Neotropical Biology and Conservation
10(3):177-181, september-december 2015
Unisinos - doi: 10.4013/nbc.2015.103.08

SHORT COMMUNICATION

Establishment of non-native predator (Pisces, Erythrinidae) in a tributary of the Upper Paraná River basin, south Brazil

Estabelecimento de predador não nativo (Pisces, Erythrinidae) em tributário da bacia do Alto rio Paraná, sul do Brasil

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Abstract

Erythrinus erythrinus is an erythrinid native from the basins of the Amazon, Orinoco, coastal rivers of the Guyana and Lower Paraná, but allochthonous of Tibagi River region, Paranapanema basin. In the present work, we report the occurrence of *E. erythrinus* in Água dos Tigres and Taquari rivers, in the Paranapanema basin, and aim to verify the occurrence of constancy and the condition of health of its specimens in sub-tributaries of the Lower Paranapanema River. The catch-per-unit-effort of the Água dos Tigres River mouth was about three times higher than the site upstream of the same river, and the Taquari River presented the lowest value. The species presented constancy of catches in tributaries of the basin, where isometric growth and good health condition of the specimens were observed. Its introduction into the Tibagi River basin may have occurred due to an intentional release as remaining live bait discarded in commercial fishery operations or may have dispersed after the flood of the Sete Quedas Falls. The presence of juveniles along with adults indicates that the species is undergoing an establishment stage of the invasion process in the region.

Keywords: Tibagi River, biological invasion, fishes, diversity loss.

Resumo

Erythrinus erythrinus é um erythrinídeo nativo das bacias do Amazonas, Orinoco, rios costeiros da Guiana e Baixo Paraná, mas alóctone da região do rio Tibagi, bacia do Paranapanema. No presente trabalho, registra-se a ocorrência da espécie nos rios Água dos Tigres e Taquari, na bacia do Paranapanema, e objetiva-se verificar a constância de captura e condições de saúde dos espécimes em subafluentes do baixo rio Paranapanema. A captura por unidade de esforço da foz do rio Água dos Tigres foi cerca de três vezes maior do que a montante do mesmo rio, e o rio Taquari apresentou o menor valor. A espécie apresentou constância de captura nos tributários da bacia, onde constatou-se crescimento isométrico e boa condição de saúde dos espécimes. Sua introdução na bacia do rio Tibagi pode ter ocorrido devido a solturas intencionais de remanescentes de iscas vivas em pescarias comerciais, ou pode ter se dispersado após a inundação dos Saltos de Sete Quedas. A presença de juvenis junto aos adultos indica que a espécie encontra-se em estabelecimento na região.

Palavras-chave: Rio Tibagi, invasão biológica, peixes, perda de diversidade.

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The biological invasion by fishes is a process associated with dam constructions, water transpositions, trade and international traffic, promoting changes in biological diversity, a common event in countries with more intense trade activities (Xu *et al.,* 2012). The translocation of fishes outside their original areas can promote biotic homogenization and, thus, put the native diversity at risk by changing ecosystem processes (Roques, 2012; Vitule and Pozenato, 2012).

In Brazil, introductions of fishes are common practices and, as a result of economic interest, population growth and leisure, such events have been occurring more frequently (Agostinho *et al.,* 2007). For example, introductions of the African catfish, *Clarias gariepinu*s (Burchel, 1822), and of the channel catfish*, Ictalurus punctatus* (Rafinesque, 1818), occurred to attend economic and fishery interests. As these fish are predators and drought-resistant, they entail considerable environmental impacts (Vitule *et al*., 2006; Zanatta *et al.,* 2010; Vitule and Pozenato, 2012).

Among the causes of translocations of allochthonous fish in northern Paraná State is the flooding of the Sete Quedas Falls, geographical barrier after the construction of the Itaipu Dam on the Paraná River (Júlio Jr. *et al.,* 2009); escapes from fish farms (Orsi and Agostinho, 1999); releases for sport fishing (Orsi and Britton, 2012), and releases of aquarium fish (Garcia *et al.,* 2014a). Furthermore, the release of remaining live baits at the end of the amateur and sport fishing seasons (Orsi and Britton, 2014) contributed to the translocations of species in the environment.

The predator *Erythrinus erythrinus* (Bloch & Schneider 1801) (common name: Jejú) occurs naturally in the basins of the Amazon and Orinoco, coastal rivers of the Guyana (Oyakawa, 2003), and in the Lower Paraná River basin (Britski *et al.,* 2007; Júlio Jr. *et al*., 2009). Despite already registered to another region of the Upper Paraná River (Langeani *et al.*, 2007), this is the first record of this species considered allochthonous in the Tibagi River, Paranapanema River basin. In its original distribution area, this species is found in different habitats, especially among the vegetation of shallow stretches of lentic environments, where it builds its nests in association with the vegetation substrate (Oyakawa and Mattox, 2009). It shows facultative air-breathing and high adaptability to environmental changes (Brosset, 1997; Jucá-Chagas, 2004).

Given the processes of biological invasion in freshwater ecosystems, the present work aimed at verifying the occurrence of constancy and the condition of health of its specimens in sub-tributaries of the Lower Paranapanema River, to test the hypothesis that this species is undergoing an establishment stage of the introduction process in that basin.

Captures were done seasonally between August 2011 and October 2012, in the Água dos Tigres and Taquari rivers, located in the lower portion of the Tibagi River basin. In the Água dos Tigres River, captures occurred at two locations: upstream (22º59'48.8"S, 50º58'43.8"W) and at the river mouth (22º59'02.9"S, 50º58'40.8"W). In the Taquari River, captures were accomplished only at the river mouth (23º11'03.6"S, 50º56'48.5"W) (Figure 1).

The specimens were captured with the use of seines and sieves with meshes of 0.5cm between adjacent knots. The specimens were anesthetized and euthanized in water saturated with clove oil, measured (standard length, SL, in centimeters) and weighed (weight total, WT, in grams), fixed in 10% formalin and deposited in the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL 5743). Individuals having one-third of the maximum total length reached by the species (20 cm) (Graça and Pavanelli, 2007; Orsi, 2010) were considered to be juveniles. The UEL Ethics Committee for Animal Use authorized the sampling collections (CEUA Nº. 21149.2012.53).

The capture constancy was obtained only for Água dos Tigres River, using the formula C = p.100/P, where C = constancy of species; p = number of samplings containing the species; P = total number of collections.

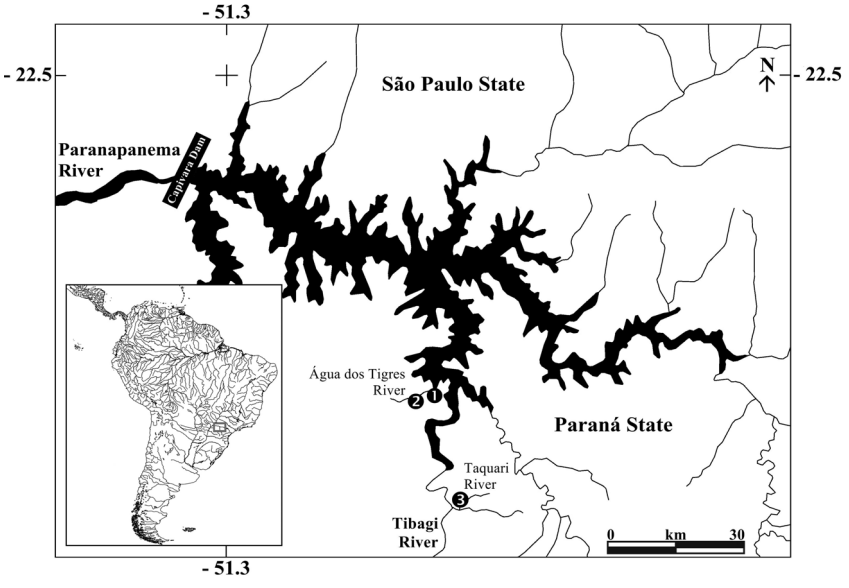

Figure 1. Location of the sampling points in the Lower Tibagi River region, Paranapanema River basin, south Brazil. 1 = Mouth of the Água dos Tigres River; 2 = Upstream from the Água dos Tigres River; 3 = Taquari River.

A given species is considered constant in the environment when it is present in over 50% of the samplings (Dajoz, 1978). The total sampling effort for this river was 11 collections.

The relative abundance of the species was estimated by the catch-per-unit-effort for the two rivers (CPUE = N*10/Effort), expressed by the number of individuals captured (N) in one hour/4.0 m^2 of collection equipment.

The weight-length relationship was calculated using $WT = a.SL^b$ (Le Cren, 1951), where *a* is the linear regression coefficient and *b* the angular regression coefficient of log transformed weight and length. The physiological state of a fish is conditioned by the interaction of biotic and abiotic factors. Variations of this state can be expressed by the condition factor (K), which indicates the recent food conditions and varies according to the sexual maturity cycle. Its value reflects the nutritional status or the energy expended in cyclical activities, or both, and can be related to the environmental conditions and behavioral aspects of the species (Vazzoler, 1996). Its calculation is dependent on fish weight and length (Verani *et al.,* 1997). Conversely, the relative condition factor (Kn) compares the measured value (WT) to the theoretically expected value (WE) for each length, and to the central value of Kn = 1.0 (Anderson and Neumann, 1996), indicating the healthiness of the population. After calculation of the Kn values, the estimation of the mean value was accomplished, and statistically compared to the central value of Kn = 1.0, by the Student's *t* test. This analysis involved 25 specimens of *E. erythrinus* (Figure 2).

We recorded the occurrence of *E. erythrinus* in both Água dos Tigres and Taquari rivers. Seventeen specimens were caught at the mouth of the Água dos Tigres River and five of them were juveniles, whereas six specimens were captured upstream (five adults and one juvenile). In the Taquari River, only two adult specimens were captured. The individuals of *E. erythrinus* were captured in eight of the 11 collections accomplished in the Água dos Tigres River. Thus, the capture constancy value was equal to 72.7%, i.e., *E. erythrinus* was considered constant in the analyzed region. The CPUE of the Água dos Tigres River mouth was about three times higher than the CPUE on the site upstream of the same river (42.5 and 15.0, respectively). The Taquari River presented the lowest value (CPUE = 5.0). The confluence of the Água dos Tigres and Tibagi Rivers is a popular place for sports and commercial fishermen. The occurrence of *E. erythrinus,* most frequently near the convergence of these two rivers, suggests that the species may have been introduced when used as live baits. This area shows lentic characteristics, since it receives the influence of the Escola Engenharia Mackenzie hydroelectric power plant reservoir (Capivara Dam) (Figure 1). The constant presence of dense grass near the river mouth is another environmental characteristic used by adults to build their nests (Suzuki *et al.,* 2004) and increase the chances for the survival of their offspring. Thus, environment disruptions may facilitate the recruitment and establishment of *E. erythrinus*. Furthermore, disturbances in the local community may promote and facilitate invasions of these and other species (Roy *et al.,* 2013). The current conditions can allow the dispersal of the species to other tributaries and sub-tributaries in the Tibagi River basin, as evidenced by the presence of specimens in the Taquari River.

The presence of juveniles together with adults of *E. erythrinus* indicates that there has been a recruitment of the species in the region (Suzuki *et al.,* 2004; Leal *et al.,* 2010). It also constitutes evidence that the species is in an establishment stage (Coulatti and MacIsaac, 2004; Blackburn *et al*., 2011). Its presence also indicates that this new environment has favorable characteristics for the development and maintenance of a viable population. Thus, the species would be fulfilling the establishment stage that follows the invasion process (Lockwood *et al*., 2007).

The analysis of the weight-length relationship provided the values of the linear coefficients (*a*) = 0.036 and the angular coefficient (*b*) = 2.928, indicative of isometric growth (Figure 3A). The mean relative condition factor obtained (with its respective standard error) was equal to 1.00 ± 0.09 (min. – max. = 0.83 – 1.24) and presented no difference when compared to the central value of Kn = 1.0 (p = 0.87). Thus, the fish had an average body weight equal to the theoretically expected (Figure 3B), indicating that the fish was in good health condition. The weight-length relationship and the relative condition factor (Kn) of introduced species suffer the influence of environmental characteristics, population size, and intra and inter-specific interactions (Le Cren, 1951; Gomiero and Braga, 2003). Thus, the survival of the species in a new area depends

Figure 2. *Erythrinus erythrinus* (MZUEL 5743) captured in the Água dos Tigres River, Lower Tibagi River region, Paranapanema River basin, south Brazil. Total length = 11 cm, Standard length = 7.2 cm.

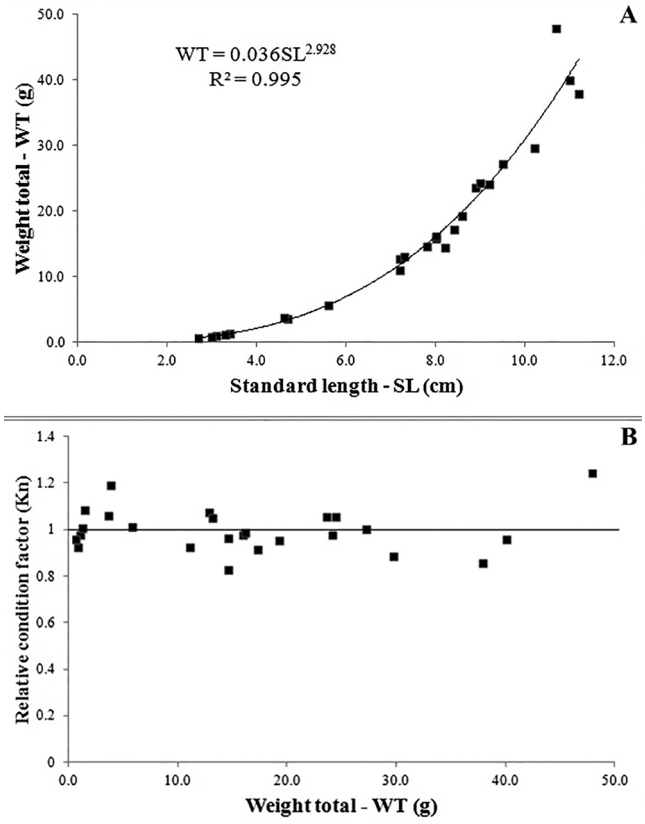

Figure 3. Weight (g)-length (cm) relationship curve for *Erythrinus erythrinus* (A) and variation of the relative condition factor (Kn), compared to the central value (Kn = 1.0) in relation to the total weight of the species (B) in the Lower Tibagi River region, Paranapanema River basin, south Brazil.

on its adaptability, which influences the reproductive and food events (Gomiero *et al*., 2010). The *E. erythrinus* specimens showed isometric growth (i.e., their body length increments were similar to their increases in body weight) and good health condition (Kn = 1.0), suggesting their adaptation to local circumstances (Garcia *et al.,* 2014b). This compliance with new environmental demands demonstrates the type of adjustability to new environments and hence success in the establishment (Vitule and Prodocimo, 2012).

The competition for food resources or locations for spawning seems to be one of the most conspicuous ways whereby invasive species can displace native species, influence the decrease of the native recruitment and, over time, of cause the decimation of the native community (Agostinho and Júlio Jr., 1996; Orsi, 2010). The consequences of *E. erythrinus* invasion are unknown. Although being small-sized, this species is considered a voracious predator that can compete for food and physical resources with the native species, including *Hoplias malabaricus* (Bloch, 1794), which also belongs to the Erythrinidae.

There was a decrease diversity and abundance of native fish in the Capivara Power Plant Reservoir after the introduction of eleven species. Among those are the piscivorous species *Plagioscion squamosissimus* (Heckel, 1840), *Astronotus crassipinnis* (Heckel, 1840) and *Cichla monoculus* Spix, 1831 (Orsi and Britton, 2014). Thus, the introduction of *E. erythrinus* can increase the ecological imbalance of the region already affected by fish invaders.

The success of the invasion depends on the ecological environment resistance and propagule pressure, such as the amount and type of life strategies of the introduced species (Holle and Simberloff, 2005). The influence of the reservoir on the sampled area (environmental damage) and the possibility of releases of live baits by fishermen (propagule pressure) are real. Therefore, the control and supervision of non-native species marketed and used as live baits are imperative. Furthermore, the eradication of introduced species in aquatic environments becomes impossible after their establishment (Gozlan *et al.,* 2010), especially in large reservoirs. Actions to raise awareness of the riverine populations, fish farmers and fishermen are necessary in order to prevent greater dispersals and the consequences of new introductions and translocations in natural aquatic ecosystems. New surveys should be conducted over a longer period in order to continue monitoring the situation of this species in this new place of occurrence.

Acknowledgments

We wish to thank Aparecido de Souza and Edson Santana for their technical support, and Alexandro Costa for his help with the field samplings; to Ana Maria Leal-Zanchet and anonymous referees for critical review.

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Submitted on January 15, 2015
Accepted on August 31, 2015