

P. punctatus). Por otra parte, los autores han comprobado que las nevadas intensas durante el período reproductor pueden causar la muerte de puestas por aplastamiento o congelación.

En las poblaciones de anfibios de Europa meridional la imprevisibilidad de los cambios bruscos de temperatura debe ser una causa de mortalidad natural, si no habitual, no inusual. Cuando estos fenómenos extremos se hacen más frecuentes, tal y como prevén los especialistas en cambio climático, podría ser que algunas poblaciones alcanzaran contingentes insuficientes para su mantenimiento a escala local. Estas situaciones de muerte por frío súbito, a menudo acompañadas de nevadas intensas durante el período reproductor, deben afectar mucho más al contingente de machos que permanecen durante períodos de tiempo más largos en las charcas y pueden llegar a

causar importantes desequilibrios en la "sex-ratio". Por otra parte, este fenómeno debe ser mucho más acusado y problemático para las poblaciones de altitud, las cuales suelen encontrarse mucho más fragmentadas y en consecuencia en mayor riesgo de extinción local. Además, en estas poblaciones de altitud la reproducción de *R. temporaria* y *B. bufo* suele iniciarse de forma explosiva cuando desaparece la cubierta de nieve y hielo, coincidiendo en muchos casos con la entrada de un frente templado de lluvias. Si acto seguido las temperaturas vuelven a bajar, la mortalidad de machos puede llegar a ser importante, especialmente en medios someros. Así, creemos que debe realizarse un seguimiento de la mortalidad por frío súbito y cualquier información adicional al respecto será una importante contribución para determinar el impacto de este fenómeno.

REFERENCIAS

- Beebe, T.J.C. 1995. Amphibian breeding and climate. *Nature*, 374: 219-220.
- Blaustein, R.A., Belden, L.K., Olson, D.H., Green, D.M., Root, T.L. & Kiesecker, J.M. 2001. Amphibian breeding and climate change. *Biology*, 15:1804-1809.
- Blaustein, A.R., Walls, S.C., Bancroft, B.A., Lawler, J.J., Searle, C.L. & Gervasi, S.S. 2010. Direct and indirect effects of climate change on amphibian populations. *Diversity*, 2:281-313.
- Heyer, W.R., Rand, A.S., Goncalvez da Cruz, C.A. & Peixoto, O.L. 1988. Decimations, extinctions and colonizations of frog populations in southeast Brazil and their evolutionary implications. *Biotropica*, 20: 230-235.

Overwintering of hatchling Western Caspian Turtles, *Mauremys rivulata*, in Great Menderes Delta (Turkey)

Dinçer Ayaz & Kerim Çiçek

Zoology Section, Biology Department, Faculty of Science, Ege University, Bornova, Izmir (Turkey). C.e.: dincer.ayaz@ege.edu.tr

Fecha de aceptación: 18 de abril de 2011.

Key words: *Mauremys rivulata*, hatchling, overwintering, Great Menderes Delta, Turkey.

RESUMEN: Durante el trabajo de campo que se realizó en el Delta del Gran Menderes (Aydın, Turquía) el día 8 de junio de 2010 se observó un galápago recién nacido de la especie *Mauremys rivulata*. La longitud del caparazón del ejemplar fue 34.1 mm y su masa corporal 6.8 g. Esta observación representa el primer registro de una eclosión primaveral en el área de distribución turca de *M. rivulata*.

Turtles from temperate zones generally lay their eggs in spring or summer, and hatchlings start to emerge in autumn (Ernst & Barbour, 1972). Actual dates of hatchling emergence, however, are well known for only a few species (Gibbons & Nelson, 1978). Overwintering, delayed emergence from the nest, is a worldwide described phenomenon in many freshwater turtles (e.g., Gibbons & Nelson, 1978; Costanzo *et al.*, 1995; Converse *et al.*, 2002; Ayaz *et al.*, 2007; Gibbons, 2008). Adult fresh-water turtles generally hibernate in water, while hatchlings can hibernate in water, in their nests or in shelters they dig (Gibbons & Nelson, 1978; Ultsch, 1989; Costanzo *et al.*, 1995).

The genus *Mauremys* is represented by 10 small- to medium-sized aquatic species, occurring in two disjunct distribution ranges (Fritz *et al.*, 2007). Western Caspian turtles *Mauremys rivulata* are distributed from Central Dalmatia along the sea coast to Greece, European Turkey and Bulgaria, in Anatolia along the Mediterranean coast southwards over the Levantine region to the northern Negev Desert in Israel. This range also includes many Mediterranean islands (Iverson, 1992; Fritz & Wischuf, 1997; Fritz & Havas, 2006). The species is found in various fresh-water habitats, such as swamps, marshes, ponds, lakes and rivers. Many studies have been made on the biology and ecology of the species (e.g., Ayaz, 2003; Auer & Taşkavak, 2004; Rifai & Amr, 2004; Chelazzi *et al.*, 2007). However, we still have inadequate information about its breeding biology (e.g., Gasith & Sidis, 1985; Sidis & Gasith, 1988). We present the first record of an early June active hatchling of *M. rivulata* and describe the morphology of an overwintered hatchling from the Great Menderes Delta (Aydın, Turkey).

During our monitoring studies of the syntopic *Emys orbicularis* and *M. rivulata* populations

in the Great Menderes Delta, two *M. rivulata* juveniles were captured at the Gölbent Village station (Söke, Aydın, Turkey; 37°40'26"N / 27°21'30"E; 7 masl) on 8 June 2010: one individual was a neonate, while the other presented a ring of one year of age on the plastron (Figure 1). The habitat where individuals were captured was densely covered with rushes (e.g., *Carex* sp., *Juncus* sp., *Phragmites* sp., *Typha* sp.). Water temperature in the area was 24° C, and air temperature was 27° C. The coexisting herpetiles comprised the following species: *Bufo bufo*, *Pseudepidalea variabilis*, *Pelophylax bedriagae*, *Lacerta trilineata*, *Natrix natrix*, *Natrix tessellata* and *E. orbicularis*.

The mating season of *M. rivulata* extends from April to June and eggs are laid between mid-May and late June depending on the latitude. Nesting occurs in June and July, and two or three clutches of four to six eggs are laid each year. Incubation period lasts around 70 days, and hatchlings emerge after the rains at the end of summer (Anderson, 1979; Ernst & Barbour, 1989; Bonin *et al.*, 2006). Therefore, the observation reported in this note is the first record of an overwintered hatchling for the Turkish population of *M. rivulata*.

Measurements of individuals are presented in Table 1. In both specimens the median and lateral keels on the carapace were evident, and coloration of carapace was primarily brownish. Borders of the plates on the plastron were cream, while the rest of the plastron was dark colored (Figure 1b). Ground color of the soft parts was blackish with light yellow stripes. No abnormalities were found regarding the keratin plates on the carapace and plastron. Any carapacial horny plate was completely covered by granules. The yolk sac trace was lost on the plastron of the one year old specimen, while it



Figure 1. Dorsal (a) and ventral (b) view of hatchling and one year-old *M. rivulata* from Great Menderes Delta.

Figura 1. Vista dorsal (a) y ventral (b) de *M. rivulata* recién eclosionado y de un año de edad del Delta del Gran Menderes.

was visible in the neonate specimen (see Figure 1b). Moreover, the fact that the neonate specimen had a partially large head suggests its recent eclosion. Hatchlings of *M. rivulata* have a carapace length of about 33 mm and are brighter colored than adults (Ernst &

Barbour, 1989). Rifa'i & Amr (2004) gave the interval of carapace length of juveniles as 33 to 93 mm and the interval of body mass as 5 to 120 g. The carapace length and mass values measured in the present study remain within the limits of previous studies.

Hatchlings have to overcome both osmotic perturbations and hypoxic or anoxic conditions in aquatic hibernacula (even if they provide stable thermal conditions) (Ultsch, 1989), and desiccation and potential dehydration in terrestrial hibernacula (Miller & Dinkelacker, 2008). Because hatchlings in those regions where winter is hard are generally anoxia-intolerant, they spend their first winter in the nesting chamber instead of spending it under frozen water (Ultsch, 1989, 2006; Miller & Dinkelacker, 2008). In the region where the *M. rivulata* neonate was observed the average temperature in winter months ranges from 8.9° C to 9.4° C (Turkish State Meteorological Service, 2011), and the region displays Mediterranean climate characteristics. Winter is generally rainy and mild. Therefore, this indicates that there is no environmental factor that may force hatchlings to spend hibernation on land. Hatchling and adult North American freshwater turtles generally overwinter under water (Gibbons & Nelson, 1978; Ultsch, 1989, 2006; Miller & Dinkelacker, 2008). Nevertheless, hatch-

Table 1. Body mass (g) and morphometric measurements (mm) of hatchling and one year-old *M. rivulata* from Great Menderes Delta. CL: carapace length, CH: carapace height, CW: carapace width, PL: plastron length, GuL: gular suture length, HuL: humeral suture length, PeL: pectoral suture length, AbdL: abdominal suture length, FemL: femoral suture length, AnL: anal suture length, TL: tail length.

Tabla 1. Masa corporal (g) y medidas morfométricas (mm) de *M. rivulata* recién eclosionado y de un año de edad del Delta del Gran Menderes. CL: longitud del caparazón; CH: altura del caparazón; CW: anchura del caparazón; PL: anchura del plastrón; GuL: longitud de la sutura gular; HuL: longitud de la sutura humeral; PeL: longitud de la sutura pectoral; AbdL: longitud de la sutura abdominal; FemL: longitud de la sutura femoral; AnL: longitud de la sutura anal; TL: longitud de la cola.

Age	Mass	CL	CH	CW	PL	GuL	HuL	PeL	AbL	FeL	AnL	TL
0	6.8	34.08	13.94	27.72	28.65	4.12	3.14	4.27	6.08	6.60	3.04	25.12
1	12	43.57	16.25	34.86	35.10	4.63	3.82	5.73	8.11	7.40	4.11	26.51

lings of North American populations of some species (e.g., *Chelydra serpentina*, *Apalone spinifer*) spend their first winter on land as their conspecific southern populations (Costanzo *et al.*, 1995). Baker *et al.* (2010) observed that hatchlings of *Chrysemys picta*, *Graptemys geographica* and *Trachemys scripta* emerged despite the presence of cold stress, although the period

during which emergence took place varied depending on the degree of cold. An important advantage of overwintering and emerging in spring is that resources such as temperature, light and food have increased (Wilbur, 1975). Probably, hatchlings of some species as *M. rivulata* increase their survival rates by emerging in spring.

REFERENCIAS

- Anderson, S.C. 1979. Synopsis of the turtles, crocodiles, and amphibiae of Iran. *Proceedings of the California Academy of Sciences*, 41: 501-528.
- Auer, M. & Taskavak, E. 2004. Population structure of syntopic *Emys orbicularis* and *Mauremys rivulata* in western Turkey. *Biologia*, 59: 81-84.
- Ayaz, D. 2003. *Göller Bölgesi ve Doğu Akdeniz Bölgesi Emys orbicularis (Testudinata: Emydidae) ve Mauremys rivulata (Testudinata: Bataguridae) türlerinin sistematik durumu, morfolojisi, dağılışı, üreme ve beslenme biyolojisi üzerine araştırmalar*. Ph.D. thesis, Ege University Graduate School of Natural and Applied Sciences.
- Ayaz, D., Tok, C.V. & Çiçek, K. 2007. Overwintered hatchling of *Emys orbicularis* (Linnaeus, 1758) observed in Turkey. *Herpetozoa*, 19: 189-192.
- Baker, P.J., Iverson, J.B., Lee Jr., R.E. & Costanzo, J.P. 2010. Winter severity and phenology of spring emergence from the nest in freshwater turtles. *Naturwissenschaften*, 97: 607-615.
- Bonin, F., Devaux, B. & Dupré, A. 2006. *Turtles of the World*. Johns Hopkins University Press. Baltimore MD.
- Chelazzi, G., Naziridis, T., Benvenuti, S., Ugolini, A. & Crivelli, A.J. 2007. Use of river-wetland habitats in a declining population of the terrapin (*Mauremys rivulata*) along the Strymon River, northern Greece. *Journal of Zoology*, 271: 154-161.
- Converse, S.J., Iverson, J.B. & Savidge, J.A. 2002. Activity, reproduction and overwintering behavior of ornate box turtles (*Terrapene ornata ornata*) in the Nebraska Sandhills. *American Midland Naturalist*, 148: 416-422.
- Costanzo J.P., Iverson, J.B., Wright, M.F. & Lee, R.E. 1995. Cold hardiness and overwintering strategies of hatchlings in an assemblage of northern turtles. *Ecology*, 76: 1772-1785.
- Ernst, C.H. & Barbour, R.W. 1972. *Turtles of the United States*. The University Press of Kentucky. Lexington.
- Ernst, C.H. & Barbour, R.W. 1989. *Turtles of the World*. Smithsonian Institution Press. Washington, DC.
- Fritz, U. & Wischuf, T. 1997. Zur Systematik westasiatisch-südosteuropäischer Bachschildkröten (Gattung *Mauremys*) (Reptilia: Testudines: Bataguridae). *Zoologische Abhandlungen Staatliches Museum für Tierkunde Dresden*, 49: 223-260.
- Fritz, U. & Havaš, P. 2006. *Checklist of Chelonians of the World*, at the request of the CITES Nomenclature Committee and the German Agency for Nature Conservation. CITES.
- Fritz, U., Ayaz, D., Buschbom, J., Kami, H.G., Mazanaeva, L.F., Aloufi, A.A., Auer, M., Rifai, L., Šilic, T. & Hundsdoerfer, A.K. 2007. Go east: phylogeographies of *Mauremys caspica* and *M. rivulata* – discordance of morphology, mitochondrial and nuclear genomic markers and rare hybridization. *Journal of Evolutionary Biology*, 21: 527-540.
- Gasith, A. & Sidis, I. 1985. Sexual activity in the terrapin, *Mauremys caspica rivulata*, in Israel, in relation to the testicular cycle and climatic factors. *Journal of Herpetology*, 19: 254-260.
- Gibbons, J.W. 2008. Overwintering hatchling turtles: some they do, and some they don't, and some you just can't tell. *In: Toronto Zoo Turtle Stewardship and Management Workshop*. 17-19 March 2008. Toronto.
- Gibbons, J.W. & Nelson, D.H. 1978. The evolutionary significance of delayed emergence from the nest by hatchling turtles. *Evolution*, 32:297-303.
- Iverson, J.B. 1992. *A Revised Checklist with Distribution Maps of the Turtles of the World*. J.P. Iverson Publishing. Richmond, Indiana.
- Miller, J.D. & Dinkelacker, S.A. 2008. Reproductive structures and strategies of turtles. 225-278. *In: Wynneken, J., Godfrey, M. & Bels V. (eds.), Biology of Turtles*. CRC Press: Taylor and Francis Group. Boca Raton, London.
- 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*, 54: 177-197.
- Sidis, I. & Gasith, A. 1988. Sexual behaviour of the Caspian terrapin, *Mauremys caspica rivulata*. *Herpetological Review*, 19: 7-8.
- Turkish State Meteorological Service. 2011. <<http://www.dmi.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=AYDIN>> [accessed: 3 March 2011].
- Ultsch, G.R. 1989. Ecology and physiology of hibernation and overwintering among fresh-water fishes, turtles, and snakes. *Biological Reviews of the Cambridge Philosophical Society*, 64: 435-516.
- Ultsch, G.R. 2006. The ecology of overwintering among turtles: where turtles overwinter and its consequence. *Biological Reviews*, 81: 339-367.
- Wilbur, H.M. 1975. The evolutionary and mathematical demography of the painted turtle *Chrysemys picta*. *Ecology*, 56: 64-77.