18	23.81
Preanal distance	pA	76.29	0.37	2.74	70.77	81.81
Length of caudal peduncle	Lcp	13.18	1.14	1.14	10.68	15.56
Length of dorsal fin base	LD	12.51	0.17	1.27	10.8	19.23
Height of dorsal fin	HD	20.77	0.17	1.28	18.4	24.55
Length of anal fin base	LA	13.37	0.19	1.46	10.04	18.88
Height of anal fin	HA	13.58	0.28	2.07	10.10	15.96
Length of pectoral fin	LP	16.99	0.10	0.74	14.90	18.40
Length of ventral fin	LV	17.27	0.17	1.30	14.04	22.00
Pectoral – ventral distance	P–V	31.44	0.32	2.40	21.88	35.40
Pectoral – anal distance	P–A	56.81	0.44	3.20	45.50	64.70
in % of head length						
Preorbital distance	Lr	25.60	0.32	2.36	19.90	32.80
Postorbital distance	Spo	56.70	0.34	2.48	50.70	68.80
Horizontal diameter eye	Do	20.90	0.20	1.49	18.40	24.60
Maxilla length	Mxl	25.40	0.35	2.54	18.90	31.20
Maxilla width	Mxw	10.40	0.22	1.60	6.40	13.30
Mandibula length	Mnl	18.10	0.24	1.74	14.80	22.80
Head height	hc	71.70	0.72	5.24	57.50	82.20
Inter orbital distance	Iod	28.20	0.28	2.09	23.80	36.10
Ratio depth to width of rostral plate	Rlr	1.5	0.1	1.4	1.3	1.8

and 21.8%. In 20 individuals the sex could not be determined based on the macroscopic observation of the gonads and they were preserved for further investigation.

Based on the studied morphometric and meristic data, all the coregonid specimens collected in Iskar Reservoir were identified as the Peipsi whitefish *Coregonus maraenoides* Polyakov, 1874.

The comparative analysis of morphology of the identified *C. maraenoides* in Iskar Reservoir with that of native coregonids from Peipus Lake (located on the border of Estonia and Russia) (Krause & Palm 2000) revealed some differences between them. As percentage of FL, the mean postdorsal distance, body depth, head height and P–V distance were higher in the specimens from Peipus Lake, while the mean head length, height of dorsal fin, and lengths of dorsal, ventral and anal fins were higher in the specimens from Iskar Reservoir. The preorbital distance and eye diameter as a percentage of head length were also higher in fishes from Iskar Reservoir (Table 3).

The mean values of unbranched rays in the dorsal fin and branched rays in the dorsal and anal fins were higher in the specimens from Iskar Reservoir compared to those from Peipus Lake. In the population from Iskar Reservoir, the mean vertebrae number was 61, while in the population from the Russian part of Peipus Lake, this number was 57 (Table 4).

Table 2. Meristic characters of the specimens of *Coregonus maraenoides* (N=54) from Iskar Reservoir, Bulgaria. Max – maximum value (cm); Min – minimum value (cm); Mean – mean value (cm); SD – Standard deviation; SE – Standard error

Character	Code	Mean	SE	SD	Min	Max
Unbranched dorsal fin rays	D	4	0.1	0.5	3	5
Branched dorsal fin rays	d	11	0.1	0.6	10	13
Unbranched anal fin rays	A	44	0.1	0.5	3	4
Branched anal fin rays	a	13	0.1	0.8	11	14
Unbranched pectoral fin rays	P	1	0	0	1	1
Branched pectoral fin rays	p	15	0.1	0.9	13	17
Unbranched ventral fin rays	V	1	0.1	0.3	1	2
Branched ventral fin rays	v	11	0.1	0.6	10	12
Unbranched caudal fin rays	C	16	0.2	0.3	14	20
Branched caudal fin rays	c	17	0.1	0.3	16	20
Vertebrae	Vr	61	0.2	1.22	59	64
Gill rakers	Gr	37	0.3	1.9	33	41
Scale number in lateral line	LL	93	0.5	3.6	87	102
Scales above LL		10	0.1	0.4	10	11
Scales below LL		8	0.1	0.5	8	9

Discussion

Based on the morphological data, all the coregonid fishes collected in Iskar Reservoir were identified as the Peipsi whitefish *C. maraenoides* Polyakov, 1874. This species can be distinguished from the other two coregonid fishes introduced in Bulgaria by the following: number of gill rakers (46–69 in *C. peled* and 41–46 in *C. albula*); rostral plate not developed in both *C. peled* and *C. albula*; lack of small black spots on the head and dorsal part (from *C. peled*); and the larger body (*C. albula* up to 200 mm) (Pravdin 1931, Berg 1948, Kottelat & Freyhof 2007). The description of *C. maraenoides* can be found in Kessler (1864) as *C. maraena* and in Berg (1923) as *C. maraena maraenoides.* Kottelat et al. (2005) provide evidence for the legitimate existence of the name *Coregonus maraenoides* described firstly by Polyakov (1874). The authors designate the specimen from the Zoological Institute in St. Petersburg collection (N ZISP 53230, 346.5 mm SL) as a neotype.

Coregonus maraenoides is an endemic whitefish in Peipus Lake (Pskovsko-Chudskoye Lake). It is a lowland shallow lake (maximum depth of 15.3 m) located in Northern Europe. The lake drains into the Narva River and is part of the Baltic Sea basin. The average summer maximum water temperature in the lake is 25°C; the average winter temperature ranges between 0.1 and 2.5°C; and the average annual water temperature is 8.2°C. Peipus Lake is characterised as an eutrophic and biologically highly productive lake (Krause & Palm 2000, Haberman et al. 2008). *Coregonus maraenoides* appeared in the lake before the last glaciation when the pass of fish from the Baltic Sea into the lake was blocked by the Narva River waterfall (Hang & Miidel 1999). In its native range, *C. maraenoides* lives up to 15 years and reaches a length of up to 600 mm (FL) and a weight of up to 3.5 kg (Krause & Palm 2000). Sexual dimorphism has not been detected (Kontsevaya & Mednikova 1994). In the 1990s, the catches of *C. maraenoides* in Peipus Lake reached 30–70 t, but later, bans and quotas were introduced because of the significant reduction of the stock (Krause & Palm 2000). *Coregonus maraenoides* has been introduced in many lakes in Latvia, Russia, Poland, Germany, the Netherlands, Japan, Armenia, and Kazakhstan, but established only in a few of them (Kottelat & Freyhof 2007, Falkowski & Wołos 2007, Mehner et al. 2018).

In Iskar Reservoir, the introduction of the coregonid species started in 1968 (Dachev 1979). The imported eggs intended for stocking were hatched in the Experimental Fishery Station located in the town of Samokov, Bulgaria. During the study in 1978 the catches in Iskar Reservoir consist of *C. maraenoides* (54%) and *C. peled* (46%) (Dachev 1979). Both species are represented by three age groups (3, 4, 5). The length and weight growth rates in *C. maraenoides* are the highest in the first two years and then gradually decrease. The growth rate in *C. peled* has similar pattern, being higher than in *C. maraenoides* (Dachev 1979). Based on official data on stocking and study results, the author concludes that both species can reproduce and have established populations in Iskar Reservoir (Dachev 1979). Our results confirm this conclusion for *C. maraenoides*. Although the reservoir has not been stocked with coregonids since the 1990s, this species is still present in the

Table 3. Comparison between morphometric characters of *Coregonus maraenoides* from Peipus Lake (Russian and Estonian parts) (Krause & Palm 2000) and Iskar Reservoir, Bulgaria (our data). All data are given with mean values (Mean), standard errors (SE) and *t*-values of Student's test. The significant differences ($p<0.05$) between the native specimens and the specimens from Iskar Reservoir are given in bold. n – number of studied specimens; nd – no data

Characters	Code	Russian part of Peipus Lake (n=40)	t	p	Estonian part of Peipus Lake (n=20)	t	p	Iskar Reservoir (n=54)
		Mean ± SE			Mean ± SE			Mean ± SE
Total length, cm	TL				46.86 ± 0.64			37.47 ± 0.64
Fork length, cm	FL				42.92 ± 0.59			33.83 ± 0.62
Standard length, cm	SL				40.30 ± 0.54			31.76 ± 0.58
in % of fork length								
Length of head	Lc	19.61 ± 0.81	1.980	0.396	19.42 ± 0.31	2.580	**0.010**	20.21 ± 0.13
Maximum body depth	H	24.68 ± 1.87	0.043	0.966	26.51 ± 0.40	4.630	**0.001**	24.61 ± 0.23
Minimum body depth	h	7.50 ± 0.35	0.778	0.439	7.62 ± 0.10	1.030	0.304	7.74 ± 0.06
Predorsal distance	pD	43.05 ± 1.20	2.160	**0.033**	45.73 ± 0.55	0.630	0.530	45.38 ± 0.27
Preventral distance	pV	nd			nd			47.92 ± 0.27
Postdorsal distance	poD	**48.21** ± 2.22	4.059	**0.001**	41.89 ± 0.36	3.590	**0.001**	**40.40** ± 0.22
Postventral distance	poV	nd			nd			48.40 ± 0.30
Prepectoral distance	pP	nd			nd			19.48 ± 0.16
Preanal distance	pA	nd			nd			71.66 ± 0.36
Length of caudal peduncle	Lcp	nd			nd			12.40 ± 0.15
Length of dorsal fin base	LD	11.32 ± 0.69	0.692	0.491	11.79 ± 0.18	0.140	0.889	11.75 ± 0.16
Height of dorsal fin	HD	**14.58** ± 0.98	5.630	**0.001**	**15.82** ± 0.29	10.257	**0.001**	**19.50** ± 0.19
Length of anal fin base	LA	nd			nd			12.56 ± 0.19
Height of anal fin	HA	11.63 ± 0.81	1.910	0.580	11.08 ± 0.16	8.670	**0.001**	**12.99** ± 0.12
Length of pectoral fin	LP	14.86 ± 1.11	1.156	0.251	16.31 ± 0.26	1.496	0.139	15.97 ± 0.10
Length of ventral fin	LV	14.98 ± 0.95	1.481	1.420	14.63 ± 0.26	5.180	**0.001**	**16.22** ± 0.16
Pectoral – ventral distance	P–V	27.97 ± 1.26	1.376	0.172	31.23 ± 0.39	3.003	**0.004**	**29.54** ± 0.31
Pectoral – anal distance	P–A	nd			nd			53.40 ± 0.40
in % of head length								
Preorbital distance	Lr	nd			24.06 ± 0.68	2.306	**0.040**	25.60 ± 0.32
Postorbital distance	Spo	nd			nd			56.70 ± 0.34
Horizontal diameter eye	Do	22.31 ± 1.76	0.992	0.359	**18.87** ± 0.31	5.350	**0.001**	**20.90** ± 0.20
Maxilla length	Mxl	nd			nd			25.40 ± 0.35
Maxilla width	Mxw	nd			nd			10.40 ± 0.22
Mandibula length	Mnl	nd			nd			18.10 ± 0.24
Head height	hc	70.79 ± 5.08	0.205	0.838	75.63 ± 1.78	2.457	**0.016**	**71.70** ± 0.72
Inter orbital distance	Iod	nd			nd			28.20 ± 0.28
Ratio depth to width of rostral plate	Rlr	nd			nd			1.30 ± 0.10

catches though not of high abundance. Within the native range, the first maturity of *C. maraenoides* is at 4–5 years. Spawning takes place in October – December, when water temperature is below 5°C, at shallow, stony places near the shores. Eggs are laid at gravel substrate and hatch until late April, at 6–8°C (Kottelat & Freyhof 2007). In Iskar Reservoir, the studied specimens of *C. maraenoides* were collected during the period from October to March, at sites with sandy, gravel and stony substrates. During our study, *C. peled* was not caught.

The comparison of morphology of *C. maraenoides* from Iskar Reservoir with that of native population from Peipus Lake (Krause & Palm 2000) revealed some differences between them, which can be explained with phenotypic plasticity and environmental conditions. The success of alien species is frequently attributed to the phenotypic plasticity, which facilitates persistence in novel environments. The phenotypic alterations may have an environmental basis, e.g. the local food ability, temperature regime, water body size, length of growing season, duration of

Table 4. Comparison between meristic characters of *Coregonus maraenoides* from Peipus Lake (Russian and Estonian parts) (Krause & Palm 2000) and Iskar Reservoir, Bulgaria (our data). n – number of studied specimens; Mean – mean value; SE – Standard error; nd – no data

Characters	Code	Russian part of Peipus Lake (n=40)	Estonian part of Peipus Lake (n=20)	Iskar Reservoir (n=54)
		Mean ± SE	Mean ± SE	Mean ± SE
Unbranched dorsal fin rays	D	3.43 ± 0.6	3.47 ± 0.11	3.9 ± 0.1
Branched dorsal fin rays	d	10.43 ± 0.72	10.23 ± 0.17	11 ± 0.1
Unbranched anal fin rays	A	2.95 ± 0.74	3.59 ± 0.14	3.6 ± 0.1
Branched anal fin rays	a	12.49 ± 0.81	11.46 ± 0.23	13 ± 0.1
Unbranched pectoral fin rays	P	nd	1	1
Branched pectoral fin rays	p	nd	14.69 ± 0.32	14.5 ± 0.1
Unbranched ventral fin rays	V	nd	1	1
Branched ventral fin rays	v	nd	10	10.6 ± 0.1
Unbranched caudal fin rays	C	nd	nd	15.9 ± 0.2
Branched caudal fin rays	c	nd	nd	17.1 ± 0.1
Vertebrae		57 ± 0.22	nd	61 ± 0.18
Gill rakers		38.01 ± 2.53	nd	37.1 ± 0.5
Scale number in lateral line	LL	95.4 ± 1.04	93.54 ± 1.07	93.2 ± 0.5
Scales above LL		nd	nd	10.2 ± 0.1
Scales below LL		nd	nd	8.3 ± 0.1

ice cover, etc. (Beacham & Murray 1987, Mamuris et al. 1998). On the other hand, the morphological differences can also arise when the genetic isolation enables genotypic differences through the local variation in selective pressures, mutations or genetic drift (Haddon & Willis 1995, Doherty & McCarthy 2004). Alterations in the morphology of *C. maraenoides* are described in nearly all populations introduced outside of the species native range. Pereskokov & Rogozin (2001) found that *C. maraenoides* introduced in Miasovo Lake (Sought Ural) has a smaller eye diameter and a longer rostrum. According to Shevchenko et al. (2014), *C. maraenoides* introduced into Svitiaz Lake (Ukraine) has longer dorsal and anal fins, caudal peduncle and a higher minimum body depth than fishes from the native range. Shevchenko et al. (2014) associate these morphological alterations with adaptation in the swimming functions that ensures finding food in the conditions of the lower food availability in the oligothrophic Svitiaz Lake. Differences in the food recourses between Peipus Lake and Iskar Reservoir could be the reason for the observed differences in the head dimensions of *C. maraenoides*. The variation in morphological parameters between the different populations of *C. maraenoides* may be the result of the sampled fishes from different age groups. Selection of the brood stock in farms of origin should also not be excluded as the cause of the observed morphological differences in the alien populations of *C. maraenoides* in Bulgaria.

Conclusions

The coregonid specimens caught in Iskar Reservoir in the period 2015–2016 were identified based on morphometric and meristic data as the Peipsi whitefish *Coregonus maraenoides* Polyakov, 1874. Our results have shown that this species, which is alien for Bulgaria, has successfully established in the reservoir. The existence of self-sustaining population has been supported by the following: a long period from the last stocking of *C. maraenoides* to the reservoir up to our study (>15 years); presence of specimens of different size classes in the catches; and presence of sexually mature female and male fishes. Further studies are necessary to assess the population abundance and dynamics of *C. maraenoides*, as well as to examine the presence of *C. peled* in Iskar Reservoir in view of implementation of the reservoir management strategies.

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