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New data on distribution of three invasive freshwater fish species in İstanbul (Turkey)

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Abstract: This paper provides new contributions for known distribution areas of invasive *Carassius gibelio* (Bloch, 1782), *Gambusia holbrooki* Girard, 1859 and *Lepomis gibbosus* (Linnaeus, 1758) in İstanbul. To determine the present expansion of these freshwater species, fish surveys were conducted in 78 stations by using portable electroshocker and gillnet between April and August, 2016. *Carassius gibelio*, *G. holbrooki* and *L. gibbosus* were captured from 14 stations included and, as a result of comparison with current literature *C. gibelio* was new recorded for Kula Stream, Sinekli Pond, Çakıl Pond, Çayırdere Pond, Büyükkokmuş Pond, Küçükkokmuş Pond and Sungurlu Stream, *G. holbrooki* for Kurfallı Stream, İzzettin Stream, Büyükkokmuş Pond, Küçükkokmuş Pond, Çilingoz Stream and Sinekli Pond, and *L. gibbosus* for Değirmenköy Pond. While *C. gibelio* and *G. holbrooki* were previously recorded from İstanbul, this is the first report in a new locality of *L. gibbosus* in the city.

Keywords: *Carassius gibelio*, *Lepomis gibbosus*, *Gambusia holbrooki*, Invasive species, Inland waters.

Introduction

In the last 30 years, most streams, lakes and reservoirs in Turkey have faced the risk of biological invasion that is threatening for indigenous and endemic freshwater fish species. To determine the current expansion of invasive species and analysing their effects in Turkish inland waters that are rich in biodiversity and especially endemic species is quite important (Ekmekçi and Kırankaya, 2006; İnnal, 2012; Tarkan et al., 2012a; Özuluğ et al., 2013; Gaygusuz et al., 2013).

Due to its geographic location (being a boundary between the Europe and Asia continents), İstanbul has a rich diversity of Europe and Asia origin freshwater fish species (Devedjian, 1926; Balık, 1985; Meriç, 1986; Özuluğ, 1999; Özuluğ et al., 2005; Özuluğ, 2008; Saç and Özuluğ, 2014). The natural distribution of fish species was blocked by the Bosphorus approximately 10,000 years ago (Ryan et al., 2003). Some of these species such as *Alburnus istanbulensis* Battalgil, 1941, *Rhodeus amarus* (Bloch, 1782), *Proterorhinus semilunaris* Heckel, 1839, *Rutilus rutilus* (Linnaeus, 1758) inhabit in both the European and Anatolian part of İstanbul (Özuluğ et al., 2005; Özuluğ, 2008). However, some species inhabit only in one part of the city (*Squalius cephalus* (Linnaeus, 1758) in European part (Özuluğ and Freyhof, 2011) and *Squalius pursakensis* (Hankó, 1925) in Anatolian part (unpublished data of second author).

The expanding distribution of invasive species in İstanbul could have an effect on their new ecosystems, as these invasive species are potential competitors for the food and habitat of native and/or endemic fish species. The negative impacts of *Carassius gibelio* (one of the most extensive invasive species in Turkey) on native fish populations in a reservoir in İstanbul has recently been determined. After the introduction of the species into the Ömerli Reservoir, some native fishes such as *Vimba vimba*, *Scardinius erythrophthalmus* and endemic fish species *A. istanbulensis* have suffered, and the abundance of these species has declined in time (Özuluğ et al., 2005; Gaygusuz et al., 2007; Tarkan et al., 2012a).

Similar to the worldwide pattern (Manchester and Bullock, 2000; Slavik and Bartoš, 2004; Alcaraz et al.,

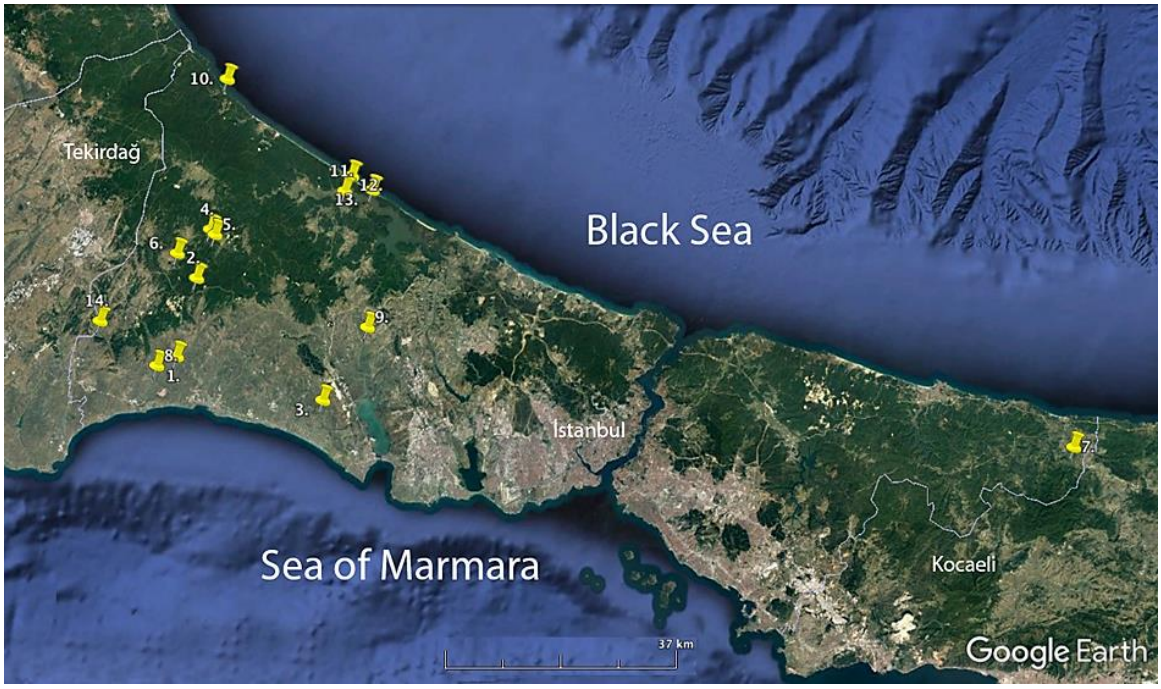

Figure 1. Sampling stations of the invasive fish species in İstanbul (1: Kula Stream, 2: Sinekli Pond, 3: Çakıl Pond, 4: Küçükkokmuş Pond, 5: Büyükkokmuş Pond, 6: Çayırdere Pond, 7: Sungurlu Stream, 8: Kurfallı Stream, 9: İzzettin Stream, 10: Çilingoz Stream, 11: Ormanlı Stream-I, 12: Ormanlı Stream-II, 13: Celepköy Pond, 14: Değirmenköy Pond).

2005; Vetemaa et al., 2005; Sterud and Jørgensen, 2006; Leonardos et al., 2008; Cucherousset et al., 2009; Lusk et al., 2010; Clavero and Hermoso, 2011; Beatty and Morgan, 2013), *C. gibelio*, *Gambusia holbrooki* and *Lepomis gibbosus* were accepted as invasive fish species for Turkish inland waters (Gaygusuz et al., 2007; Tarkan et al., 2012a; Tarkan et al., 2012b; Gaygusuz et al., 2013; Yoğurtçuoğlu and Ekmekçi, 2014; Ağdamar et al., 2015). To investigate the possible effects of these invasive species on native populations or ecosystems, it is very important to detect their range of expansion. Based on this requirement, the aim of the present study is to document the current distributions of invasive *C. gibelio*, *G. holbrooki* and *L. gibbosus* in İstanbul.

Materials and Methods

Fish samples were collected from 78 stations (59 stations from European part and 19 stations from Anatolian part of İstanbul) included streams and ponds in the city. Surveys were conducted by using portable electroshocker and gillnet (5 mm mesh size) between April and August, 2016. Fish samples were fixed in 5% formaldehyde solution and then stored as museum material (in İstanbul University Science Faculty Hydrobiology Museum-IUSHM) in 70% ethanol.

Results and Discussion

Surveys in İstanbul inland waters revealed new contributions for known distribution areas of invasive *C. gibelio*, *G. holbrooki* and *L. gibbosus.* As a result of comparison with current literature, *C. gibelio* was newly recorded for Kula Stream, Sinekli Pond, Çakıl Pond, Çayırdere Pond, Büyükkokmuş Pond, Küçükkokmuş Pond and Sungurlu Stream, *G. holbrooki* for Kurfallı Stream, İzzettin Stream, Büyükkokmuş Pond, Küçükkokmuş Pond, Çilingoz Stream and Sinekli Pond, and *L. gibbosus* for Değirmenköy Pond. A total of 146 individuals of three invasive species was collected from the stations listed in the Table1 and indicated in the Figure 1. Other fish species that live with the invasive species in the same areas are also listed in the Table. Amongst the study stations, only Sungurlu Stream is located in Anatolian part of İstanbul.

The introduction of *G. holbrooki* to the inland waters of Turkey occurred in 1920s in the southern region of Anatolia (İnnal and Erk'akan, 2006) and it has extended its range to Edirne in Thrace (Güner, 2010). However, *C. gibelio* and *L. gibbosus* were introduced to the Thrace region of Turkey in 1980s (Erk'akan, 1983; Baran and Ongan, 1988) for the first time and the distribution of these two species has conversely extended to the most of

Table 1. Records of *Carassius gibelio*, *Gambusia holbrooki* and *Lepomis gibbosus* in İstanbul, Turkey. Asterisks indicate newly recorded localities.

Species	Date	n	Locality	Coordinates	Native fish species
Caraccius gibelio	07.04.2016	1	Kula Stream*	41°07'28"N 28°10'05"E	*Gobio bulgaricus, Cobitis pontica, Squalius borysthenicus, Neogobius melanostomus*
	07.04.2016	14	Sinekli Pond*	41°14'16"N 28°11'36"E	*G. bulgaricus, S. borysthenicus, G. holbrooki*
	12.04.2016	2	Çakıl Pond*	41°04'40"N 28°27'00"E	*R. rutilus, R. amarus, Perca fluviatilis, C.pontica, N. melanostomus*
	10.05.2016	16	Küçükkokmuş Pond*	41°18'30"N 28°12'42"E	*G. holbrooki*
	10.05.2016	1	Büyükkokmuş Pond*	41°18'06"N 28°13'15"E	*Cyprinus carpio, S. borysthenicus, G. holbrooki*
	23.05.2016	3	Çayırdere Pond*	41°16'15"N 28°09'10"E	*R. amarus, Leucaspius delineatus, S. borysthenicus*
	23. 08.2016	2	Sungurlu Stream*	41°04'45"N 29°51'48"E	*V. vimba, R. amarus, A. istanbulensis, S. borysthenicus, P. semilunaris*
Gambusia holbrooki	07.04.2016	2	Kurfallı Stream*	41°06'33"N 28°07'57"E	*G. bulgaricus, C.pontica, S. borysthenicus*
	07.04.2016	19	Sinekli Pond*	41°14'16"N 28°11'36"E	*G. bulgaricus, S. borysthenicus, C. gibelio*
	13.04.2016	5	İzzettin Stream*	41°11'07"N 28°31'24"E	*C.pontica*
	10.05.2016	45	Küçükkokmuş Pond*	41°18'30"N 28°12'42"E	*C. gibelio*
	10.05.2016	19	Büyükkokmuş Pond*	41°18'06"N 28°13'15"E	*C. carpio, S. borysthenicus, C. gibelio*
	24.05.2016	2	Çilingoz Stream*	41°31'33"N 28°13'06"E	*A. istanbulensis, Atherina boyeri, Gasterosteus aculeatus, S. borysthenicus*
	26.05.2016	1	Ormanlı Stream-I	41°22'38"N 28°27'36"E	*S. borysthenicus*
	26.05.2016	6	Ormanlı Stream-II	41°24'00"N 28°28'15"E	*Esox lucius, Abramis brama, Tinca tinca, A. istanbulensis, R. amarus, S. erythrophthalmus, S. borysthenicus*
	27.05.2016	3	Celepköy Pond	41°22'53"N 28°30'42"E	*A. istanbulensis, S. erythrophthalmus, R. amarus, S. borysthenicus*
Lepomis gibbosus	06.04.2016	5	Değirmenköy Pond*	41°10'05"N 28°00'47"E	*P. fluviatilis, R. amarus*

the Anatolian inland waters (Tarkan et al., 2015). Although it is an important discussion how these species passed the Bosphorus and Dardanelles (Wildekamp et al., 1997; Ekmekçi and Kırankaya, 2006; Yeğen et al., 2015), it is thought that human activities (recreational fishing, research for aquaculture, biological control, accidental, etc.) were the most important factors in this case.

Although *C. gibelio* and *G. holbrooki* are now widely distributed all over Turkey, the distribution of *L. gibbosus* is limited by Edirne (İpsala Canal and Gala Lake), Muğla (Geyik Reservoir and Sarıçay), Aydın (Dipsiz-Çine Stream, Topçam Reservoir, Kemer Reservoir, Akçay Stream) and İzmit (Bayraktar, Çayırköy and Davuldere reservoirs) (Erk'akan, 1983; Baran and Ongan, 1988; Barlas et al., 2001; Şaşı and Balık, 2003; Yılmaz et al., 2006; Özcan, 2007; Tarkan et al., 2012b, Ekmekçi et al., 2013, Gaygusuz et al., 2013; Keskin et al., 2013; Özuluğ et al., 2013; Erdoğan et al., 2014; Saç and Özuluğ, 2014; Yerli et al., 2014). In the present study, *L. gibbosus* was first recorded in İstanbul. Dispersal of the species has been facilitated with stocking practise of common carp and recreational fishing (Aydın et al., 2011; Ağdamar et al., 2015).

The first record of *C. gibelio* and *G. holbrooki* in

İstanbul was from the Büyükçekmece Reservoir (Özuluğ, 1999); after then, *C. gibelio* was reported from the Pond of İstanbul Technical University (Özuluğ et al., 2004), Ömerli Reservoir (Gaygusuz et al., 2007), Topaçlı Reservoir (Tarkan et al., 2012b) and Lake Durusu basin (Saç and Özuluğ, 2014), while *G. holbrooki* was reported from the Ömerli Reservoir (Özuluğ et al., 2005) and Lake Durusu basin (Özuluğ, 2008). However, *L. gibbosus* has not been observed in the city until the present study.

Freshwater habitats in İstanbul (a metropolitan with a population of 15 million people) are under threat of invasive species besides water pollution. To deal with the potential impacts of these invasive fishes such as competition for food and space, niche displacement, hybridisation, their current expansion should continuously be monitored.

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