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The first recording of the threatened species, the European weather loach, *Misgurnus fossilis* (Berg, 1949), in the diet of the pike

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Abstract: In autumn 2011 and spring 2012, the diet of pike ($n = 112$) captured in a backwater in eastern Hungary was examined. Eight species of prey-fish were found in the stomachs of 31 of the 112 pike individuals, and 71.9% of the prey-fish in the stomachs of 16 of the 31 pike individuals were European weather loach, *Misgurnus fossilis*. This first recording of European weather loach in the diet of pike is a valuable finding, because it provides new information on an endangered species categorized as vulnerable in the IUCN Red List of Threatened Species. The high number of European weather loach found in the diet of pike suggests that this species was easy prey for the predator after the spawning period when pike start to feed intensively to replace the energy used for reproduction.

Key words: *Esox lucius*, piscivorous diet, prey-fish, endangered species, *Misgurnus fossilis*, Hungary

The piscivorous feeding habits of the pike, *Esox lucius* (Linnaeus 1758), have been the subject of a number of North American (Diana, 1979; Beaudoin et al., 1999; Soupier et al., 2000) and European studies (Mann, 1982; Dominguez and Pena, 2000; Alp et al., 2008; Kekalainen et al., 2008; MÉRÓ, 2014). The larger pike feed mostly on fish (Diana, 1979; Bregazzi and Kennedy, 1980; Alp et al., 2008; Winfield et al., 2012; MÉRÓ, 2014), whereas the offspring at a few weeks old consume small invertebrates (Guti et al., 1991; Dgebuadze et al., 2010). At times, the diet of large-bodied pike includes amphibians (Alp et al., 2008), birds (Dominguez and Pena, 2000; Brown and McIntyre, 2005), and small mammals (Dominguez and Pena, 2000; Harvey, 2009). Although a wide range of potential aquatic prey species is available, the prey-fish content of the pike appears to be narrow, e.g., the Arctic charr, *Salvelinus alpinus*, and the brown trout, *Salmo trutta*, in the United Kingdom (Winfield et al., 2012) and the crucian carp, *Carassius gibelio*, in Serbia (MÉRÓ, 2014). Occasionally their diet extends to rarely occurring prey-fish such as the Iberian loach, *Cobitis calderoni* (Dominguez and Pena, 2000), and the spined loach, *Cobitis taenia* (Alp et al., 2008). The aim of the present paper was to report that the threatened European weather loach, *Misgurnus fossilis* (Berg, 1949), has been recorded as a new prey-fish species in the pike diet.

The study was conducted in a backwater of the Tisza River (47.6°N, 20.9°E; Figure) with an area of approximately

3.9 ha. The banks of the backwater are overgrown with reed (*Phragmites australis*). The predominant vascular plant vegetation is the water chestnut, *Trapa natans*, which covers 90% of the water surface from May to November. The study was conducted in two seasons, late autumn 2011 (between November 7 and December 13) and spring 2012 (between March 19 and April 21). It was not possible to capture pike in the summer of 2011 or in the winter of 2012 because of the dense vegetation cover of water chestnut and ice cover due to a harsh winter, respectively. The pike were captured by angling (Arlinghaus et al., 2008; MÉRÓ, 2011, 2014) during the first 2 h after dawn and the final 2 h before sunset, with the exclusive use of artificial lures. Immediately after capture, the pike were killed with an accurate blow to the head by a blunt instrument in order to slow down the digestion. The stomach contents of the pike were investigated within 1 h after angling. Only reliably identified contents were recorded. Well-digested items were not taken into consideration in the study because of the uncertainty of species determination. The authors' long-year experience and the guide of Zaugg and Pedroli (1997) were used to determine the prey-fish. The lengths of the pike and the fish-prey were measured with a measuring tape. The proportions of the prey-fish were calculated from the numbers of individuals found in the stomachs of the pike.

A total of 112 pike (mean length 51.4 ± 9.49 cm) were captured in the study period; autumn of 2011 (32) and

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Figure. The location of the study area (black dot) near the Tisza River in East Hungary.

spring of 2012 (80). We found eight species of prey-fish (a total of 57 individuals) in 31 pike individuals (Table). The most numerous of the prey-fish was the European weather loach in the spring of 2012: 41 individuals were found in the stomachs of 16 pike. Individuals of other prey-fish species accounted for only 28.1% ($n = 16$, both seasons included). In addition to the prey-fish, one frog (*Pelophylax* sp.) was found in the diet of one pike in the autumn of 2011.

During the 33 days of angling in the spring of 2012, the European weather loach was identified in the diet of the pike on 7 days in March ($n = 36$) and on 5 days in April ($n = 5$). The highest observed daily number of European weather loach was 11 (March 20) in the stomachs of four pike, while the highest number per pike was seven individuals (March 22). The mean length of the pike individuals that consumed the European weather loach

was 55.8 ± 5.77 (SD, range: 40–67) cm, while the mean length of the prey was 12.8 ± 3.04 (SD, range: 9.8–21.0) cm. Previously published data on prey-fish species found in the diet of pike indicate that this is the first recording of relatively numerous occurrences of the European weather loach in the diet of the pike. The European weather loach is an endangered species, categorized as vulnerable in the IUCN Red List of Threatened Species. Since the end of the 19th century, the abundance of this species has declined as a consequence of the destruction of its habitat throughout Central and Eastern Europe. River regulation, the drainage of marshes in the lowlands, and widespread pollution of water bodies are the main threats that have led to major decline in habitat suitable for the European weather loach (Povž, 1996; Telcean and Cupşa, 2012; Freyhof, 2013).

In the Carpathian Basin, the second half of March is generally regarded as the postspawning period (the major

Table. The proportion of prey fish found in autumn 2011 and spring 2012 in the diet of pike.

Prey-fish species	Proportion of prey-fish individuals found in the diet of pike (%)	
	Autumn 2011	Spring 2012
<i>Esox lucius</i>	0.27	0.02
<i>Perca fluviatilis</i>	0.00	0.02
<i>Ictalurus nebulosus</i>	0.00	0.02
<i>Misgurnus fossilis</i>	0.00	0.90
<i>Carassius gibelio</i>	0.27	0.00
<i>Rutilus rutilus</i>	0.09	0.02
<i>Scardinius erythrophthalmus</i>	0.36	0.00
<i>Blicca bjoerka</i>	0.00	0.02

spawning period is the second half of February and the first half of March) when the pike start to feed intensively to replace energy spent in the exhausting reproduction period. During spring (the postspawning period of pike), the European weather loach start to feed intensively before spawning in late spring. In consequence of their intensive foraging movements, they may become easy prey for the pike, which would be a reasonable explanation of the findings of this study. In contrast, the absence of the European weather loach from the diet of the pike in late autumn of 2011 may be explained by the low water temperature in November, when this species is in its wintering phase, hidden in the mud.

On the other hand, 51 prey-fish species were recorded in the stomachs of pike in different studies (scientific names are given in alphabetical order): *Abramis brama*, *Alburnus alburnus* (Mérő, 2014), *Anguilla anguilla* (Mann, 1982; Adams, 1991), *Aphanius anatoliae* (Alp et al., 2008), *Atherina boyeri* (Lorenzoni et al., 2002), *Barbus bocagei* (Dominguez and Pena, 2000), *Blennius fluviatilis* (Elvira et al., 1996), *Carassius carassius* (Guti et al., 1991), *C. gibelio* (Alp et al., 2008; Mérő, 2014), *Chondrostoma meandrense* (Alp et al., 2008), *C. polylepis* (Dominguez and Pena, 2000), *Cobitis calderoni* (Dominguez and Pena, 2000), *C. taenia* (Lorenzoni et al., 2002; Alp et al., 2008), *Coregonus lavaretus* (Adams, 1991), *Cottus gobio* (Mann, 1982; Kekalainen et al., 2008), *Ctenopharyngodon idella* (Mérő, 2014), *Cyprinus carpio* (Elvira et al., 1996; Dominguez and Pena, 2000), *Esox lucius* (Mann, 1982; Adams, 1991; Elvira et al., 1996; Beaudoin et al., 1999; Soupir et al., 2000; Dominguez and Pena, 2000; Kekalainen et al., 2008; Alp et al., 2008; Mérő, 2014), *Gambusia affinis* (Alp et al., 2008), *G. holbrooki* (Dominguez and Pena, 2000; Lorenzoni et al., 2002), *Gasterosteus aculeatus* (Adams, 1991; Beaudoin et al., 1999; Kekalainen et al., 2008), *Gobio gobio* (Mann, 1982; Elvira et al., 1996; Dominguez and Pena, 2000; Alp et al., 2008), *Gymnocephalus cernuus* (Adams, 1991; Kekalainen et al., 2008), *Hemigrammocapoeta kemali*

(Alp et al., 2008), *Hypophthalmichthys molitrix*, *Ictalurus nebulosus* (Mérő, 2014), *Lampetra fluviatilis* (Kekalainen et al., 2008), *L. planeri* (Mann, 1982), *Lepomis gibbosus* (Guti et al., 1991; Elvira et al., 1996; Lorenzoni et al., 2002; Mérő, 2014), *Leuciscus carolitertii* (Dominguez and Pena, 2000), *L. cephalus* (Alp et al., 2008), *L. leuciscus* (Mann, 1982), *Micropterus salmoides* (Elvira et al., 1996; Dominguez and Pena, 2000; Soupir et al., 2000; Lorenzoni et al., 2002), *Nemachilus barbatulus* (Mann, 1982; Kekalainen et al., 2008), *Oncorhynchus mykiss* (Dominguez and Pena, 2000), *Perca flavescens* (Beaudoin et al., 1999; Soupir et al., 2000), *P. fluviatilis* (Adams, 1991; Guti et al., 1991; Kekalainen et al., 2008), *Phoxinus phoxinus* (Mann, 1982; Adams, 1991), *Platichthys flesus* (Mann, 1982), *Pseudorasbora parva* (Mérő, 2014), *Pungitius pungitus* (Kekalainen et al., 2008), *Rhodeus sericeus* (Mérő, 2014), *Rutilus arcasii* (Dominguez and Pena, 2000), *R. rutilus* (Mann, 1982; Adams, 1991; Mérő, 2014), *Salmo salar* (Mann, 1982; Adams, 1991; Kekalainen et al., 2008), *S. trutta* (Mann, 1982; Adams, 1991; Dominguez and Pena, 2000), *Salvelinus alpinus* (Winfield et al., 2012), *Sander lucioperca* (Mérő, 2014), *Scardinius erythrophthalmus* (Guti et al., 1991; Lorenzoni et al., 2002; Mérő, 2014), *Thymallus thymallus* (Mann, 1982), and *Tinca tinca* (Dominguez and Pena, 2000; Lorenzoni et al., 2002; Alp et al., 2008).

In conclusion, we suggest that the European weather loach became easy pike prey in spring when their foraging movements were more intensive. The identification of the European weather loach in the diet of the pike is new information. In addition to contributing to knowledge on the broad feeding behavior of this predator, it furnishes valuable information on an endangered species featured on the IUCN Red List of Threatened Species.

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