First report on the importance of alien gobiids in the diet of native piscivorous fishes in the lower Vistula River (Poland)

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Abstract

We conducted a snapshot study to check the importance of non-native Ponto-Caspian gobies (monkey and racer goby) in the diet of native obligate (northern pike, pikeperch) and facultative (Eurasian perch) predators in the Vistula River 3-4 years after the appearance of aliens. In total 71 fish with non-empty stomachs, taken randomly from net catches from various parts of the river were analyzed, including 32 pike, 20 pikeperch and 19 perch specimens. We found that gobiids prevailed in the diet of smaller (<30 cm standard length, SL) individuals of pike and pikeperch, as well as larger (>15 cm SL) specimens of perch, although the effect of predator size on the presence of gobiids in the diet was not significant in the case of perch. Our results indicate that gobiids as a prey fish can stimulate considerable changes in local food webs, which require further studies.

INTRODUCTION

In recent decades, spectacular expansion of Ponto-Caspian fish from the Gobiidae family has been noted in Laurentian Great Lakes in North America (Jude et al. 1992; Charlebois, Corkum 2001; Poos et al. 2009), in the Baltic Sea (Skóra, Stolarski 1993; Sapota 2004; Sapota, Skóra 2005) and in European rivers both in the Baltic (Copp et al. 2005) and the North Sea basins (van Beek 2006). In the lower Vistula River in Poland, which is a part of the central inland corridor used by Ponto-Caspian species to migrate in Europe (Bij de Vaate et al. 2002), two gobiids (the racer goby Neogobius gymnotrachelus and the monkey goby Neogobius fluviatilis) were recorded for the first time in the years 2000-2001 (Kostrzewa, Grabowski 2001, 2002). After 3-4 years (2004), they dispersed successfully in the river, becoming common species in its nearshore zone (Kakareko et al. 2009; Kakareko, Pawlikowska 2010). In 2008 another gobiid species, the tubenose goby Proterorhinus marmoratus, was reported in the Vistula for the first time (Grabowska et al. 2008).

The Ponto-Caspian gobiids can substantially alter food webs in novel environments (e.g. Johnson et al. 2005) due to their high abundance and specific ecological traits. They are small, bottom-dwelling, specialized benthivorous fish (Berg 1949) that may affect native benthic invertebrates (Dubs, Corkum 1996; Kuhns, Berg 1999; Janssen, Jude 2001; Barton et al. 2005) but at the same time become a substantial food resource for the top predators. Perhaps the latter phenomenon, contrary to the former, could be considered as a positive effect of the dispersion of the gobies in new areas. In the Great Lakes, the invasive round goby Neogobius melanostomus is a common prey species for several predatory species, including yellow perch Perca flavescens, largemouth bass Micropterus salmoides, northern pike Esox lucius and...
double-crested cormorants *Phalacrocorax auritas* (Johnson et al. 2005, 2010; Taraborelli et al. 2010). In Europe this species has also been found to constitute a major dietary item for some predators, such as cormorants *Phalacrocorax carbo* (Bzoma 1998), cod *Gadus morhua callarias* and turbot *Psetta maxima* (Sapota, Skóra 2005), in shallow waters of the Gulf of Gdańsk (Baltic Sea).

Little is known about the impact of other gobiid species, such as monkey and racer goby, on the trophic ecology of predators in newly invaded areas. We hypothesized that the alien fish could become an important dietary item of native predators due to their small body size (mostly up to ca. 10 cm) and oblong shape, which makes them relatively easy to take by gape-limited predators like piscivorous fish. However, no data on the role of these fish in the diet of predatory species in novel environments of European rivers have been published so far. Therefore, the aim of the present study was to assess the importance of the invaders as prey in the lower Vistula River shortly after their appearance. We ran a snapshot study on the diet of the most common predators (northern pike, pikeperch *Sander lucioperca* and Eurasian perch *Perca fluviatilis*) to check if the Ponto-Caspian gobiids became a common dietary item a few years (from 2000–2001 to 2004) after their appearance in the river. Our specific objective was to present the contribution of gobiids in the diet of predators in a standard manner to allow inter-population comparisons with past and future studies.

**MATERIALS AND METHODS**

**The study area and sampling procedure**

The Vistula River is the major river flowing through Poland. It is 1068 km long and has a catchment area of about 194,300 km² (Mikulski 1963). The lower course of the river (lower Vistula), runs for 391 km. The transit depth is 1.9 m and the width of the navigable channel is 375 m (Kloze 1983, after Głogowska 2000). The mean annual water discharges are from 900 m³ s⁻¹ at the upper part (downstream from the Narew River’s mouth) to ca. 1050 m³ s⁻¹ at the mouth (Głogowska 2000). Its hydrology is modified by a dam reservoir (Włocławek Reservoir), the largest (75 km²) in Poland and the only one along this river course (Giziński et al. 1989).

The sampling was conducted in the lower Vistula between 744ʰ and 772ʰ km of the river course (near the city of Bydgoszcz, ca. 70 km below the dam of the reservoir), successively from 8 July and 22 October 2004, using two fishing techniques depending on the size of collected fish. Smaller individuals (<15 cm standard length, SL) of predatory fish were collected between the 758ʰ and 772ʰ km of the river course with a special pouch-style seine net (length: 19 m, width in the end of wings: 0.6 m, width in the pouch: 2.5 m), with stretched mesh size of 2 × 5 mm. The catches were carried out in the daytime at various hours, in shallow (below 1 m in depth) and deeper (up to 2 m) nearshore areas with soft bottom and slow or moderate flow. Such habitats are most common along the shores of the lower Vistula River. The details of the sampling procedure have been described by Kakareko et al. (2009). Larger fish (>15 cm SL) were captured between the 744ʰ and 748ʰ km of the river course using gillnetting by a commercial fisherman. They were sampled at night by 100-150 m long, drifting or standing trammel nets with 30, 60 and 80 mm mesh sizes.

**Stomach content analysis**

In total, the diet of 71 fish with non-empty stomachs was analyzed, including 32 pike, 20 pikeperch and 19 perch specimens. Means, standard deviations and ranges of the standard length (SL) of the fish studied (in cm) were as follows: pike 26.8, 17.7, 8.9-68.0; pikeperch 38.0, 21.0, 63.0-72.0; perch 16.4, 7.2, 8.5-35.0. Immediately after capture, the fish were killed and their total and standard length was measured to the nearest 1 cm. Then their alimentary tracts were extracted by dissection and stored in 4% formalin for the later stomach content analysis. In the laboratory, stomach contents were removed and analyzed under a stereomicroscope. All recognizable prey remains were separated and identified. Invertebrate prey items were divided into nine categories: Gastropoda, Lumbricidae, Amphipoda, Copepoda, *Axellas aquaticus*, Decapoda, Coleoptera, Chironomidae larvae and Zygoptera larvae. Fish prey species were identified on the basis of scales and bones (e.g. pharyngeal teeth, opercula) and measured to the nearest 1 mm. Size (height or width) of pharyngeal teeth was used for the reconstruction of the standard length of partially digested fish prey according to Radke et al. (2000).

The by-volume (%V) composition and frequency of occurrences (%FO) were determined for all identified prey species to quantify their contribution