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SIZE OF MARSH FROGS IN THE DIET OF EURASIAN OTTER IN SOUTHERN BULGARIA

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ABSTRACT - Our study was carried out in the south of Bulgaria, providing original data on the size of the marsh frog *Pelophylax ridibundus* (Pallas, 1771) in otter *Lutra lutra* (Linnaeus, 1758) diet. A method was devised for estimating the size of these anurans found as bone remains in otter spraints. A very strong positive correlation between the ileum's maximum width and frogs' standard body length was highlighted. The linear regression equation was: standard body length = 10.4 + 14.1 × ileum's maximum width. The mean body length of marsh frogs in otter spraints was 53.49 mm. During the warm season otters fed on about four times more diverse sized anurans. The size group 41-60 mm always dominated in otter diet, particularly in the cold season. It could be concluded that in the study area otters fed predominantly on juvenile and sub-adult marsh frogs.

Key words: Lutra lutra, *Pelophylax ridibundus*, Eastern Europe, anurans, body length

RIASSUNTO – ***Dimensioni di* Pelophylax ridibundus *predate dalla lontra nel sud della Bulgaria.*** La ricerca, condotta nella Bulgaria meridionale, ha fornito dati inediti circa le dimensioni degli esemplari di rana verde maggiore (*Pelophylax ridibundus* Pallas, 1771) predati dalla lontra *Lutra lutra* (Linnaeus, 1758), stimate a partire dai resti ossei indigeriti reperibili nelle feci del mustelide. Una netta correlazione positiva è stata evidenziata tra la larghezza massima dell'ileum e la lunghezza totale standard degli esemplari esaminati. La regressione lineare ha fornito l'equazione: lunghezza totale = 10,4 + 14,1 × larghezza massima dell'ileum. La lunghezza media degli esemplari predati è risultata pari a 53,49 mm. Durante la stagione calda, le lontre utilizzano una varietà di taglie quattro volte maggiore che nella stagione fredda. La classe 41-60 mm è risultata sempre predominante, particolarmente nel periodo freddo, suggerendo che le lontre predano soprattutto individui giovani e sub-adulti.

Parole chiave: Lutra lutra, *Pelophylax ridibundus*, Europa orientale, Anuri, lunghezza totale

INTRODUCTION

Despite several relatively detailed studies on Eurasian otter (*Lutra lutra* Linnaeus, 1758) diet carried out in Europe, knowledge about the size of its prey still shows some gaps (Kruuk, 2006). Some methods, such as regression equations, have been developed to assess the size of fish prey from the length of preserved bones found in otter spraints (Libois *et al*., 1988; Copp and Kovač, 2003; Hajkova *et al*., 2003; Beyer *et al*., 2006). The size of crayfish has

been estimated using the size of their uropod endopodities (Mcfadden and Fairley, 1984). Amphibians are predated by the otter throughout its European range (Clavero *et al*., 2003), constituting an important part of otter diet in many locations (Erlinge, 1972; Adrian and Delibes, 1987; Brzezinski *et al*., 1993; Beja, 1996; Sulkava, 1996; Clavero *et al*., 2005). Their size has been studied mainly for the most widely distributed European species, the common frog *Rana temporaria* Linnaeus, 1758 (Libois *et al*., 1987; Weber, 1990). Till now no information has been available on the size of marsh frog *Pelophylax ridibundus* (Pallas, 1771) preyed on by otters and no method has been developed for its estimation, although marsh frogs represent an important food source for otters in the southeast of Europe (Macdonald and Mason, 1985; Prigioni *et al*., 1986; Georgiev, 2006). Consequently our study aimed to investigate the body length of marsh frogs in otter diet in southern Bulgaria.

STUDY AREA AND METHODS

The study was conducted in southern Bulgaria between 2005 and 2007. Otter spraints (N = 2183) were collected from various habitats - rivers, streams, canals, lakes, dams, ponds and other suitable otter sites in Bulgaria (Georgiev, 2005) - in the catchments of the rivers Maritza and Tundza (total surface of the catchments - 28968 km^2, 26.1% of the whole surface of Bulgaria). Otter faeces were softened in 75% ethanol and prey items were separated and identified under a binocular microscope. In the southern regions of its distribution range, the marsh frog hibernates from November-December to February (Kuzmin, 1999), so we decided to investigate frog size variation in otter diet between the active and wintering seasons splitting up our data into a warm season (spring-summer) and a cold one (autumn-winter). The variance (CV) was calculated to highlight the variation of frogs' size in the spraints.

A total of 33 individuals of *Pelophylax ridibundus* (wet preparations) from the collections of the Faculty of Biology of Plovdiv University were measured. The standard length of the body was estimated using a caliper, measuring from the tip of the muzzle to the cloaca. Skull bones and pelvis are usually used for frog species identification (Marz and Banz, 1987; Felix and Montori, 1986). The first ones are rare in otter spraints, whilst ilia are relatively abundant (Sulkava, 1996; Clavero *et al*., 2005). Accepting that the front part of the ilia were diagnostic in distinguishing European anurans (Marz and Banz, 1987), we chose to measure the maximal width of the bone (extracted from the individuals studied), at the level of processus superior (Fig. 1). The correlation index (r) was used to highlight any relationship between the maximum width of the ileum and the standard body length of frogs. Finally, a regression equation (y = a + bx) was built for estimating the size of frogs preyed on by otters from bone remains.

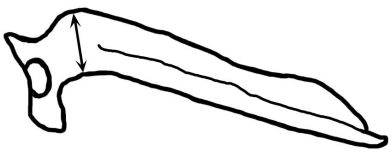

Figure 1 - Measuring point of the ileum of the marsh frog.

The chi-square (χ^2) test was used to compare the frequency of occurrence in otter diet of four frog size classes (21-40, 41-60, 61-80, >80 mm) in the two sampling seasons. Mann-Whitney's U test was used to check for seasonal variation in the mean length of frogs.

RESULTS AND DISCUSSION

The ileum's maximum width showed a strong positive correlation with frogs' standard body length (r = 0.97). The resulting linear regression equation was: standard body length = 10.4 + 14.1 × ileum's maximum width.

In our study area, anurans were found in 667 out of 2183 spraints (30.55%). As a whole, bone remains from legs dominated in the spraints (N = 626, 93.85%). In second place were the bones of the front and hind girdles (N = 270, 40.48%), followed by skull fragments (n = 110, 16.49%), whilst vertebrae were the rarest anuran bones (N = 87, 19.68%).

A total of 93 marsh frog specimens were determined by the well preserved ilia, whilst only 10 by skull bones.

The mean body length of marsh frogs preyed upon by otters was 53.49 mm (N = 93, min-max = 24.50-134.48 mm, SD = 16.83). Mean frog size did not show a significant seasonal variation (U = 1032, n.s.), being 55.45 mm in spring-summer, (N = 42, min-max = 24.50-134.48, SD = 22.17) and 51.87 mm in autumn-winter, (N = 51, min-max = 31.55-87.95, SD = 10.59). In spring and summer, otters mostly preyed on 41-60 mm long specimens (n = 20, 47.62%; χ^2 = 20.44, P<0.001, 3 d.f.), (Fig. 2). In second place were the frogs sized 61-80 mm (N = 12, 28.57%), followed by those of 21-40 mm (N = 7, 16.67%), and >80 mm (N = 3, 7.14%). During autumn and winter the prey size groups were graded with the same hierarchy but with different proportions. A sharp dominance of 41-60 mm long frogs was found (N = 40, 78.43%; χ^2 = 104.8, P<0.0001, 3 d.f), whilst the frequency of the other size groups was negligible (61-80 mm, N = 6, 11.76%; 21-40 mm, N = 4, 7.84%; >80 mm, N = 1, 1.96%).In particular, otters preyed on more 41-60 mm long frogs in the cold season (χ^2 = 9.55, P<0.002, 1 d.f.) and more 61-80 mm long frogs in the active period (χ^2 = 4.17,

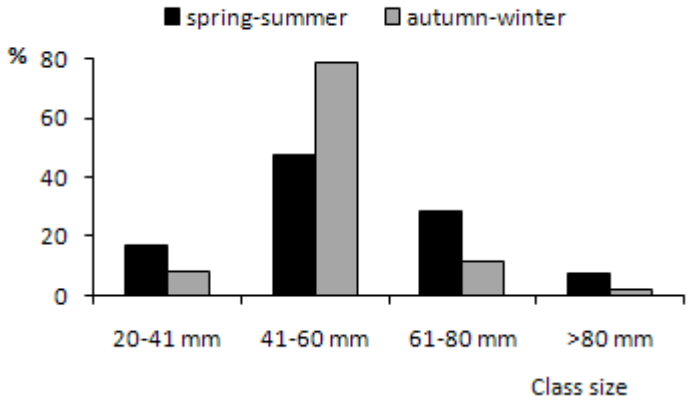

Figure 2 - Size distribution of marsh frogs preyed on by otters during the warm and cold seasons of southern Bulgaria.

P<0.04, 1 d.f.). During the warm season otters fed on about four times more diverse sized anurans (CV = 491.49) than in the cold season (CV = 112.14). Accepting that the marsh frog reaches sexual maturity when its body length is 60-70 mm (Kuzmin, 1999) and that adult males are smaller than females (in Bulgaria: ♂ 90-100 mm, ♀ 120-140 mm; Stoyanov, 2007), it could be concluded that in our area otters fed mainly on juvenile and subadult marsh frogs, possibly with a predominance of males. The variety of frog sizes in otter diet was probably a consequence of the relative availability of the different prey size groups during seasons. The prevalence of 61-80 mm long frogs in spring-summer with respect to the cold period could be due to the predation of reproductive specimens by otters. At the end of summer most tadpoles have passed through metamorphosis and frogs are reaching the body length of 41-60 mm (Kuzmin, 1999). Moreover, they possibly hibernate into more accessible sites to predators and are more easily predated. During the active warm season we observed that larger marsh frogs move very rapidly in the water, whilst smaller ones spent their time mostly on riverbanks hiding in the grass vegetation. So their capture probably provides the otters the best ratio between the energy spent for capture and energy intake.

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REFERENCES

Adrian M. and Delibes M. 1987. Food habits of the otter (*Lutra lutra*) in 2 habitats of the Donana National Park, SW Spain. *Journal of Zoology*, London, 212(33): 399-406.

Beja P. 1996. An analysis on otter *Lutra lutra* predation on introduced American crayfish *Procambarus clarkii* in Iberian streams. *Journal of Applied Ecology*, 33: 1156-1170.

Beyer K., Miranda R., Copp G. and Gozlan R., 2006. Biometric data and bone identification of topmouth gudgeon, *Pseudorasbora parva* and sunbleak, *Leucaspius delineatus*. *Folia Zoologica*, 55(3): 287-292.

Brzezinski M., Jedrzejewski W. and Jedrzejewska B. 1993. Diet of otters (*Lutra lutra*) inhabiting small rivers in the Bialowieza National Park, eastern Poland. *Journal of Zoology*, London, 230: 495-501.

Clavero M., Prenda J. and Delibes M. 2003. Trophic diversity of the otter (*Lutra lutra* L.) in temperate and Mediterranean freshwater habitats. *Journal of Biogeography*, 30: 761-769.

Clavero M., Prenda J. and Delibes M. 2005. Amphibian and reptile consumption by otters (*Lutra lutra*) in a Coastal area in southern Iberian Peninsula. *Herpetological Journal*, 15: 125-131.

Copp G. and Kovac, V. 2002. Biometric relationships between body size and bone lenghts in fish prey of the Eurasian otter *Lutra lutra*: chub *Leuciscus cephalus* and perch *Perca fluviatilis*. *Folia Zoologica*, 52(1): 109-112.

Erlinge S. 1972. Interspecific relations between otter (*Lutra lutra*) and mink (*Mustela vison*) in Sweden. *Oikos*, 23: 327-335.

Felix J. and Montori A. 1986. Determinacion de las especies de anfibios anuros del nordeste iberico mediante el hueso ilion. *Miscelanea Zoologica*, 10: 239-246.

Georgiev D. 2005. Habitats of the otter (*Lutra lutra* L.) in some Regions of Southern Bulgaria. *IUCN Otter Specialist Group Bulletin*, 18(1): 6 - 13.

Georgiev D. 2006. Diet of the otter *Lutra lutra* in different habitats of South-Eastern Bulgaria. *IUCN Otter Specialist Group Bulletin*, 23 (1): 4 - 10.

Hajkova P., Roche K. and Kocian L. 2003. On the use of diagnostic bones of brown trout, *Salmo trutta* m. *fario*, grayling, *Thymallus thymallus* and Carpathian sculpin, *Cottus poecilopus* in Eurasian otter, *Lutra lutra* diet analysis. *Folia Zoologica*, 52(4): 389-398.

Kruuk, H. 2006. Otters: ecology, behaviour and conservation. Oxford University Press, Oxford.

Kuzmin S. 1999. The Amphibians of the former Soviet Union. Pensoft Publishing, Sofia-Moskow.

Libois R., Philppart J., Rosoux R. and Vraken M. 1982. Quel avenir pour la loutres en Belgique? *Cahiers d`Ethologie appliqué*, 2: 1-15.

Libois R., Hallet-Libois C. and Lafontaine L. 1987. Le regime de la loutre *Lutra lutra* en Bretagne interieure. *Review Ecololgie*, 42: 135-144.

Macdonald S. and Mason C. 1985. Otters, their habitat and Conservation in Northeast Greece. *Biological Conservation*, 31: 191-210.

Marz R. and Banz K. 1987. Gewöll- und Rupfungskunde. Acad. Verlag Berlin, Berlin.

Prigioni C., Bogliani G. and Barbieri F. 1986. The otter *Lutra lutra* in Albania. *Biological Conservation*, 36: 375-383.

Stoyanov A. 2007. Order Anura. In: Biserkov V. (ed.), A Field Guide to Amphibians and Reptiles of Bulgaria. Green Balkans,39-63. [In Bulgarian with English summary]

Sulkava R. 1996. Diet of otters *Lutra lutra* in central Finland. *Acta Theriologica*, 41: 395-408.

Weber J. 1990. Seasonal exploitation of amphibians by otters (*Lutra lutra*) in north-east Scotland. *Journal of Zoology*, London, 220: 641-651.