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Survey of angler's internet posts confirmed the occurrence of freshwater fishes of the genus *Ictiobus* (Rafinesque, 1819) in natural waters of Czechia

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Abstract – The information regarding the fish species occurrence in rivers and lakes depends on the quantity and quality of ichthyofaunal surveys. Non-native buffalo fishes, *Ictiobus cyprinellus* and *I. niger* (Catostomidae) were introduced to pond aquaculture in the 20th century but since that time they have never been recorded from the natural environment in Europe. Forensic analysis was performed using online data from Czech anglers websites to test whether these fishes were ever caught. In total 13 records were obtained but only 3 were verified in terms of species identification, locality and date. The found records are scattered throughout the area of Czechia and they are without an obvious distribution pattern. The analysis of online fishing web sites can be considered a suitable source of additional information on the occurrence of fishes.

Keywords: anglers / non-native / Czech Republic / Catostomidae

Résumé – L'étude des messages Internet des pêcheurs à la ligne a confirmé la présence de poissons d'eau douce du genre Ictiobus (Rafinesque, 1819) dans les eaux naturelles de la Tchéquie. L'information sur la présence d'espèces de poissons dans les rivières et les lacs dépend de la quantité et de la qualité des relevés de l'ichtyofaune. Les buffalos à grande bouche non indigènes, Ictiobus cyprinellus et I. niger (Catostomidae) ont été introduits dans l'aquaculture en étang au 20ème siècle, mais depuis lors, ils n'ont jamais été signalés dans l'environnement naturel en Europe. Une analyse scientifique a été effectuée à l'aide de données en ligne provenant des sites Web des pêcheurs tchèques afin de vérifier si ces poissons ont été capturés. Au total, 13 enregistrements ont été obtenus mais seulement 3 ont été vérifiés en termes d'identification de l'espèce, de localité et de date. Les enregistrements trouvés sont dispersés dans toute la région de la Tchéquie et ne présentent pas de schéma de distribution évident. L'analyse des sites Web de pêche en ligne peut être considérée comme une source appropriée d'informations supplémentaires sur la présence de poissons.

Mots-clés: pêcheur à la ligne / non-indigène / République tchèque / Catostomidae

1 Introduction

The presence of non-native fish in the natural environment is generally associated with loss of native biodiversity (Clavero and García-Berthou, 2005). However, there is a long history of non-native fish introductions related to an intended increase of fisheries production of various water bodies for commercial as well as for recreational purposes (Copp *et al.*, 2005). Many introductions were driven by the need of species diversification in aquaculture production (Musil *et al.*, 2010; Gozlan *et al.*, 2010) and normally, these species in aquaculture facilities appeared later in close connected rivers and lakes (Takács *et al.*, 2017). Especially in case of pond aquaculture, the semi-natural environment and permeable separation from surroundings enable escapees to spread outside (Gherardi *et al.*, 2009).

In Czechia, ponds are distributed almost over the whole country and traditional pond aquaculture was responsible for 80% of non-native fish introductions during the history (Musil *et al.*, 2010). A number of non-native species were introduced into the territory of Czechia as contaminants of fish stocks of common carp (*Cyprinus carpio*) and herbivorous fishes including *Hypophthalmichthys nobilis*, *H. molitrix* and *Ctenopharyngodon idella* and these newcomers have become established (*Lepomis gibbosus*, *Ameiurus melas*,

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Pseudorasbora parva and *Carassius gibelio*) (Lusk *et al.*, 2010; Lusková *et al.*, 2010).

Although there are ongoing expert surveys on rivers and reservoirs, *e.g.* in three year period within the implication of European Water Framework Directive (European Union, 2000), it is very unlikely to record escapees from aquaculture or ornamental fish culture facilities. The information in the scientific literature regarding the finding of escapees are mainly based on improbable coincidence see *e.g.* Zięba *et al.* (2010) and therefore the processes of establishment of non-native species may stay undiscovered for a long time (Nehring, 2005). But the detection of invaders in their early stages of an invasion process is crucial for application of mitigation measures in regards of their future impact (Copp *et al.*, 2005).

However, in order to avoid future invasions, in addition to the prevention of non-native introductions, a cheap and alternative monitoring of aquatic environment is needed.

The rapid development of technologies and internet applications in recent decades have been associated with an increasing opportunity to utilize valuable information generated by the users of such technologies. This technological change may facilitate efficient biological monitoring by ordinary citizens (Silvertown, 2009; Hochachka *et al.*, 2012). Anglers form a community that frequently uses social media to share their experiences (Claussen *et al.*, 2013). These data can be analysed and used by managers and scientists *e.g.* for a detection of non-native species (Ribeiro and Veríssimo, 2014; Banha *et al.*, 2015; Banha *et al.*, 2017) or management settings (Martin *et al.*, 2012).

In the present work, we have focused on two catostomid fishes bigmouth buffalo *I. cyprinellus* (Valenciennes, 1844) and black buffalo *I. niger* (Rafinesque, 1819), which have been introduced to Europe but till now lack any record from the wild (Kottelat and Freyhof, 2007). Both fishes originate from the Mississippi River basin in North America, although the native range of black buffalo extends largely east and west of the Mississippi along coastal drainage of the Gulf of Mexico (Bart *et al.*, 2010). Both species occurre in a broad range of freshwater habitats usually main channels or oxbows lakes of big rivers (Breder and Rosen, 1966; Stauffer *et al.*, 1995).

Buffalo fishes were successfully introduced around 1970 into pond polycultures in the former USSR (Vinogradov, 1987) and later to other European Eastern Bloc countries (Dimitrov 1987; FAO 1997; Kottelat and Freyhof, 2007). Into former Czechoslovakia, *I. cyprinellus* and *I. niger* were introduced in 1986 (Adámek and Kouřil, 1996) and aspects of their pond aquaculture have been studied under local conditions (*e.g.* Pokorný *et al.*, 1990; Adámek *et al.*, 2003).

We decided to use internet source (anglers forums) to obtain information about the occurrence of buffalo fishes in the wild and by that we tried to prove the usefulness of such an approach.

2 Material and methods

We started our investigation by searching in literature sources usually written in Czech. Beside scientific literature we were focused on local sources (grey literature) including books, conference proceedings, fish inventory reports and various student thesis.

2.1 Search at anglers websites

We chose two the most visited Czech angling websites forums based on the number of visits 1) http://www.mrk.cz/ (online since 1996; average of daily attendance 21155; 78355 registered members; 77985 photos; 41401 questions in forums; 2956 topics of articles) and 2) http://www.chytej.cz/ (online since 2007; average of daily attendance 3463; 19327 registered members). Both forums were accessed between 17th January and 2nd February 2018. We examined website by Google Site Search tool for both forums using the keywords entered one by one. As keywords we chose names used among Czech anglers community for fishes of the genus *Ictiobus* sp. namely: "kaprovec", "buffalo", "bufalo" and "Ictiobus". All results were inspected and records that did not relate to our object were excluded. In all relevant records, we wrote down all available information. The geographical coordinates were extracted from Google Maps. When the locality was not clearly specified, we used the river point nearest to the referred geographical name in the particular record. In case of a reservoir, we used coordinates of its mid-point.

2.2 Evaluation of the records

We categorized records in two quality levels. Following Gago *et al.* (2016), we considered a species record as verified when it contained a locality, year and accompanying picture. In case the record had picture but lacked other information, we tried to contact the angler *via* websites messaging service to complete it. All other incomplete records we considered as unverified. The record was considered unverified also in the case it included all information listed before but the species (or at least, the genus) was not recognizable from the picture.

2.3 Fish species identification

We downloaded the photographs from the websites and the species identification followed characteristic given in Page and Burr (1991) particularly the shape of dorsal fin, eyes, absence of barbels and the position of mouth. If it was possible to recognize the genus but not the species, the record was marked as *Ictiobus* sp.

3 Results

In total, we extracted 19 records, 6 records were from literature and 13 records from web sites (mrk.cz 9; chytej.cz 4). No record was simultaneously announced on both forums. Five records included photographs and only three records were evaluated as verified, allowing the identification of *I. niger* (1 individual) and *I. cyprinellus* (2 individuals), for the places of their catch see Table 1.

4 Discussion

The findings of our study confirmed the occurrence of two non-native species of buffalo fishes *Ictiobus cyprinellus* and *I. niger* in the rivers of Czechia based on anglers records. Although both species are listed among non-native fishes in

Table 1. Records of buffalo fishes including *Ictiobus niger* and *I. cyprinellus* from Czechia. The evaluation of the record is based on the quality and includes 1) Literature − the record was found in literature, 2) non-verified − the record lack some attributes given in material and methods, 3) verified − the record fulfill all attributes given in material and methods, 4) verified + − the record fulfill all attributes given in material and methods and was confirmed by the angler.

	Date	Locality	Locality (GPS)	Picture	Taxon	Source	Evaluation
1	1986	Aquaculture facility, Milevsko	49°27'40.9"N 14°21'52.0"E	no	*Ictiobus cyprinellus*	(Šanda, 2006)	Literature
2	1986	Aquaculture facility, Vodňany	49°09'029.2"N 14°10'53.9"E	no	*Ictiobus cyprinellus*	(Šanda, 2006)	Literature
3	N/A	Aquaculture facility, Březina	50°32'46.5"N 15°02'052.2"E	no	*Ictiobus cyprinellus*	(Šanda, 2006)	Literature
4	N/A	Pond Vidlák, Troskovice	50°31'21.1"N 15°12'44.6"E	no	*Ictiobus cyprinellus*	(Šanda, 2006)	Literature
5	N/A	Aquaculture facility, Pohořelice	48°57'56.5"N 16°32'30.2"E	no	*Ictiobus cyprinellus*	Pergl *et al.*, 2016	Literature
6	2002	Aquaculture facility, MO Liberec	50°43'42.3"N 15°02'056.6"E	no	*Ictiobus cyprinellus*	(Šanda, 2006)	Literature
7	December 2003	Pond Pístovický	49°16'21.1"N 16°54'04.5"E	no	*Ictiobus* sp.	mrk.cz	non-verified
8	April 2007	–	–	yes	*Ictiobus* sp.	mrk.cz	non-verified
9	May 2006	Jizera River	50°16'59.3"N 14°48'50.0"E	yes	*Ictiobus cyprinellus*	mrk.cz	verified +
10	October 2006	Pond Hoděčín	50°09'55.9"N 16°09'56.1"E	no	*Ictiobus* sp.	mrk.cz	non-verified
11	–	Pond Nový	50°35'22.4"N 14°37'26.9"E	yes	*Ictiobus niger*	mrk.cz	non-verified
12	April 2008	Elbe River	50°10'20.1" N14°43'7.3"E	yes	*Ictiobus niger*	mrk.cz	verified
13	May 2008	–	–	yes	*Ictiobus niger*	chytej.cz	non-verified
14	March 2011	Ohře River	50°22'5.1"N 13°27'13.1"E	no	*Ictiobus* sp.	mrk.cz	non-verified
15	April 2014	Vltava River	49°02'47.4"N 14°26'47.5"E	yes	*Ictiobus cypríinellus*	mrk.cz	verified +
16	N/A	Blanice River	49°09'17.4"N 14°10'34.0"E	no	*Ictiobus* sp.	mrk.cz	non-verified
17	N/A	Aquaculture facality, Březina	50°32'46.5" N 15°02'052.2"E	no	*Ictiobus* sp.	chytej.cz	non-verified;
18	N/A	Pond Dvorský	48°51'24.8"N 17°04'027.1"E	no	*Ictiobus* sp.	chytej.cz	non-verified
19	N/A	Elbe River	–	no	*Ictiobus* sp.	chytej.cz	non-verified

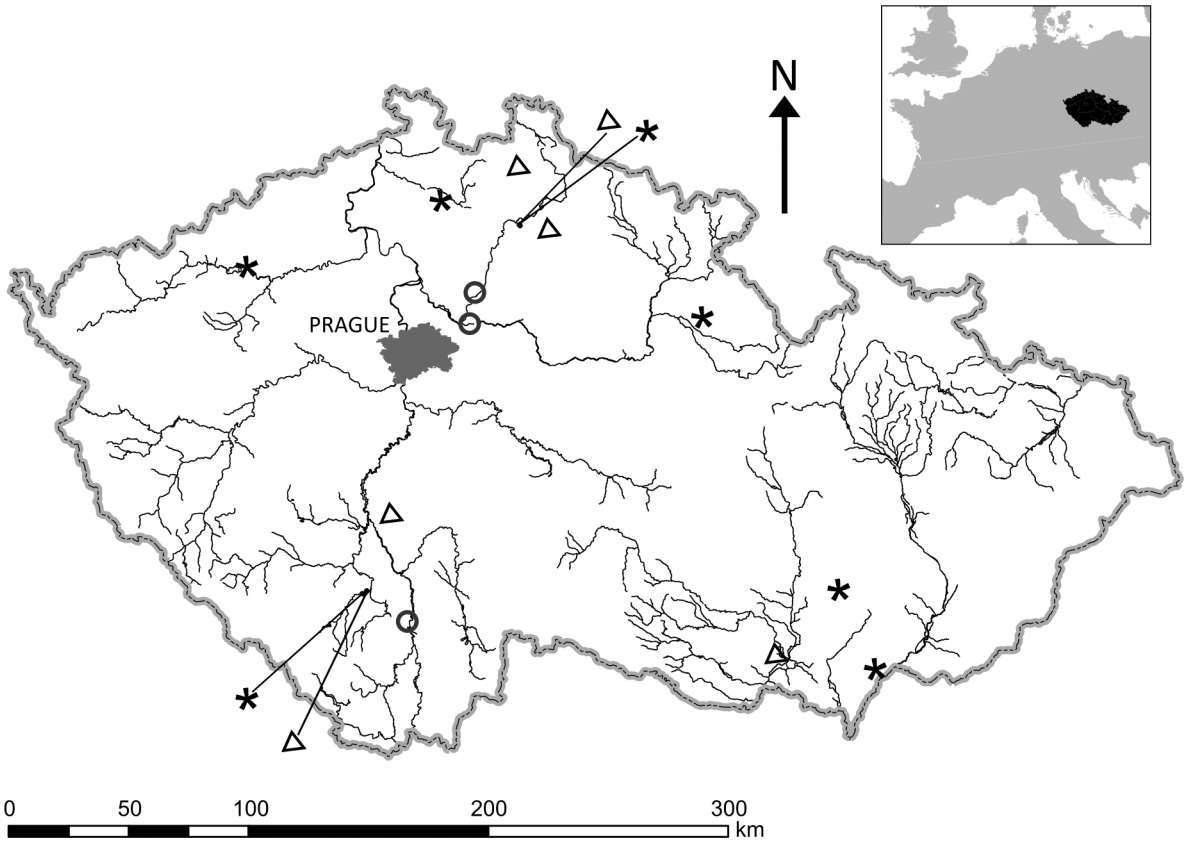

Fig. 1. Map of Czechia showing the localities of buffalo fish records. Circles show the confirmed records, stars show unconfirmed records and triangles show records referred in the literature. Detailed information are given in the Table 1.

various European countries (Holčík, 1991; García-Berthou *et al.*, 2005; Kottelat and Freyhof, 2007; Uzunova and Zlatanova, 2007; Nowak *et al.*, 2008; Mastitsky *et al.*, 2010, Musil *et al.*, 2010), these are the first known records out of aquaculture facilities in Europe. It is interesting because besides scientific literature, publications presenting lists of non-native organisms usually includes also information from so-called grey literature, which brings a more varied view of the spectrum and the occurrence of the non-native fishes in particular country. Despite the reference to successful establishment of buffalo fishes in Bulgaria in the compilation article of Uzunova and Zlatanova (2007), there is missing of a primary information source for that statement. This unprovable information was uncritically cited further *e.g.* Hanel *et al.* (2011) or Yankova (2016).

The lack of written records of buffalo fishes in European rivers and lakes reflects its absence or very low abundance. The situation is in accordance with the low establishment success of buffalo fishes in the world (Bomford *et al.*, 2010) and their relatively low potential of invasiveness (Mastitsky *et al.*, 2010; Howeth *et al.*, 2016).

On the other hand, the presence of both species *I. cyprinellus* and *I. niger* in the rivers of Czechia at least 28 years after their introduction is surprising and can be explained either by their natural reproduction in rivers or by their continuous artificial reproduction in aquaculture followed by escapes or stocking. Since natural reproduction is not likely in European waters and has never been recorded an unofficial stocking is a more probable explanation.

After the introduction of buffalo fishes to Czechoslovakia from USSR in 1986, both species were kept in two experimental aquaculture facilities in South Bohemia (Elbe River system) (Adámek and Kouřil, 1996). Later they were introduced into the aquaculture company in Eastern Bohemia from were some buffalo fishes were transported in 2002 into the aquaculture facility of the local organization of Czech Anglers Union in North Bohemia (Šanda, 2006).

These locations where buffalo fishes were kept are not in the close vicinity of the places where we recorded anglers catches (Fig. 1.) and thus the origin of fish as escapees are less probable than intended stocking. Moreover, the distribution of recorded catches (including non-verified) is scattered without a hint of any pattern (see the Fig. 1). Interestingly the records of buffalo fish catches started in 2003, just a year after they entered aquaculture facility of Czech Anglers Union. The last record of a catch, shown on Figure 2, was in 2014 from the Vltava River (South Bohemia).

We assume that a human curiosity was most likely behind an illegal stocking of buffalo fishes in natural waters managed by individuals from Czech Anglers Union or related persons. Recreational fisheries is recognized as one of the major pathways of the non-native fishes introductions both world-wide (Johnson *et al.*, 2009) and in Czechia *e.g.* Kalous *et al.* (2013).

Fig. 2. *Ictiobus cyprinellus* caught in April 2014 in the Vltava River (Elbe River Basin) near the city Hluboká nad Vltavou in South Bohemia (Czechia). The fish was caught and photographed by Petr Zatloukal.

In Czechia are currently more than 2 active web angling forums dedicated to freshwater fishing activities, with more than 100 000 users and overall more then 200 000 posts. These forums provide a diversity of data, including perceived species abundances, places and methods of capture, photos, short articles and even places suggested for future introductions of non-native fishes. Thirteen records of catches of buffalo fishes were quickly available after a systematic online survey of anglers web forums. This approach is solely based on the low-cost analysis of publicly accessible online data. On the contrary deep searching in scientific literature resulted in 6 records but none out of aquaculture facility. We are in agreement with Banha *et al.* (2015) that the methodology could be considered very useful especially in case of forensic analysis dealing with non-native fish introduction history. On the other hand we are aware of disadvantages of the presented approach, which are summarized in Banha *et al.* (2017) including various biases caused by the heterogeneity of anglers and different attitudes to publish their records.

Our study suggests that published records of angler's community is valuable source of data for environmental monitoring. In the case of buffalo fishes the presented analyses were much more sensitive than regular surveys of an ichthyofauna by means of control electrofishing. Such analyses may help with the management of non-native fishes. It may bring earlier alarm of their potential presence or the only data available for reconstruction of the speed and direction of their spreading. Despite usefulness of an online forensic analysis, the possibility of fake records exist, therefore the scientific confirmation of the occurrence at three verified locations is recommended.

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