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Short communication

Clearhead icefish, (*Protosalanx hyalocranius* Abbott, 1901) (Salmoniformes, Salangidae), a new non-native species has established a population in the Amur River, China

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Introduction

The clearhead icefish (*Protosalanx hyalocranius* Abbott, 1901) is a cold-water pelagic Salangid native to the East China Sea, Yellow Sea, and Bohai Sea, as well as to their tributaries and adjacent rivers and lakes in eastern Asia and Vietnam (Xie and Xie, 1997). *P. hyalocranius* exhibited a typically hierarchical growth (Zhu, 1985; Nguyen and Nguyen, 1994). Early juveniles feed primarily on zooplankton, and some larger individuals transition to a diet of fish and shrimp in late juvenile and adult stages (Tang et al., 2013a). Reaching a maximum size of 225 mm standard length, *P. hyalocranius* has a lifespan of approximately 1 year (Tang et al., 2012). The clearhead icefish exhibits a semelparous reproductive strategy, with spawning primarily taking place during January (Xie et al., 2001).

The high value of this species has resulted in widespread introductions into many reservoirs and lakes, including the brackish waters of northern inland China (Xie, 1996). In some areas the clearhead icefish is firmly established and has become the dominant species, leading to declines in native aquatic species populations (Wang et al., 2009). The Amur River, located in the high latitudes of northeastern Asia, ranks ninth in longest rivers of the world. China and Russia are separated by the mainstem Ussuri River and its tributary (Fig. 1). Introductions into reservoirs and lakes in the Amur River basin began approximately two decades ago. The first reported introduction of the clearhead icefish was in the brackish Nashidai Pool of Lianhuan Lake in 1995 (Kong, 1997) (Fig. 1). In 1997, rapidly developing populations of clearhead icefish were noted in Wengquan Reservoir (Kong et al., 2007) (Fig. 1). Subsequently, established populations of clearhead icefish were discovered (Fig. 1) in Lianhua Lake (Guan and Fu, 2002), Maoxing Lake (Kong et al., 2007), the Erlongshan Reservoir (Sun and Ben, 2007), and Khanka (Xingkai) Lake (Xun et al., 2009; Svirsky and Barabanshchikov, 2010; Tang et al., 2011, 2012). The recent discovery of clearhead icefish in the Songhua River has led to speculation that it had spread to the mainstem of the Amur River (Tang et al., 2013b). However, prior to this report, there has been no evidence documenting the clearhead icefish anywhere in the Amur River.

Materials and methods

On 15–17 October 2013 and 17–18 January 2014, two alien clearhead icefish, *Protosalanx hyalocranius,* inventories were conducted in the middle reach of the Amur River mainstem, Fuyuan County, China. Gill nets measuring 30 m long × 1.5 m deep, with a 1.5 cm mesh size (distance between opposite knots) were secured in shallow water over a sandy substrate within close proximity to the riverbank (134°7′35″E; 48°17′39″N) (Fig. 1). Upon collection, specimens were determined as to sex and maturation stage and measured for standard length (to the nearest 0.1 cm, *SL*) and weighed (to the nearest 0.1 g, *W*), and the condition factor then calculated for each fish as $K = 100WSL^{-3}$.

Results

Fifty specimens of clearhead icefish, including 20 females and 30 males, were captured between 15 and 17 October 2013, the second sexual characteristics exhibited in all males and all female gonads had developed to stage IV or III. Six specimens including one female and five males were captured under the ice cover 17–18 January 2014, the female had spawned before the catch, which indicated that the sampling area is a new spawning ground of clearhead icefish. The length and weight distribution, as well as the condition factor of *P. hyalocranius* captured in the two sampling are shown in Table 1.

Discussion

This report provides evidence that the non-native clearhead icefish has established in the mainstem of the Amur River, well beyond the northernmost point of its previously known range. Tang et al. (2013b) first noted the occurrence of clearhead icefish in the upper Dadingzishan Dam, Songhua River,

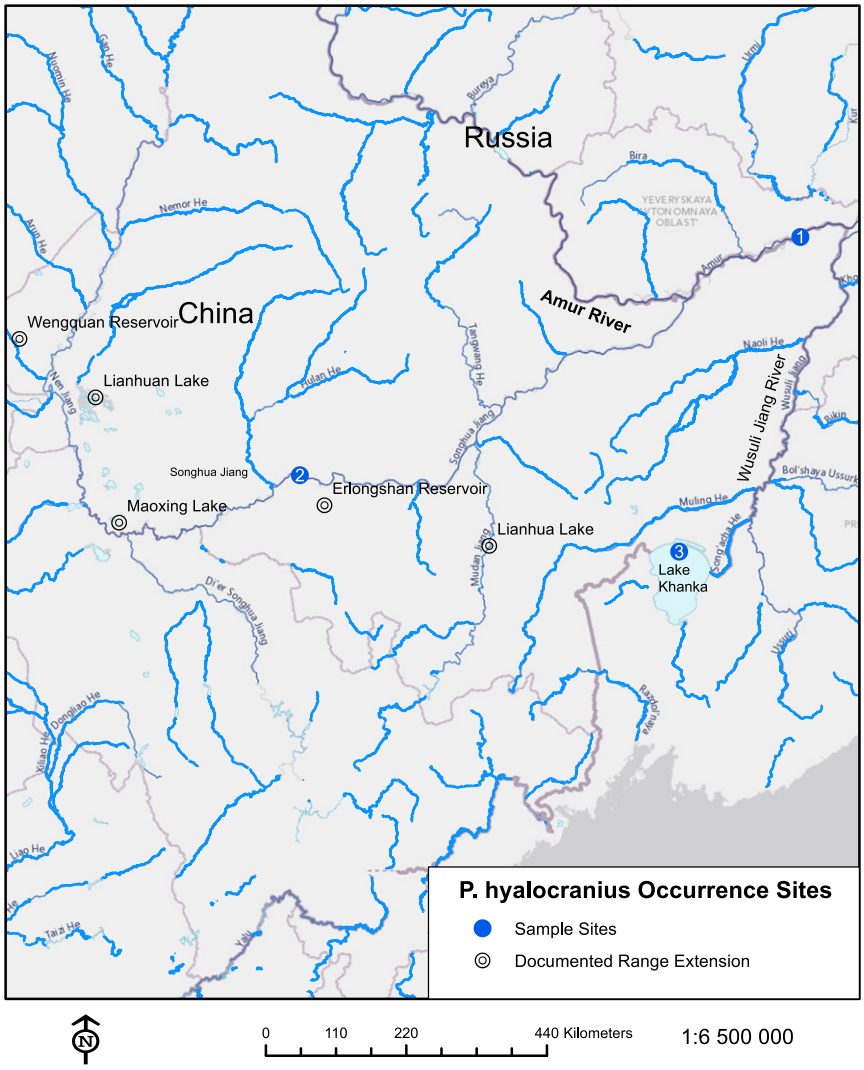

Fig. 1. Sites of introduced clearhead icefish, *P. hyalocranius,* and occurrence in Amur River system. (1) Sampling site, Fuyuan County, China, and the likely source of this sampled population; (2) Site of first record of clearhead icefish in the Songhua River, upper Dadingzishan Dam, Harbin section of Lake Khanka, located in the upper reaches of the Ussuri River, where a large population of *P. hyalocranius* has become established (Tang et al., 2013a,b); (3) Other sites: documented introductions (Xun et al., 2009; Svirsky and Barabanshchikov, 2010; Tang et al., 2011)

Table 1
Distribution of length, weight, and condition factor of sampled *P. hyalocranius*, Amur River

		SL (cm)		*W*			
Sampling dates	Sex	Range	Mean ± SD	Range	Mean ± SD	*K*	*N*
15–17	Female	10.2–14.2	12.84 ± 1.08	2.8–14.2	8.47 ± 2.88	0.39 ± 0.08	20
October 2013	Male	10.7–15.1	12.92 ± 0.93	4.8–15.7	9.09 ± 2.51	0.41 ± 0.05	30
17–18	Female	14.2		9.1		0.32	1
January 2014	Male	11.0–14.9	12.92 ± 1.48	6.2–11.8	8.56 ± 2.09	0.40 ± 0.06	5

which is a tributary of the Amur River (Fig. 1(2)). Although this is the most likely source, it is unknown whether the Amur River population (Fig. 1(1)) has spread from the Songhua River, Khanka Lake (Fig. 1(3)), or from other infested waters. Regardless of the source or direction of spread, there is great concern regarding the potential negative impacts that the invasive clearhead icefish may have on native species, such as the rapid decline of the sawbelly *Hemiculter leucisculus* (Basilewsky 1855), thought to have been caused by the introduction of clearhead icefish into the Erlongshan Reservoir (Tang et al., 2013a). As an 'ecological generalist', the clearhead icefish is able to persist in a variety of habitats, and is considered an invasive species that threatens more specialized endemic populations (Baxter, 1977). For example, the clearhead icefish naturally occurs in fresh, brackish and coastal waters, and both freshwater resident and diadromous forms exist naturally, which make this fish characterized by its adaptability to environments of different

salinities. Because of this ability, the clearhead icefish has the great potential to spread to the estuaries of the Amur River and Tartar Strait, and possibly to the Sea of Okhotsk through the lower reaches of the Amur River located within Russia. Therefore, ongoing inventory and monitoring assessments should be conducted within its current and predicted ranges. It is imperative that future research identifies the potential pathways for range extension, and begins to address effective methods for removal of this invasive species from its non-native range. Additionally, since evidence now exists that the clearhead icefish is established in the Amur River basin, ecological monitoring should be conducted in this region in order to understand the potential impacts on endemic species that are affected by its presence.

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