

## *Blood Cells Morphology and Erythrocytes Count of Two Freshwater Turtles, *Emys orbicularis* and *Mauremys rivulata*, from Turkey*

*Kerim Çiçek\*, Hüseyin Arıkan, Dinçer Ayaz*

Section of Zoology, Department of Biology, Faculty of Science, Ege University,  
35100, Izmir, TURKEY

\*Corresponding author: kerim.cicek@hotmail.com or kerim.cicek@ege.edu.tr

**Abstract.** In the present study, the peripheral blood cells (erythrocytes, leucocytes and thrombocytes) morphology of *Emys orbicularis* and *Mauremys rivulata* were examined in the blood smears prepared using Wright's stain and the erythrocyte number was conducted as well. In *E. orbicularis*, the average of erythrocyte length was measured as 20.1µm, width 12.7µm and size 200.8µm<sup>2</sup>; while in *M. rivulata* these were measured as 19.3µm, 12.3µm, and 186.7µm<sup>2</sup> respectively. The fact that agranulocytes (lymphocytes and monocytes) were dominant cells; nucleus cannot be distinguished in eosinophiles and basophiles due to intensive granulation in cytoplasm; thrombocytes are flat, ellipsoid cells were observed in the blood smears. In 1mm<sup>3</sup> blood, the average erythrocyte count in *E. orbicularis* was 430,666 and 467,500 in *M. rivulata*, and the erythrocyte count was established to be higher in males.

**Key words:** Emydidae, Geoemydidae, blood cell morphology, blood smears, erythrocyte count.

### **Introduction**

European pond turtle, *Emys orbicularis* (L., 1758), is distributed from Northern Africa, Southern, Central, and Eastern Europe, Caucasus to Western Asia (VAN DIJK *et al.*, 2014). Western Caspian turtle, *Mauremys rivulata* (Valenciennes, 1833), spread over from Balkan Peninsula, Middle East, and some Aegean and Mediterranean islands (UETZ & HOŠEK, 2014; VAN DIJK *et al.*, 2014). IUCN/SSC Tortoise and Freshwater Turtle Specialist Group listed *E. orbicularis* as lower risk/near threatened, while *M. rivulata* is listed in the least concern category (TFTSG, 1996; VAN DIJK *et al.*, 2004, 2014).

Even though there are numerous studies on the haematology of freshwater turtles (TAYLOR & KAPLAN, 1961; METIN *et al.*, 2006, 2008; HIDALGO-VILA *et al.*, 2007; PERPIÑÁN *et al.*, 2008; ARIZZA *et al.*, 2014), the haematology and blood biochemistry on the

freshwater turtles living in Turkey is limited (UĞURTAŞ *et al.*, 2003; METIN *et al.*, 2006, 2008, YILMAZ & TOSUNOĞLU, 2010; TOSUNOĞLU *et al.*, 2011). In the present study, the blood cell morphology, size and erythrocyte counts of *E. orbicularis* and *M. rivulata* were evaluated comparatively and discussed with the literature.

### **Material and Methods**

A total of 23 specimens, 15 *E. orbicularis* (10 male and 5 female) and 9 *M. rivulata* (4 male and 5 female), caught in İzmir (Western Anatolia, Turkey) in early April 2010 were used in the study. Peripheral blood samples were taken from the caudal veins of the caught individuals (SZARSKI & CZOPEK, 1966; ARIKAN & ÇİÇEK, 2014) and afterwards, the samples were released to the habitat they were caught from.

The blood smear preparations prepared using Wright's stain were utilized to measure the morphology and size of erythrocytes. The erythrocytes were measured using MOB-1-15x micrometric ocular. On each blood smear preparation, the length (L) and width (W) of 40 random erythrocytes and their nuclear length (NL) and nuclear width (NW) were measured (ARIKAN & ÇIÇEK, 2014). The erythrocyte sizes and their nuclear sizes were calculated according to the formulae  $(LW\pi)/4$  and  $(NLNW\pi)/4$ . The cellular and nuclear shapes were compared using the L/W and NL/NW ratios, while the comparison of nucleus/cytoplasm ratio was made according to the N/C ratio. Besides, Leucocytes (lymphocytes, monocytes, heterophils, eosinophils, and basophils) and thrombocytes were also measured. The erythrocyte count was conducted as diluting solution with Neubauer hemocytometer by using standard Hayem solution (ARIKAN & ÇIÇEK, 2014). The photographs of the blood cells were taken with Olympus CX21-Altra 20 Soft Imaging system. PAST statistical program was used to perform statistical analyses (HAMMER *et al.*, 2001). The means compared t-test and presented with standard deviations (SD).

## Results

In the both freshwater turtles, typical shape of erythrocytes is oval, as is the case for fish, amphibians and other reptile species. Their nuclei are also oval and almost located at the centre of the cell. In Wright-stained preparations, cytoplasm are light yellowish pink and chromophilic nuclei are purplish black (Fig. 1A, B).

In *E. orbicularis*, the average length of erythrocytes was established as 20.1 $\mu$ m (1SD= 1.78), its width as 12.7 $\mu$ m (1.43) and its size as 200.8 $\mu$ m<sup>2</sup> (30.74), L/W ratio was identified as 1.6 (0.21); the average length of nucleus was established as 7.2 $\mu$ m (0.85), its width as 6.1 $\mu$ m (0.75), and its size as 34.7  $\mu$ m<sup>2</sup> (7.04), the NL/NW) ratio was established as 1.2 (0.15) (Table 1). Whereas in *M. rivulata*, the average length of erythrocytes was calculated as 19.3 $\mu$ m (1.99), its width as

12.3 $\mu$ m (1.39), its size as 186.7 $\mu$ m<sup>2</sup> (34.53), L/W ratio was calculated as 1.6 (0.19); the average length of nucleus was calculated as 6.7 $\mu$ m (0.72), its width as 5.9 $\mu$ m (0.67), its size as 31.0 $\mu$ m<sup>2</sup> (5.82), NL/NW ratio was calculated as 1.1 (1.15) (Table 1).

Variation based on sex was observed in terms of values L (t= 2.33, P $\leq$  0.02) and L/W ratio (t= 1.99, P $\leq$  0.05) in *E. orbicularis*, and L (t= 7.78, P $\leq$  0.00), W (t= 4.46, P $\leq$  0.00), L/W (t= 2.04, P $\leq$  0.04), ES (t= 7.19, P $\leq$  0.00), NS (t= 1.99, P $\leq$  0.05), and ES/NS (t= 6.94, P $\leq$  0.00) in *M. rivulata*. Moreover, differences in terms of erythrocyte morphology between two species were observed [L (t= 6.69, P $\leq$  0.00), W (t= 4.17, P $\leq$  0.00), NL (t= 9.80, P $\leq$  0.00), NW (t= 2.98, P $\leq$  0.00), L/W (t= 1.74, P $\leq$  0.02), NL/NW (t= 4.10, P $\leq$  0.00), ES (t= 6.28, P $\leq$  0.00), NS (t= 6.31, P $\leq$  0.00), and ES/NS (t= 12.00, P $\leq$  0.00)].

Both small and large lymphocytes were observed in blood smears of two species examined. In small lymphocytes, almost the whole cell was filled with chromophilic nuclei. Cytoplasm was reduced to a small zone (Fig. 1C). In small lymphocytes, the average diameter was measured as 8.2  $\mu$ m in *E. orbicularis* and as 8.5  $\mu$ m in *M. rivulata* (Table 2). In large lymphocytes, spheric and chromophilic nucleus was localized in a specific area of the cell. Cytoplasmic zone was larger and was stained pale blue (Fig. 1D). The average diameter of large lymphocytes was measured as 12.1  $\mu$ m in *E. orbicularis* and as 12.2  $\mu$ m in *M. rivulata* (Table 2).

Monocytes were observed as kidney-shaped and as cells having dark purplish blue nuclei with Wright's stain. Cytoplasm are light grey (Fig. 1E). The average diameter of monocytes was measured as 12.6  $\mu$ m in *E. orbicularis* and 11.9  $\mu$ m in *M. rivulata* (Table 2). Agranulocytic cells (lymphocytes and monocytes) were observed to be dominant cells in both species. Heterophiles have usually 2-lobed nuclei; their cytoplasm was stained light blue and filled with numerous eosinophilic bright red granules (Fig. 1F). In heterophiles, the average diameter was measured as 10.7  $\mu$ m for *E. orbicularis* and as 13.6  $\mu$ m for *M. rivulata* (Table 2).

**Table 1.** The erythrocyte and their nuclei measurements established in the peripheral bloods of *E. orbicularis* (*E.o.*) and *M. rivulata* (*M.r.*). [L: Erythrocyte length, W: Erythrocyte width, ES: Erythrocyte size, NL: Nucleus length, NW: Nucleus width, NS: Nucleus size; NS/ES: Nucleocytoplasmic ratio].

Species		L (µm)	W (µm)	NL (µm)	NW (µm)	LW	NL/NW	ES (µm <sup>2</sup> )	NS (µm <sup>2</sup> )	ES/NS
<i>E.o.</i>	N	15	15	15	15	15	15	15	15	15
	Mean	20.1	12.7	7.2	6.1	1.6	1.2	200.8	34.7	1.4
	SE	0.08	0.06	0.04	0.03	0.01	0.01	1.30	0.30	0.10
	Min	14.0	9.3	4.7	4.7	1.1	0.8	115.1	17.0	0.1
	Max	24.5	16.3	9.3	8.2	2.3	1.8	298.3	52.2	9.9
	SD	1.78	1.43	0.85	0.75	0.21	0.15	30.74	7.04	2.38
<i>M.r.</i>	N	9	9	9	9	9	9	9	9	9
	Mean	19.3	12.3	6.7	5.9	1.6	1.1	186.7	31.0	0.2
	SE	0.10	0.07	0.04	0.04	0.01	0.01	1.82	0.31	0.00
	Min	14.0	9.3	5.8	4.7	1.1	1.0	115.1	21.3	0.1
	Max	23.3	16.3	9.3	7.0	2.3	1.5	298.3	51.1	0.3
	SD	1.99	1.39	0.72	0.67	0.19	0.15	34.53	5.82	0.04

**Table 2.** Leucocytes and thrombocytes measurements established in the peripheral bloods of *E. orbicularis* (*E.o.*) and *M. rivulata* (*M.r.*). [TL: thrombocyte length, TW: thrombocyte width].

Species		Lympho- cyte (small)	Lympho- cyte (Large)	Mono- cyte (µm)	Eosino- phil (µm)	Baso- phil (µm)	Hetero- phil (µm)	TL (µm)	TW (µm)
<i>E.o.</i>	N	15	15	15	15	15	15	15	15
	Mean	8.2	12.1	12.6	12.4	10.8	10.7	13.5	5.8
	SE	0.12	0.25	0.21	0.16	0.08	0.09	0.36	0.10
	Min	7.3	10.5	11.3	11.8	10.5	10.5	12.5	5.3
	Max	9.3	13.5	13.8	13.0	11.0	11.0	15.0	6.0
	SD	0.48	0.99	0.78	0.43	0.19	0.21	0.95	0.27
<i>M.r.</i>	N	9	9	9	9	9	9	9	9
	Mean	8.5	12.2	11.9	11.2	10.9	13.6	14.5	6.8
	SE	0.15	0.18	0.48	0.17	0.27	0.12	0.16	0.14
	Min	7.8	11.0	9.5	10.8	10.3	13.3	13.8	5.5
	Max	9.0	13.0	13.0	11.8	11.8	13.8	15.8	7.5
	SD	0.47	0.60	1.28	0.41	0.60	0.24	0.56	0.50

The cytoplasm of eosinophiles were stained light yellowish with Wright's stained. As the nucleus is masked by the large and bright granules in the cytoplasm, its shape cannot be distinguished properly (Fig. 1G). The average diameter in eosinophiles was measured as 12.4 µm for *E. orbicularis* and as 11.2 µm for *M. rivulata* (Table 2).

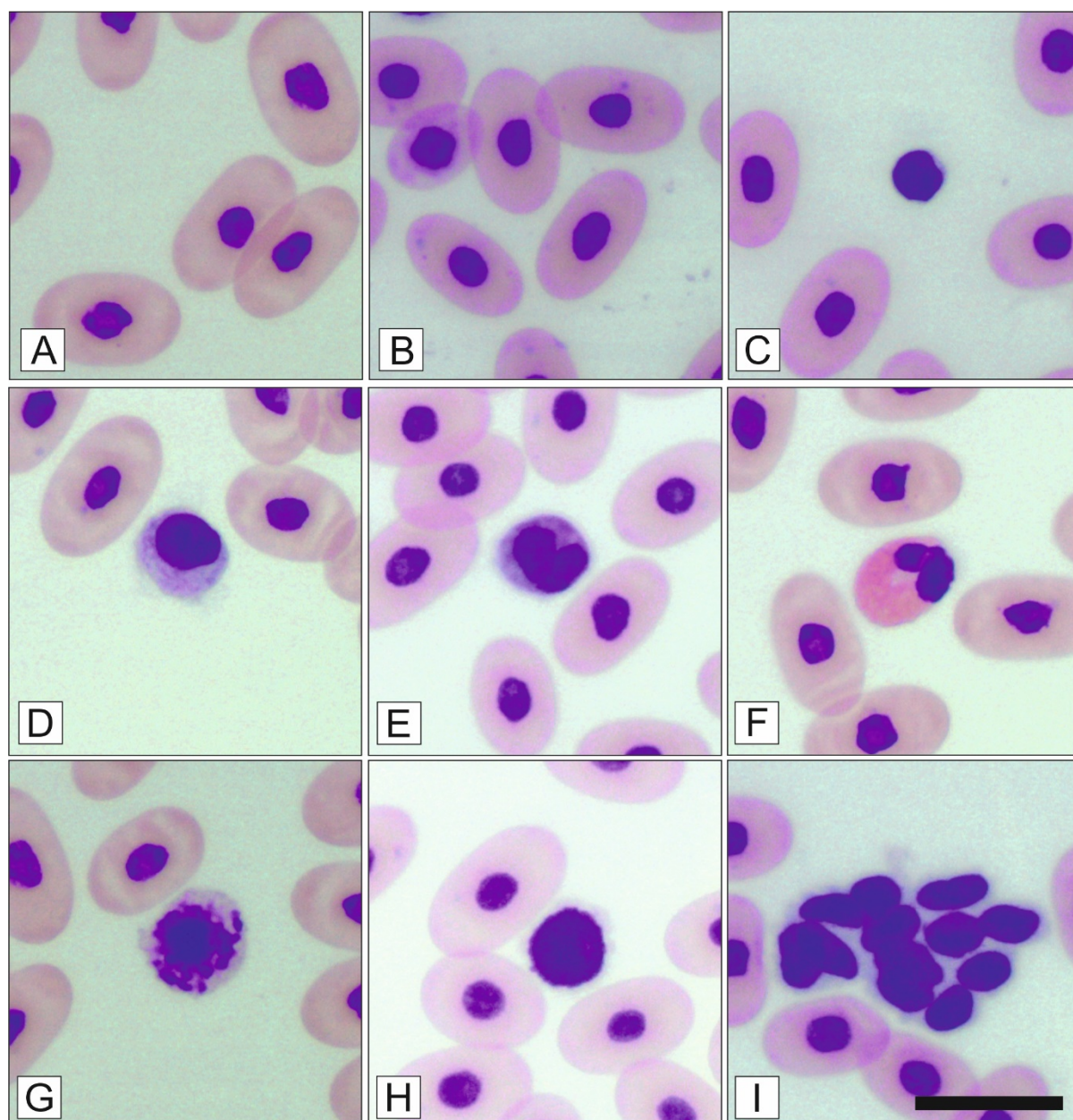
The cytoplasm of basophiles were filled with purplish black granules. As is the case with eosinophiles, the granules were observed to be masking the nucleus (Fig. 1H). The average diameter in basophiles was measured as 10.8 µm for *E. orbicularis* and as 10.9 µm for *M. rivulata* (Table 2).

Thrombocytes were observed as fusiform cells for both species. Almost the whole cell was filled with chromophilic nuclei (Fig. 1I). The average length of thrombocytes was established as 13.5 µm and width as 5.8 µm for *E. orbicularis*, the average length and width for *M. rivulata* were established as 14.5 µm and 6.8 µm, respectively (Table 2).

The erythrocyte count in 1mm<sup>3</sup> blood (RBC) was calculated as 435714 (range= 380000 -580000) in males and as 426250 (330000-580000) in females for *E. orbicularis*. The erythrocyte count in 1mm<sup>3</sup> blood for *M. rivulata* was calculated as 475000 (450000-500000) and 460000 (440000-480000) respectively (Table 3). The erythrocyte count

**Table 3.** The erythrocyte count in 1mm<sup>3</sup> blood of *E. orbicularis* (*E.o.*) and *M. rivulata* (*M.r.*).

Species	Gender	N	Mean	Min	Max
<i>E.o.</i>	Males	10	435714	380000	580000
	Females	5	426250	330000	580000
	Total	15	430667	330000	580000
<i>M.r.</i>	Males	4	475000	450000	500000
	Females	5	460000	440000	480000
	Total	9	467500	440000	500000



**Fig. 1.** Photomicrographs of peripheral blood cells in *E. orbicularis* and *M. rivulata*. A: erythrocytes (*E. orbicularis*), B: erythrocytes (*M. rivulata*), C: small lymphocyte (*M. rivulata*), D: large lymphocyte (*E. orbicularis*), E: monocyte (*M. rivulata*), F: heterophil (*E. orbicularis*), G: eosinophil (*E. orbicularis*), H: basophil (*M. rivulata*), I: a cluster of thrombocytes (*M. rivulata*). Scale (horizontal bar): 20µm.



was found to be higher in male than females for both species.

### Discussion

Many researchers (e.g. HARTMAN & LESSLER, 1964; SZARSKI & CZOPEK, 1966; SAINT GIRONS, 1970; ARIKAN *et al.*, 2015) have reported that reptiles constitute a heterogeneous group among vertebrates in terms of blood cell morphology, and show significant variations between orders and even between species in the same family. In reptiles, the largest erythrocytes are found in *Sphenodon punctatus*, tortoises and alligators and the smallest in Lacertid lizards (HARTMAN & LESSLER, 1964; SAINT GIRONS, 1970).

In aquatic terrapins, the erythrocyte length was reported as 22.5µm in *Chelydra serpentina* as 22.2µm in *Trionyx spinifer*, as 21.0µm in *Emys blandingi* (SZARSKI & CZOPEK, 1966), as 20.5µm in *Pseudoemys scripta elegans* (TAYLOR & KAPLAN, 1961), as 18.6µm in *Pseudoemys ornata* (HARTMAN & LESSLER, 1964), as 18.5µm in *Pseudoemys elegans* (HEADY & ROGERS, 1963).

The average erythrocyte length was established as 21.73 µm; width as 12.53 µm and size as 214 µm<sup>2</sup> in *E. orbicularis*; as 20.16µm, 11.64 µm, 184.30 µm<sup>2</sup> respectively in *M. rivulata* by UĞURTAŞ *et al.* (2003). In captivity conditions, 19.07µm, the values were 11.68µm, 174.95µm<sup>2</sup> for *Mauremys caspica* and 19.76µm, 11.44µm, 177.72µm<sup>2</sup> for *M. rivulata* (METIN *et al.*, 2008). In *Trachemys scripta elegans*, values of L 19.2µm, W 13.6µm, ES 204.9µm<sup>2</sup> and in *E. trinacris* values of L 22.5µm, W 14.1µm, ES 249.4µm<sup>2</sup> were recorded (ARIZZA *et al.*, 2014). In the present study, variations were observed interspecies and even in the blood smears of same species in terms of erythrocyte morphology. The average erythrocyte length was established as 20µm, erythrocyte width as 13µm and size as 201µm<sup>2</sup> for *E. orbicularis*; for *M. rivulata* these were 20µm, 12µm, 187µm<sup>2</sup>, respectively.

The erythrocyte count in 1mm<sup>3</sup> of blood was reported to be 370000 (250000-1160000) in Pascagoula Map Turtle (*Graptemys gibbonsi*); 420000 (200000 - 840000) in Southeast Asian Box turtle (*Cuora*

*amboinensis*) (PERPIÑÁN *et al.*, 2008); 503000 (260000 - 680000 (DUGUY, 1970); in different populations of *E. orbicularis* (ALDER & HUBER, 1923); 401310 in summer and 540280 in autumn in *M. leprosa* (PAGES *et al.*, 1992), 330000 in females and 420000 in males (HIDALGO-VILA *et al.*, 2007). The average erythrocyte count in *E. trinacris* was measured as 422500 in males and 379400 in females (ARIZZA *et al.*, 2014). There is negative correlation between erythrocyte number and size (RYERSON, 1949). Our results support this hypothesis.

The erythrocyte count in *E. orbicularis* was stated to be 471594 (range= 360000 - 620000) during the breeding period and 433859 (273333 - 573333) at the end of the breeding period by YILMAZ & TOSUNOĞLU (2010). Same researchers established the erythrocyte count in *M. rivulata* as 399487 (226666-700000) during the breeding period and 391944 (165000-586666) at the end of the breeding period. The erythrocyte count, depending on the quality of water, was reported to be between 414333 - 455555 in *E. orbicularis*, and 197333-449333 in *M. rivulata* by TOSUNOĞLU *et al.* (2011).

Various researchers (e.g. HADEN, 1940; ALTMAN & DITTMER, 1961) have drawn attention to the important role various environmental factors play on the size of erythrocyte in amphibians. ATATÜR *et al.* (1999) stated that entirely aquatic species have bigger erythrocytes whereas terrestrial species have smaller erythrocytes. In this study, erythrocyte and nucleus sizes of aquatic terrapins, *E. orbicularis* and *M. rivulata* (Table 2) are larger than Testudinidae (ARIKAN & ÇİÇEK, 2014; ARIKAN *et al.*, 2015). Therefore, this finding confirms ATATÜR *et al.* (1999), UĞURTAŞ *et al.* (2003).

SAINT GIRONS (1970) have drawn attention to the fact that small and large lymphocytes are dominant cells in blood smears of different reptile species, in both eosinophiles and basophiles the nucleus cannot be seen clearly due to intensive granulation in cytoplasm. ARIKAN & ÇİÇEK (2014) have reached similar results in different reptile species from Turkey. In addition, ARIZZA *et al.* (2014) have stated that eosinophiles are found more in *E. trinacris*

males while lymphocytes are more present in *E. trinacris* females. In the present study, agranulocytes were observed to be dominant cells in both turtles. As in previous studies, the shape of the nucleus could not be distinguished in blood smears due to intensive granulation in eosinophiles and basophiles cytoplasm and the neutrophils were identified as rarely seen leucocytes. The thrombocyte nucleus was observed as considerably chromophilic, centrally-located and flat oval-shaped cells.

## References

- ARIKAN H., K. ÇIÇEK. 2014. Haematology of amphibians and reptiles: a review. - *North-Western Journal of Zoology*, 10 (1): 190-209.
- ARIKAN H., D. AYAZ, K. ÇIÇEK, A. MERMER. 2015. Blood cells morphology of *Testudo graeca* and *Testudo hermanni* (Testudines: Testudinidae) from Turkey. - *Biharean Biologist*, Art.#151303, in press.
- ALDER A., E. HUBER. 1923. Untersuchungen über Blutzellen and Zellbildung bei Amphibien und Reptilien. - *Folia Haematologica*, 29: 1-22.
- ALTMAN P.L., D.S. DITTMER. 1961. *Blood and other body fluids*. Washington, D.C. Federation of the American Society of Experimental Biologists. 540 p.
- ARIKAN H., K. ÇIÇEK. 2014. Haematology of amphibians and reptiles: a review. - *North-Western Journal of Zoology*, 10 (1): 190-209.
- ARIZZA V., D. RUSSO, F. MARRONE, F. SACCO, M. ARCULEO. 2014. Morphological characterization of the blood cells in the endangered Sicilian endemic pond turtle, *Emys trinacris* (Testudines: Emydidae). - *Italian Journal of Zoology*, 81(3): 344-353. DOI:10.1080/11250003.2014.938371.
- ATATÜR M.K., H. ARIKAN, İ.E. ÇEVİK. 1999. Erythrocyte sizes of some anurans from Turkey. - *Turkish Journal of Zoology*, 23: 111-114.
- DUGUY R. 1970. Numbers of Blood cells and their variation. - In: GANS C., T.S. PARSONS. (Eds.), *Biology of the Reptilia* (Vol: 3). Academic Press, pp. 93-109.
- HADEN R.L. 1940. Factors affecting the size and shape of the red cell. - In: MOULTON F.R. (Ed.), *Blood, heart and circulation*. A.A.A.S. Publication No. 13, pp. 27-33.
- HAMMER Ø., D.A.T. HARPER, P.D. RYAN. 2001. PAST: Paleontological statistics software package for education and data analysis. - *Palaeontologia Electronica*, 4 (1): 1-9.
- HARTMAN F.A., M.A. LESSLER. 1964. Erythrocyte measurements in fishes, amphibians and reptiles. - *The Biological Bulletin*, 126: 83-88.
- HEADY J.M., T.E. ROGERS. 1963. Turtle blood cell morphology. - *The Proceedings of the Iowa Academy of Science*, 69: 587-590.
- HIDALGO-VILA J., C. DIAZ-PANIAGUA, N. PEREZ-SANTIGOSA, A. PLAZA, I. CAMACHO, F. RECIO. 2007. Hematologic and biochemical reference intervals of free-living Mediterranean Pond Turtles (*Mauremys leprosa*). - *Journal of Wildlife Diseases*, 43(4): 798-801. DOI: 10.7589/0090-3558-43.4.798
- METIN K., Y. BAŞIMOĞLU KOCA, F. KARGIN KIRAL, S. KOCA, O. TÜRKOZAN. 2008. Blood cell morphology and plasma biochemistry of captive *Mauremys caspica* (Gmelin, 1774) and *Mauremys rivulata* (Valenciennes, 1833). - *Acta Veterinaria Brno*, 77(2): 163-174. DOI: 10.2754/avb200877020163.
- METIN K., O. TÜRKOZAN, F. KARGIN KIRAL, Y. BAŞIMOĞLU KOCA, E. TAŞKAVAK, S. KOCA. 2006. Blood cell morphology and plasma biochemistry of the captive European Pond Turtle *Emys orbicularis*. - *Acta Veterinaria Brno*, 75(1): 49-55. DOI: 10.2754/avb200675010049.
- PAGÉS T., V.I. PEINADO, G. VISCOR. 1992. Seasonal changes in hematology and blood chemistry of the Freshwater Turtle *Mauremys caspica leprosa*. - *Comparative Biochemistry and Physiology*, 103A(2): 275-278. DOI: 10.1016/0300-9629(92)90579-F
- PERPIÑÁN D., S.M HERNANDEZ-DIVERS, K.S. LATIMER, T. AKRE, C. HAGEN, C.A.

- BUHLMANN, S.J. HERNANDEZ-DIVERS. 2008. Hematology of the Pascagoula Map turtle (*Graptemys gibbonsi*) and the Southeast Asian Box turtle (*Cuora amboinensis*). - *Journal of Zoo and Wildlife Medicine*, 39(3): 460-463.
- RYERSON D.L. 1949. A preliminary survey of reptilian blood. - *Journal of Applied Entomology and Zoology*, 41: 49-55.
- SAINT GIRONS M.C. 1970. Morphology of the circulating blood cells. - In: GANS C., T.S. PARSONS (Eds.), *Biology of Reptilia* (Vol. 3). Academic Press, pp. 73-91.
- SZARSKI H., G. CZOPEK. 1966. Erythrocyte diameter in some amphibians and reptiles. - *Bulletin of the Polish Academy of Sciences Biological Sciences*, 14: 433-437.
- TAYLOR K., H.M. KAPLAN. 1961. Light microscopy of the blood cells of *Pseudemys* turtles. - *Herpetologica*, 17: 186-196.
- TFTSG TORTOISE & FRESHWATER TURTLE SPECIALIST GROUP 1996. *Emys orbicularis*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: [www.iucnredlist.org]. Accessed: 16.01.2015.
- TOSUNOĞLU M., N. YILMAZ, Ç. GÜL. 2011. Effects of varying ecological conditions on the blood parameters of freshwater turtles in Çanakkale (Turkey). - *Ekoloji* 20, 78: 7-12. DOI: 10.5053/ekoloji.2011.782
- UETZ, P., J. HOŠEK, (eds.). 2014. The Reptile Database, Available at: [http://www.reptile-database.org]. Accessed: 08.11.2014.
- UĞURTAŞ İ.H., M. SEVINÇ, H.S. YILDIRIMHAN. 2003. Erythrocyte Size and Morphology of Some Tortoises and Turtles from Turkey. - *Zoological Studies*, 42 (1): 173-178.
- VAN DIJK P.P., J.B. IVERSON, A.G.J. RHODIN, H.B. SHAFFER, R. BOUR. 2014. Turtles of the world, 7th edition: annotated checklist of taxonomy, synonymy, distribution with maps, and conservation status. - In: RHODIN A.G.J., P.C.H. PRITCHARD, P.P. VAN DIJK, R.A. SAUMURE, K.A. BUHLMANN, J.B. IVERSON, R.A. MITTERMEIER. (Eds.), *Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group*. - *Chelonian Research Monographs* 5(7): 000.329-479, doi:10.3854/crm.5.000.checklist.v7.2014.
- VAN DIJK P.P., P. LYMBERAKIS, A.M. DISI, R. AJTIC, V. TOK, I. UĞURTAŞ, M. SEVINÇ, I. HAXHIU. 2004. *Mauremys rivulata*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: [www.iucnredlist.org]. Accessed: 16.01.2015.
- YILMAZ N., M. TOSUNOĞLU. 2010. Hematology and some plasma biochemistry values of free-living freshwater turtles (*Emys orbicularis* and *Mauremys rivulata*). - *North-Western Journal of Zoology*, 6(1): 109-117.

Received: 03.02.2015  
Accepted: 12.03.2015