First Records of Rhinogobius lindbergi (Teleostei: Gobiidae) and Abbottina rivularis (Teleostei: Cyprinidae) in the Lake Buyr Drainage, Mongolia

Article *in* Journal of Great Lakes Research · June 2008

DOI: 10.3394/0380-1330(2008)34[334:FRORLT]2.0.CO;2

3 authors, including:

Mark Henry Sabaj Pérez
Academy of Natural Sciences of Drexel University

Bud Mendsaikhan
Institute of Geography and Geoecology, MAS

J. Great Lakes Res. 34:334–341
Internat. Assoc. Great Lakes Res., 2008

First Records of *Rhinogobius lindbergi* (Teleostei: Gobiidae) and *Abbottina rivularis* (Teleostei: Cyprinidae) in the Lake Buyr Drainage, Mongolia

David A. Neely[1,*], Mark H. Sabaj Perez[2], and Bud Mendsaikhan[3]

[1]*California Academy of Sciences*
875 Howard St.
San Francisco, California 94103

[2]*Academy of Natural Sciences*
1900 Benjamin Franklin Parkway
Philadelphia, Pennsylvania 19103

[3]*Institute of Geoecology*
Baruun Selbe-13
Ulaanbaatar 211238, Mongolia

ABSTRACT. *We report the first records of Amur goby,* Rhinogobius lindbergi *and the Chinese false gudgeon,* Abbottina rivularis *from the Lake Buyr drainage of eastern Mongolia. Both species were previously known only from much farther downstream in the Amur River basin. Because of their abundance at three sites separated by 11 km in Lake Buyr and a tribuary stream, and presence of multiple size classes, we strongly suspect that these species are established. Both species have been widely dispersed outside of the Amur River basin as contaminants in cultured, large-bodied cyprinids* (Ctenopharyngodon, Hypophthalmichthys, Parabramis), *and we suggest that this is the most likely means of their introduction into Lake Buyr. The long-term impacts of these species on the native ichthyofauna are unknown, but unlikely to be positive. We suggest that immediate measures be taken to monitor their dispersal, and to prevent similar introductions in the future.*

INDEX WORDS: *Fishes, Gobiidae, Cyprinidae, introduced, invasive, non-indigenous, Asia, Amur River.*

INTRODUCTION

Human-mediated dispersal of non-indigenous organisms plays a major role in the homogenization of native faunas on a global scale (Sheldon 1988, Rahel 2000). Aquatic faunas in general, and large lakes in particular, are disproportionately impacted (Witte *et al.* 1992, Ricciardi and MacIsaac 2000). Invasive aquatic species are introduced through a wide range of possible mechanisms, are nearly impossible to eradicate once established, and may have far-reaching and unexpected impacts (Witte *et al.* 1992, Fuller *et al.* 1999, Clout 2005, Mooney and Cleland 2001). The impact of within-basin translocations is harder to quantify, but in large, heterogeneous drainages translocations may be as damaging as inter-basin movement.

A survey of fishes in the upper Amur River drainage of eastern Mongolia during August, 2006 resulted in the discovery of two fishes native to the lower Amur River but not previously recorded from the upper Amur River. Neither species had previously been reported from Mongolia. Herein we discuss these species, the level of threat they pose to the native ichthyofauna, and suggest a likely mechanism for their introduction.

STUDY AREA

Lake Buyr (also occasionally spelled Lake Buir or Buyr Nuur) is a large (615 km^2 surface area), shallow (10 m maximum depth) natural lake, on the

*Corresponding author. E-mail: dneely@calacademy.org

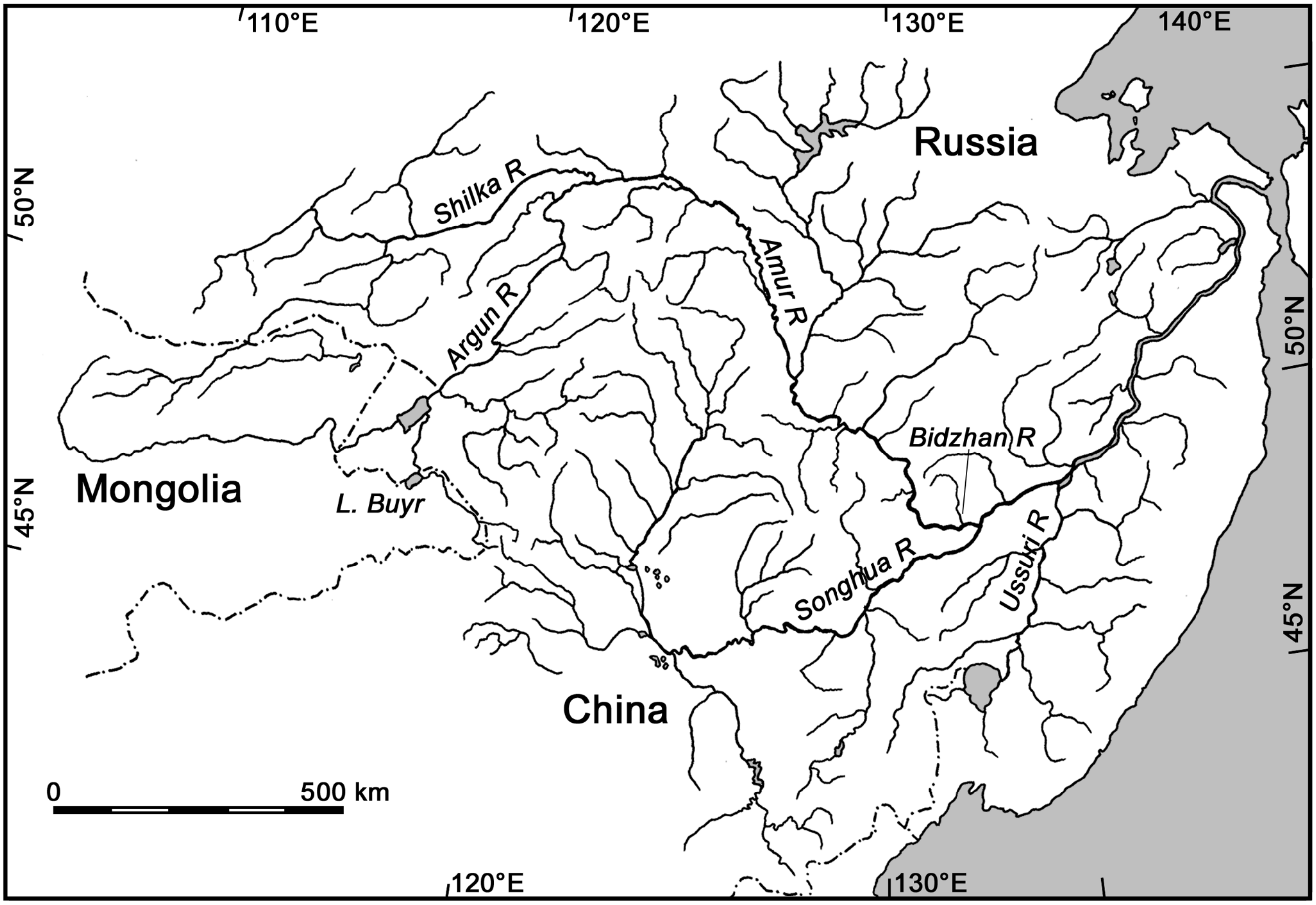

FIG. 1. Amur River drainage. Mouth of Bidzhan River represents previous upstream record for **Rhinogobius** *in the drainage.*

eastern border between Mongolia and China (Figs. 1, 2). The lake is surrounded by dry, sandy steppe, and the bottom is composed primarily of sandy substrates. The lake receives and is also drained by the Halhin River, which flows north into Lake Hulun and eventually to the mainstem Amur River (which is formed by the confluence of the Argun and Shilka rivers). The Kerulen River is a large tributary to Lake Hulun that drains from the Kentai Mountains in central Mongolia eastward, entering China just east of the city of Choybalsan.

Lake Buyr previously supported an important commercial fishery as well as a diverse fish community of > 40 species, but catches have declined precipitously since the 1980s (Dulmaa 1999, Kottelat 2006). Lake Buyr is still intensively fished by the Chinese, especially during winter, when large nets are pulled by truck under ice cover (M. Erdenebat, pers. comm., Institute for Geoecology, Baruun Selbe-13, Ulaanbaatar 211238, Mongolia).

METHODS

We sampled several sites in the Lake Buyr drainage during late August 2006 as part of a survey of the fishes of the Amur River drainage of Mongolia. We used a 3.6 m × 1.3 m haul seine with 3.1 mm mesh, a 9 m × 1.3 m bag seine with 9.5 mm mesh, or a backpack electrofishing unit, depending on current velocity, water depth, substrate composition, and density of aquatic vegetation. We attempted to sample all habitats present at each site, and retained specimens of all species encountered. Captured fishes were anesthetized with clove oil (0.05 mL L^{-1}), preserved in 10% formalin or 95% ethanol, and deposited into the Academy of Natural Sciences, Philadelphia (ANSP), Pennsylvania, USA; Saint Louis University, St. Louis, Missouri, USA (STL); or a reference collection at the Institute of Geo-Ecology, Ulaan Baatar, Mongolia. A list of vouchered specimens is provided below in the

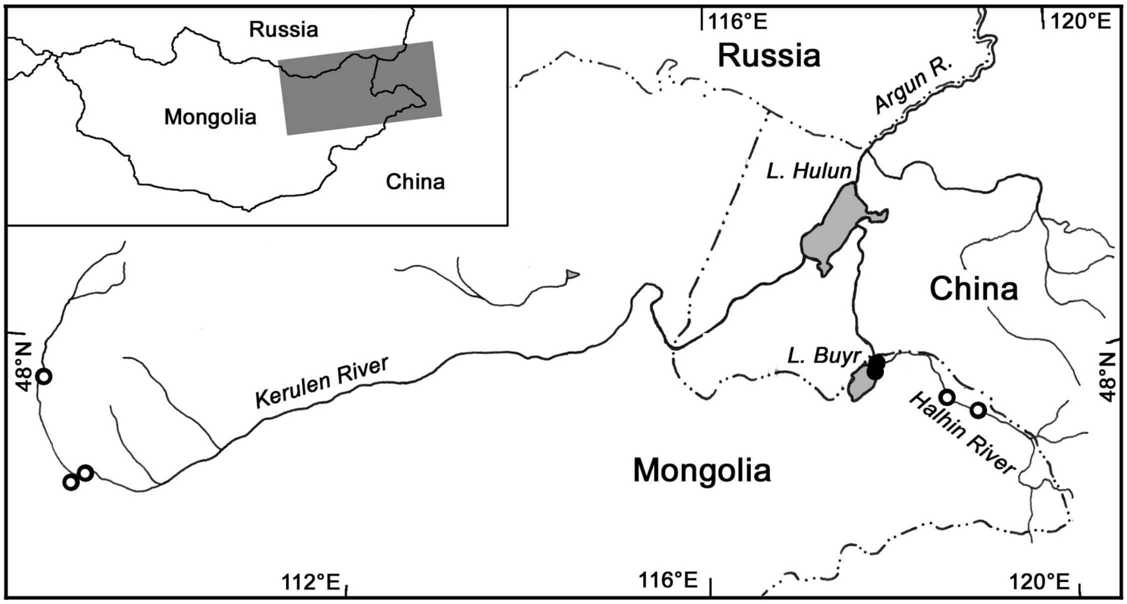

FIG. 2. Lake Buyr and surrounding area, with localities of capture of* Rhinogobius lindbergi *and* Abbottina rivularis *depicted by closed symbols; other localities in drainage sampled during August 2006 depicted by open symbols. Shaded box in inset corresponds to extent of larger map.

Appendix. Selected specimens of each species were photographed prior to preservation in the field. Contents of the digestive tract of subsamples of fish specimens were identified to the finest taxonomic level possible under a dissecting scope and enumerated. Standard length is abbreviated as SL.

RESULTS

On 28-29 August 2006 we collected 263 specimens (SL 17–30 mm) of Amur goby, *Rhinogobius lindbergi* Berg (Fig. 3) at two sites along the northeast shore of Lake Buyr (elevation 578 m) and at one site in the Halhin River (elevation 582 m) approximately 4 km upstream from its confluence with the lake (Fig. 1). At the same localities we also collected 12 specimens (SL 33–58 mm) of Chinese false gudgeon *Abbottina rivularis* Basilewsky (Fig. 4). Both represent first records for Mongolia.

Neither species was found at two additional sites on the Halhin River, approximately 100 and 120 km upstream from its mouth near the town of Halhgol, Mongolia, elevation 679–707 m, nor were they collected at several sites in the upper portion of the the Kerulen River (Fig. 2). Given their current abundance, and as the lake and its tributary streams have been thoroughly sampled in the past (Sokolov 1983, Dulmaa 1999), we do not feel that these species would have escaped notice in prior sampling efforts.

In the Halhin River, both *Rhinogobius lindbergi* and *Abbottina rivularis* were collected in near-shore habitats with silty substrates at depths of from 0.1-1.2 m. The main channel was composed almost entirely of shifting sand, and both species were notably absent from this habitat. In Lake Buyr, both species were most abundant along the wave-swept shoreline (depths < 0.5 m), and less abundant away from shore over open sand. The lake had a high concentration of *Spirulina* algae, which dramatically reduced water clarity. Other species collected in these efforts are listed in Table 1.

Examination of digestive tract contents of 20 Amur gobies revealed microhabitat-associated differences in food items; the predominant food item in 10 specimens from ANSP 185372 (a shallow, heavily vegetated cove of Lake Buyr) was ostracods (abundant), with much lesser numbers of chironomids (uncommon) and a single ephemopteran. In contrast, 3 of 10 specimens from ANSP 185223 (Halhin River,) had recently ingested small (~1 mm in diameter) fish eggs, likely from cyprinids. Other food items included chironomids (abundant), odonates (uncommon), and hymenopterans (uncommon).

Digestive tract contents of five *Abbottina rivularis* (ANSP 185398) were primarily (~80% of organic

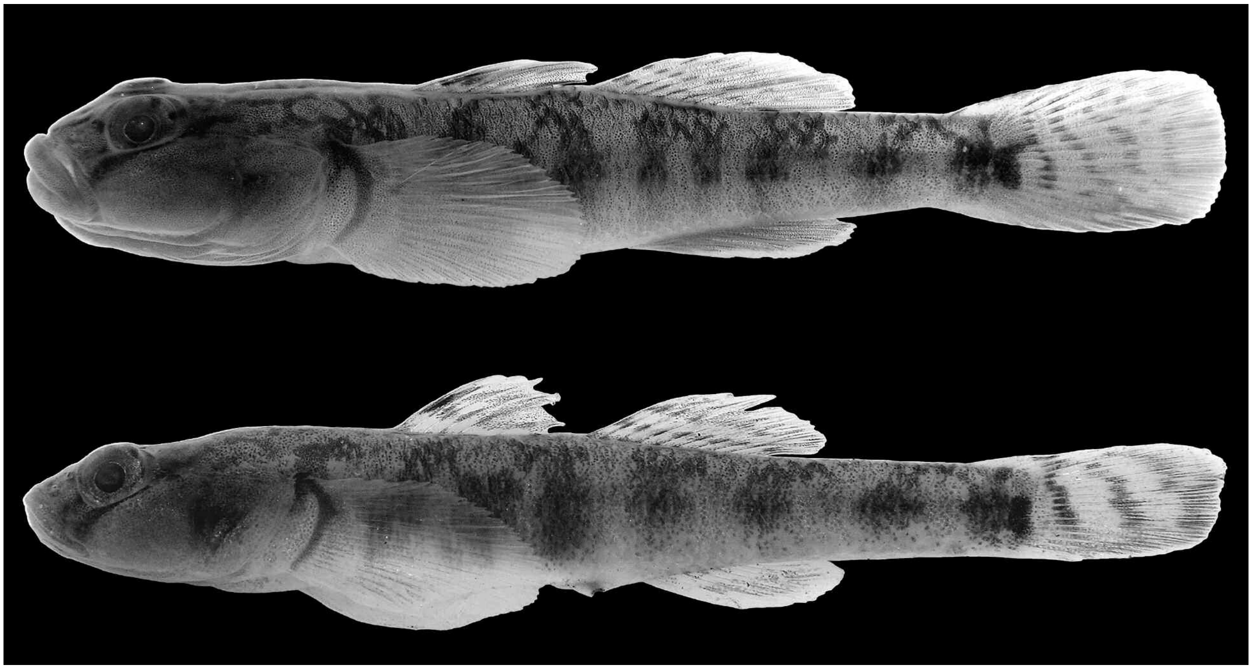

FIG. 3. **Rhinogobius lindbergi,** *ANSP 185223, 30 mm SL (top), 29 mm SL (bottom). See http://silurus.acnatsci.org/ACSI/field/Mongolia2006/ for color version of same photo of live specimens.*

matter) ostracods, with a large quantity of ingested sand grains (~50% by volume). Chironomids and terrestrial hymenopterans were uncommon (< 5%).

Food items observed in both taxa appeared to reflect the most common benthic invertebrates at each site. Given this, dietary overlap with other small-bodied benthic invertivores is expected to be substantial. We suggest that other benthic fishes in Lake Buyr and its tributaries (*Gobio cynocephalus* Dybowsky*, Microphysogobio anudarini* Holcik and Pivnicka, *Sarcocheilichthys soldatovi* (Berg), *Saurogobio dabryi* Bleeker) may be particularly impacted by competition with Amur goby and Chinese false gudgeon.

Length-frequency distribution of 227 specimens of *Rhinogobius lindbergi* (Fig. 5) suggests the presence of two year-classes. Gonads of larger specimens (> 23 mm SL) of both sexes of *Rhinogobius* were resorbing, suggesting that they had spawned earlier in the year. Some specimens as small as 23 mm SL displayed bright sexually dichromatic patterns, suggesting attainment of reproductive maturity during their first year. Sex ratio in 20 specimens was 11 males:9 females.

FIG. 4. **Abbottina rivularis,** *ANSP 185399, 49 mm SL. See http://silurus.acnatsci.org/ACSI/field/Mongolia2006/ for color version of same photo of live specimen.*

TABLE 1. Additional fish species collected at each locality supporting invasive species.

Location	Family	Scientific Name	Common Name
Halhin River	Cyprinidae	*Acheilognathus asmussii* (Dybowski)	Russian bitterling
		Cyprinus rubrofuscus Lacepède	Asian wild carp
		Gobio cynocephalus Dybowski	Siberian gudgeon
		Leuciscus waleckii (Dybowski)	Amur ide
		Pseudaspius leptocephalus (Pallas)	redfin
		Pseudorasbora parva (Temminck & Schlegel)	stone moroco or topmouth gudgeon
		Rhodeus sericeus (Pallas)	Amur bitterling
		Rhynchocypris lagowskii (Dybowski)	Amur minnow
	Cobitidae	*Cobitis melanoleuca* Nichols	none
	Salmonidae	*Brachymystax lenok* (Pallas)	lenok
Lake Buyr	Cyprinidae	*Acheilognathus asmussii*	Russian bitterling
		Carassius gibelio (Bloch)	crucian carp
		Cyprinus rubrofuscus	Asian wild carp
		Eupallasella percnurus	lake minnow
		Hemiculter leucisculus (Basilewsky)	sharpbelly
		Gnathopogon strigatus (Regan)	Manchurian gudgeon
		Gobio cynocephalus	Siberian gudgeon
		Gobio sp.	none
		Leuciscus waleckii	Amur ide
		Microphysogobio anudarini Holcik & Pivnicka	none
		Pseudaspius leptocephalus	redfin
		Pseudorasbora parva	stone moroco or topmouth gudgeon
		Rhodeus sericeus	Amur bitterling
		Rhynchocypris lagowskii	Amur minnow
	Cobitidae	*Cobitis melanoleuca*	none
		Misgurnus mohoity (Dybowski)	none
	Odontobutidae	*Perccottus glenii* Dybowski	Amur sleeper
	Siluridae	*Silurus asotus* (Linnaeus)	Amur catfish

The lower numbers of specimens of *Abbottina rivularis* preclude a detailed length-frequency comparison, but the size range of specimens suggests representation of more than a single year-class. Gonads in specimens > 40 mm SL were resorbing, suggesting spawning earlier in the summer.

DISCUSSION

The Amur River basin is a large, heterogeneous basin, and many fish species are restricted to different portions of the basin (Bogutskaya and Naseka 1996, Froufe *et al.* 2003, Kottelat 2006). The low-gradient middle and lower portion of the Amur River basin supports a very different fish fauna than does the upper portion or upland tributaries. Gradient of the mainstem Amur River within the native range of both *Abbottina rivularis* and *Rhinogobius lindbergi* ranges from 0.08–0.12 $m*km^{-1}$, while in upstream areas the gradient is higher, ranging from 0.22–0.3 $m*km^{-1}$. We suspect that this difference in gradient historically inhibited upstream dispersal of both species. Intra-basin transfer of fishes from one subbasin to another can contribute to homogenization of ichthyofaunas (Rahel 2000). Species transferred from different sub-basins are effectively non-indigenous, and can have the same catastrophic effects as species from external basins.

Rhinogobius spp. have been distributed widely outside of their native range, including the Middle East (Al-Hassan and Miller 1987, Coad and Abdoli 2000, Wonham *et al.* 2000), Central Asia (Kopylets and Dukravets 1981, Kamilov and Urchinov 1995, Salnikov 1998), Russia (Bogutskaya and Naseka 2002), as well as from portions of China to which it is not native (Yang 1996, Neely unpubl. data) and the Columbia River drainage of the western United States (Fuller *et al.* 1999.).

Rhinogobius lindbergi is native to the lower and middle portion of the Amur River (Berg 1965, Novomodny *et al.* 2004), and was previously known to extend upstream only to the vicinity of the mouth of the Bidzhan River, Russia (Fig. 1), approximately 1,060 km east and 1,800 river km

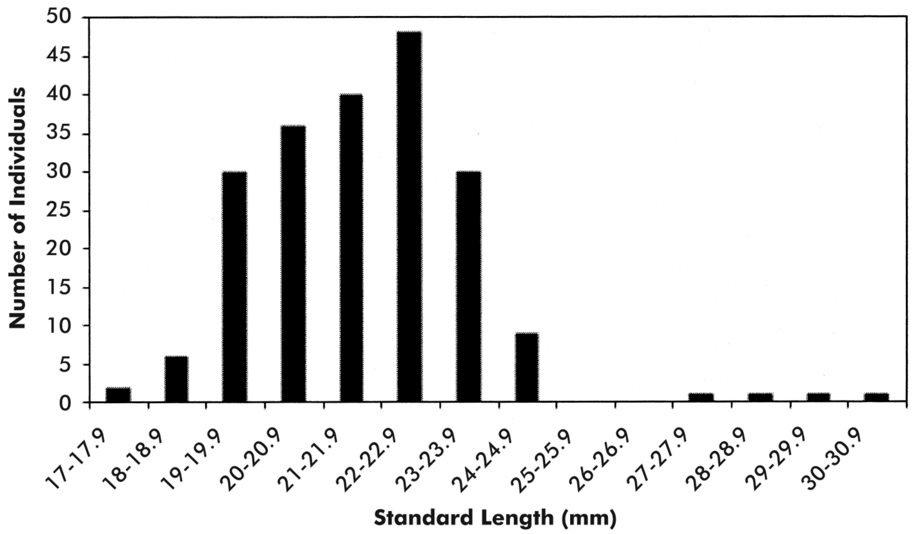

FIG. 5. Length-frequency distribution of **Rhinogobius lindbergi** *(N = 227) from the Lake Buyr drainage.*

downstream of Lake Buyr. *Abbottina rivularis* is native to portions of Korea, China, and Japan (Kim 1997, Masuda *et al.* 1984, Yue 1998), and reaches its northern natural limit in the middle and lower portions of the Amur River basin (Bogutskaya and Naseka 1996, Novomodny *et al.* 2004). It reaches a maximum size of about 95 mm SL (pers. obs. D.A. Neely).

Identification as part of the *Rhinogobius lindbergi* complex was verified by I.-S. Chen, Institute of Marine Biology and Life Sciences, Taiwan. They differ from nominal *R. lindbergi* by having 28 vertebrae (vs. 27 in *R. lindbergi*, pers. comm. I.-S. Chen, 2007). *Rhinogobius lindbergi* reaches a maximum size of 43 mm SL (Berg 1965).

Introduced gobies have decimated populations of small-bodied, native fishes in North America, Europe, Asia, and Australia through predation on eggs, larvae, and adults (Hoese 1973, Middleton 1982, Charlebois *et al.* 1997, Stepien and Tumeo 2006), and through competition for habitat (Brittan *et al.* 1970) or prey items (Jude *et al.* 1995, French and Jude 2001) or nest interference (Janssen and Jude 2001). While the small adult body size of *Rhinogobius lindbergi* might be expected to reduce the potential impacts of this introduction, this species can reach very high densities and could as a result have substantial effects on eggs or larval fishes of other species.

Abbottina rivularis has also been widely introduced outside of its native range, including Europe (Grabda and Heese 1991, Hanel and Novák 2002), Central Asia (Kamilov and Urchinov 1995, Salnikov 1998), Russia (Bogutskaya and Naseka 2002), Thailand (Vidthayanon and Kottelat 1995), and Laos (Kottelat 2001). In the Salween drainage of China and adjacent Myanmar, they are now one of the dominant, small-bodied benthic fishes in slow-moving pool habitats with sandy or silty substrates (Neely, unpubl. data). Following their introduction into Fuxian Lake, China, shifts in reproductive timing, growth rates, and fecundity of gobies were observed (Yan and Chen 2007), suggesting that the species is plastic and can rapidly adapt to local conditions. While this species has not yet been implicated in declines of native fishes, given its omnivorous diet and overall similarity to many of the endemic species of *Gobio* and *Microphysogobio*, the potential for negative impacts are considerable.

We hypothesize that the likely mechanism for introduction of the exotic fishes discussed herein is as contaminants in introductions of commercially-cultivated fishes. Records of large-bodied Chinese carps (*Ctenopharyngodon, Hypophthalmichthys*, and *Parabramis*) in Lake Buyr (Sokolov 1983, Kottelat 2006) are the result of stocking activities on the Chinese side of the lake. In both China and Russia, both *Abbottina rivularis* and *Rhinogobius* spp. have been introduced widely outside of their native range as contaminants in shipments of commercially valuable carps (*Ctenopharyngodon idellus* (Valenciennes), *Hypophthalmichthys nobilis* (Richardson), *Hypophthalmichthys molitrix* (Valenciennes), and *Mylopharyngodon piceus* (Richardson)) stocked for fishery enhancement (Yang 1996, Bogutskaya and Naseka 2002, Neely unpubl. data).

Aquatic biodiversity in eastern Asia is under severe threat from habitat destruction, overfishing, and translocations of non-indigenous fishes (Kottelat and Whitten 1996). Of these factors, non-indigenous fishes may be the most insidious. Whereas habitat may be restored, dams will eventually fail, and stocks can sometimes recover if harvest is reduced, there is usually no way to eliminate introduced populations of exotic fishes once established. While the ichthyofauna of Mongolia has recently been summarized (Kottelat 2006) and does not include a large number of invasive, non-indigenous fishes, our discovery suggests that the pandemic of translocations and invasions currently observed in China (Yang 1996) has spread across the border. The impact of these introduced species is unknown, but may pose a substantial threat to the several species of cyprinids endemic to the Lake Buyr drainage.

We recommend that immediate measures be taken to reduce the risk of spread of these species into other water bodies in Mongolia, perhaps including educational programs or a ban on transfer of live fishes between watersheds in Mongolia. While we did not find *Rhinogobius* or *Abbottina* at any sites sampled in the Kerulen River, which drains into Lake Hulun in China and which might be expected to eventually serve as a dispersal corridor for these species, we did not sample near the border with China. Further surveys of this portion of the drainage are needed, both to monitor dispersal of these invasive species and adequately inventory the native fauna of the upper Amur River drainage.

ACKNOWLEDGMENTS

We thank Odsuren Batdelger, Senjim Bazarsad, Badarch Khasbaatar, Maria Cristina Pérez, and Oyunchuluun Yadamsuren for assistance in the field. Ulambayar Tsedendamba and Dulamdorj Sanjaajamts provided logistical support and vodka. Our survey of fishes of the Amur basin was supported by the Academy of Natural Sciences, Philadelphia, and by funding through US NSF to the All Catfish Species Inventory (ACSI), DEB 0315963, and the Cypriniformes Tree of Life (CToL) project, EF 0431326. D. Jude and an anonymous reviewer provided helpful comments that substantially improved the manuscript.

REFERENCES

Al-Hassan, L.A.J., and Miller, P.J. 1987. *Rhinogobius brunneus* (Gobiidae) in the Arabian Gulf. *Jpn. J. Ichthyol.* 33:405–408.

Berg, L.S. 1965. *Freshwater fishes of the U.S.S.R. and adjacent countries. Vol. III, 4th ed.* Israel Program for Scientific Translations Ltd., Jerusalem.

Bogutskaya, N.G., and Naseka, A.M. 1996. *Cyclostomata and fishes of Khanka Lake drainage area (Amur River basin): an annotated check-list with comments on taxonomy and zoogeography of the region.* St. Petersburg.

______, and Naseka, A.M. 2002. An overview of non-indigenous fishes in inland waters of Russia. *Proc. Zool. Inst. Russ. Acad. Sci.* 296:21–30.

Brittan, M.R., Hopkirk, J.D., Conners, J.D. and Martin, M. 1970. Explosive spread of the oriental goby *Acanthogobius flavimanus* in the San Francisco Bay-Delta region of California. *Proc. Calif. Acad. Sci.* 38:207–214.

Charlebois, P.M., Marsden, J.E., Goettel, R.G., Wolfe, R.K., Jude, D.J., and Rudnicka. S. 1997. *The round goby* Neogobius melanostomus *(Pallas): a review of European and North American literature*. Illinois Natural History Survey Special Publication No. 20. Illinois Natural History Survey and Illinois-Indiana Sea Grant College Program.

Clout, M.N. 2005. Biodiversity loss caused by invasive alien vertebrates. *Z. Jagdwiss.* 48:51–58.

Coad, B.W., and Abdoli, A. 2000. *Rhinogobius* cf. *similis* Gill, 1859, a goby new to the fish fauna of Iran and the problem of alien invasions. *Zool. Middle East* 20:55–59.

Dulmaa, A., 1999. Fish and fisheries in Mongolia. In *Fish and fisheries at higher altitudes: Asia*, T. Petr, ed., pp. 187–236. FAO Fish. Tech. Pap. No. 385. FAO, Rome.

French, J.R.P., and Jude, J.D. 2001. Diets and diet overlap of nonindigenous gobies and small benthic native fishes co-inhabiting the St. Clair River, Michigan. *J. Great Lakes Res.* 27:300–311

Froufe, E., Knizhin, I., Koskinen, M.T., Primmer, C.R., and Weiss, S. 2003. Identification of reproductively isolated lineages of Amur grayling (*Thymallus grubii* Dybowski 1869): concordance between phenotypic and genetic variation. *Mol. Ecol.* 12(9): 2345–2355

Fuller, P.M., Nico, L.G., and Williams, J.D. 1999. *Non-indigenous Fishes Introduced into Inland Waters of the United States*. Special Publication 27, Am. Fisheries Soc., Bethesda, MD.

Grabda, E., and Heese, T. 1991 *Polskie nazewnictwo popularne kraglouste i ryby. Cyclostomata et Pisces.* Wyzsza Szkola Inzynierska w Koszalinie. Koszalin, Poland.

Hanel, L., and Novák, J. 2002. *Ceské názvy zivocichu V. Ryby a ryboviti obratlovci (Pisces) 3. maloústí*

(Gonorhynchiformes)—máloostní (Cypriniformes). Národní muzeum (zoologické oddelení), Praha.

Hoese, D.F. 1973. The introduction of the gobiid fishes *Acanthogobius flavimanus* and *Tridentiger trigonocephalus* into Australia. *Kookewong* 2:3–5.

Janssen, J., and Jude, D.J. 2001. Recruitment failure of mottled sculpin *Cottus bairdi* in Calumet Harbor, southern Lake Michigan, induced by the newly introduced round goby, *Neogobius melanostomus*. *J. Great Lakes Res*. 27:3 19–328.

Jude, D.J., Janssen, J., and Crawford, G. 1995. Ecology, distribution, and impact of the newly introduced round and tubenose gobies on the biota of the St. Clair and Detroit rivers. In *The Lake Huron ecosystem: ecology, fisheries, and management,* M. Munawar, T. Edsall, and J. Leach., eds., pp. 447–460. Ecovision World Monograph Series, S. P. B. Academic Publishing, The Netherlands.

Kamilov, G., and Urchinov, Zh.U. 1995. Fish and fisheries in Uzbekistan under the impact of irrigated agriculture. In *Inland fisheries under the impact of irrigated agriculture: Central Asia*. T. Petr, ed., pp. 10–41. FAO Fisheries Circular No. 894.

Kim, I.S. 1997 Illustrated encyclopedia of fauna and flora of Korea. Vol. 37. *Freshwater fishes*. Ministry of Education, Seoul.

Kopylets, S.K., and Dukravets, G.M. 1981. Morphological and biological characteristics of the goby *Rhinogobius similis* Gill, an adventitious species from the Ili River. *Vop. Ikhtiologii*, 21:600–607.

Kottelat, M., 2001 *Fishes of Laos*. WHT Publications Ltd., Colombo 5, Sri Lanka.

______. 2006. *Fishes of Mongolia: A check-list of the fishes known to occur in Mongolia with comments on systematics and nomenclature*. The World Bank, Washington, D.C.

______, and Whitten, T. 1996. *Freshwater biodiversity in Asia, with special reference to fish.* World Bank Tech. Pap. 343.

Masuda, H., Amaoka, K., Araga, C., Uyeno, T., and Yoshino, T., eds. 1984. *The fishes of the Japanese Archipelago.* Tokai University Press.

Middleton, M.J. 1982. The Oriental Goby, *Acanthogobius flavimanus* (Temminck and Schlegel), an introduced fish in the coastal waters of New South Wales, Australia. *J. Fish Biol.* 21:513–523.

Mooney, H.A., and Cleland, E.E. 2001. The evolutionary impact of invasive species. *Proc. Natl. Acad. Sci. USA*. 98:5446–5451.

Novomodny, G., Sharov, P., and Zolotukhin, S. 2004. *Amur fish: wealth and crisis.* WWF, Vladivostok, Russia.

Rahel, F.J. 2000. Homogenization of fish faunas across the United States. *Science* 288:854–856.

Ricciardi, H., and MacIsaac, H.J. 2000. Recent mass invasion of the North American Great Lakes by Ponto-Caspian species. *Trends Ecol. Evol.* 15:62–65.

Salnikov, V.B. 1998. Anthropogenic migration of fish in Turkmenistan. *J. Ichthyol.* 38:591–602.

Sheldon, A.L. 1988. Conservation of stream fishes: patterns of diversity, rarity, and risk. *Cons. Biol.* 2:149–156.

Sokolov, V.E. (ed.) 1983. *The fishes of the Mongolian People's Republic*. Nauk, Moskva.

Stepien, C.A., and Tumeo, M.A. 2006. Invasion genetics of Ponto-Caspian gobies in the Great Lakes: a 'cryptic' species, absence of founder effects, and comparative risk analysis. *Biol. Invas.* 8:61–78.

Vidthayanon, C., and Kottelat, M. 1995. First record of *Abbotina rivularis* (Cyprinidae: Gobioninae) from the Mekong Basin. *Jpn. J. Ichthyol*. 41:463–465.

Witte, F., Goldschmidt, T.T., Wanink, J., Vanoijen, M., Goudswaard, K., Wittemaas, E., and Bouton, N. 1992. The destruction of an endemic species flock-quantitative data on the decline of the Haplochromine cichlids of Lake Victoria. *Env. Biol. Fish.* 34:1–28.

Wonham, M.J., Carlton, J.T., Ruiz, G.M., and Smith, L.D. 2000. Fishing and ships: relating dispersal frequency to success in biological invasions. *Mar. Biol.* 136: 1111–1121.

Yan, Y.Z., and Chen, Y.F. 2007. Changes in the life history of *Abbottina rivularis* in Lake Fuxian. *Journal of Fish Biology* 70(3):959–964.

Yang, J.X. 1996. The alien and indigenous fishes of Yunnan: a study on impact ways, degrees and relevant issues. In *Conserving China's Biodiversity (II),* J.S. Peter, S. Wang, and Y. Xie, eds., pp. 157–168. China Environmental Science Press. Beijing.

Yue, P. 1998. Gobioninae. In *Fauna Sinica. Osteichthyes. Cypriniformes II*. Y.Y. Chen, et al., eds., pp. 232–389. Science Press. Beijing.

Submitted: 7 February 2007
Accepted: 15 February 2008
Editorial handling: John Janssen

APPENDIX

Materials Examined: *Rhinogobius lindbergi*. ANSP 185223 (n = 55), Halhin River ca. 2 km upstream from mouth at Lake Buyr, elev. 582 m, 47°55′32″N, 117°51′03″E. ANSP 185373 (n = 114), northeast shore of Lake Buyr, south of mouth of Halhin River, elev. 578 m, 47°51′43″N, 117°53′13″E. ANSP 185372 (n = 64), shallow cove of Lake Buyr near mouth of Halhin River, elev. 578 m 47°54′16″N, 117°51′48″E. *Abbottina rivularis*. STL uncat. (n = 2, orig. pres. in 95% EtOH), Halhin River, ca. 2 km upstream from mouth at Lake Buyr, elev. 582 m, 47°55′32″N, 117°51′03″E. ANSP 185399 (n = 2), northeast shore of Lake Buyr, south of mouth of Halhin River, elev. 578 m, 47°51′43″N, 117°53′13″E. ANSP 185398 (n = 6), shallow cove of Lake Buyr near mouth of Halhin River, elev. 578 m 47°54′16″N, 117°51′48″E.