MERTENSIELLA **18** | 365-369 | 20 September 2011 | ISBN 978-3-9812565-4-3

A Preliminary Study on the Feeding Biology of the Dice Snake, *Natrix tessellata,* in Turkey

Bayram Göçmen, Kerim Çiçek, Mehmet Z. Yildiz, Mehmet K. Atatür, Yunus E. Dinçaslan & Konrad Mebert

Abstract. Food composition of the Dice snake, *Natrix tessellata,* was studied in the Anatolian part of Turkey. A total of 76 prey items were recorded from 51 museum specimens and compared between sexes and age groups. The diet of *N. tessellata* consists almost entirely of fishes (72.4%). The remaining stomach contents were insects (7.9%), gastropods (2.6%), amphibians (14.5%), reptiles (1.3%), and mammals (1.3%). Our results confirm that Turkish *N. tessellata* forage predominantly in water. Food composition did not differ significantly between sexes and age groups, but the largerst prey items were consumed by relatively large females.

Key words. Squamata, Serpentes, *Natrix tessellata*, food composition, Turkey

Zusammenfassung. Eine Nahrungsanalyse von Würfelnattern, *Natrix tessellata,* aus dem anatolischen Teil der Turkei wurde vorgenommen. Ein Total von 76 Beutetieren wurde in 51 Museumsexemplaren gefunden und zwischen den Geschlechtern und Altersgruppen verglichen. Die Nahrung der *N. tessellata* bestand fast gänzlich aus Fischen (72.4%). Die übrigen Magenbefunde waren Insekten (7.9%), Schnecken (2.6%), Amphibien (14.5%), Reptilien (1.3%), und Säuger (1.3%). Unsere Resultate bestätigen, dass *N. tessellata* hauptsächlich im Wasser auf Nahrungssuche geht. Es gab keine deutliche geschlechtsspezifische oder altersbedingte Unterschiede in der Nahrungswahl, außer dass die größten Beutetiere von relativen großen Weibchen konsumiert wurden.

Introduction

Snakes can be expected to exhibit unusual feeding habits compared to other ectothermic vertebrates because of their elongated morphology and ecological characteristics, e.g. being obligate carnivores, swallowing their prey whole, and preferring a solitary life style. Analyses of global feeding preferences in snakes are ideally suited to illustrate the unusual nature of feeding behavior of these fascinating animals (Luiselli 2006).

The majority of snake species inhabiting the Mediterranean region have a large geographical distribution (e.g. Bruno & Maugeri 1990, Schultz 1996) and are ecologically little specialized (e.g. Pleguezuelos & Moreno 1990, Luiselli & Agrimi 1991, Capula & Luiselli 2002, Pleguezuelos & Fahd 2004, Filippi et al. 2005, Luiselli et al. 2005, Santos et al. 2005). The dice snake, *Natrix tessellata*, is a medium sized semi-aquatic snake with a maximum length of around 130 cm (Gruschwitz et al. 1999). While there are several studies on the feeding habits of *N. tessellata* (e.g. Laňka 1978, Luiselli & Rugiero 1991, Lenz & Gruschwitz 1993, Filippi et al. 1996, Zimmermann & Fachbach 1996, Luiselli et al. 2007), there are no detailed studies describing diets or feeding behavior in Turkish populations.

The aim of the present work is to determine the types and diversity of prey consumed by dice snakes, *Natrix tessellata*, of Anatolia, to contribute to the general knowledge of the ecology of Turkish populations of this species.

Materials and Methods

We examined the stomach contents of 51 preserved specimens of *Natrix tessellata* (15 males, 20 females, 16 juveniles) from the herpetological museum at the Zoology Department, Ege University (ZDEU), collected from different parts of Anatolia, Turkey (see Appendix). We investigated stomach contents by making a midventral incision to open the stomach. We did not dissect type specimens or specimens in poor condition. For each specimen with prey in its stomach, we recorded its locality, snout-vent length (SVL), and total length (TL) in millimeters. The prey items were determined to the lowest possible taxonomic level. Snakes were grouped according to their sex and size (juvenile: < 280 mm SVL; adult: > 280 mm SVL). Adult size was based on a male with straw colored testes and the mentioned minimal length, presumably representing maturity (dissection by second author). Such small size of mature males is also reflected in the successfull reproduction event involving a one-year old *N. tessellata* under captive conditions (Trobisch-Gläßer & Trobisch 2001). The proportion of specific prey taxa in the diet of *N. tessellata* (n%) and the frequency of snakes containing a specific prey taxa (f%) was calculated. Some stomach contents included pebbles and soil particles. However, we assume that this material was ingested accidentally during feeding, and, hence, we did not consider it as a part of the diet.

To estimate the similarity in the diet between adults, juveniles and the sexes, Pianka's overlap index (Pianka 1973) was applied. This index varies between 0 (no similarity) and 1 (large similarity). Food-niche breadth was

calculated using Shannon's index (Shannon 1948). Undetermined prey items were not considered in our calculation of food-niche breadth and similarity. All niche calculations were done using the "EcoSim 700" program (Gotelli & Entsminger 2009) and all statistical analyses were performed using SPSS 10.0 with the alpha level set at 5%.

Results

Sexes differed in SVL (Student's t-test, $t_{1, 49} = 3.130$, $P = 0.003$) and TL ($t_{1, 49} = 3.018$, $P = 0.004$) with females being slightly larger than males (Tab. 1). A total of 76 prey items were retrieved and determined from the stomachs. All snakes contained prey. The number of prey items in a stomach varied between 1 and 5 (mean: 1.0 ± 0.92). More than one prey item was found in 16 specimens (31.37%), the other 35 specimens (68.62%) contained a single prey item. A comparison among males, females and juveniles showed no statistical difference in consuming distinct prey taxa (One-Way ANOVA, $F_{2, 48} = 2.595$, $P = 0.085$).

Members of four vertebrate groups (Actinopterygii, Amphibia, Reptilia, and Mammalia) and two invertebrate groups (Gastropoda, Insecta) were found in the stomach contents (Tab. 2). Fish constituted the primary prey group consumed (n% = 72.4%). Among the prey groups, the most diverse one was Insecta (7.9%) with four families identified: Carabidae (1.3%), Scarabaeidae (2.6%), Dytisciade (1.3%), and Formicidae (2.6%). Gastropods (2.6 %) were detected only in males, while both sexes contained insects. Interestingly, only *Dytiscus marginalis* is an aquatic species. Largest prey ingested were the fish *Esox lucius* (approx. TL 230 mm), the lizard *Lacerta trilineata* (approx. TL 200 mm) and a mouse *Dryomys nitedula* (approx. TL 320 mm), which all were found in large females *N. tessellata* (TL= 88.70; 85.80; 91.50 mm respectively).

Only 14.4% of the food content consisted of terrestrial prey items (members of Carabidae, Scarabaeidae, Formicidae, Bufonidae, Lacertidae, Gliridae), whereas the remaining 85.6% were aquatic prey. The large majority of the food contents (89.5%) consisted of vertebrates. As suggested by Pianka's niche overlap index, the two sexes shared a large similarity in their diet (Tab. 3). Food niche breadth (Shannon's index) was 0.872, 0.838 and 0.798 in males, females and juveniles, respectively.

Discussion

Based on our data, *Natrix tessellata* appears to be predominantly piscivorous in Anatolia, which concurs with most observations from other regions (see refs. in Gruschwitz et al. 1999), but also from Turkey (Franzen et al. 2008). However, the proportion of fish items in the diet of *N. tessellata* can vary greatly. For example, in populations from Central Italy, it ranged from 59.25% (Luiselli & Rugiero 1991), 60-66% (Bagnoli 1985), to approximately 97% (Filippi et al. 1996, Luiselli et al. 2007) and to 98% in southern Austria (Zimmermann & Fachbach 1996). Besides fish, the second largest proportion on prey items in *N. tessellata* consists of amphibians, mostly anurans and often their tadpoles, which are consumed by juvenile snakes (Luiselli et al. 2007). The proportion of amphibian diet in *N. tessellata* varies geographically to approximately complement the missing fish diet (see review in Gruschwitz et al. 1999). For example, Darevskij & Terentev (1967) pointed out that in Russian populations 58% of the prey consisted of fishes, the remainder being amphibians. In some Asian population, *N. tessellata* consumes more amphibians than fish, with some sites lacking fish whereas others contain an abundance of fish (see Esterbauer 1985, 1994 for southwestern Syria; Selkownikov cit. in Nikolskij 1916 for Azerbaijan; and Hecht 1930 for mountain streams of western Asia). The proportion of amphibian diet is much smaller in populations of *N. tessellata* from Western Europe. Although, the complementing proportion in the diet of central Italian *N. tessellata* consisted mostly of amphibians, it constitutes a small portion. For example, Filippi et al. (1996) found that less than 3% of prey items consisted of the anurans *Rana italica* and *Bufo bufo*. Also in Italy, Luiselli et al. (2007) found between 1.1-4.7% of anuran prey. Interestingly, such geographic variation appears to have an influence on the head morphology of *N. tessellata* (Brecko et al. 2011). Our dietary results of *N. tessellata* across a broad area in Anatolia indicate a medium level of fish consumption with 72.4% fish prey.

The overall high freqeuncy of aquatic prey in the diet of Anatolian *N. tessellata* confirms that this species in our study area principally forages in water, hunting for fish that it ingests under-water or on land. According to Schaeffel & Mathis (1991), underwater vision is well developed in *N. tessellata* and superior in comparison to its congener *N. natrix*, which is specialized on anuran

Table 1. Morphometric data (mean, standard deviation, min.–max.) for Anatolian *Natrix tessellata* in mm; snout–vent length (SVL) and total length (TL).

	SVL	TL
Males ($n = 15$)	478.6 (12.61) 310.0 – 860.0	599.7 (10.75) 390.0 – 812,0
Females ($n = 20$)	564.3 (14.07) 288.0 – 850.0	701.0 (17.30) 370.0 – 1060.0
Juveniles ($n = 16$)	221.0 (3.20) 160.0 – 280.0	280.0 (3.65) 220.0– 350.0

Table 2. Food composition of Anatolian *Natrix tessellata* (*n* = 51; 15 males, 20 females, 16 juv.). n (%): absolute number of a particular prey taxa; (proportion of that particular prey taxon compared to all prey taxa found); f (%): absolute number of snakes containing a particular prey taxa (proportion of snakes containing a particular prey taxon).

	Number of Prey Items (n%)			Total n %	Total f %
Prey taxa	M	F	J		
Gastropoda, Pulmonata	2 (8.3)			2 (2.6)	2 (3.9)
Lymnaeidae, *Lymnaea* sp.	1 (4.2)			1 (1.3)	1 (2.0)
Planorbidae, *Planorbis* sp.	1 (4.2)			1 (1.3)	1 (2.0)
Insecta	2 (8.3)	2 (7.7)	2 (7.1)	6 (7.9)	4 (7.8)
Coleoptera		2 (7.7)		2(2.6)	2(3.9)
Carabidae, *Carabus* sp.		1 (3.8)		1 (1.3)	1 (2.0)
Scarabaeidae			2 (9.1)	2 (2.6)	1 (2.0)
Dytiscidae, *Dytiscus marginalis*		1 (3.8)		1 (1.3)	1 (2.0)
Hymenoptera, Formicidae	2 (8.3)			2 (2.6)	1 (2.0)
Actinopterygii	17 (70.8)	19 (73.1)	19 (67.9)	55 (72.4)	41 (80.4)
Cypriniformes	12 (50.0)	9 (34.6)	12 (42.9)	38 (43.4)	21 (41.2)
Cyprinidae, *Cyprinus carpio*	1 (4.2)		1 (3.6)	2 (2.6)	2 (3.9)
Cyprinidae, *Carassius carassius*	1 (4.2)	3 (11.5)	3 (10.7)	7 (9.2)	7 (13.7)
Cyprinidae, *Alburnus* sp.	2 (8.3)	3 (11.5)	2 (7.1)	7 (9.2)	5 (9.8)
Cyprinidae, *Leuciscus cephalus*			1 (3.6)	1 (1.3)	1 (2.0)
Esociformes		1 (3.8)		1 (1.3)	1 (2.0)
Esocidae, *Esox lucius*		1 (3.8)		1 (1.3)	1 (2.0)
Amphibia	3 (12.5)	1 (3.8)	7 (25.0)	11 (14.5)	6 (11.8)
Anura, Ranidae, *Pelophylax bedriaga*	3 (12.5)	1 (3.8)	2 (7.1)	6 (7.9)	4 (7.8)
Anura, Bufonidae, *Pseudepidalea variabilis* juv.			4 (14.3)	4 (5.3)	1 (2.0)
Urodela, Salamandridae, *Lissotriton vulgaris*			1 (3.6)	1 (1.3)	1 (2.0)
Reptilia, Lacertidae, *Lacerta trilineata*		1 (3.8)		1 (1.3)	1 (2.0)
Mammalia, Gliridae, *Dryomys nitedula*		1 (3.8)		1 (1.3)	1 (2.0)

diet. An increase in visual acuity underwater thus allows specialization towards fish prey in *N. tessellata*. Compared with other reptiles, *N. tessellata* is relatively more specialized with respect to feeding habits (Toft 1985).

Although 14.4% of the food content of *N. tessellata* consisted of terrestrial prey and included insects, reptiles and mammals, they represent animal species that also inhabit the shore zone of water bodies. We suggest that *N. tessellata* consumed such prey during their foraging activity along the shoreline or while moving into or out of the water. Although uncommon, such terrestrial prey has been variably reported by several authors (see review in Gruschwitz et al. 1999). But it cannot be excluded that terrestrial prey migth be consumed passively, either that they were in the stomach of the actual fish or frog prey of *N. tessellata,* or were picked up while floating accidentially on the water suface, as it is imaginable for insects. Here again, depending on the geographic location, such terrestrial and semi-aquatic prey items show different frequencies in the stomach content of *N. tessellata*. This shows that feeding of the species is not fixed to fish and does exhibit some plasticity for the selection of prey, possibly depending on their availability.

The larger size of female *N. tessellata* has been previously reported from many areas throughout its distribution (see review in Gruschwitz et al. 1999, Zimmermann & Fachbach 1996, Luiselli et al. 2007). Sexual dimorphism in body size has been related primarily to fecundity selection, which favors an increase in maternal abdominal volume (Shine 1993). This might be achieved by larger body sizes only, as in Palearctic taxa of Natricinae including *N. tessellata* (Mebert 1993, Gruschwitz et al. 1999), or an increase in body size and the number of ventral scales as in the genus *Nerodia*, American Natricinae related to *N. tessellata* (Mebert 2010). It is a common trait in aquatic and semi-aquatic snakes that females have also a larger head than males by equal SVL (Shine 1986) but in particular also for Natricinae (Gregory 2004) such as *N. tessellata* (Mebert 1993). The cephalic sexual-dimorphism may work in concert with a general larger body size of females to promote a different prey spectrum and ecological niche for each gender, in particular to gain extra energy to allocate to the growth of embryos (Shine 1991, 1993 or to restore energy after oviposition (Luiselli & Rugiero 2005). Luiselli et al. (2007) suggested that since females are larger, they also have a wider food spectrum, as their larger jaws allow ingesting larger prey. Their conclusion was supported by sexual dietary differences they found in Italian *N. tessellata* with an increased data set (Luiselli 2007), after the same group of authors did not de-

Table 3. Values of Pianka's overlap index on food composition (prey taxa) between sexes.

	Males	Females	Juveniles
Males	-	0.986	0.975
Females	0.986	-	0.954
Juveniles	0.975	0.954	-

tect such differences previously with a smaller sample from the same study site (see Filippi et al. 1996). Although, our results for populations from Anatolia indicate a strong similarity in prey taxa between males and females (Tab. 3), they corroborate the Italian findings. The females also showed a tendency to consume larger prey than males, in particular as the three largest food contents (a fish, a lizard, and a mouse) were all found in stomachs of female snakes. With this in mind and the relatively small sample size (n = 51) in our study compared to the Italian study (n = 2255), we can not decline the possibility of sex-dependent prey differences, in size or type.

Several authors have previously reported differences in feeding habits between adult and juvenile snakes, with adults typically displaying a broader food spectrum, e.g. for natricine snakes in *Afronatrix anoscopus* (Luiselli et al. 2003), or *Natrix natrix* (Luiselli & Rugiero 1991). In contrast, juveniles of *Natrix maura* (Santos & Llorente 1998) and *Nerodia rhombifer* (Plummer & Goy 1984, Gibbons & Dorcas 2004) showed a broader food spectrum. While our results are statistically not significant, they resemble more the results from the Italian studies led by L. Luiselli (see above) in that the food niche breadths of adults (Shannon's index: males = 0.872, females = 0.838) are slightly broader than that of juveniles (0.798). However, Table 3 shows that the food type composition was largely similar among the snake groups. But we can not preclude that this is an articfact of the relatively small sample size in our study (n with prey = 51)

N. tessellata inhabits wetlands that are widespread throughout Turkey (Baran & Atatür 1998, Budak & Göçmen 2008). For example, Demirsoy (1997) reported that *N. tessellata* is quite abundant in Turkey and suggested that the main factors endangering their survival are habitat degradation and destruction, the drying out of wetlands, pollution, and spreading urbanization. Although consequences of the increasingly prominent effects of global warming for the habitat of *N. tessellata* are not clear, we suggest the need of establishing sustainable policies in agricultural countries like Turkey as precautionary measurement. Because *N. tessellata* depends strongly on water, it will face threats by the destruction of wetlands. It is currently not listed in any category of the IUCN Red List of 2008 in Turkey and its status remains unclear. We therefore regard that providing an appropriate conservation status for *N. tessellata* in Turkey would be an important measure to ensure its future survival.

References

Bagnoli, C. (1985): Anfibi e Rettili della Provincia di Roma. – Provincia di Roma, Ass. Sanita e Ambiente, WWF Lazio, Italy.

Baran, I. & M.K. Atatür (1998): Turkish Herpetofauna (Amphibians & Reptiles). – Ministry of Environment, Ankara, Turkey.

Brecko, J., Vervust, B., Herrel, A. & R. van Damme (2011): The relationships between head morphology and diet in the dice snake (*Natrix tessellata*). – Mertensiella **18**: 20–29.

Bruno, S. & S. Maugeri (1990): Serpenti d' Italia e d' Europa. – Editoriale Giorgio Mondadori, Milano, Italy.

Budak, A. & B. Göçmen (2008): Herpetoloji. –Fen Fakültesi Kitaplar Serisi, **194**, Ege Üniversitesi Basımevi, Bornova, İzmir, E. Ü.

Capula, M. & L. Luiselli (2002): Feeding strategies of *Elaphe longissima* from contrasting Mediterranean habitats in central Italy. – Ital. J. Zool. **69**: 153–156.

Darevskij, I.S. & P.V. Terentev (1967): Estimation of energy flow through amphibian and reptile populations. – Proceedings of Working Meeting Jablonna 1966, Institute of Ecology, Polish Academy of Sciences: 181–197 (in Russian).

Demirsoy, A. (1997): Türkiye Sürüngenleri. – Monografi, Meteksan Yayınları, Meteksan Baskı Tesisleri, Ankara, Turkey.

Esterbauer, H. (1985): Zur Herpetofauna Südwestsyriens. – Herpetofauna **7**: 23–34.

Esterbauer, H. (1994): Lebensweise und Verhalten der Würfelnatter im Masil al Fawwar (Syrien). – DATZ **47**: 308–311.

Filippi, E., Capula, M., Luiselli, L. & U. Agrimi (1996): The prey spectrum of *Natrix natrix* (Linnaeus, 1758) and *Natrix tessellata* (Laurenti, 1768) in sympatric populations. – Herpetozoa **8**: 155–164.

Filippi, E., Rugiero, L., Capula, M., Capizzi, D. & L. Luiselli (2005): Comparative food habits and body size of five populations of *Elaphe quatuorlineata*: The effects of habitat variation, and the consequences of intersexual body size dimorphism on diet divergence. – Copeia **2005**: 517–525.

Franzen, M., Bussmann, M., Kordges, T. & B. Thiesmeier (2008): Die Amphibien und Reptilien der Südwest-Türkei. – Lauernti Verlag, Bielefeld, Germany.

Gibbons, J.W. & M.E. Dorcas (2004): North American Watersnakes. – University of Oklahoma Press, Norman, Oklahoma, USA.

Gotelli, N.J. & G.L. Entsminger (2009): EcoSim: Null Model Software for Ecology. – Version 7. Acquired Intelligence Inc. & Kesey-Bear. Jericho, VT 05465. Available at http://gary-entsminger.com/ecosim.htm.

Gregory, P.T. (2004): Sexual dimorphism and allometric size variation in a population of grass snakes (*Natrix natrix*) in southern England. – Journal of Herpetology **38**: 231–240.

Gruschwitz, M., Lenz, S., Mebert, K. & V. Laňka (1999): *Natrix tessellata* (Laurenti, 1768) – Würfelnatter. – In: Böhme, W (Ed.): Handbuch der Reptilien und Amphibien Europas, **Vol. 3**/Schlangen II. – AULA-Verlag, Wiesbaden, Germany: 581–644.

Hecht, G. (1930): Systematik, Ausbreitungsgeschichte und Ökologie der Europäischen Arten der Gattung *Tropidonotus* (Kuhl) H. Boie. – Mitt. Zool. Mus. Berlin, **16**: 244–393.

Laňka, V. (1978): Variabilität und Biologie der Würfelnatter (*Natrix tessellata*). – Acta Universitatis Carolinae, Biologica **1975–1976**: 167–207.

Lenz, S. & M. Gruschwitz (1993): Zur Autökologie der Würfelnatter, *Natrix t. tessellata* (Laurenti, 1768) (Reptilia: Serpentes: Colubridae) in Deutschland. – Mertensiella **3**: 235–252.

Luiselli L., Capizzi D., Filippi E., Anibaldi C., Rugiero L. & M. Capula (2007): Comperative diets of three populations of an aquatic snake (*Natrix tessellata*, Colubridae) from different Mediterranean streams with different hydric regimes. – Copeia **2007**(2): 426–435.

Luiselli, L & L. Rugiero (1991): Food niche partitioning by water snakes (genus *Natrix*) at a freshwater environment in central Italy. – Journal of Freshwater Ecology. **6**(4): 439–444.

Luiselli, L & L. Rugiero (2005): Individual reproductive success and clutch size of a population of the semi-aquatic snake *Natrix tessellata* from central Italy: Are smaller males and larger females advantaged? – Revue d'Ecologie (Terre et Vie) **60**: 77–81.

Luiselli, L. (2006): Broad geographic, taxonomic and ecological patterns of interpopulation variation in the dietary habits of snakes. – Web Ecology **6**:2–16.

Luiselli, L. & U. Agrimi (1991): Composition and variation of the diet of *Vipera aspis francisciredi* in relation to age and reproductive stage. – Amphibia-Reptilia **12**: 137–144.

Luiselli, L., Filippi, E. & M. Capula (2005): Geographic variation in diet composition of the grass snake (*Natrix natrix*) along the mainland and an island of Italy: The effects of habitat type and interference with potential competitors. – Herpetological Journal **15**: 221–230.

Luiselli, L., Akani, G.C., Angelici, F.M., Politano, E., Ude, L. & S.M. Wariboko (2003): Diet of the semi-aquatic snake, *Afronatrix anoscopus* (Colubridae) in southern Nigeria. – African Journal of Herpetology **52**: 123–126.

Mebert, K. (1993): Untersuchungen zur Morphologie und Taxonomie der Würfelnatter *Natrix tessellata* (Lauernti, 1768) in der Schweiz und im südlichen Alpenraum. – M.S. thesis, Zoological Museum, University of Zürich, Switzerland.

Mebert, K. (2010): Massive Hybridization and Species Concepts, Insights from Watersnakes. – VDM Verlag, Germany.

Nikolskij, A.M. (1916): Fauna of Russia and adjacent countries, **Vol. II**, Ophidia. – Israel Program for Scientific Translations, Jerusalem 1964.

Pianka, E.R. (1973): The structure of lizard communities. – Ann. Rev. Ecol. Syst. **4**: 53–74.

Pleguezuelos, J.M. & S. Fahd (2004): Body size, diet, and reproductive ecology of *Coluber hippocrepis* in the Rif (Northern Morocco). – Amphibia-Reptilia **25**: 287–301.

Pleguezuelos, J.M. & M. Moreno (1990): Alimentación de *Coluber hippocrepis* en el SE de la peninsula Iberica. – Amphibia-Reptilia **11**: 325–337.

Plummer, M.V. & J.M. Goy (1984): Ontogenetic dietary shift of water snakes (*Nerodia rhombifera*) in a fish hatchery. – Copeia **1984**: 550–552.

Santos, X. & G.A. Llorente (1998): Sexual and size-related differences in the diet of the snake *Natrix maura* from the Ebro Delta, Spain. – Herpetological Journal **8**: 161–165.

Santos, X., Llorente, G.A., Feriche, M., Pleguezuelos, J.M., Casals, F. & A. de Sostoa (2005): Food availability induces geographic variation in reproductive timing of an aquatic oviparous snake (*Natrix maura*). – Amphibia-Reptilia **26**: 183–191.

Shine, R. 1986. Sexual differences in morphology and niche utilization in an aquatic snake, *Acrochordus arafurae*. – Oecologia **69**: 260–267.

Shine, R. (1991): Intersexual dietary divergence and the evolution of sexual dimorphism in snakes. – American Naturalist **138**: 103–122.

Shine, R. (1993): Sexual dimorphism in snakes. – In: Seigel. R.A. & J.T. Collins (Eds.): Snakes: Ecology and Behaviour. – McGraw-Hill, New York, USA: 49–86.

Schaeffel, F. & U. Mathis (1991): Underwater vision in semiaquatic European snakes. – Naturwissenschaften **78**: 373–375.

Schultz, K.D. (1996): A Monograph of the Colubrid Snakes of the Genus *Elaphe* Fitzinger. – Koeltz Scientific Books, Wurselen, Germany.

Shannon, C.E. (1948): A mathematical theory of communication. – Bell System Technical Journal **27**: 379–423.

Toft, C.A. (1985): Resource partitioning in amphibians and reptiles. – Copeia **1985**: 1–20.

Trobisch-gläsSer & Trobisch (2001): Ein Mauerblümchen in der Terraristik: Die Würfelnatter *Natrix tessellata* (Laurenti, 1768). – Elaphe **9**(4): 17–24.

Zimmermann P. & G. Fachbach (1996): Verbreitung und Biologie der Würfelnatter, *Natrix tessellata tessellata* (Laurenti, 1768), in der Steiermark (Österreich). – Herpetozoa **8**(3/4): 99–124.

Appendix

Specimens examined

ZDEU. 20/1957, 1 female, 1 juvenile, Lake Nazik (Van); ZDEU. 78/1964, 1 juvenile, Burdur; ZDEU. 103/1965, 1 male, Kargıca Village, Silifke (Mersin); ZDEU. 98/1965, 1 male, Kadirli (Adana); ZDEU. 59/1967, 1 juvenile, Kozan (Adana); ZDEU. 129/1968, 1 juvenile, Karamürsel Airport (Kocaeli); ZDEU. 65/1968, 6 males, 3 females, 8 juv, Lake Apolyont (Bursa); ZDEU. 162/1969, 1 juvenile, Viranşehir (Şanlıurfa); ZDEU. 191/1969, 1 juvenile, Bitlis; ZDEU. 223/1969, 1 male, Çiftekayalar Village, Pınarbaşı (İzmir); ZDEU. 25/1971, 1 juvenile, Kemalpaşa creek (İzmir); ZDEU. 136/1996, 1 male, Aydınlı Village, Ereğli (Konya); ZDEU. 141/1996, 1 female, Yeniyıldız Village, Ulukışla (Niğde); ZDEU. 19/2003, 1 male, 1 female, Lake Eber (Afyonkarahisar); ZDEU. 21/2003, 2 females, Lake Karamık (Afyonkarahisar); ZDEU. 27/2003, 2 females, Lake Karamık (Afyonkarahisar); ZDEU. 23/2003, 2 females, 1 juvenile, Lake Akşehir (Afyonkarahisar); ZDEU. 27/2003, 2 females, Lake Akşehir (Afyonkarahisar); ZDEU. 24/2004, 1 male, Lake Karamık (Afyonkarahisar); ZDEU. 264/2005, 3 females, 2 females, Lake Beyşehir (Konya); ZDEU. 00/2008, 1 male, 1 female, Lake Sarıkum (Sinop).

Authors

Bayram Göçmen, Kerim Çiçek, Mehmet Kutsay Atatür, Ege University, Faculty of Science, Biology Department, Bornova, Izmir, Turkey, e-mail: kerim.cicek@ege.edu.tr; Mehmet Zülfü Yıldız, Harran University, Faculty of Arts and Sciences, Biology Department, Osmanbey Campus, Sanliurfa, Turkey; Yunus Emre Dinçaslan, Environmental Protection Agency for Special Areas, 35680 Eskifoça/İzmir, Turkey; Konrad Mebert, Siebeneichenstrassse 31, 5634 Merenschwand, Switzerland.