ISSN 1995-4255, Contemporary Problems of Ecology, 2017, Vol. 10, No. 6, pp. 612–620. © Pleiades Publishing, Ltd., 2017.
Original Russian Text © A.N. Reshetnikov, A.S. Golubtsov, V.B. Zhuravlev, S.L. Lomakin, A.S. Rezvyi, 2017, published in Sibirskii Ekologicheskii Zhurnal, 2017, No. 6, pp. 696–707.

Range Expansion of Rotan *Perccottus glenii*, Sunbleak *Leucaspius delineatus*, and Bleak *Alburnus alburnus* in the Ob River Basin[1]

A. N. Reshetnikov[a, *], A. S. Golubtsov[a, b], V. B. Zhuravlev[c], S. L. Lomakin[d], and A. S. Rezvyi[e]

[a] *Severtsov Ecology and Evolution Institute, Russian Academy of Sciences, Moscow, 119071 Russia*
[b] *Papanin Institute of Biology of Inland Waters, Russian Academy of Sciences, Borok, Yaroslavl oblast, 152742 Russia*
[c] *Altai State University, Barnaul, 656049 Russia*
[d] *Altai Branch of Upper Ob, Glavrybvod, Barnaul, 656056 Russia*
[e] *Museum of Nature and Man, Khanty-Mansiysk, 628011 Russia*
**e-mail: anreshetnikov@yandex.ru*

Received March 20, 2017; in final form, April 18, 2017

Abstract—The ranges of three alien fish species (rotan *Perccottus glenii*, sunbleak *Leucaspius delineatus*, and bleak *Alburnus alburnus*) in the Ob River basin, West Siberia, have expanded. Our data prove the expansion of rotan and sunbleak ranges to the north. In particular, for the first time, populations of rotan are reported from the lower section of the Ob. We also present new data about range expansion of the studied fish species southward. All three species have probably reached the southern limits of their possible distribution in the Upper Ob system, entering the potamon/rhithron transition zone, because the species under study prefer lowland waters. The spatio-temporal dynamics of their expansion reveals the role of the Ob River as the main invasion corridor, enhancing their distribution mostly in meridional direction. In the system of the Upper Ob, rotan and sunbleak were found by us in isolated ponds and lakes, as well as in floodplain systems. This is in agreement with the concept of two invasion vectors: the translocation of fish by humans between water bodies and self-distribution along the river courses.

Keywords: range, West Siberia, Ob, Irtysh, alien species
DOI: 10.1134/S1995425517060105

The Ob-Irtysh basin has the largest drainage area among the river basins of Russia. Compared to basins of other great Siberian rivers, this drainage is more affected by human influence due to more developed industry and a higher population density. Apparently, the influence of humans results in a high percentage (almost a third) of the occasionally or deliberately introduced alien fish species in the contemporary ichthyofauna of the Ob-Irtysh basin, while this proportion does not exceed 20% in basins of other great Siberian rivers (the Yenisei and Lena) (*Ekologiya ryb*..., 2006; Popov, 2009).

Rotan *Perccottus glenii* Dybowski, 1877 (Odontobutidae) appeared in the Ob-Irtysh basin no later than in the 1970s, because in 1973–76 it was noted in Lake Peschanoe in the basin of Tobol, the largest left tributary of the Irtysh (Reshetnikov and Chibilev, 2009). In the Ob basin itself (excluding the Irtysh basin), the rotan has been found in the ponds within the city of Tomsk since 1990; then it penetrated into the Tom River floodplain, from where it began to invade the river system as a whole (Petlina and Ryabova, 2004; Reshetnikov and Petlina, 2007). It is noteworthy that the upper Ob basin is adjacent to the upper Irtysh basin, from where the rotan is known at least since 1988 when it was caught in Lake Cheredovoe within the city of Omsk (S.M. Bondarev, personal communication).

The first introduction of the sunbleak *Leucaspius delineatus* Heckel, 1843 (Cyprinidae) into the region under consideration seemingly happened occasionally in 1962, when this fish was transported together with carp seedlings from the Bryansk oblast into the ponds of a fish farm located on the Oyash River, a tributary of the Ob (Krivoshchekov, 1973; Interesova, 2016). Later this species widely invaded the system of the upper and middle Ob (Popov et al., 2000; Golubtsov and Malkov, 2007; Interesova, 2012, 2016). We have to stress that reports from the 19th century on finding sunbleak in the Ob-Irtysh basin were considered erroneous by Berg (1949).

A record of the bleak *Alburnus alburnus* (Linneaus, 1758) (Cyprinidae) in "Lake Itkul (or Kaslinskoe) connected to the Tobol system" was mentioned by

[1] The article was translated by the authors.

Berg (1949) with reference to L.P. Sabaneev. There were no other reports on finding this species in the Irtysh basin during the first seven decades of the 20th century. The fist reliable data on the occurrence of the bleak in the enclosed basin adjacent to the upper Ob basin appeared in the early 1970s, when V.L. Zakharov, a researcher at the Siberian Fish Culture and Acclimatization Station, found this species in Lake Khoroshee in the Burlinskaya system of lakes in the Karasukskiy district of Novosibirsk oblast (Gundrizer et al., 1984). The wide expansion of the bleak in the upper and middle Ob basin started from the 1990s (Yurakova and Petlina, 2001), and currently the species is common in many rivers of this basin (Interesova, 2016).

This work is aimed an analysis of the modern dynamics of distribution of the three alien fish species (rotan, sunbleak, and bleak) in the Ob-Irtysh basin.

MATERIALS AND METHODS

Fish samples were obtained from the Ob-Irtysh basin using various fishing gear (cast, frame and loop nets, fish traps, and hooks and line) in the summer seasons of 2014–2016. Original data were analyzed in comparison with the published information. New original data (obtained from 18 localities) on distribution of the rotan in the upper Ob basin (the drainages of the Aley, Barnaulka, Katun, Kashkaragaikha, and Charysh rivers within the Altai krai) and in the region of confluence of the Ob and Irtysh in the Khanty-Mansi Autonomous Area of Tyumen oblast are compared with information presented in the reviews (Reshetnikov and Petlina, 2007; Reshetnikov, 2009; Reshetnikov and Chibilev, 2009; Reshetnikov and Ficetola, 2011) and more recent works (Sokolov et al., 2011; 2013; Emtsev, 2012; Korzun and Kassal, 2012; Yadrenkina, 2012; Zhigileva and Kulikova, 2016). In total, 264 localities of the rotan findings in the region under consideration were analyzed (Fig. 1a). In addition to original data, information about the distribution of the sunbleak (45 localities, in total) and bleak (29 localities, in total) in the Ob-Irtysh basin (Figs. 1b, 1c) was taken from the following sources: for the upper and middle Ob basin (including Tom and Chulym drainages) from Babueva (1982, 1984), Vesnina et al. (1999), Popov et al. (2000), Toropov (2000), Vizer (2007), Golubtsov and Malkov (2007), Zhuravlev et al. (2010), Yadrenkina (2010), Zlotnik (2011, 2014), Zhuravlev and Inozemtsev (2012), Romanov et al. (2012), Interesova (2012, 2016), Skalon (2012), Babkina et al. (2013), Babkina (2015), and Interesova and Khakimov (2015); for the enclosed river and lake systems separating the basins of the upper Ob and upper Irtysh, from Gundrizer et al. (1984), Yadrenkina (2010, 2012), and Interesova (2012, 2016); for the Irtysh basin, from Pereskokov (2004), Kolomin (2005), Terent'eva and Mukhachev (2006), Zinov'ev and Baklanov (2007), Kirichenko and Zharenkov (2009), Korlyakov and Dubchak (2010), Korlyakov (2011), Ubaskin (2011), Interesova (2012, 2016), Kirichenko (2012), Korzun and Kassal (2012), Yadrenkina (2012), and Plekhanova (2015). In some cases, if it was impossible to precisely determine the geographic locality of the species record in the particular part of the hydrographic network mentioned in a publication, the middle point or the point in the lower reaches (for the small rivers) were mapped. ArcViewGIS was used for visualization and analysis of the geographic data (*Vvedenie*..., 1999; Pushkarev and Kuzmin, 2001).

RESULTS AND DISCUSSION

Data on the new locations of the studied fish species are presented in the Table 1 and Fig. 1. As follows from these data, the northern limit of the rotan distribution in the middle Ob basin has been moved northward from that known previously (Reshetnikov and Petlina, 2007; Reshetnikov, 2009). The distribution of this species downstream the Ob (which appears to be a natural invasive corridor) reached at least the settlement of Lokosovo between the cities of Nizhnevartovsk and Surgut by 2012 (Emtsev et al., 2012). It is interesting that in the previous years the northern front of the rotan distribution relatively quickly moved downstream the lower Irtysh: in 2006–2009 this front progressively shifted northward (Table 2), and in 2009 it was reported near the settlement of Batovo, 100 km upstream of the confluence of the Ob and the Irtysh (Reshetnikov, 2009; Reshetnikov and Ficetola, 2011). Presently, the northern border of the rotan distribution occurs much lower, because this species has invaded the Maramka branch connecting the Irtysh and the Ob (in the vicinities of the former village of Akhtino), as well as the floodplain of the Ob downstream of its confluence with the Irtysh, in particular, the oxbow lakes near the settlements of Lugovoy, Troitsa, and Urmannyi (Table 1, Fig. 1a).

The high abundance of rotans in the catches from the oxbow lakes, as well as their various ages (in particular, the presence of fry), evidences the establishment of self-supporting populations. Few individuals of rotan were found immediately in the main channel of the Ob, for example, in the vicinities of the settlement of Kirpichnyi. These individuals probably have been washed down from the oxbow lakes. Thus, it is shown that the rotan populations appeared in the floodplain system of the lower section of the Ob. Most likely these populations were founded by individuals that arrived from the Irtysh, because this species is still not recorded from the Ob system immediately upstream of the Ob-Irtysh confluence (for example, from the bodies of water in the vicinities of the settlement of Poykovskiy (61°00′ N, 71°52′ E) and the villages of Shapsha (61°05′ N, 69°27′ E) and Seliyarovo (61°17′ N, 70°21′ E). This species was not found in the large tributaries in the region under consideration: in the Konda River, a tributary of the Irtysh, at the village of Sotnik (59°29′ N, 66°13′ E), and in the Nasym River,

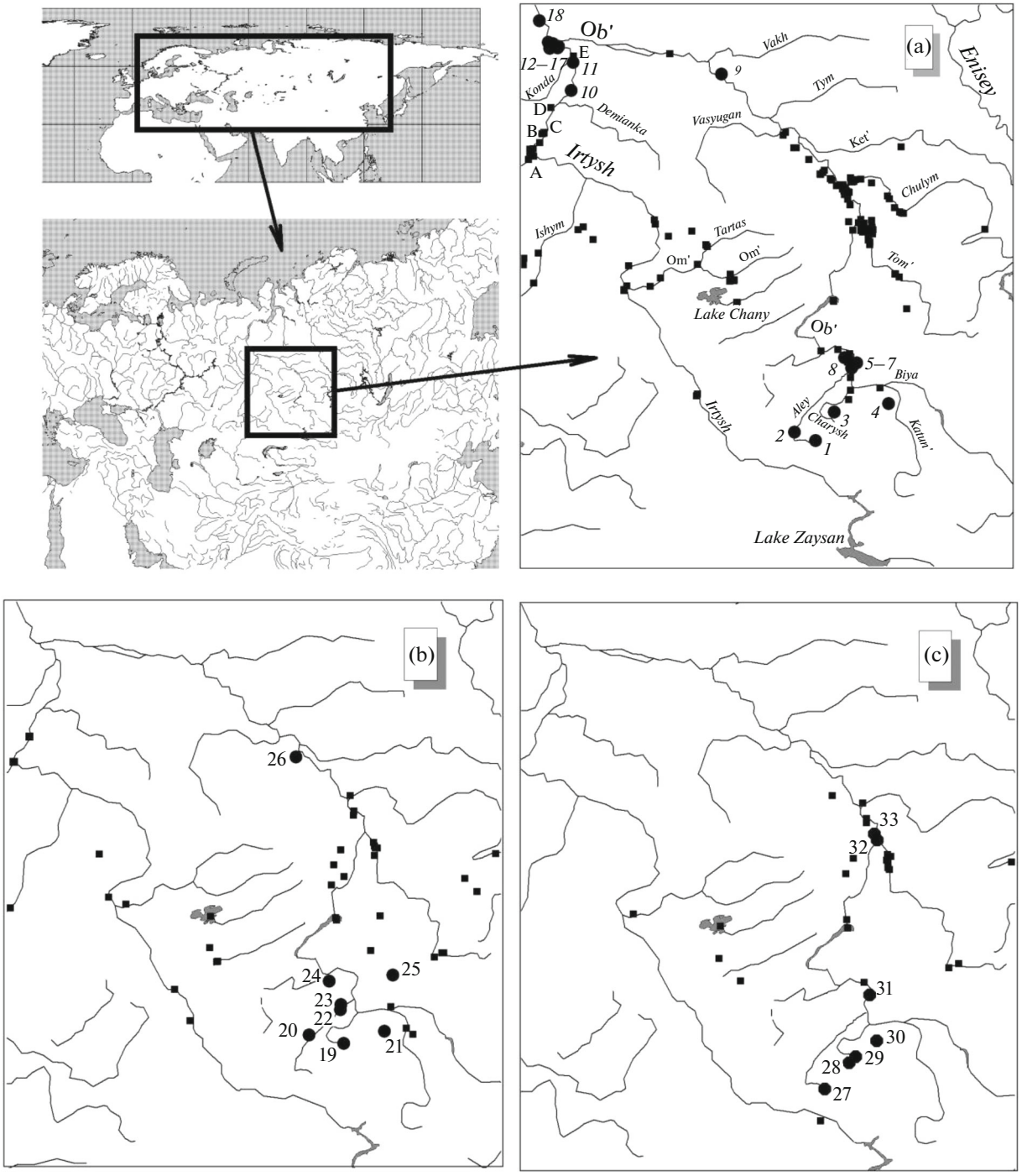

Fig. 1. Distribution of alien fish species in the Ob River basin: (a) rotan *Perccottus glenii*, (b) sunbleak *Leucaspius delineatus*, and (c) bleak *Alburnus alburnus*. Localities from literature sources are presented by squares, original new records are presented by circles; number and letter designations correspond to those in Tables 1 and 2.

a tributary of the Ob, at the village of Kyshik (61°27′ N, 68°56′ E). A junction of the initially isolated western and eastern parts of the range of the rotan in the Ob-Irtysh basin is expected in the nearest future. The species is known from the western part since 1973 (Reshetnikov and Chibilev, 2009), while from the eastern part it is known since 1990 (Petlina and Ryabova, 2004; Reshetnikov and Petlina, 2007).

The floodplain of the Ob at its confluence with the Charysh River was previously considered as the southern front of the rotan distribution (Zhuravlev et al., 2006; Reshetnikov, 2009). Presently, this border in

Table 1. New records of three alien fish species (*Perccottus glenii*, *Leucaspius delineatus*, and *Alburnus alburnus*) in the Ob-Irtysh basin. The dates of the first detection are given in the column 'year'

Locality	Oblast/krai	District	Drainage	Body of water	Year	Geographical coordinates
			rotan *Perccottus glenii*			
1	Altai krai	Zmeinogorskiy	Aley, Ob tributary	Man-made pond	2016	51°08′ N, 82°07′ E
2	Altai krai	Rubtsovskiy	Aley, Ob tributary	Floodplain lake	2016	51°21′ N, 81°13′ E
3	Altai krai	Krasnoshchekovskiy	Berezovka, Charysh tributary	Man-made pond at v. Berezovka	2015	51°51′ N, 82°58′ E
4	Altai krai	Altayskiy	Kamenka, Katun tributary	Floodplain lake at v. Altayskoe	2016	51°59′ N, 85°22′ E
5	Altai krai	Pervomaiskiy	Koshkargaikha, Ob tributary	Oxbow lake	2015	52°59′ N, 83°48′ E
6	Altai krai	Pervomaiskiy	Ob	Lake Pyaterevo	2016	53°01′ N, 83°51′ E
7	Altai krai	Pervomaiskiy	Ob	Lake Bolshoe Sidorovo	2015	53°06′ N, 84°03′ E
8	Altai krai	City of Barnaul	Barnaulka, Ob tributary	Main channel	2016	53°15′ N, 83°31′ E
9	Tomsk oblast	Aleksandrovskiy	Ob	Oxbow lake	2014	60°37′ N, 77°38′ E
10	Tyumen oblast	Khanty-Mansiyskiy	Irtysh	Oxbow lake at v. Bobrovskiy	2009	59°56′ N, 69°50′ E
11	Tyumen oblast	Khanty-Mansiyskiy	Irtysh	Oxbow lake at v. Repolovo	2009	60°39′ N, 69°50′ E
12	Tyumen oblast	Khanty-Mansiyskiy	Ob	Branch Maramka, connecting Irtysh to Ob (25 km W of City Khanty-Mansiysk)	2010	60°57′ N, 68°32′ E
13	Tyumen oblast	Khanty-Mansiyskiy	Irtysh	Lake beyond floodplain	2011	60°59′ N, 68°56′ E
14	Tyumen oblast	Khanty-Mansiyskiy	Irtysh	Floodplain lake at branch Gornaya	2010	61°01′ N, 68°59′ E
15	Tyumen oblast	Khanty-Mansiyskiy	Ob	Floodplain lakes at v. Lugovskoi	2016	61°03′ N, 68°30′ E
16	Tyumen oblast	Khanty-Mansiyskiy	Ob	Ob main channel at v. Kirpichnyi	2011	61°04′ N, 68°40′ E
17	Tyumen oblast	Khanty-Mansiyskiy	Ob	Floodplain lake at v. Troitsa	2011	61°06′ N, 68°25′ E
18	Tyumen oblast	Khanty-Mansiyskiy	Ob	Floodplain lake opposite to v. Urmannyi	2013	61°37′ N, 67°47′ E
			sunbleak *Leucaspius delineatus*			
19	Altai krai	Krasnoshchekovskiy	Maralikha, Charysh tributary	Man-made pond Shipunovskiy at v. Novoshipunovo	2015	51°44′ N, 83°15′ E
20	Altai krai	Pospelikhinskiy	Aley, Ob tributary	Floodplain lake	2015	51°57′ N, 81°51′ E
21	Altai krai	Town of Belokurikha	Belokurikha, Peschanaya tributary	Settling pond at v. Belokurikha	2015	52°00′ N, 84°57′ E
22	Altai krai	Topchikhinskiy	Aley, Ob tributary	Main channel of R. Ziminka		52°33′ N, 83°09′ E
23	Altai krai	Topchikhinskiy	Aley, Ob tributary	Main channel of R. Chistyunka at V. Chistyunka		52°40′ N, 83°11′ E
24	Altai krai	Pavlovskiy	Kasmala, Ob tributary	Main channel of R. Funtovka	2014	53°15′ N, 82°43′ E
25	Altai krai	Kytmanovskiy	Chumysh, Ob tributary	Main channel of R. Kharaba		53°19′ N, 85°25′ E
26	Tomsk oblast	Parabelskiy	Ob	Man-made pond at v. Parabel	2015	58°43′ N, 81°30′ E
			bleak *Alburnus alburnus*			
27	Altai krai	Tret'yakovskiy	Ob	R. Aley	2015	50°58′ N, 81°58′ E
28	Altai krai	Krasnoshchekovskiy	Charysh, Ob tributary	R. Maralikha	2015	51°35′ N, 82°57′ E
29	Altai krai	Krasnoshchekovskiy	Maralikha, Charysh tributary	R. Vydrikha	2015	51°43′ N, 83°14′ E
30	Altai krai	Smolenskiy	Ob	R. Peschanaya upstream of v. Sychevka	2015	52°04′ N, 84°06′ E
31	Altai krai	Pervomaiskiy	Ob	R. Bobrovka at v. Bobrovka	2016	53°10′ N, 83°54′ E
32	Tomsk oblast	Tomskiy	Ob	Mouth of R. Tom, Lobaznaya branch	2009	56°50′ N, 84°31′ E
33	Tomsk oblast	Tomskiy	Ob	Ob at its eastern bank downstream of R. Tom junction	2009	56°59′ N, 84°24′ E

Table 2. Data on dynamics of the northernmost documented records of the rotan *Perccottus glenii* in the floodplain of the lower Irtysh in the Tyumen Province with the first detection dates and geographical coordinates

Locality	Year	District	Body of water	Geographical coordinates	Source of information
A	2006	Tobolskiy	Oxbow Lake Karachinskaya, 14 km from Tobolsk	58°02′ N, 68°10′ E	Reshetnikov and Chibilev, 2009, p. 407
B	2008	Uvatskiy	L. Irymnoe (Arynnoe) at Missiya Biological Station	58°44′ N, 68°42′ E	A.N. Reshetnikov's expedition survey (July 10, 2008)
C	2008	Uvatskiy	Oxbow lake at v. Gornoslinkino	58°46′ N, 68°46′ E	A.N. Reshetnikov's expedition survey (July 11, 2008)
D	2008	Uvatskiy	Oxbow lake at v. Solyanka	59°26′ N, 68°58′ E	Reshetnikov and Chibilev, 2009, p. 407
E	2009	Khanty-Mansiyskiy	Oxbow lake	60°50′ N, 69°50′ E	Reshetnikov and Ficetola, 2011, p. 2969

Altai krai has moved substantially southward. Our data indicate occurrences of this species in a man-made pond on the Berezovka River at the village of Berezovka (Krasnoshchekovskiy district), in an oxbow lake of the Kamenka River at the village of Altayskoe, and in two ponds in the Aley River drainage in the Zmeinogorskiy and Rubtsovskiy districts. The latter two ponds are currently the southernmost records of the species in the Ob-Irtysh basin (Table 1, Fig. 1). Additionally, we found a rotan beyond the Ob floodplain in Lake Sidorovo, 2 km SE of the village of Sosnovka (Table 1, Fig. 1), in 2015. According to verbal information from local people, this fish was purposefully introduced in the lake a few years ago. All these records are close to the theoretically predicted southern limit of the rotan distribution in the region under consideration (Reshetnikov and Ficetola, 2011).

In the 2000s, the rotan populations in the middle and upper Ob basin reached such high densities that this species became significant for commercial fisheries. As follows from the data of the Federal Government Institution "Center of Fishery Monitoring and Communication," the main catches of rotan (up to 70% for Altai krai) were obtained from the Ob floodplain at the Shelabolikhinskiy and Kamenskiy fishing zones with the use of beach seines and gill nets. The annual commercial catch from the Kalmanskiy, Kamenskiy, Pavlovskiy, Ust-Pristanskiy, and Shelabolokhinskiy fishing zones varied from 2.3 to 6.5 t (4.49 ± 0.56 per year, mean $\pm$ standard error) in 2009–2016 (excluding 2011 with missing data). The rotan is used as food by humans. As was shown previously (Reshetnikov and Chibilev, 2009), rotan fishing and marketing facilitate its dispersion, because this species could be transported alive for long distances and in some cases of rotans purchased at markets being released into natural water bodies are documented.

Parasitological data can be used for retrospective analyses of invasion vectors (Reshetnikov et al., 2011). These data (Sokolov et al., 2011, 2013) indicate that the rotan was occasionally introduced into the Ob-Irtysh basin with fish-stocking material of the cultured fish species to fish farms or brought as a bite by anglers. The same data reject the possibility that the local rotan populations were founded by individuals released by aquarium fish hobbyists. Rotan invasion is harmful to ecosystems of shallow enclosed bodies of water (Manteifel and Reshetnikov, 2001; Reshetnikov and Chibilev, 2009).

The last most comprehensive data on the sunbleak distribution in the middle and upper Ob basin were published by E.A. Interesova (2012, 2016). According to those data, the southern border of the sunbleak range in Altai krai occurs a bit south of the confluence of the Biya and Katun rivers, while the northern border of the range is Lake Monatka (57°21′ N, 84°05′ E) in the middle Ob basin. In 2015 we found the sunbleak in the drainages of the three southern tributaries of the upper Ob (the Aley, Charysh, and Peschanaya rivers); this seems somewhat southward from the limit indicated by Interesova (2012, Fig. 1). In the Charysh drainage, the species was recorded from the Shipunovskiy Reservoir (at the village of Novoshipunovo) on the Vydrikha River, a tributary of the Maralikha River flowing into the Charysh from the east. In the Aley drainage, it was collected from the oxbow lake (its local name is Militseiskaya) on the eastern side of the Aley at the village of Pospelikha. In the Peschanaya drainage, it was recorded from a settling pond in the town of Belokurikha. Earlier we reported the sunbleak from a number of more northern localities occurring apparently within the range outlined by Interesova. These localities are following: the Funtovka River (a tributary of the Kasmala River flowing into the Ob from the left) at the village of Pavlovsk, the Ziminka

River (a tributary of the Aley) at the settlement of Kirovskiy, the Chistyunka River (a tributary of the Aley) at the village of Chistyunka, and the Kharaba River (a tributary of the Chumysh) at the village of Oktyabrskiy (Table 1, Fig. 1). As the northern border of the sunbleak distribution in the middle Ob basin, we found this species in a small excavated pond in the village of Parabel near a private estate at the address Pristanskiy pereulok 1. The distance from Lake Monatka to this locality is 250 km to the northeast (150 km in the latitudinal direction).

Previously, Golubtsov and Malkov (2007) reported the sunbleak from the waters of the Altai Republic to the south of the confluence of the Biya and Katun rivers, but they did not present the geographical coordinates of the localities. These localities appear to be among the most southern findings of the species, and we present their coordinates below. These are ponds of the Podgornyi state farm in the Maiminskiy district (52°01′ N, 85°51′ E) and the Saidys River between the villages of Kyzylozek and Karasuk in the same region (51°52′ N, 86°06′ E). Both localities belong to the Katun basin. Thus, the Shipunovskiy reservoir in the Charysh drainage (51°44′ N) appears to be the southernmost reported locality of the sunbleak (Table 1, Fig. 1).

In a recent work, Interesova and Khakimov (2015, p. 225) considered the distribution of the bleak in the middle and upper Ob basin and stated that "there is no published information about findings of this species in the Ob basin upstream of the Novosibirsk Reservoir." However, Zhuravlev and Inozemtsev (2012) reported this species from the Fedulovskaya Ob branch close to the mouth of the Povalikha River, the eastern tributary of the Ob, 5 km downstream of the city of Barnaul. In the present work we report four more southern localities for the bleak in Altai krai. We recorded this species from (1) the Aley River approximately 3 km upstream of the village of Staroaleyskoe; (2) from the Vydrikha River (just downstream the dam of the Shipunovskiy reservoir at the village of Novoshipunovo), a tributary of the Maralikha River in the Charysh basin; (3) the Maralikha River itself between the villages of Maralikha and Kuibyshevo; and (4) the Peschanaya River 0.5 km upstream of the village of Sychevka. Thus, the bleak has widely dispersed in the drainages of the southern Ob tributaries in Altai krai, where the southernmost locality is at the upper reaches of the Aley River (50°58′ N). In the Irtysh basin, however, this species occurs even more southward (50°13′ N); it is recorded in the Shulbinskiy Reservoir and upstream of it (Kirichenko, 2012).

Both bleak and sunbleak could be occasionally delivered into the Irtysh basin with fish stocking material from the enclosed lake systems of the south of Western Siberia (Korlyakov and Dubchak, 2010). Other or additional sources for this invasion could be self-dispersion or introduction from the European river systems (Terent'eva and Mukhachev, 2006; Zinov'ev and Baklanov, 2007; Korlyakov and Nokhrin, 2014).

None of the three alien species were found in the uppermost reaches of the four tributaries of the upper Ob basin: the Charysh system in the Ust-Kanskiy district of the Altai Republic and in the region of the Tigirek Natural Reserve in Altai krai, the Anuy and Peschanaya systems in the Altai Republic, and the Katun system upstream of Maiminskiy district of the Altai Republic. The bleak was not found in the Parabel'skii district of Tomsk oblast in the middle Ob basin. According to our data, the rotan seems to be still lacking in the Ob floodplain immediately upstream of the confluence of the Ob and Irtysh.

It is interesting that the rotan and sunbleak were collected by us from both isolated natural and man-made lakes and floodplain lakes connected to river systems. This observation evidences the action of two invasion vectors. In the latter case, both the purposeful introductions by single persons (typical to rotan) and the occasional transfers with the stocking material of other fish species (typical for all three species studied) are possible. It should be noted that the rotan is characterized by low swimming performance, and its ability to disperse upstream fast-flowing rivers is not evident.

Considering our results, we distinguished the terms 'date of the first appearance' and 'date of the first record.' As a rule, the first stages of invasion of the alien species into a river system remain unrecorded. Its discovery occurs usually at invasion stage V (Reshetnikov, 2013, p. 194), when the self-supporting populations are already established and they reach relatively high densities. Most of our samples were taken from such well-established populations, excluding individuals of rotan caught in the main channels of relatively large rivers: the Ob and its tributary Barnaulka (Table 1).

CONCLUSIONS

Our results indicate that the expansion of the range into the new parts of the Ob basin in all three studied alien species has occurred intensively over the last few years. The spatio-temporal dynamics of records reveal the role of the Ob as a main invasion corridor enhancing the range expansion mostly in the meridional direction. The dispersal of these alien species in the main tributaries—flowing mostly in the latitudinal direction—is also reported. For the Tom and Chulym Rivers, large right tributaries of the Ob, this dispersion is relatively well documented; there is almost no information on the distribution of the species in question in other large Ob tributaries (the Vasyugan, Ket, Tym, and Vakh rivers), except for the record of rotan in the middle Ket at the village of Stepanovka (Fig. 1a).

Probably all three species have reached the southern limits of their possible distribution in the Upper Ob system, entering the potamon/rhithron transition zone. There are no data on their distribution in the

Biya River drainage, where the southern limits are probably not yet reached. There is also the possibility that some of these alien species can be introduced by humans into some isolated water bodies to the south within their ecological limits of distribution.

The northern limits of distribution in the Ob-Irtysh basin for the studied species cannot be depicted precisely. The shift to the north of the bleak distribution seems to be probable. Currently, the northernmost records of this species are Lake Monatka and the mouths of the Chulym and Shegarka rivers, Ob tributaries (Zlotnik, 2014; Interesova and Khakimov, 2015; Interesova, 2016). Our data are in agreement with the concept of two invasion vectors: the translocation of fish by humans between water bodies and self-distribution along river courses.

ACKNOWLEDGMENTS

We are grateful to S.V. Batenev, S.M. Bondarev, N.A. Bulakhova, A.P. Chvanov, V.E. Chikodanov, N.P. Griva, A.A. Koldenberg, V.F. Konev, S.I. Korepanov, I.N. Kudinova, A.M. Nakataev, A.P. Pyshnograi, V.M. Rodionova, S.N. Satukov, V.D. Shegurova, and A.V. Ubaskin, as well as K. Leushina, V. Obraztsova, and K. Ryzhakova for assistance in data collection. Data analysis on the rotan distribution and MS preparation were financially supported by the Russian Science Foundation, project no. 16-14-10323; sampling of the middle and upper Ob basin and data analysis on the bleak and sunbleak distribution were financially supported by the Russian Foundation for Basic Research, project no. 15-29-02772.

REFERENCES

Babkina, I.B., Ichthyofauna of the Lower Tom' River basin: dynamics and modern status, *Extended Abstract of Cand. Sci. (Biol.) Dissertation*, Tomsk, 2015.

Babkina, I.B., Petlina, A.P., and Shestakova, A.S., Morphoecological features of the common bleak (*Alburnus alburnus* (L.)) from the Lower Tom' River, *Vestn. Tomsk. Gos. Pedagog. Univ.*, 2013, no. 8, no. 136, pp. 61–69.

Babueva, R.V., The common bleak in Burlinskaya lake system, in *Zametki po faune i flore Sibiri* (Notes on Fauna and Flora of Siberia), Tomsk: Tomsk. Gos. Univ., 1984, pp. 31–33.

Babueva, R.V., Izotova, G.P., and Krivoshchekov, G.M., Belica *Leucaspius delineatus* in the Karasuk River basin, in *Opyt kompleksnogo izucheniya i ispol'zovaniya Karasukskikh ozer* (Comprehensive Study and Use of Karasuk Lakes), Novosibirsk: Nauka, 1982, pp. 204–206.

Berg, L.S., *Ryby presnykh vod SSSR i sopredel'nykh stran* (Freshwater Fishes of Soviet Union and Adjacent Countries), Moscow: Akad. Nauk SSSR, 1949, part 2, pp. 469–925.

Ekologiya ryb Ob'-Irtyshskogo basseina (Ecology of Fishes of Ob-Irtysh Basin), Pavlov, D.S. and Mochek, A.D., Eds., Moscow: KMK, 2006.

Emtsev, A.A., Bernikov, K.A., and Akopyan, E.K., Extension of the range borders of some animal species in the northern part of Western Siberia, *Mir Nauki, Kul't., Obraz.*, 2012, no. 6 (37), pp. 471–477.

Golubtsov, A.S. and Malkov, N.P., *Ocherki ikhtiofauny Respubliki Altai: sistematicheskoe raznoobrazie, rasprostranenie i okhrana* (Description of Ichthyofauna of Altai Republic: Taxonomic Diversity, Distribution, and Protection), Moscow: KMK, 2007.

Gundrizer, A.N., Ioganzen, B.G., and Krivoshchekov, B.G., *Ryby Zapadnoi Sibiri: uchebnoe posobie* (Fishes of Western Siberia: Manual), *Tomsk*: Tomsk. Gos. Univ., 1984.

Interesova, E.A., Belica *Leucaspius delineatus* (Cyprinidae) in waterbodies of southwest Siberia, *J. Ichthyol.*, 2012, vol. 52, no. 5, pp. 356–361.

Interesova, E.A., Alien fish species in the Ob River basin, *Russ. J. Biol. Invasions*, 2016, vol. 7, no. 2, pp. 156–167.

Interesova, E.A. and Chakimov, R.M., Bleak *Alburnus alburnus* (Cyprinidae) in the Inya River (southwestern Siberia), *J. Ichthyol.*, 2015, vol. 55, no. 2, pp. 282–284.

Kirichenko, O.I., Morphobiological characteristic of the common bleak (*Alburnus alburnus*) from the Irtysh River and its significance for ecosystems of Irtysh River basin, *Vestn. Kazan. Nats. Univ., Ser. Ekol.*, 2012, no. 1, pp. 81–84.

Kirichenko, O.I. and Zharkenov, D.K., *Bleak is the alien species in the Irtysh River basin and the problem of biological invasions*, *Selevinia*, 2009, pp. 155–158.

Kolomin, Yu.M., About find of two species of carp fishes (fam. Cyprinidae): common bleak *Alburnus alburnus* (Linne) and sunbleak *Leucaspius delineatus* (Heckel) in reservoirs of North Kazakhstan region, in *Rybokhozyaistvennye issledovaniya v respublike Kazakhstan: istoriya i sovremennoe sostoyanie* (Fishery Studies in Kazakhstan Republic: History and Modern Status), Almaty: Bastau, 2005, pp. 203–206.

Korlyakov, K.A., Alien short-cycle fishes in reservoirs of Southern Ural region, *Extended Abstract of Cand. Sci. (Biol.) Dissertation*, Perm, 2011.

Korlyakov, K.A. and Dubchak, K.A., Production and parasitological characteristics of invasive short-cycle fish species in water bodies on the eastern slope of the Southern Urals, *Russ. J. Ecol.*, 2010, vol. 41, no. 4, pp. 347–351.

Korlyakov, K.A. and Nokhrin, D.Yu., Appearance of invasive Volga–Ob corridor, *Vestn. Sov. Mol. Uchen. Spets. Chelyab. Obl.*, 2014, no. 2, pp. 19–28.

Korzun, A.S. and Kassal, B.Yu., Distribution of alien fish species in water bodies of Omsk oblast, *Russ. J. Biol. Invasions*, 2013, vol. 4, no. 1, pp. 39–44.

Krivoshchekov, G.M., The sunbleak in Western Siberia, in *Vodoemy Sibiri i perspektivy ikh rybokhozyaistvennogo ispol'zovaniya* (Reservoirs of Siberia and Their Prospective Use for Commercial Fishery), *Tomsk*: Tomsk. Gos. Univ., 1973, pp. 86–87.

Manteifel', Yu.B. and Reshetnikov, A.N., Selective predation on tadpoles of three anuran species, *Zh. Obshch. Biol.*, 2001, vol. 62, no. 2, pp. 150–156.

Pereskokov, A.V., Ichthyofauna of the Bol'shoe Miassovo Lake, *Sibirskaya zoologicheskaya konferentsiya posvyashchennaya 60-letiyu Instituta sistematiki i ekologii zhivotnykh SO RAN, 15–22 sentyabrya 2004 g., Tezisy dokladov*

(Siberian Zoological Conf. Dedicated to 60th Anniversary of the Institute of Systematics and Ecology of Animals, Siberian Branch, Russian Academy of Sciences, September 15–22, 2004, Abstracts of Papers), Novosibirsk, 2004, pp. 166–167.

Petlina, A.P. and Ryabova, T.S., Ecology of rotan from reservoirs of Tomsk vicinities, *Sibirskaya zoologicheskaya konferentsiya posvyashchennaya 60-letiyu Instituta sistematiki i ekologii zhivotnykh SO RAN, 15–22 sentyabrya 2004 g., Tezisy dokladov* (Siberian Zoological Conf. Dedicated to 60th Anniversary of the Institute of Systematics and Ecology of Animals, Siberian Branch, Russian Academy of Sciences, September 15–22, 2004, Abstracts of Papers), Novosibirsk, 2004, pp. 303–304.

Plekhanova, V.V., Ecological epizootic characteristics of trematodes of mollusks and carp fishes in reservoirs affected by different anthropogenic burden, *Cand. Sci. (Biol.) Dissertation*, Syktyvkar, 2015.

Popov, P.A., Species composition and pattern of fish distribution in Siberia, *J. Ichthyol.*, 2009, vol. 49, no. 7, pp. 483–495.

Popov, P.A., Vizer, A.M., and Upadyshev, E.E., Fishes form Novosibirsk reservoir, *Sib. Ekol. Zh.*, 2000, no. 2, pp. 177–186.

Pushkarev, S.V. and Kuz'min, S.L., Compilation of digital grid maps of areals by the example of amphibians of Northern Eurasia, *Izv. Ross. Akad. Nauk, Ser. Geogr.*, 2001, no. 1, pp. 97–99.

Reshetnikov, A.N., The current range of Amur sleeper *Perccottus glenii* Dybowski, 1877 (Odontobutidae, Pisces) in Eurasia, *Russ. J. Biol. Invasions*, 2010, vol. 1, no. 2, pp. 119–126. doi 10.1134/S2075111710020116

Reshetnikov, A.N., Spatio-temporal dynamics of the expansion of rotan *Perccottus glenii* from West-Ukrainian centre of distribution and consequences for European freshwater ecosystems, *Aquat. Invasions*, 2013, vol. 8, no. 2, pp. 193–206.

Reshetnikov, A.N. and Chibilev, E.A., Distribution of the fish rotan (*Perccottus glenii* Dybowski, 1877) in the Irtysh River basin and analysis of possible consequences for environment and people, *Contemp. Probl. Ecol.*, 2009, vol. 2, no. 3, pp. 224–228. doi 10.1134/S1995425509030102

Reshetnikov, A.N. and Ficetola, G.F., Potential range of the invasive fish rotan (*Perccottus glenii*) in the Holarctic, *Biol. Invasions*, 2011, vol. 13, no. 12, pp. 2967–2980.

Reshetnikov, A.N. and Petlina, A.P., Distribution of the rotan (*Perccottus glenii* Dybowski, 1877) in the Ob River, *Sib. Ekol. Zh.*, 2007, no. 4, pp. 551–555.

Reshetnikov, A.N., Sokolov, S.G., and Protasova, E.N., The host-specific parasite *Nippotaenia mogurndae* confirms introduction vectors of the fish *Perccottus glenii* in the Volga River basin, *J. Appl. Ichthyol.*, 2011, vol. 27, no. 5, pp. 1226–1231.

Romanov, V.I., Babkina, I.B., Karmanova, O.G., Petlina, A.P., Skalon, N.V., and Yurakova, T.V., Dynamics of biological parameters of nonmigratory and invader fish in the basin of the lower Tom' River, *Contemp. Probl. Ecol.*, 2012, vol. 5, no. 1, pp. 50–57.

Skalon, N.V., Fauna of Kemerovo oblast, in *Krasnaya kniga Kemerovskoi oblasti. Tom 2. Redkie i nakhodyashchiesya pod ugrozoi ischeznoveniya vidy zhivotnykh* (The Red Data Book of Kemerovo Oblast, Vol. 2: Rare and Endangered Species of Animals), Kemerovo: Aziya Print, 2012, pp. 15–18.

Sokolov, S.G., Protasova, E.N., Pel'gunov, A.N., Voropaeva, E.L., and Reshetnikov, A.N., Parasitofauna of rotan *Perccottus glenii* Dybowski, 1877 (Osteichthyes, Odontobutidae) in the Irtysh River, *Povolzhsk. Ekol. Zh.*, 2011, no. 1, pp. 103–109.

Sokolov, S.G., Lebedeva, D.I., and Yadrenkina, E.N., The first data on the parasite fauna of Amur sleeper *Perccottus glenii* Dybowski, 1877 (Actinopterygii: Odontobutidae) from waterbodies of forest-steppe zone of West Siberian plains, *Parazitologiya*, 2013, vol. 47, no. 6, pp. 448–460.

Terent'eva, N.N. and Mukhachev, I.S., Ecological role of new commercial fish species in the Ob' River basin, *IX S"ezda Gidrobiologicheskogo obshchestva RAN, Tezisy dokladov* (IX Congr. of Hydrobiological Society of Russian Academy of Sciences, Abstracts of Papers), Tolyatti: Inst. Ekol. Volzhsk. Basseina, Ross. Akad. Nauk, 2006, vol. 2, p. 188.

Toropov, A.V., Fishes naturalized in the Biya River and their impact on local ichthyofauna, *Materialy Vserossiiskoi konferentsii "Regional'nye problemy ekologii i prirodopol'zovaniya"* (Proc. All-Russ. Conf. "Regional Problems of Ecology and Nature Management"), Tomsk: Tomsk. Gos. Univ. Sist. Uprav. Radioelektron., 2000, pp. 35–36.

Ubas'kin, A.V., Impact of of hydroelectric power plants on the ecosystem of the Middle Irtysh within Kazakhstan, *Materialy VI mezhdunarodnoi nauchno-prakticheskoi konferentsii "Reki Sibiri," Krasnoyarsk, 22–24 marta 2011g.* (Proc. VI Int. Sci.-Pract. Conf. "Rivers of Siberia," Krasnoyarsk, March 22–24, 2011), Krasnoyarsk: Krasn. Gos. Pedagog. Univ. im. V.P. Astaf'eva, 2011, pp. 77–80.

Vesnina, L.V., Zhuravlev, V.B., Novoselov, V.A., et al., *Vodoemy Altaiskogo kraya: biologicheskaya produktivnost' i perspektivy ispol'zovaniya* (Reservoirs of Altai Krai: Biological Productivity and Prospective Use), Novosibirsk: Nauka, 1999.

Vizer, A.M., Species structure of ichthyocenes of the Upper Tom' River, *Materialy Vserossiikoi konferentsii "Biologicheskie aspekty ratsional'nogo ispol'zovaniya i okhrany vodoemov Sibiri"* (Proc. All-Russ. Conf. "Biological Aspects of Rational Use and Protection of Siberian Reservoirs"), Tomsk: Lito-Print, 2007, pp. 26–29.

Vvedenie v ArcView GIS (Introduction to ArcView GIS), Ryazan: Rinfo, 1999.

Yadrenkina, E.N., Ichthyofauna of the upper Tom' affected by thermal pollution (West Siberia), *Contemp. Probl. Ecol.*, 2010, vol. 3, no. 5, pp. 541–546.

Yadrenkina, E.N., Distribution of alien fish species in lakes within the temperate climatic zone of Western Siberia, *Russ. J. Biol. Invasions*, 2012, vol. 3, no. 2, pp. 145–157.

Yurakova, T.V. and Petlina, A.P., The structure of ichthyocenes of the Lower Tom' River tributaries, in *Sovremennye problemy gidrobiologii Sibiri* (Modern Problems of Hydrobiology of Siberia), Tomsk: Tomsk. Gos. Univ., 2001, pp. 105–106.

Zhigileva, O.N. and Kulikova, A.A., Specific biological features and genetic variation of Chinese sleeper *Perccottus glenii* (Odontobutidae) in aquatic bodies of Tyumen oblast, *J. Ichthyol.*, 2016, vol. 56, no. 1, pp. 124–132.

Zhuravlev, V.B. and Inozemtsev, A.G., About find of the common bleak *Alburnus alburnus* (L.) in the upper stream of the Ob' River, *Altaisk. Zool. Zh.*, 2012, no. 6, pp. 77–80.

Zhuravlev, V.B., Lomakin, S.L., and Satyukov, S.N., *Opredelitel' ryb vodoemov basseina Verkhnei Obi* (Guide for Identification of Fishes from Reservoirs of the Upper Ob' River Basin), Barnaul: Altaiskaya Pravda, 2010.

Zhuravlev, V.B., Lomodurov, E.I., and Luk'yanov, D.P., Invasion of Amur sleeper and flood reservoirs of the Upper Ob', *IX S"ezda Gidrobiologicheskogo obshchestva RAN, Tezisy dokladov* (IX Congr. of Hydrobiological Society of Russian Academy of Sciences, Abstracts of Papers), Tolyatti: Inst. Ekol. Volzhsk. Basseina, Ross. Akad. Nauk, 2006, vol. 1, p. 163.

Zinov'ev, E.A. and Baklanov, M.A., Fish fauna and its unusual elements in reservoirs of Chelyabinsk and Kurgan oblasts, *Vestn. Permsk. Univ., Ser. Biol.*, 2007, no. 5 (10), pp. 53–56.

Zlotnik, D.V., The results of naturalization of valuable whitefishes in the Verkhne-Chulym lake group (Krasnoyarsk krai), *Materialy Vserossiiskoi konferentsii s mezhdunarodnym uchastiem posvyashchennoi 100-letiyu so dnya rozhdeniya professora B.G. Ioganzena i 80-letiyu so dnya osnovaniya kafedry ikhtiologii i gidrobiologii TGU "Vodnye ekosistemy Sibiri i perspektivy ikh ispol'zovaniya"* (Proc. All-Russ. Conf. with International Participation Dedicated to 100th Anniversary of Prof. B.G. Ioganzen and 80th Anniversary of the Foundation of the Department of Ichthyology and Hydrobiology, Tomsk State University "Aquatic Ecosystems of Siberia and Their Prospective Use"), Tomsk, 2011, pp. 197–199.

Zlotnik, D.V., Modern revision of species composition of fishes from the Chulym River basin (Middle Ob River basin), *Materialy II Vserossiiskoi shkoly-konferentsii "Ekosistemy malykh rek: bioraznoobrazie, ekologiya, okhrana"* (Proc. II All-Russ. School-Conf. "Ecosystems of Small Rivers: Biological Diversity, Ecology, and Protection"), Yaroslavl: Siligran', 2014, vol. 2, pp. 154–157.