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PENSOFT

Expanding the geographical distribution of *Rhynchocypris czekanowskii* (Dybowski, 1869) (Cypriniformes, Cyprinidae) in the basin of the Yenisei River, Eastern Siberia, Russia

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Abstract
The currently known geographical distribution of Chekanovskii's Minnow, *Rhynchocypris czekanowskii* (Dybowski, 1869), is limited only by the lower reaches of the arctic river basins in which this species lives. We report *R. czekanowskii* from the small water bodies of middle part of Yenisei river basin, expanding its distribution to the south of the river basin to 55°51′41″ N latitude, more than 100 km south from previously known occurrences of this species.

Key words
Arctic river basins, Chekanovskii's Minnow, Krasnoyarsk region, Leuciscinae, Northern Asia.

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Introduction

Chekanovskii's Minnow, *Rhynchocypris czekanowskii* (Dybowski, 1869), belongs to the genus *Rhynchocypris* Günther, 1889, which includes 6–11 valid species (Sakai et al. 2006, Froese and Pauly 2018, Fricke et al. 2019). Despite a widespread distribution in Eurasia, this species is poorly known relative to other members of its genus with large ranges: *R. percnurus* (Pallas, 1814), *R. lagowskii* (Dybowski, 1869), and *R. oxycephalus* (Sauvage & Dabry de Thiersant, 1874). Knowledge of the geographical distribution of *R. czekanowskii* (Dybowski, 1869) is based primarily on the work of Berg (1949), who gave the distribution as in the Amur river basin and rivers flowing into the Arctic Ocean, from the Kara to the Kolyma rivers. In the basins of these arctic rivers, it is thought that this species inhabits only the lower reaches (Reshetnikov 2002, Freyhof and Kottelat 2008; Fig. 1). Our previous studies confirmed the presence of *R. czekanowskii* in the basin of the Pyasina River and lower reaches of the Yenisei River (Zuev et al. 2006). However, recently a number of populations of *R. czekanowskii* have been discovered far to the south of the known distribution area.

Methods

An assessment of the biological diversity of fish in small water bodies of the middle reach of the Yenisei River was conducted in 1999–2017 by electrofishing. Geographical coordinates of new occurrence records of *Rhynchocypris czekanowskii*, as well as the type of water body,

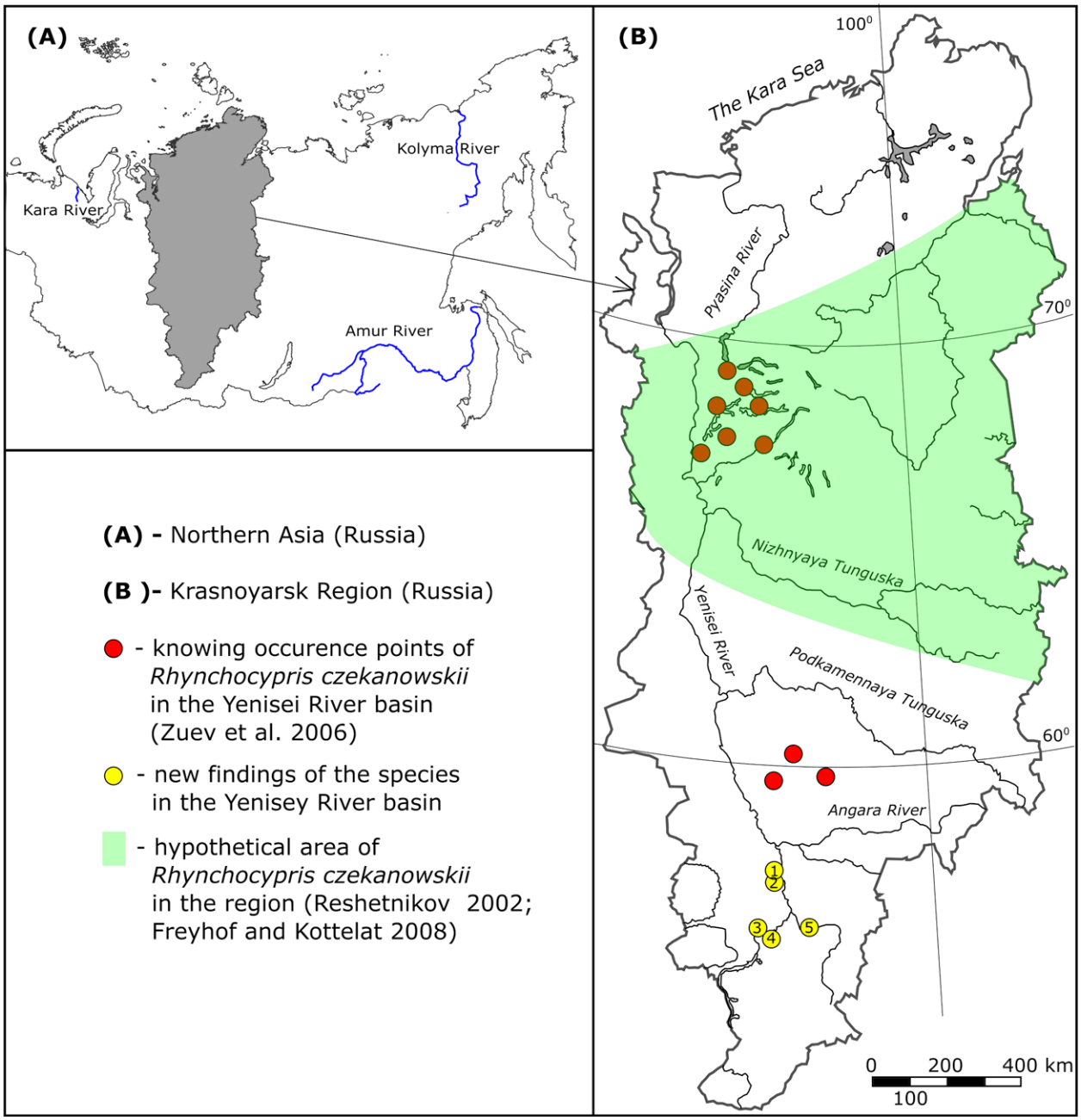

Figure 1. Map of distribution of *Rhynchocypris czekanowskii* in river basins of the Krasnoyarsk region. 1 = pond on Savina River; 2 = pond on Bobrovka River; 3 = little pond on Cheremushka River; 4 = pond on Berezovka River; 5 = Bogunay River.

fish species composition, and pH were recorded. Specimens from Sites 1 and 2 were euthanized with overdose of clove oil (Underwood et al. 2013), preserved with 10% neutral formalin and deposited in the Zoological Collection of the Department of Water and Terrestrial Ecosystem, Siberian Federal University, Russia (WTESFU). Specimens from sites 3 and 4 were kept alive in aquariums during several months. Fishes were identified as *R. czekanowskii* based on taxonomic criteria proposed by Berg (1949) and Kottelat and Freyhof (2007) and using observations of external morphology. Morphometric measurements to the nearest 0.1 mm using a digital caliper were performed on the left side of the fish following Kottelat and Freyhof (2007). Measurements are expressed as percentages of standard length (SL).

Results

New records. Site 1: WTESFU 15.1.21.1, 27 specimens, 47.1–96.2 mm SL, Russia, East Siberia, Krasnoyarsk region, pond on Savina River, 57°27′08″ N, 093°11′05″ E (Fig. 1), Ivan V. Zuev, Sergey M. Chuprov, 13 August 2015 (Fig. 2). Site 2: WTESFU 16.1.21.2, 23 specimens, 32.4–101.8 mm SL, Russia, East Siberia, Krasnoyarsk region, pond on Bobrovka River, 57°16′59″ N, 093°08′38″ E (Fig. 1), Ivan V. Zuev, Sergey M. Chuprov, 8 July 2016. Site 3: Russia, East Siberia, Krasnoyarsk region, little pond on Cheremushka River, 56°07′58″ N, 092°58′59″ E, (Fig. 1), Ivan V. Zuev, 25 August 2014 (Fig. 3A). Site 4: Russia, East Siberia, Krasnoyarsk region, pond on Berezovka River, 55°51′41″N, 093°21′51″ E (Fig. 1), Ivan V. Zuev, 5 August 2017 (Fig. 3B). Site 5: Russia, East

Figure 2. Diagnostic features of *Rhynchocypris czekanowskii* from the Savina river basin (WTESFU 15.1.21.1). **A.** Male, 59.6 mm SL. **B.** Incomplete lateral line. **C.** Genital papilla.

Siberia, Krasnoyarsk region, Bogunay River, 56°08′33″ N, 094°32′05″ E, (Fig. 1), Sergey M. Chuprov, June–August 1999 (Fig. 3C).

Both Sites 1 and 2 are small (0.1–0.3 km^2) artificial semi-flowing ponds that were formed in 1965–1975 by damming of the short, left tributaries of Yenisei River by a road connecting Krasnoyarsk and Yeniseysk (Fig. 4C, D) (Aferenko 2016). Maximum depth of these ponds does not exceed 2 m. The substrate is represented by silt overgrown with macrophytes. In July the pH ranged from 7.5 to 8.3. Fish fauna in the ponds included Belica *Leucaspius delineatus* (Heckel, 1843), Prussian Carp *Carassius gibelio* (Bloch, 1782) (Cyprinidae), and Siberian Stone Loach *Barbatula toni* (Dybowski, 1869) (Nemacheilidae). *Leucaspius delineatus* is an invasive species in the Yenisei river basin, which has spread throughout the southern part of this basin over the past 50 years (Zuev et al. 2016).

At Site 3, we found a small population of *R. czekanowskii* in a little pond (about 4 m in diameter, 1 m in depth) on the short, left tributary of Yenisei River in 2014 (Fig. 4A). Over the next 2 years of observation, the population remained stable. In September pH was 7.9. No other fish species were found.

At Site 4, *R. czekanowskii* was caught in a small pond (about 0.3 km^2) overgrown with macrophytes, with pH varied 7.1–7.4 during August (Fig. 4B). Other species collected at this site included: B. toni, and Perca fluviatilis (Linnaeus, 1758) (Percidae).

Site 5 is in the Bogunay River, a right tributary of the Kan River; the Bogunay River is 58 km long. At sampling site, the width of the river was 10–12 m, the depth was 0.5–2 m, and the pH was 7.5. The river was divided into 2 sections by a 6 m long rapid. The upper section is inhabited only by *R. czekanowskii*, but in

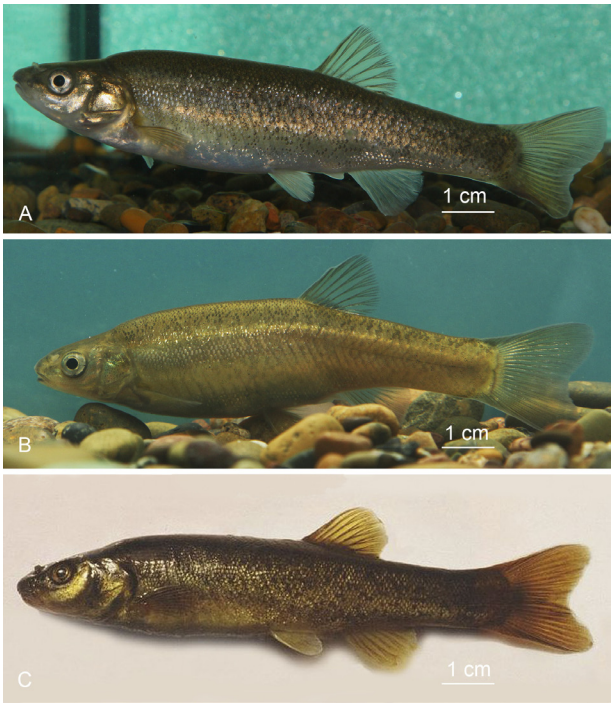

Figure 3. *Rhynchocypris czekanowskii* from the Yenisei River basin. **A.** Female, 98.3 mm SL, little cave on Cheremushka River. **B.** Female, 84.5 mm SL, pond on Berezovka River. **C.** Female, 93.1 mm SL, Bogunay River.

Figure 4. Biotopes of *Rhynchocypris czekanowskii* in the Yenisei river basin. **A.** Little pond on Cheremushka River. **B.** Pond on Berezovka River. **C.** Pond on Bobrovka River. **D.** Pond on Savina River.

the lower section there were Eurasian Minnow *Phoxinus phoxinus* (Linnaeus, 1758), Gudgeon *Gobio sibiricus* Nikolsky, 1936, Common Dace *Leuciscus leuciscus* (Linnaeus, 1758) (Cyprinidae), Perch *P. fluviatilis*, and Ruffe *Gymnocephalus cernua* (Linnaeus, 1758) (Percidae). All of these species are native in the Yenisei river basin (Popov 2009).

Identification. According to Berg (1949) and Fujita and Hosoya (2005), *R.* (*Phoxinus*) *czekanowskii* differs from its congenerates by having an incomplete lateral line. From *R. percnurus*, which is the only similar species in the Yenisei river basin, it is distinguished in having a subterminal mouth, the maximum body depth not exceeding 23% of SL, the body depth less than the length of caudal peduncle, and the male genital papilla with a long pointed conical projection (Berg 1949, Kottelat and Freyhof 2007).

The lateral line of live specimens was poorly or not visible (Fig. 3), but distinct after fixation (Fig. 2B). The lateral line ended behind the tip of the pectoral fin, but in rare cases, it reached the beginning of the abdominal fin. The shape of the genital papilla in males in all cases was conical and pointed (Fig. 2C). The upper jaw slightly protruded beyond the lower jaw, especially in large individuals. The body depth varied among specimens from 17.1 to 26.2, and on average 21.4% of SL in WTESFU 15.1.21.1 and 22.1% of SL in WTESFU 16.1.21.2. The length of caudal peduncle was 23.3% in WTESFU 15.1.21.1 and 24.2% in WTESFU 16.1.21.2.

Discussion

The ranges of most species of *Rhynchocypris* overlap in the northern Far East, which is considered to be the center of speciation of the subfamily Leuciscinae (Ito et al. 2002, Sakai et al. 2006, Perea et al. 2010). A large number of minnow species from this region have been reported and variously classified. At present, the species status is confirmed only for some of the previously identified taxa, including *R. czekanowskii* (Ito et al. 2002, Sakai et al. 2006).

Rhynchocypris czekanowskii is distributed throughout the Amur river basin, where it was first described by Dybowski (Dybowski 1869, Nikol'skii 1956, Karasev 1987, Kottelat et al. 2006, Bogutskaya et al. 2008). It occurs on the Sakhalin Island (Nikitin and Safronov 2009), in the basins of the Kolyma, Yana, Indigirka (Chereshnev and Kirillov 2007), Lena (Kirillov and Knizhin 2014), and Yenisei rivers (Zuev et al. 2006). Despite the indication of *R. czekanowskii* in the lower reaches of the Ob and Kara rivers (Berg 1949, Sudakov 1977), about the spread of this species into the middle part of the Ob river basin is controversial (Romanov et al. 2017). New records of *R. czekanowskii* in the basin of the Irtysh River (Kassal 2017) and the relationship

of these populations with Central Asian species of minnows requires clarification.

Little information is available on the distribution of *R. czekanowskii* in the Yenisei river basin. Mostly these data are in local Russian publications in which the exact collection sites are not indicated (Podlesny 1958, Kuklin 1999, Romanov 2004, Zadelenov et al. 2006, Popov 2015). The current version of the distribution map for this species defines the southern border of this species' range to be the Yenisei basin along its right tributary, the Nizhniyaya Tunguska River (Reshetnikov 2002, Freyhof and Kottelat 2008). During 2000–2006 we found more southern populations of *R. czekanowskii* in the basin of the Podkamennaya Tunguska River (near 60° N latitude) (Zuev et al. 2006; Fig. 1). Our new records are located more than 500 km south from the hypothetical border (Reshetnikov 2002, Freyhof and Kottelat 2008) and more than 100 km south from the Podkamennaya Tunguska River.

Species of the genus *Rhynchocypris* tend to occupy different biotopes. The Lake Minnow *R. percnurus* prefers exclusively lakes, ponds, and swamps, while *R. lagowskii* and *R. oxycephalus* mostly inhabit running waters (Bogutskaya et al. 2008, Freyhof and Kottelat 2008, Kusznierz et al. 2011, Liang et al. 2014, Nishida et al. 2014). *Rhynchocypris czekanowskii* is considered to be equally a lotic and lentic species (Reshetnikov 2002, Nikitin and Safronov 2009, Kirillov and Knizhin 2014, Antonov 2017). According to our data, *R. czekanowskii* is a more of a lentic species and inhabits mostly low-flow lakes and reservoirs, where it overwinters. Although this species can move along rivers, its greatest population density is formed in stagnant waters. Undoubtedly, sites occupied by *R. czekanowskii* must be greater than we have found because many similar water bodies, both natural and artificial, exist between the previously known and newly reported found localities.

Rhynchocypris czekanowskii is included in some Russian regional conservation lists (Magadan Oblast and Nenets Autonomous Okrug) as a rare and poorly studied species at the edge of its range (Lavrinenko and Lavrinenko 2006, Chereshnev 2008). However, the number of recent records of *R. czekanowskii* in Krasnoyarsk Territory shows that it is a common species with much wider range then previously known. This minnow is not exploited, and its biotopes are not threatened by anthropogenic activities. Thus, our data confirm the previous assessment of the species as Least Concern using International Union for Conservation of Nature criteria (Freyhof and Kottelat 2008).

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Authors' Contributions

IZ and SC collected and catalogued the data, IZ and AZ wrote the first draft and subsequent editorial work.

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