The population of *Mauremys rivulata* (VALENCIENNES, 1833) on the Island of Bozcaada, Turkey

The only freshwater habitat on the Turkish Island of Bozcaada (Greek name: Tenedos) is inhabited by a population of *Mauremys rivulata* (VALENCIENNES, 1833). The authors analyzed physico-chemical and bacteriological characteristics of the water, the turtles' oral and cloacal bacterial flora, feeding habits and morphological features.

The Island of Bozcaada (39°47'30''-39°50'90''N; 25°57' 80''-26°05'00''E; size: 37.51 km²; maximum elevation: Göztepe - 192 m a.s.l., Yenikale Hill - 115 m a.s.l.) is located in the northeast Aegean Sea, southwest of the Çanakkale Strait (Dardanelles) and situated on the continental shelf, about 7 km off the Turkish Aegean coast (Fig. 1). The island (human population about 2,500; main industries: fishing, viniculture and tourism) lacks wetland areas (DERMITZAKIS 1990) with the exception of a single lake (TOSUNOĞLU et al. 2009). Lake Azmak (39°50' 28''N, 26°02'13''E; length 100 m, width 5 m, depth 2 m) is a stagnant water body at sea level.

Field studies were carried out on four days (June 18, July 27, August 9 and September 15) in 2012 when a fish trap was placed in the lake between 07:00 to 8:00 h in the morning and checked at noon. Captured individuals were marked by notching the marginal scutes of the shell using files (CAGLE 1939). Juvenile turtles with soft shells were marked with nail scissors. Body measurements, oral and cloacal swabs and stomach contents were taken from the samples which were released into the lake thereafter. A total of 29 *M. rivulata* individuals (21 females, six males and two juveniles) were sampled: six in June, four in July, four in August and 15 in September.

Isolation of selected pathogens from oral and cloacal swabs followed standard methods for Enterobacteriaceae (Mac Conkey agar), *Vibrio* sp. (Thiosulfate Citrate Bile Salts Sucrose (TCBS) Agar), *Aeromonas* sp. (Glutamate Starch Phenol Red Agar) and *Pseudomonas* sp. (Pseudomonas Isolation Agar). Plates were incubated at 25-30 °C and examined after 24-48 hours. Isolated colonies were identified by Gram and biochemical reactions (MURRAY et al. 1999). In addition, microbiological water quality parameters (total coliform bacteria - TC, faecal coliform bacteria - FC) were assessed using the most probable number (MPN) method (FINSTEIN 1972). Water temperature, pH, electrical conductivity (EC) and dissolved oxygen (DO) readings were taken on the spot with a Hatch-Lange TM ecological kit.

The physico-chemical and microbiological qualities of Bozcaada fresh water are shown in Table 1. According to the Turkish WATER POLLUTION CONTROL REGULATION (2004) that classifies inland water into categories, high quality (Class I), moderate quality (Class II), polluted (Class III) and highly polluted waters (Class IV), water

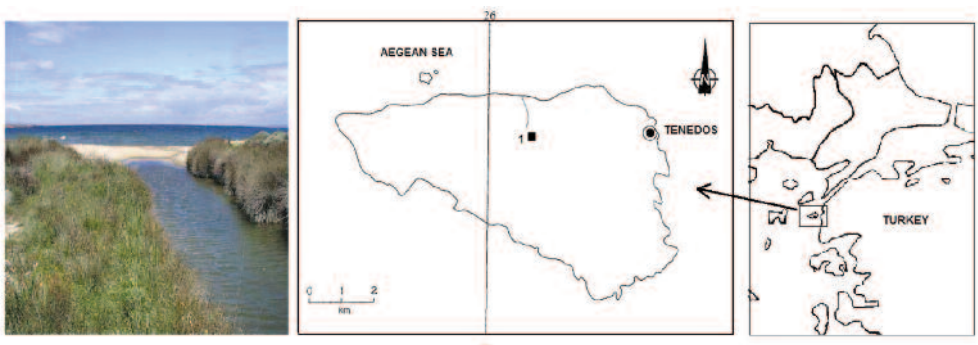

Fig. 1: Geographical location of Bozcaada Island (Turkey) and view of Lake Azmak (left), the only wetland habitat on Bozcaada Island.

Fig. 2: Dorsal, ventral and lateral views of *Mauremys rivulata* (VALENCIENNES, 1833). A specimen typical of the population of Lake Azmak, Bozcaada Island (Turkey), is shown.

temperature, EC, pH and DO averages complied with inland water quality parameters Classes I – II in all months of the study. However, dissolved oxygen values entered (Classes II – III) in July and August. Similarly, microbial and fecal pollution indicator bacteria counts were within the water quality parameters of Class I. Fecal coliform levels showed sudden increase in August and September, thus downgrading the water quality to Classes III and IV. A total of 113 Gram negative bacteria were isolated from oral and cloacal samples of *M. rivulata*. *Enterobacter aerogenes* was the most common microorganism identified (38/113, 33.62%). Other bacteria isolated were *Vibrio* sp. (33/113, 29.20%), *Aeromonas* sp. (24/113, 21.23%) and *Pseudomonas* sp. (15/113; 13.27%), respectively. Monthly total bacteria counts amounted to three in June, eight in July, 37 in August, and 65 in September.

The bacteria which were isolated in this study are all considered opportunistic pathogens in reptiles and amphibians, and their presence in association with overt clinical signs of disease should be considered as significant (FILIPPI et al. 2010). While in all months, coliform bacteria values were within a tolerable range, the counts of fecal coliform bacteria exceeded acceptable threshold values with an increase in temperature. There was a positive correlation between the number of potentially pathogenic bacteria isolated from oral and cloacal swabs and the number of aquatic pollution indicator bacteria, especially in the months of August and September. However, an obvious negative effect of the increaseing microbial contamination on the turtle population was not observed, unless the small number of juveniles would be taken as indicative.

Applying stomach flushing (LEGLER 1977), the stomach contents of eight indi-

Table 1: Physico-chemical and microbiological quality of the water in Lake Azmak, Bozcaada Island (Turkey). The water quality class rating I-IV (WATER POLLUTION CONTROL REGULATION 2004) is given in parentheses.

Month	June	July	August	September
Temperature (^{O}C)	21.7 (I-II)	26.9(I-II)	27.9 (I-II)	20.5 (I-II)
Dissolved oxygen (mg/L)	7.35 (II)	5.17 (III)	5.45 (III)	8.86 (I)
pH	8.29 (I)	7.98 (I)	7.16 (I)	8.27 (I)
Electrical conductivity (µS/cm)	3.09 (I)	3.27 (I)	3.47 (I)	3.29 (I)
Total coliform (MPN/100 mL)	40 (I)	30 (I)	40 (I)	1500 (I)
Faecal coliform (MPN/100 mL)	0 (I)	90 (I)	230 (III)	4600 (IV)

Table 2: Morphometric measurements and ratios of 29 specimens of *Mauremys rivulata* (Valenciennes, 1833) collected from Lake Azmak, Bozcaada Island (Turkey). M – males, F – females.

Straight Carapace Lenght (SCL)	M	6	144.0-168.0	154.0	8.6	3.5
	F	21	115.0-200.0	155.4	21.5	4.7
	M+F	27	115.0-200.0	155.1	19.3	3.7
	Juv.	2	73.0-85.0	79.0	8.4	6.0
Carapace Width (CW)	M	6	95.0-114.0	105.0	6.8	2.8
	F	21	80.0-135.0	106.5	12.3	2.6
	M+F	27	80.0-135.0	106.1	11.2	2.1
	Juv.	2	55.0-66.0	60.5	7.7	5.5
Plastron Lenght (PL)	M	6	115.26-126.10	120.94	3.76	1.53
	F	21	99.10-168.00	138.61	17.09	3.73
	M+F	27	99.10-168.00	134.68	16.83	3.24
	Juv.	2	59.11-76.60	67.85	12.36	8.74
Plastron Width (PW)	M	6	79.37-88.77	86.05	3.49	1.42
	F	21	69.55-111.65	92.71	11.25	2.45
	M+F	27	69.55-111.65	91.23	10.38	1.99
	Juv.	2	44.76-53.77	49.26	6.37	4.50
SCL/CW	M	6	1.31-1.57	1.46	0.09	0.03
	F	21	1.25-1.57	1.45	0.08	0.01
	M+F	27	1.25-1.57	1.46	0.08	0.01
	Juv.	2	1.29-1.33	1.30	0.02	0.01
PL/PW	M	6	1.36-1.45	1.40	0.03	0.01
	F	21	1.42-1.57	1.49	0.03	0.00
	M+F	27	1.36-1.57	1.47	0.05	0.01
	Juv.	2	1.32-1.42	1.37	0.07	0.05
Body Mass	M	6	336-494	426	55.05	22.47
	F	21	215-978	606.71	210.84	46.01
	M+F	27	215-978	566.55	201.59	38.79
	Juv.	2	53-96	74.50	30.40	21.50

viduals were collected immediately after capture, to cope with the rapid prey digestion in turtles. Prey items were preserved in 70 % ethanol and identified to the lowest taxonomic level possible with a Boeco binocular microscope and an Olympus BX51 microscope, using appropriate literature (Borror & White 1970; Öktem & Baran 1977; Komarek & Anagnostidis 1986, 1989, 1999; Krammer & Lange-Bertalot 1991a, 1991b, 1999a, 1999b; John et al. 2003; Balian et al. 2008; Guiry & Guiry 2012).

In the stomach contents analyzed, animal prey items (26 %) comprised Crustaceans (Malacostraca: 9.8 %) and Arthropods (Insecta - Odonata nymphs: 5.4 %, Odonata adults: 4.5 % and Hymenoptera adults: 6.3 %); plant matter (74 % of prey items) included Monocotyledons (*Holophila* sp.), Trebouxiophyceae, Coleochaetophyceae, Conjugatophyceae (*Spirogyra* sp.), Cyanophyceae, Bacillariophyceae, Cymbellaceae and seeds of aquatic plants.

Fecal analysis revealed that *M. rivulata* feeds on aquatic and terrestrial invertebrates, filamentous algae, epipelic algae and other aquatic plants, identifying this species as an opportunistic omnivore (Sidis & Gasith 1985) which was endorsed by Çiçek & Ayaz (2011) who found insects, fishes, amphibians and plant matter in *M. rivulata* stomach contents. Feeding on animal prey was never doubted but feeding on plant matter was debated with regard to its intentional or accidental ingestion (Labboroni & Chelazzi 1991). In this study, however, animal matter represented the minority (26 %) of prey items in the stomach contents of *M. rivulata*. Among the plants observed, microalgae were likely taken accidentally, whereas macroalgae such as *Holophila* sp. and *Spirogyra* sp. were most likely eaten intentionally.

Straight carapace and plastron lengths (SCL, PL) and widths (CW, PW), were taken with a Mitutoyo digital caliper (precision: 0.01 mm) and ratios CL/CW and PL/PW

were calculated. Body mass was weighed using a digital balance. Descriptive statistics of the measurements and rates were calculated using the SPSS (10.0) program.

The carapace was mostly brown or olive green to green in color, the plastron much darker, sometimes almost black (Fig. 2). Morphometric data are summarized in Table 2. Comparative body measurements are available in FRITZ (1994, 1995). The present observations are in line with previous studies which found that females of the Balkan Terrapin are larger and heavier than males (AUER & TAŞKAVAK 2004; RIFAI & AMR 2004; GÜÇLÜ & TÜRKOZAN 2010) and the straight carapace length not to exceed 220 mm (WERNER 1902; SIEBENROCK 1913; ÇEVIK 1982; TOK 1999; WISCHUF & BUSACK 2001; AYAZ & BUDAK 2008).

ACKNOWLEDGMENTS: This study was funded by the Scientific and Technological Research Council of Turkey (TÜBİTAK Project No. 112T063).

REFERENCES: AUER, M. & TAŞKAVAK, E. (2004): Population structures of syntopic *Emys orbicularis* and *Mauremys rivulata* in western Turkey.- Biologia, Bratislava, 59 (Suppl. 14): 81-84. AYAZ, D. & BUDAK, A. (2008): Distribution and morphology of *Mauremys rivulata* (VALENCIENNES, 1833) (Reptilia: Testudines: Geoemydidae) in the Lake District and Mediterranean region of Turkey.- Turkish Journal of Zoology, Ankara; 32: 137-145. BALIAN, E. V. & LEVEQUE, C. & SEGERS, H. & MARTENS, K. (2008): Freshwater animal diversity assessment.- Hydrobiologia, Dordrecht; 595: 9-26. BORROR, D. J. & WHITE, R. E. (1970): A field guide to the Insects. New York (Houghton Mifflin), pp. 404. CAGLE, F. R. (1939): A system for marking turtles for future identification.- Copeia, Washington; 1939: 170-173. ÇEVIK, E. (1982): Trakya kaplumbağa ve kertenkelelerinin taksonomik araştırılması, Ph.D. thesis, Ege University, İzmir, pp. 85. ÇIÇEK, K. & AYAZ, D. (2011): Çizgili Kaplumbağanın (*Mauremys rivulata*) besin içeriği üzerine bir ön çalışma; p. 181. In: X. Ulusal Ekoloji ve Çevre Kongresi, 4-7 Ekim 2011 [10th National Ecology and Environment Congress, 4-7 October 2011], Çanakkale. DERMITZAKIS, M. D. (1990): Paleogeography, geodynamic processes and event stratigraphy during the late cenozoic of the Aegean area. International symposium on Biogeographical aspects of Insularity, Rome, 18-22 May 1987, Academia Nazionale dei Lincei, 85: 263-288. FILIPPI, E. & D'ALTERIO, G. L. & BROZZI, A. B. & MICCI, M. & POLITI, P. & MANTERO, D. (2010): Note on the intestinal bacterial populations of free living snakes in Italy.- Herpetology Notes, Braunschweig; 3: 263-265. FINSTEIN, M. S. (1972): Pollution microbiology. A Laboratory Manual. New York (Marcel Dekker), pp. 273. FRITZ, U. (1994): Zur innerartlichen Variabilität von *Emys orbicularis* (LINNAEUS, 1758), 4. Variabilität und Zoogeographie im pontokaspischen Gebiet mit Beschreibung von drei neuen Unterarten.- Zoologische Abhandlungen des Museums für Tierkunde, Dresden; 48 (4): 53-93. FRITZ, U. (1995): Zur innerartlichen Variabilität von *Emys orbicularis* (LINNAEUS, 1758). 5a. Taxonomie in Mittel-Westeuropa, auf Korsika, Sardinien, der Apenninen-Halbinsel und Sizilien und Unterartengruppen von *Emys orbicularis* (Reptilia: Testudines: Emydidae).- Zoologische Abhandlungen des Museums für Tierkunde, Dresden; 48 (13): 185-242. GUIRY, M. D. & GUIRY, G. M. (2012): AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. WWW document available at < http://www. algaebase.org > [last accessed on 25 April, 2012]. GÜÇLÜ, Ö. & TÜRKOZAN, O. (2010): Population structure of *Mauremys rivulata* in Western Turkey.- Turkish Journal of Zoology, Ankara; 34 (3): 385-391. JOHN D. M. & WHITTON, B. A. & BROOK, A. J. (2003): The freshwater algal flora of the British Isles: an identification guide to freshwater and terrestrial algae. Cambridge (Cambridge University Press), pp. 702. KOMAREK, J. & ANAGNOSTIDIS, K. (1986): Moderm approach to the classification system of Cyanophytes. 2-Chroococcales.- Algological Studies, Stuttgart; 43: 157-226. KOMAREK, J. & ANAGNOSTIDIS, K. (1989): Modem approach to the classification system of Cyanophytes. 4-Nostocales.- Algological Studies, Stuttgart; 56: 247-345. KOMAREK, J. & ANAGNOSTIDIS, K. (1999): Cyanoprokaryota. Part 1: Chroococcales. Jena (Gustav Fischer), pp. 548. KRAMMER, K. & LANGE-BERTALOT, H. (1991a): Süßwasserflora von Mitteleuropa. Bacillariophyceae, Vol. 213, Part 3: Centrales, Fragillariaceae, Eunoticeae. Stuttgart (Gustav Fischer), pp. 576. KRAMMER, K. & LANGE-BERTALOT, H. (1991b): Süßwasserflora von Mitteleuropa. Bacillariophyceae, Vol. 214, Part 4: Achnanthaceae, Kritische Ergänzungen zu *Navicula* (Lineolatae) und *Gomphonema*. Stuttgart, Jena (Gustav Fischer), pp. 437. KRAMMER, K. & LANGE-BERTALOT, H. (1999a): Süßwasserflora von Mitteleuropa. Bacillariophyceae, Vol. 211, Part 1: Naviculaceae. Berlin (Spectrum Akademischer Verlag), pp. 876. KRAMMER, K. & LANGE-BERTALOT, H. (1999b): Süßwasserflora von Mitteleuropa. Bacillariophyceae, Vol. 2/2, Part 2: Bacillariaceae, Epithemiaceae, Surirellaceae. Berlin (Spectrum Akademischer Verlag), pp. 610. LABBORONI, M. & CHELAZZI, G. (1991): Activity pattern of *Emys orbicularis* L. (Chelonia: Emydidae) in Central Italy.- Ethology, Ecology & Evolution, Firenze; 3: 257-263. LEGLER, J. M. (1977): Stomach flushing: A technique for chelonian dietary studies.- Herpetologica, Lawrence; 33: 281-284. MURRAY, P. R. & BARON, E. J. & PFALLER, M. A. & TENOVER, F. C. & YOLKEN, R. H. (1999): Manual of clinical microbiology. 7th Edition. Washington (American Society for Microbiology), pp. 1773. ÖKTEM, N. & BARAN, İ. (1977): Arthropoda laboratuvar klavuzu.- Ege Üniversitesi Fen Fakültesi Kitaplar Serisi İlker Matbaası, Bornova-İzmir; 75: 1-69. RIFAI, L. B. & AMR, Z. S. (2004): Morphometrics and biology of the striped-necked terrapin, *Mauremys rivulata* (VALENCIENNES, 1833), in Jordan (Reptilia: Testudines: Geoemydidae). Zoologische Abhandlungen des Museums für Tierkunde, Dresden; 54: 177-197. SIDIS, I. & GASITH, A. (1985): Food habits of the Caspian Terrapin (*Mauremys caspica rivulata*) in unpolluted and polluted habitats in Israel.- Journal of Herpetology, Houston etc.; 19 (1): 108-115. SIEBENROCK, F. (1913): Schildkröten aus Syrien und Mesopotamien.- Annalen des Naturhistorischen Museums, Wien; 27: 171-225. TOK, C. V. (1999): The taxonomy and ecology of *Mauremys caspica rivulata* VALENCI-

ENNES, 1833 (Testudinata: Bataguridae) and *Testudo graeca ibera* PALLAS, 1811 (Testudinata: Tesdudinidae) in Resadiye (Datça) Peninsula.- Turkish Journal of Zoology, Ankara; 23 (1): 17-21. TOSUNOĞLU, M. & GÜL, Ç. & UYSAL, İ. (2009): The herpetofauna of Tenedos (Bozcaada, Turkey). Herpetozoa, Wien; 22 (1/2): 75-78. WATER POLLUTION CONTROL REGULATION (WPCR) (2004): Water pollution control regulation, Chapter 1.- Official journal, Ankara; 25687: 7-29. WERNER, F. (1902): Die Reptilien- und Amphibienfauna von Kleinasien.- Sitzungsberichte der Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse, Wien; 111: 1057-1121. WISCHUF, T. & BUSACK, S. D. (2001): *Mauremys rivulata* (VALENCIENNES in BORY DE SAINT-VINCENT et al., 1833) – Ostmediterrane Bachschildkröte, pp. 125-178. In: FRITZ, U. (ed.): Handbuch der Reptilien und Amphibien Europas, Band 3/IIIA: Schildkröten I. Wiebelsheim (Aula Verlag).

KEY WORDS: Reptilia: Testudines: Geoemydidae: *Mauremys rivulata*; ecology, aquatic habitat pollution, food habits, population estimate, morphology, Bozcaada Island, Aegean See, Çanakkale, Turkey

SUBMITTED: May 6, 2013

AUTHORS: Çiğdem GÜL (corresponding author < gulcigdem17@hotmail.com > < gulcigdem@comu.edu.tr >); Murat TOSUNOĞLU, Nurcihan HACIOĞLU, Tuğçe ÇAPRAZLI, Hüseyin ERDUĞAN, İbrahim UYSAL - Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences, Department of Biology, 17100 Çanakkale, Turkey.