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Article

Invasion of the common percarina *Percarina demidoffii* (Percidae, Perciformes) in the Dnieper River upstream

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Abstract
In December 2016, the common percarina *Percarina demidoffii* Nordmann, 1840 has been evidentiary detected in the Dniprovske (Zaporizske) reservoir for the first time. Two specimens of percarina were caught in the rowing channel area (the upper part of the reservoir) near the Dnipro city. One individual was caught there in 2017 as well. The paper presents their morphological characteristics, as well as a comparison with specimens from the brackish waters of the Dniester estuary (the Black Sea). The preliminary data allow us to assume that differences in some plastic characters may have adaptive character in relation to the environment. There are no any meristic differences between these fishes. It is noted that the new finding of this fish species in the cascade of Dniprovske reservoirs allows us consider *P. demidoffii* as not mesohaline but as a freshwater-oligohaline species. The finding of the common percarina in the Dniprovske reservoir confirms a few earlier published data about the advance of this fish upstream of the Dnieper River and extends its current range. The presence of *P. demidoffii* as a new species for the fish fauna of the Dniprovske reservoir shows a continued active advance of the Ponto-Caspian fish species upstream of the cascade of reservoirs on the Dnieper River.

Key words: invasive fish; distribution; morphologic characters; Dniprovske reservoir.

Introduction

According to modern concepts (Froese & Pauly, 2012), the genus *Percarina* includes two species – the common percarina *P. demidoffii* Nordmann, 1840 and Azov percarina *P. maeotica* Kuznetsov, 1888. Both these species are representatives of the Ponto-Caspian faunistic complex. The species from the Sea of Azov for a long time has been considered a subspecies of the common percarina (Berg, 1949; Shcherbukha, 1982; Collette & Banarescu, 1977). Some researchers (Vasil'eva, 2007) consider that the taxonomic separation of the populations of the Black and Azov Seas is unauthorized. According to Kottelat & Freyhof (2007) and Movchan (2011), these species differ in the presence or absence of scales on the head, chest and gill covers,

eye diameter relative to the snout length, as well as some colour variations. It is clear that further research is needed to clarify this issue. In this paper, we adhere the validity of the names of these two species.

Common percarina is a relict endemic species, which inhabited the brackish basin of the former Eastern Paratethys. According to Morduhai-Boltovskoi (1960), Shcherbukha (1982), brackish-water *P. demidoffii* avoids fresh water, although it lives in freshened waters of the north-western Black Sea, the Dniester, Dnieper-Bug, Berezan and Tiligul estuaries, as well as the mouths of the Danube, Dniester, Southern Bug and Dnieper rivers (Shcherbukha, 1982; Movchan, 2011).

Common percarina is included in the IUCN and European Red Lists (Near Threatened category) species, but for EU 27 countries that species has the category "Endangered" (IUCN, 2019).

Some researchers noted that prior to regulation of the Dnieper River flow the common percarina was spread across the waters of the Dnieper-Bug estuary, and in the lower reaches of the Dnieper River above Kherson city (Lyaschenko, 1958; Zalumi, 1967).

After the regulation of the Dnieper River and its turning into a cascade of reservoirs *P. demidoffii* firstly appears in a composition of the fish community of the Kakhovske reservoir in 1988 (Shcherbukha et al, 1995). The species was also found in the hydraulic channel "Dnipro-Kryvyi Rig", as well as in the Zelenodolske reservoir, which is a cooling pond of the Kryvyi Rig Thermal Power Plant (Bulakhov et al., 2008). Maksimenko (2015) informed that in the Kakhovske reservoir the common percarina contribute not more than 0.1 % to the total number of fishes in the catches made by the local amateurs. The information on much earlier findings of the common percarina in Dniprovske reservoir in 2012 (Marenkov, 2018) and in the upper (!) Dniprodzerzhinske reservoir in 2009 (Khrystenko, 2011) have not been supported by any evidences and look doubtful.

It is an interesting fact that, the captures of percarina in the Dnieper River's reservoirs are known for ice-fishing only. No information for the captures from spring to fall have been presented, and our data confirm that.

In this paper, we present our new proven data on the spread of the common percarina upstream the cascade of Dnieper reservoirs, as well as its morphology compared with specimens from the brackish waters of the north-western part of the Black Sea (the Dniester estuary).

Materials and methods

Presented data were collected in December 2016–2017 in the upper part of the Dniprovske (Zaporizske) reservoir of the Dnieper River. As we reported (Novitskiy & Manilo, 2017), two specimens of percarina were firstly caught in the rowing channel area (the upper part of the reservoir) near the Dnipro city (N 48.422289, E 35.075628). Three individuals were caught there in 2017 as well. In 2016 the specimens were deposited in the Ichthyological collection of the Department of Zoology (National Museum of Natural History, National Academy of Sciences of Ukraine, Kyiv): *Percarina demidoffii* Nordmann, 1840, No. 10238, two specimens, Ukraine, Dnipropetrovsk region, Dnipro, Dniprovske reservoir (upper part, rowing channel of the Dnieper River), depth 6 m, muddy sand, winter spoon bait, 30.12.2016, collector V. Yermoshin.

For comparison of morphological characters, we have used the material collected in the Odessa region: *P. demidoffii* Nordmann, 1840, No. 1152, five specimens, Ukraine, Belgorod-Dniester district, Dniester estuary, Black Sea, 15-20.09.1968, collector A.I. Alexandrova.

Since the investigated fish specimens are small in size, all measurements were taken using the electronic performed calliper with a 0.1 mm precision under a binocular microscope MBS-9 according to the procedure adopted for the family Percidae (Pravdin, 1966) with minor changes. We studied: (1) SL – standard body length, (2) H – maximum height of the body (near the 3rd spiny ray of the first dorsal fin), (3) h – height of caudal peduncle, (4) aD – antedorsal (length from the upper lip to the first dorsal fin base), (5) aP – antepectoral (length from the upper lip to the pectoral fin), (6) aV – anteventral (length from the upper lip to the ventral fin base), (7) aa – length from the upper lip to the anus, (8) aA – anteanal (length from the upper lip to the anal fin), (9) pD – postdorsal length (from the end of dorsal fin base to the beginning of the base of the middle rays of caudal fin), (10) l_{caud} – the length of caudal peduncle (from the end of anal fin base before the base of the middle rays of caudal fin), (11) lD – length of the dorsal fin base, (12) hD_1 – height of the first dorsal fin (the 2nd spiny ray), (13) hD_2 – height of the second dorsal fin (the first soft ray), (14) lA – length of the anal fin base, (15) hA – height of the anal fin (the first soft ray), (16) lP – length of the pectoral

fin, (17) wP – width of the pectoral fin base, (18) lV – length of the ventral fin, (19) C – head length (up to the end of the horizontal spine on opercle), (20) hC – head height in the vertical middle of the eye, (21) r – snout length (from the upper lip to the eye orbit), (22) mx – length of the maxilla, (23) o – horizontal diameter of the eye, (24) po – postorbital length (from the posterior edge of the eye up to the end of the horizontal spine on opercle), and (25) io – interorbital length.

The following meristic characters were also measured: D_1 – the number of spiny rays in the first dorsal fin, D_2 – the number of spiny rays in the second dorsal fin, d_2 – the number of soft rays in the second dorsal fin, A – the number of spiny rays in anal fin, a – the number of soft rays in anal fin, P – the number of rays in pectoral fin, Squ – the number of bored scales in lateral line, sp.br. – the number of gill rakers on the first gill arch. In order to avoid (if possible) the influence of dimensional variation, only specimens similar in size (percarina from north-western part of the Black Sea – the Dniester estuary) were chosen. Calculations were made in MS Excel 2007.

Results & Discussion

Taking into account that Bulakhov et al. (2008) and other authors did not described the morphology of the species from the Kakhovske and Zelenodolske Reservoirs, as well as that individuals of *P. demidoffii* was caught in the Dniprovske Reservoir for the first time (Fig. 1), we consider as appropriate to provide the information on morphometric characters and to make a comparative morphological analysis with the specimens from the brackish waters of the Black Sea.

Figure 1. Common percarina *P. demidoffii* from the Dniprovske Reservoir. Photo R. Novitskiy (2016).

Brief diagnosis

D1 IX–X (M = 9.5), D2 III 10–11 (M = 10.5), A II 9, P 12–13, Squ 34, sp.br. 24–25 (M = 24.5) (n = 2) (Dniprovske reservoir, our data).

D1 IX–X (M = 9.2), D2 III 11–12 (M = 11.4), A II 9–10 (M = 9.2), P 12–13 (M = 12.4), Squ 34–35 (M = 34.8); sp.br. 24–26 (M = 25.0) (n = 5) (Black Sea, Dniester estuary, our data).

D1 VII–XI, D2 II–III 9–15, A II 7–12, P 12–13, V I 5, Squ 33–41, sp.br. 21–28 (Black Sea; Movchan, 2011).

Table 1. Morphometric characters of the common percarina from the Dniprovske reservoir and the Dniester estuary.

Characters	Dniprovske Reservoir (n = 2)		Dniester estuary (n = 5)		
	min	max	min	max	M
Plastic characters					
SL, mm	42.0	51.0	39.0	56.0	48.6
		in % SL:			
H	27.06	27.38	23.56	26.55	24.90
h	7.06	7.38	7.64	8.33	8.04
aD	36.67	37.14	34.22	37.50	36.57
aP	35.24	36.86	34.67	37.18	35.61
aV	33.14	34.52	33.54	36.41	35.08
aa	57.62	58.04	54.44	60.73	57.52
aA	60.24	60.59	60.26	66.91	62.72
pD	19.29	19.80	17.68	19.82	18.62
lcaud	19.29	20.00	17.64	20.00	18.70
lD	46.27	48.10	47.64	50.44	48.29
hD_1	19.22	20.71	18.39	20.22	19.11
hD_2	19.22	19.29	16.61	20.44	18.05
lA	20.71	21.76	18.18	21.79	19.74
hA	19.05	21.57	18.21	20.51	19.39
lP	23.33	25.69	22.67	24.36	23.35
wP	3.81	4.51	3.93	4.58	4.21
lV	23.10	24.51	22.32	26.73	24.74
C	34.90	35.95	33.75	38.72	36.28
		in % C:			
hC	47.19	52.98	45.98	50.26	47.54
r	27.53	27.81	25.86	28.57	27.47
mx	47.68	48.88	47.02	51.32	48.37
o	27.53	27.81	25.86	29.63	27.77
po	46.63	47.68	43.10	45.96	44.58
io	20.22	21.19	19.54	22.22	20.75
Meristic characters					
D_1	9	10	9	10	9.2
D_2	3	3	3	3	3
d_2	10	11	11	12	11.4
P	12	13	12	13	12.4
A	2	2	2	2	2
a	9	9	9	10	9.2
Squ	34	34	34	35	34.8
sp.br.	24	25	24	26	25.0

Note: min, max – minimum and maximum values of the character; M – mean value

Description

The body is slightly elongated, laterally flattened, covered with ctenoid scales. The head, gill covers and the chest have no scales on their surface. Two dorsal fins are contiguous. The first dorsal fin is higher than the second one. Bases of the pectoral fins are located above the bases of the ventral ones. Edges of the pectoral fins are rounded, reaching the anterior part of the second dorsal fin. The caudal fin is deeply forked. Caudal peduncle is laterally compressed, its length is 19–20 % of the standard length of the body. Lateral line is complete, does not extend to the caudal fin. The head is triangular. Cheeks are not prominent. There are quite

big pores of the seismosensory system on the head. The mouth is terminal, large, retractable, with a small bristle-like teeth. The posterior end of the maxilla reaches the vertical of the posterior edge of the eye. The snout length is approximately equal to the diameter of the eye orbit. Eyes are large, located in the upper part of the head, the interorbital distance is narrow (19–20 % of the head length). The posterior edge of preopercle contains the spikes. The posterior edge of the gill cover is covered by the spike, located at the superior part of the cleithrum. The ratios of plastic characters to the standard body length and length of the head, as well as meristic characters are shown in Table 1.

The general backdrop of the fish body is translucent, with gray-silver pearlescent tint, lighter on the sides. The belly is silvery-white. The colouring is somewhat darker at the base of the anal and dorsal fins. There are dark dots along the lateral line, as well as clearly visible dot on the back of the head beyond the upper edge of the eye. All fins are transparent (Fig. 1).

Comparative analysis

The limited material available at our disposal does not allow doing an in-depth analysis of morphometric data and obtaining significant differences for plastic and meristic characters. The size and age variability of the common percarina also has not been studied previously.

Comparing the two individuals from the Dnieper reservoir with those fishes (similar in size) from the Dniester estuary, we can note some differences in body proportions: the relative height of the caudal peduncle (h/SL) and postorbital length (po/C) are much bigger in fishes from the Dnieper reservoir (Fig. 2). Differences in meristic characters between them are absent. The preliminary data on the differences between the fish traits from different habitats may have adaptive character.

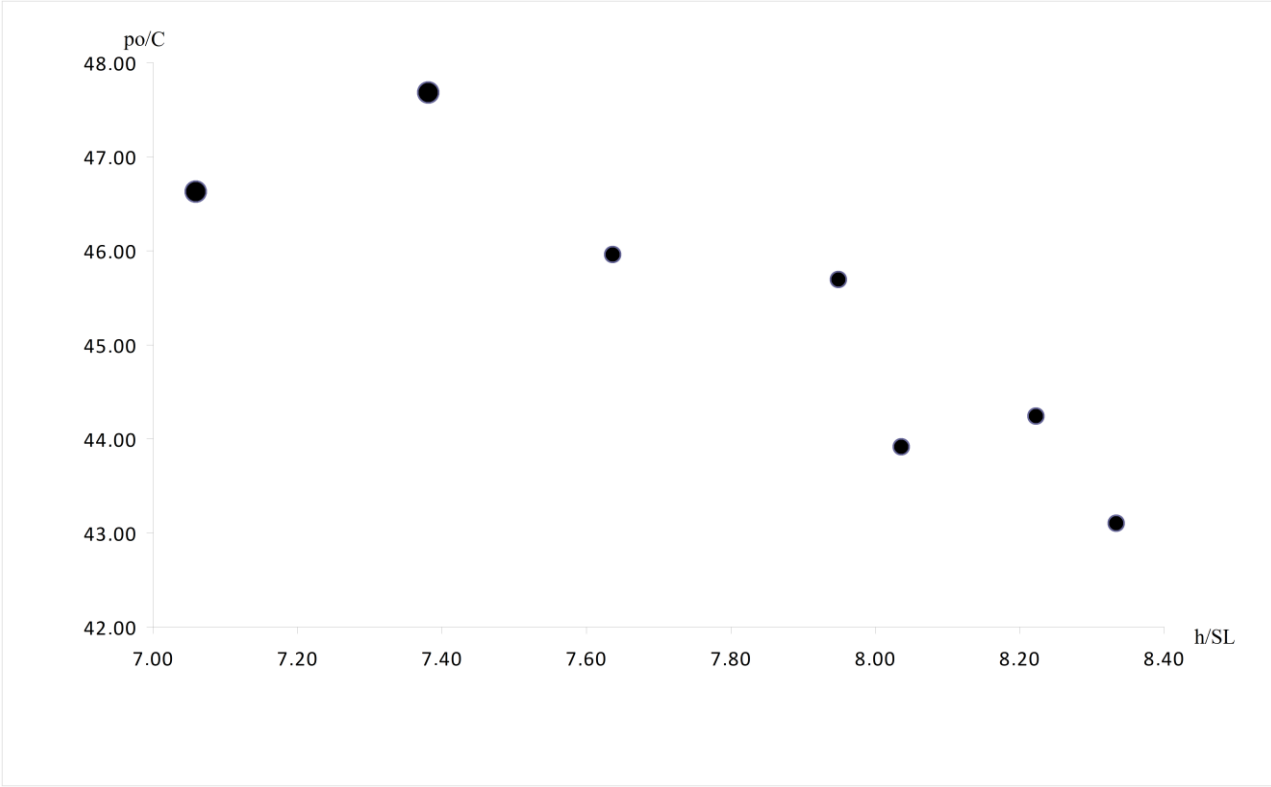

Figure 2. Distribution of seven individuals of the common percarina in space of the two characters h/SL and po/C values. Large circles – Dniprovske Reservoir, small circles – Dniester estuary

Biological characteristics

The biology of the percarina is hitherto poorly understood. Recent data on the ecology of this species, reproduction, fertility, and diet dated back to the middle of the 20th century (Chugunova, 1949; Alekseeva, 1952; Ambroz, 1956; Scherstyuk, 1968). Taking into account its advance into freshwater bodies, the common percarina is a freshwater-oligohaline species; according to Morduhai-Boltovskoi (1960), *P. demidoffii* could inhabit brackish waters for the second time because of its invasion from the freshwater

bodies. It is schooling, demersal, pelagic species found mostly near the bottom, but also in the water column at depths of 5–10 m. Sometimes it forms common shoals with the Black Sea-Azov sprat *Clupeonella cultriventris* (Nordmann, 1840) and in all probability feeds on young specimens of the latter one. The percarina reaches sexual maturity in the second year of life. Depending on the water temperature, the spawning season lasts from late May to August. Fertility of the common percarina averages 2.5–3 thousands eggs.

The diet of *P. demidoffii* in the northwestern part of the Black Sea includes hardroe and the baby fishes (sprat, silverside, and gobies), zooplankton and phytoplankton, small crustaceans, polychaetes and insect larvae. Both specimens of percarina from the upper part of the Dniprovske reservoir (Dnipro, the rowing channel) were caught on winter spoon bait, and bloodworm was used as a lure.

In January 2017, anglers caught three individuals of the common percarina in the same place as in 2016 (the rowing channel), but another one – 10 km downstream the Dnieper River – in the Mokra Sura River mouth. It is deposited in the ichthyological collection of the Department of Aquatic Bioresources and Aquaculture, Dnipro State Agrarian and Economic University, Dnipro, Ukraine.

Percarina lifespan is up to four years. Their maximum body length is 110 mm; individuals up to 50–60 mm usually dominate in the population.

Distribution

The finding of the common percarina in the Dniprovske (Zaporizske) reservoir confirms a few earlier published data about the advance of this fish upstream of the Dnieper River and extends its current range. Besides, our record allows us to consider the common percarina as freshwater-oligohaline (not mesohaline) species. It should be noted that percarina from the Sea of Azov is not going upstream of the flowing rivers; that may partly confirm its separate taxonomic status.

The presence of *P. demidoffii* in the fish fauna of the Dniprovske reservoir also may confirm a continued active advance of the Ponto-Caspian fish species upstream of the cascade of reservoirs on the Dnieper River (Pan'kov, 2007; Manilo, Didenko, 2013; Novitskiy, Hubanova, 2016).

The reasons of penetration of the common percarina into the fresh waters of the Dniprovske and Kakhovske reservoirs as well as vectors of its distribution in secondary water bodies of the Dnieper River are unknown to date; therefore, further studies are required.

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