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**Presence of an Invasive Fish Species, *Carassius gibelio* (Bloch, 1782)
in the Diet of the Dice Snake, *Natrix tessellata* (Laurenti, 1768)**

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Abstract: This study provides a description of the dice snake, *Natrix tessellata* (Laurenti, 1768) diet from a temperate lake (Lake Iznik) in the Marmara region, Turkey. A total 17 prey items belonging to three species were identified from the dice snake stomachs examined. Prussian carp, *Carassius gibelio* (Bloch, 1782) constitute the dominant group by weight (97.36%), freshwater blenny, *Salaria fluviatilis* (Asso, 1801) and spined loach, *Cobitis vardarensis* Karaman, 1928 are assumed to be incidental prey. Predation effect of dice snake on dangerous invasive fish species like prussian carp would be very important for controlling of these fish species in their new habitats.

Key words: *Natrix tessellata*, *Carassius gibelio*, prey-predator relationship, Lake Iznik

Introduction

Depredation of fish stocks by piscivorous fauna in inland waters has long been a contentious fishery management issue (Cowx, 2003). This fauna consist of fish (Mann and Beaumont, 1980; Fickling and Lee, 1981), birds (Raven, 1986; Adams and Mitchell, 1995; Veldkamp, 1997), mammals (Wise, 1980; Prenda and Granado-Lorencio, 1992) and water snakes (Luiselli and Rugiero, 1991; Santos *et al.*, 2000). Among these populations, water snakes are particularly important as they are known to preferably feed on fishes (Greene *et al.*, 1994; Aldridge *et al.*, 2003). Water snakes are widely distributed and abundant. They are also plastic in their ecology, both spatially and temporally, in response to variation in resources (Gregory and Isaac, 2004).

Some aspects of the natural history of water snakes have been well studied. Their feeding ecology (Greene *et al.*, 1994; Himes, 2003), reproduction (Madsen and Shine, 1993; Brown and Weatherhead, 2004) and evolution and phylogeny (Guicking *et al.* 2006) are well known. However, their predation effect on fish has usually been neglected or poorly understood.

Dice snake, *Natrix tessellata* is a common water snake in much of its distribution range. This is a species associated with rivers, streams, lakes, ponds and the surrounding terrestrial habitat. This species lays a clutch of between 5 and 37 eggs (Cox and Rondinini, 2005). Dice snake is widespread in suitable biotopes in most part of Turkey (Basoglu and Baran, 1988; Ugurtas *et al.*, 2000; Baran *et al.*, 2001; Gocmen and Bohme, 2002). This species also inhabits in Lake Iznik and its occurrence in the lake was first given by Yildirimhan *et al.* (1996) with a study on helminth fauna of dice snake. Lake Iznik is located in Bursa province, between the towns Orhangazi and Iznik (40°23' to 40°30' N: 29°30' to 29°42' E) at an altitude of 80 m. In the lake, 19 fish species present and 3 of

them were introduced species (Ozulug *et al.*, 2005a). One of the most important introduced fish species in the lake is sand smelt, *Atherina boyeri* Risso, 1810. In last a few decades, population of this species has considerably increased and become important in the economy of Iznik town as it is imported to some Mediterranean countries (Gaygusuz, 2006). Another important introduced species is prussian carp, *Carassius gibelio* (Bloch, 1782), introduced into the lake by local fisherman 5-6 years ago (personal communication). After its introduction, this species has established sound population in the lake (Gaygusuz *et al.*, 2005). Due to lack of predator fish species (Ozulug *et al.*, 2005a), their only possible natural enemies are water snakes which are very abundant in the lake (Gaygusuz, 2006) and water birds. Up to the date, studies on dice snake were related to its occurrence and taxonomy (Ugurtas *et al.* 2000; Baran *et al.*, 2001; Gocmen and Bohme, 2002) and to the best of our knowledge no information is available on the diet of dice snake from Turkish waters.

Here, the aim of present study was to emphasize presence of fish in the diet of dice snake living in Lake Iznik and suggested that this finding would be considerable for estimating vulnerable size range and accurate estimates of fish species consumed by dice snake. Since dice snake primarily feed on fishes and catch them by diving in water or from the shore, we hypothesized that abundant fish species, especially which was introduced to the lake could be found in the dice snake diet.

Materials and Methods

We caught 16 dice snake individuals from Lake Iznik in 29 July 2004. These snakes were caught with gillnets which aims in fact to catch fishes from the lake. The snakes were then transported to the laboratory for further analysis. They were identified according to the Basoglu and Baran (1988). Length measurements were taken to the nearest millimetre in a straight line via meter board. Length of each snake individual was measured from the snout to the end of tail. Body mass was weighted to the nearest 0.01 g total weight (W). Sex was determined by examination of the gonad tissue by eye. Stomach content was examined by sorting prey items (Fig. 1) by naked eye and substantially preserved 10% formalin. Each prey fish was identified to the lowest taxon. Total length, standard length and weight of each prey fish were determined. Hard parts (e.g., operculum, cleithrum, pharyngeal bones,



Fig. 1: Prey fishes in the stomach of *Natrix tessellata*

dorsal and anal spines) found in the stomach content of dice snake were used as the primary means of classification of fishes. They were measured to the nearest 0.1 mm by a digital calliper. Prey fish lengths (TL, cm) were estimated from these measurements by non-linear equations given by Acipinar *et al.* (2004), then fish weights was obtained from length-weight relationships of fishes in Lake Iznik (Tarkan *et al.*, 2005).

Results and Discussion

Nine female and 7 male dice snake individuals were examined. Lengths and weights of the species varied between 59-92 cm and 58.1-205 g, respectively. Stomachs of 7 dice snake individuals were empty. The stomach content of the individuals examined includes 17 individuals belonging to three fish species. Of all prey fishes were identified according to Berg (1949) and Banarescu (1964) (Table 1). Prussian carp constitute the largest component by weight (97.36%), freshwater blenny, *Salaria fluviatilis* and spined loach, *Cobitis vardarensis* were other preys of minor proportion (2.64%) (Table 1). Smallest prey species was 3.3 cm (total length) and 0.3 g (spined loach) while largest one was 5.9 cm (total length) and 3.1 g (prussian carp).

Three fish species identified are encountered for the first time in the dice snake diet. These findings have revealed that dice snake diet generally reflects the species and length composition of the fish populations within their habitat. The most striking finding was dominance of prussian carp in the stomach content of dice snake. Prussian carp is considered to be an invasive species (Ozulug *et al.*, 2004) and has spread many natural and artificial water bodies in Turkey (Gaygusuz *et al.*, 2005) after its first report in European part of Turkey in 1988 (Baran and Ongan, 1988). This species is well known as a hazardous fish species for native fish communities (Ozulug *et al.*, 2005b). It may easily become one of the dominant species in stagnant and slow running waters and change the flow of nutrients in the whole ecosystem (Paulovits *et al.*, 1998). The species would be crucial in the future with its impacts on native fish species as severe competitor in Lake Iznik.

Even though sand smelt is also very abundant in the lake, we did not find any individual of this species in the diet of dice snake. This phenomena may attributed to the habitat preferences and schooling behaviour of sand smelt. They are pelagic fish species (Bardin and Pont, 2002) and especially concentrated at depths of 10 to 20 m (Yusufova, 1970) which is usually not preferred by dice snake. As the dice snake populations continue to establish, the possibility remains that fish stocks in managed, still waters will be a target for this species diet. Its predation effect on fish which is especially on dangerous invasive species would be very important for controlling of these fish species inhabiting in the aquatic ecosystems.

Table 1: Prey species and number in the stomach of *Natrix tessellata*

Prey item	N	TW (g)	W (%)
Teleostei			
Cyprinidae			
<i>Carassius gibelio</i> (Bloch, 1782)	15	29.5	97.36
Blenniidae			
<i>Salaria fluviatilis</i> (Asso, 1801)	1	0.3	0.99
Cobitidae			
<i>Cobitis vardarensis</i> Karaman, 1928	1	0.5	1.65
Total	17	30.3	100

N, number of specimens; TW, total wet weight (including estimated weight for prey fishes based on equations given by literature); W (%), percentage of the total weight of all food items

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