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SHORT COMMUNICATION

Opportunistic alien catfish: unexpected findings in the diet of the alien species *Ictalurus punctatus* in Central Italy

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Abstract. Alien fish species are known for the negative impacts they can have on native species and their ability to shape recipient communities. One such case is the North American channel catfish, *Ictalurus punctatus* (Raf.), in the Arno River in central Italy. During river bank reconstruction, specimens of this species (n=40) were collected, and the stomach content was analysed. As a result, we highlight the opportunistic feeding behavior of this alien species that is responding rapidly to newly available resources and also poses a threat to native species.

Keywords: *Ictalurus punctatus,* feeding, opportunistic, impact

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Introduction

Dietary analyses of invasive species is a common technique employed by biologists examining invasions, and such analyses have revealed much information about the biology and associated impact of invasive alien species (Kolar and Lodge 2002, Feyrer et al. 2003). Opportunistic fish species are known especially for their generally plastic diet and adaptability (Tyus and Nikirk1990, García-Berthou 2002, Copp et al. 2009), and they often exhibit high variability among populations, years, and even seasons (Panek and Weis 2013, Purdom et al. 2015).

By nature, catfish are known to be opportunistic scavengers (Andrews et al. 1977, Tucker and Hargreaves 2004). In the Arno River in Florence, Italy, the abundant alien North American Channel catfish, *Ictalurus punctatus* (Raf.), has become a highly abundant species in biomass and number (Nocita 2007). In its native habitat, this catfish has been observed exhibiting seasonally variable, generally opportunistic predation (Busbee 1969, Ploeg and Tucker 1994), but information about it in Italy is rare or only anecdotal (Ligas 2007, Haubrock et al. 2017, 2018). In a highly anthropogenically affected ecosystem like the Arno River, alien aquatic species dominate in number and biomass (Nocita and Lenuzza 2016) and engage in interactions

within the aquatic ecosystem and potentially with semi-aquatic organisms (Gelwick and McIntyre 2017).

During mechanical reconstruction work by the local Arno River Basin Authority on the vegetation zone along the Arno River in the city of Florence, Italy, plant material and gravel were discarded into the river (Fig. 1). In addition to its function as a natural barrier, this zone is characterized by large energy, nutrient, and biotic flow because of its proximity to aquatic (Cummins 1974, Sedel et al. 1974) and terrestrial ecosystems (Odum 1978). Eliminating this zone is likely to have negative a impact on both aquatic and terrestrial ecosystems (Odum 1978), while discarding plant material and gravel into the river might have an unforeseeable impact on the aquatic ecosystem.

To investigate how this abundant catfish species responds to such an external impact on the aquatic ecosystem, *Ictalurus punctatus* was sampled, and their diet was analysed. This type of study can help increase our understanding of alien fish behavior in general while also providing much needed information about the feeding behavior of alien catfish.

Materials and methods

Sampling

Fish were caught during construction work (March to June 2018) in the segment of the Arno River (43°45'49.9"N, 11°18'04.2"E) located in the city of Florence. *Ictalurus punctatus* was caught using standard fishing rods (2.20-3.90 m), 0.22-0.36 mm monofilament line, and size 2-26 fishing hooks baited with a variety of baits (maggots, worms, freshly cut liver, or bait-fish) that were deployed on the bottom and in the mid water column. The fish caught were placed on ice before being transported to the laboratory of the Department of Biology and the Natural History Museum La Specola in Florence.

Data and dietary analyses

Total fish length (TL) and weight (g) were measured (Norton et al. 1976), and the sex of the fish was determined. Prey items in the stomach of the catfish were identified to the lowest possible taxa under a standard stereo-microscope. Fragmented prey items were considered to be part of whole organisms, and they were counted as such. Only the numbers of the prey items were recorded. Consumed prey items were analysed as the frequency of occurrence ($\% = 100 \times A^I \times N^{-I}$) where A^I is the number of fish preying on species I, N is the total number of fish analysed (excluding those with empty stomachs), and Number is of food items (N%) following the formula

$$N^i = \frac{N_i}{\sum_{i1}^{Q} N_i},$$

where N_i is the number of food category i.

Results

During the study, both riverbanks were cleared of vegetation, some of which was discarded into the river resulting in increased nutrient input (Figure 1), which strongly increased turbidity. The specimens collected (21 male, 19 female) ranged from 13.5 to 64 cm in length (33.8 ± 2.2 cm) and weighed

Table 1
Dietary analysis results for *Ictalurus punctatus* (n=40) sampled from the Arno River

Prey	N%	F%
Aquatic plants	20.67	60
Terrestrial plants	1.68	7.5
Crustaceans	29.6	50
Aquatic molluscs	2.79	5
Hirudinea	0.56	2.5
Aquatic insects	8.94	32.5
Terrestrial insects	23.46	40
Small Cyprinidae	7.26	25
Large Cyprinidae	0.56	2.5
Fish larvae	1.68	7.5
Small mammals	0.56	2.5
Small birds	1.68	7.5
Testudines	0.56	2.5

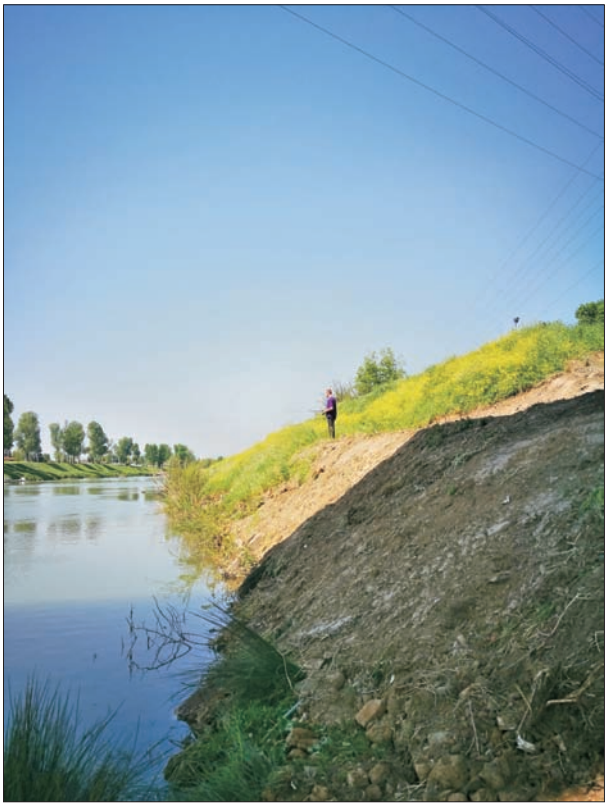

Figure 1. North riverbank of the Arno River after the mechanical removal of vegetation.

between 20 and 3,500 g (538.5 ± 106.3 g). The results of the dietary analyses are listed in Table 1.

Discussion

Sampling predatory fish species, and and especially opportunistic ones, to analyze their diets and potential diet shifts can provide important information about imbalanced trophic interactions or other disturbances (Kolar and Lodge 2002, Syväranta et al. 2010). Additionally, when performed for alien species, these analyses can reveal important information about the behavior and the impact of the species studied (Copp et al. 2009, Moris and Atkins 2009). In the case of the present study, plant material (aquatic and terrestrial), crustaceans (*Procambarus clarkii, Dikerogammarus villosus*), and terrestrial insects were the most dominantly consumed prey, while the percentage shares of other prey categories were lower (Table 1). Nonetheless, the high percentages of terrestrial insects were based on items such as Scaraboidae, the larvae of which can be found in the soil, and other beetles (e.g., Coccinellidae and Curculionidae), which are items that are usually found in vegetated areas. The identification of multiple juvenile birds (Columbidae) and mammals (*Rattus norvegicus*) indicates opportunistic feeding behavior, which likely intensified because of the reconstruction works on the river banks that increased the availability of these prey. Indeed, comparing these observations with those from diet analyses of native populations showed the increased consumption of terrestrial prey items. Apart from these high quantities of terrestrial prey items, the dietary spectrum observed was similar to that identified among native populations (Bailey and Harrison 1948, Tyus and Nikirk 1990).

Lastly, the remains of an alien pond slider (*Trachemys scripta*) was noted in the stomach of *I. punctatus*. This is the first documented occurrence of an alien Ictaluridae feeding on Testudines outside its native range, and, at least to our knowledge, the first ever documentation of this behavior. This underscores the opportunistic nature of this species and thus, its potentially negative impact on recipient species communities (Cadi and Joly 2003, Fritz et al. 2005, Strayer 2010). In addition to the mechanical removal of the vegetation zone having had a negative impact on both aquatic and terrestrial ecosystem and their inhabitants, it can be concluded from the additional prey identified that *Ictalurus punctatus* exhibits opportunistic feeding behaviour when given the opportunity.

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