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Morphology of Blood Cells of Agama Stellio (Linnaeus, 1758)

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Abstract:

Ten were chosen Agama stellio healthy adults, five males and five females, for this study. The morphological characteristics were examined because they are of peripheral blood cells. Been identified seven different types of blood cells, such as red blood cells, thrombocytes, Kperalmufoyat of, monocytes, heterophil, basophils, small lymphocytes. Lengths were measured and declined to these cells, and also to measure the lengths of red cell nuclei of Agama stellio. The red blood cells for females was (± 2.71 17.69 micron length x width 8.34 ± 2.31 microns).And for males (17.26 ± 2.61 length × width of 8.02 ± 2.02 micrometer microns). Htroppeals the granules contain The spherical features with homogeneous content., Eosinophils of similar size to neutrophils or slightly larger. The subunit contains an average amount of light bluegray, cytoplasm darling smooth, oval nucleus. And A Thrombocytes were oval and often showed vacuolation.

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Keywords: Blood cells, (Agama)stellio(Linnaeus,1758).

Introduction

Stellagama is a monotypic genus of agamid lizards containing the single species Stellagama stellio (Muro , *et al*1998. ;Jacobson E.R, OriggiF. 2002).Common names for the species include *Stellion*, hardun, star lizard, painted dragon, starred*Agama*, sling-tailed agama and roughtail rock *Agama*. It is found in Greece, Southwest Asia, and Northeast Africa.Like many *Agamids*, *stellions* can change color to express their moods. They bask on stone walls, rocks, and trees. They are usually found in rocky habitats, and are quite shy, being very ready to dive into cracks to hide from potential predators.Most studies on hematology in saurian species dealt mainly with blood cell counts and cell sizes. (HartMan and LesLer 1964;HutcHison and szarski 1965; szarski and czopek 1966; Duguy 1970; MerMer 1999; sevinç*et al*. 2000; sevinç&uğurtaş 2001; atatür*et al*. 2001; tosunoğLu*et al*.2004; sevinç*et al*. 2004; saccHi*et al*.2007; ponsen*et al*. 2008; troiano*et al*.2008). other hematological parameters, such as hematocrit value, total hemoglobinconcentration, mean cell volume, mean cell hemoglobin and mean cell hemoglobin concentration, were rarely studied (Harr*et al*. 2001; cuaDraDo*et al*.2002; ponsen*et al*.2008; troianoet al.2008). Erythrocytes are morphologically similar among the various lizard species. However, it was reported that red blood cell count and size displayed significant individual and interspecies variation, and that thisvariation was also related to body weight, Data for the agama stellio have included red and white blood cell counts(.RyersonDL.1943).erythrocyte sizemeasurements (Hartman FA, *et al*. 1968).hematocrit,specific gravity, blood volume, plasma volume, and total body water Thorson (TB.1968).percent protein(Friar W. 1964).total protein, sialic acid (Seal US.1964) and calcium, sodium, magnesium, and cholesterol (Jackson OF.1991).However, little or no previous study has presented values for a widerange of blood variables for the *Agama stellio*. Clarification of the morphological characteristics and classification of blood cells, especially WBCs, from the *Agama stellio* is important because this species information could be used to assist those attempting to interpret WBC counts for clinical and research specimens in the wild.

Materials and Methods animals

Agamastellio collected adult males and females from different locations in the desert area, "Borg", 50 km west of Alexandria, Egypt. Ajami was arrested in the active season (July 2012).Ten animals (5 maleand 5 female).during the summer and kept in large tarariom at a depth of 30 cm sand in the laboratory. The animals were decapitated with a sharp blade, blood was collected in a tube hibarinisid.(**Fig**.1)

Fig.(1). Photograph of the adult agama stellio
(Adel A. Ibrahim and Moustafa H. El- Naggar. 2013)

Blood smears stained with Wright's stainwere used in measuring the blood cells (erythrocytes, leukocytes and thrombocytes). Cell measurements were performed under a microscope with an ocular micro - meter. erythrocytes were randomly chosen on each blood smear; cell lengths (eL) and widths (eW), together with the lengths (nL) and widths (nW) of theirnuclei, were measured (µm).The measurements included maximal length (L) and maximal width (W). Sizes of cells were calculated according to the formula (L×W ×µ)/4 Ugˇurtas SH, 2003); MetinK,et. AI .2006).

Statistical Analysis

Numerical Data are presented as mean ± standard deviation (S.D.). Data were analyzed for statistical significance using student t test. P value of less than 0.05indicatessignificance. Confidence intervals, at 95% level, were also calculated. All statistical analyses were accomplished with the statistical package for the social sciences (SPPS 9.0, SPSS Inc. Corp.,Chicago , IL, USA) computer package.

RESULTS

Physical Parameters

Red Blood Cells Morphology

The erythrocytes of Agama stellio (Fig. 2a) Mature erythrocytes were ellipsoidal. The cytoplasm of mature erythrocytes appeared light and dark pink. The nuclei of mature erythrocytes are chromophilic. They contain vacuoles (Fig. 2b). Erythrocyte measurements for females were (length 17.69 ± 2.71 µm × width 8.34 ± 2.31µ) and for males were (length 17.26 ± 2.61 µm × width 8.02 ± 2.02 (µm)

The nucleus was centrally . The measurements of the nucleus for were (4.64 ± 0.60 µm × 2.93± 0. 67 µm) and for females were (4.81 ± 0.61 µm × 3.28 ± 0.67 µm) (Fig.3). Size means of the erythrocytes for was females (136.60 ± ±49.52 µ²)(Fig.3). (134.94 ± 43.88 µ²) and for males (136.60 ± ±49.52 µ²)(Fig.3).

White Blood Cells Morphology

Granulocytes

Granulocytes include the leukocytes that contain specific granules that identify the cell lineage. These cells include heterophils, eosinophils, and basophils

Heterophils–

The heterophil (**Fig**. 2c) reddish-orange granules in cytoplasm. These granules were spindle – shaped (with sharp poles).However, the shape was not always clearly visible, especially when the cytoplasm was filled with them. The eccentric placed nucleus of heterophil was round to oval pale blue and darker toward the centre

Heterophil measurements in males were (length 14.02 ± 2.21µm andwidth 11.98 ± 2.09 µm) and in females were (length 13.97 ± 2.01µm and width 11.35 ± 2.03µm)(**Fig**. 3). Heterphils size meansof the male was (167.25± 53.13 µ²) and in the female was (151.58± 43.77µ²) (**Fig**.4).

Eosinophils

The eosinophil (**Fig**. 2d) were round cells and less numerous. Their granules were darker, more red and round. Nucleus was eccentric placed, uniform in colour, with clumped Chromatin. Its measurements in males were (length 12.97 ± 1.33 µm and width 9.21± 1.49 µm) and in females were(length 12.683± ±1.59µm and width 8.57± 1.09 µm) (Fig.3). Eosinophil size means of the male was (117.37± 27.75 µ²) and infemale was (112.87± 30.23µ²)(**Fig**. 4).

Basophils-

The basophil (Fig. 2e) was filled with round granules, which are large, prominent over

periphery. Colour varied from deep purple to deep blue or black. The nucleus was almost invisible, only chromatin. Its measurements in maleswere(length 10.67 ± 1.16 µm and width 10.40 ± 1.13 µm) and in females were (length 11.04 ± 1.29 µm and width 10.75 ± 1.33 µm) (Fig.3). Basophil size means of the male was (109.42 ± 18.97 µ²) and in female was (116.52 ± 23.20 µ²) (Fig. 4).

Mononuclear Cells- The mononuclear cells include lymphocytes and monocytes. These cells generally lack significant lobulation of the nucleus and do not contain an abundance of cytoplasmic granules.

Lymphocytes - The lymphocytes(Fig. 2f) They had compact dark nucleus and thin cytoplasm fringe of blue or violet colour. Its measurements in males were (length 7.64 ± 2.03 µm and width 6.19± 1.63 µm) and in females were (length 8.58± 2.01µm and width 7.20± 2.15µm) (**Fig**.3). Lymphocytes size means of the male was (52.68± 17.52 µ²) and in female was (67.57± 22.52µ²)(**Fig**.4).

Monocytes - The monocyte (**Fig**. 2g). were cells with large quadratic nuclei with pale and fine chromatin. These cells had square shape, their cytoplasm was blue-gray, spacious, with or without vacuoles.. Monocytes in males were (length 13.15± 2.21 µm and width 8.76± 1.73 µm) and in females were (length13.48± 2.51 µm and width 9.407± 1.61 µm) (Fig.3). Size means of the monocyte in male was (112.85± 43.87 µ²) and in female was (120.27± 54.51 µ²)(Fig.4).

Thrombocytes–The thrombocytes (Fig. 2h) The nucleus of was round to oval and dark. The cytoplasm of one form of thrombocytes was find sitting on the nucleus, or instead of that the membrane loosely frilled around the nucleus. The other form was oval with a good visible membrane and transparent cytoplasm. The thrombocytes in males were (length 4.67 ± 0.80 µm x width 3.07± 0.83 µm) and in females were (length 4.77± 0.88 µm and width 3.10± 0.90 µm) (Fig.3). Thrombocyte size means of the male was (17.23± 5.92 µ²) and in female was (17.75± 6.38 µ²)(Fig. 4).

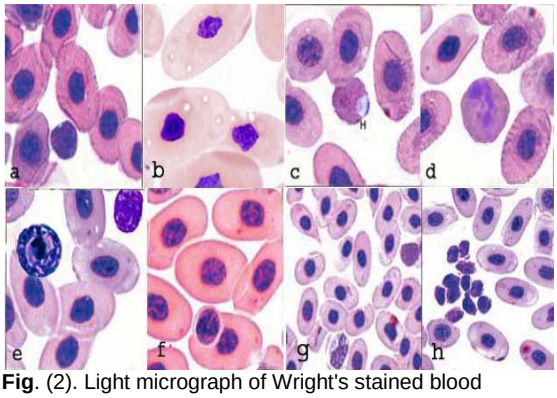


Fig. (2). Light micrograph of Wright's stained blood smears from the Agama stellioshowing: (a) Erythrocytes, (b) Erythrocytes with prominent vacuoles, (c) Heterophil , (d) Eosinophil ,(e) Basophil , (f) Lymphocyte , (g) Monocyte , (h) Clumps of thrombocytes . (Wright stain ×1000).

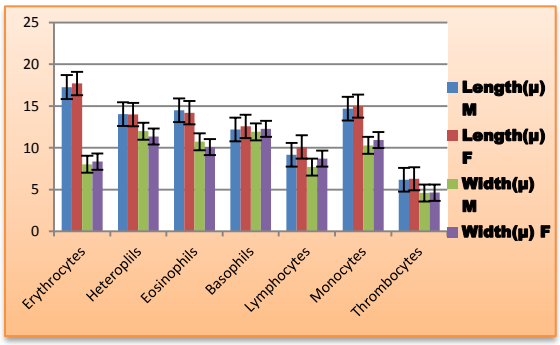
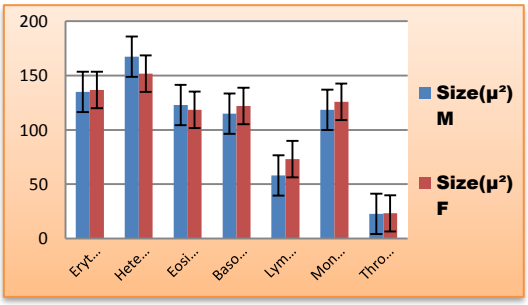


Fig (3) cell lengths (eL) and widths (eW), together with the lengths (nL) and widths (nW) of their nuclei, in males and in females.were measured (µm).*P value of less than 0.05 indicates a significant difference between the compared means of male and female*Agama* .



Fig(4) The measurements included maximal length (L) and maximal width (W) , males and in females.were measured (µ²). *P value of less than 0.05 indicates a significant difference between the compared means of male and female *Agama* .

DISCUSSION

This study attempt was to the morphological characteristics of the blood cells. The data presented will provide theveterinary clinician with specific hematological data which will allow for a more comprehensive medical assessment in *Agama stellio* clinical cases. Picea have a maximum total length of 25 to 30 cm. They have a rough scale structure. The ground color is dark black/blue with intensely colored darkyellow to orange spots which leads to bands on the tail (Avital E. 1981) .

The head is almost totally black in males but can vary from grey to dark grey in females. The males have a grayish belly and throat Werner (1998, 1992). (The piceapictured on the right is a male)(**Fig**. 5).

(**Fig**. 5).*Agama stellio* .males and females, (The picea pictured on the right is a male). (Alel A. Ibrahim and Moustafa H. El-Nagar. 2013).

Hematology and bloodbiochemical parameters are essential to assess the health and physiological status of stoic animals like the agama stellio (Khalifa, S.A. 2003).several authors (saintgirons 1970; sevinçet al. 2000; sevinç and uğurtaş2001; atatüret al. 2001; ponsenet al. 2008), who studied the blood of lizards, reported species-specific variations concerning both erythrocyte and leukocyte counts. sevinçet al. (2004) and MerMer (1999) reported no sexual dimorphism in blood cell counts in the gecko and scincid species studied. our results did not show any sexual differences in terms of erythrocyte counts.erythrocytes play an important role in oxygen and carbon dioxide transport. the erythrocytes' surface-area-to-volume ratio is a determining factor in their capacity of oxygen and carbon dioxide exchange in the tissues in that a small erythrocyte is relatively more efficient in gas exchange than a larger one (HartMan LessLer 1964; sevinçet al. 2000). our results are not in agreement with paL et al. 2008. according to our observations szarski czopek (1966) found no differences in the total hemoglobin between male and female Agama. However, the re - sults of the present study showed that total hemoglobin, Mean cell Hemoglobin and Mean cell Hemoglobin concentration were different between males and females.

II. Erythrocytes

The erythrocytes or red blood corpuscles of the circulating blood areNucleated, oval cells, rounded at their. Their nuclei are also oval, more or less regular, and centrally located; their long axes lie parallel to those of the cells**.**In blood smears stained by the classic May-Grünwald-Giemsa technique, the yellowish cytoplasm most often appears translucent and homogeneous. The nuclei of mature erythro- *In the lizard Acanthodactyluserythrums the long axes of more than 50% of the nuclei deviate from those of the cells in the only specimen of this form that I have studied.

2. MORPHOLOGY OF THE CIRCULATING BLOOD CELLS 75 cytes are chromophilic. The masses of chromatin are more or less visible, depending on the age of the cells. The most critical staining permits the demonstration of granules within the cytoplasm (Hirschler, 1928; Ryerson, 1949) and of the Golgi apparatus (Bhattacharya and Brambell, 1924).

The circulating blood contains immature cells of the erythrocytic series (basophilic and polychromatophilicnormoblasts) characterized by a rounded form, blue cytoplasm, and a large nucleus which is less chromophilic than that of a matureerythrocyte. These cells are especially common in young or moulting animals (Saint Girons,1961) or ones heavily infected byhemoparasites (Pienaar, 1962). The senile forms of the red blood cells are larger than the normal erythrocytes. Their cytoplasm stains weakly, and their nuclei are pycnotic and often irregularly shaped. In the final stage, the cytoplasmdisappears, and only the nucleus is visible in a smear. These different stages have been studied in detail in one turtle (Jordan and Flippen, 1913), one lizard (Pienaar,1962), and two snakes(Slonimski,1934). the erythrocytesand their nuclei become more circular (Wood, 1935). In lizards from Mexico and Florida, the presence of Plasmodium spp. within the corpuscles affected the dimensions of the cells, causing a more or less marked increase in their size (Thomson and Huff, 1944and Bergman, 1957; Reichenbach- Klinke,1963).

III. Eosinophilic Granulocytes

The eosinophilic granulocytes of all reptiles are large, generally rounded cells in which the variablyshaped nuclei lie near the periphery. The nuclei stain rather weakly with the May-Grunwald-Giemsa technique. The cytoplasm contains granules that are usually highly chromophilic and appear a more or less brilliant yellow-brown. Loewenthal (1931) reported only a weak staining reaction of the granules in Anguisfragilis. Two types of eosinophils may be distinguished on the basis of the shapes of theintracytoplasmic granules which may be cylindrical or, more commonly, spherical. These two types have been reported in all the orders of reptiles: Testudines (Loewenthal, 1930; Ryerson, 1943), Rhynchocephalia (Komocki, 1936), Squamata (Pena Roche, 1939,Pienaar, 1962;Loewenthal, 1928, Viperaaspis), and Crocodilia (Slonimski, 1935; Ryerson, 1943). Bernstein (1938) differentiated three types of eosinophils in Psammobates(Testudoauct.) geometricus based on the affinity of the cytoplasmic granules for eosin. A recent study presents histochemical and ultrastructural data on these cells in Lacertaagilis and Emys orbicularis (Kelenyi and Nemeth, 1969).

The size of these cells is very variable, not only between species, but even in one animal and in a single blood smear. Because of thisvariation, the data presented which gives the maximum, mean, and minimum lengths of the greatest diameter, can only be taken as indications, valuable only in that a certain number of species belonging to different orders may be compared. Surprisingly the average sizes are nearly similar in all cases. The eosinophilic granulocytes of Sphenodonpunctatus, unlike its erythrocytes, are among the smaller ones. Lizards have small eosinophils, snakes the largest ones, and turtles and crocodilians are intermediate in this regard. The intracytoplasmic granules vary in size, reaching two to three micra in their largest diameter. The density of the granulation may obscure the position and form of the nucleus. The latter is often multilobate, but the number of lobes does not appear to be very high.

IV. Basophilic Granulocytes The basophilic granulocytes are very easy to recognize. In all the species studied, they are small, circular or nearly circular corpuscles.

2 Morphology of the crculationg blood cells

plasm is usually filled with extremely chromophilic granules . In a blood smear, they resemble mulberries. The granulation is so dense that the weakly staining nucleus may only rarely be seen (Michels, 1923). In some species, including Lacertaviridis and Typhlopspunctatus, the basophils are slightly oval.

The interspecific variation in the size of the basophilic granulocytes is less than that of the eosinophils. They are smallest in the lizards,especially Lacerta, larger in snakes,still larger in turtles and crocodilians,and largest in Sphenodonpunctatus. Michels (1923) Largest Diameters (in mcm) of Basophilic Granulocytes in someRepresentatives of the Different Orders of Reptiles (after Saint Girons and Duguy, 1963, with supplements

V.Azurophilic Granulocytes

The presence of azurophilic granulocytes in reptilian blood wasfirst reported by Pappenheim(1909). Although they are, in most cases, difficult todifferentiate by the May-Grunwald-Giemsa technique, they may becharacterizedby the possession of granules that stain with pure azure dyes and with the pyronin of methylgreen-pyronin mixtures (Pienaar, 1962). Hematologistshave attributed them to different leucocytic series, most often to the monocyticseries (Zylberszac, 1937; Ryerson, 1949) or the neutrophilicgranulocyticseries (Loewenthal, 1930; Slonimski, 1934; Bernstein, 1938).These cells have relatively small, irregular, eccentric nuclei. They varygreatly in size. Azurophilic granulocytes usually contain lipid bodies in thecytoplasm, but those may be absent, as in Cordylus (Pienaar, 1962). Senilecells contain many vacuoles.

VI. Neutrophilic Granulocytes

The neutrophilic granulocytes are circular or oval cells that frequentlyform groups of two or three cells beside each other in blood smears(Pienaar,1962).Their name refers to their staining reactions only; they are probablynot homologous to the neutrophils ofmammals. The small, irregular nucleuslies near the periphery of the cell. The neutrophils may be regarded asmorphological variants of the azurophilic granulocytes with which they haveoften been confused. They have also been described as heterophils; the factthat this last name has also been applied to the eosinophilic granulocytes with cylindrical granules only

adds to the nomenclature confusion (Ryerson,1949).

VII. Lymphocytes

Lymphocytes form the most important class of leucocytes if, as manybelieve, they retain all of their potential to differentiate into the other bloodcells while they are circulating in the blood. They show a large range in size,and the distinction between "large" and "small" lymphocytes is most oftenarbitrary. In Cordylusvittifer, Pienaar (1962) divided this category into largelymphocytes in which the diameter is at least 14.5 μ and small lymphocyteswith diameters of 5.5 to 10 μ. Lymphocytes are characterized by transparent, moderately to weakly basophilic .the nuclei are circular and centrally located in small lymphocytes, but more irregular inlarge ones. Chromophobic vacuoles and some azurophilic granules occur in the cytoplasm.In Ranapipiens there is a direct genetic relation between lymphocytes andmonocytes (Jordan, 1925); all gradations occur, in morphology, physiology,and staining properties, between small lymphocytes and large monocytes.

The situation is probably the same in reptiles (Pienaar, 1962).

VIII. Plasma Cells

The plasma cells, which are usually rare in the circulating blood, may arisefrom medium-sized or large lymphocytes. They are characterized by an eccentric nucleus, opaque basophilic cytoplasm, and a perinuclear halo of hyaloplasm.

IX. Monocytes

Monocytes have been confused with several other types of cells and maynot always be distinct (Fig. 12). In CordylusPienaar (1962) considered themas a type of azurophilic granulocyte although, in his table of terms, he treatsthem as a distinct series. They are generally rare and have markedly irregularshapes. Their nuclei vary in shape, but are frequently polymorphous.

X. Thrombocytes

The thrombocytes are small, oval cells characterized by elongate, centrallylocated, highly chromophilic nuclei. The nucleo-cytoplasmicratio is especially high, and the cytoplasm appears as a narrow border aroundthe nucleus. The cytoplasm is almost colorless (faintly acidophilic) andhence difficult to see in a blood smear. It frequently contains some azurophilic granules. Pienaar (1962) described a large acidophilic granule at onepole of the nucleus in thrombocytes of the turtle Pelomedusa Subrufa. Thrombocytes are fragile cells**,** and in blood smears their very viscouscytoplasm is often lost. The nuclei are then clumped in groups which maycontain ten or more elements.

XI. Parasites in the Blood of ReptilesA. GENERAL

Although a detailed treatment of the parasites in the blood is outside the

scope of this chapter,a brief mention of them may be appropriate heresince

they can be seen in blood smears and may affect the morphology of the differentblood cells. The literature on the parasites in reptilian blood is veryextensive, with papers treating hemogregarines being especially numerous.So as not to overload the text, I have cited only the most important or especiallyinteresting works. The recent papers of Pienaar (1962) and Reichenbach-Klinke (1963) contain extensive bibliographies. (A detailed treatmentof the various reptilian parasites will furthermore be included in the volumeson Ecology).Parasites of the blood may be divided into two classes depending onwhether they infect the blood without attacking the corpuscles or whether theybecome established within the corpuscles.

Acknowledgements

this study is the first attempt to characterize the health status of the Agama stellio. In general, our findings suggest that these agama are in good health. However, some of our findings suggest that these keystone species should continue to be monitored to protect them into the future.

REFERENCES

Adel A. Ibrahim and Moustafa H. El-Naggar.(2013): Diet and reproductive biology of the Starred Agama, Laudakia stellio (Linnaeus, 1758) (Squamata: Agamidae), in the northern Sinai, Egypt -Zoology in the Middle East.59(2):143-136.

Amr, Z. S. S., et al. (2012): Stellagma stellio. In: IUCN 2012. IUCN Red List of Threatened Species.Version 2012.2.

Atatür, M. k. &arikan, H. &çevik, i. e. &MerMer, a. (2001): erytrocyte measurements of somescincids from turkey.-turkish Journal of zoology, ankara; 25: 149-152.

Avital,E. (1981): Resource Partitioning Between Two Lizard Species of Genus Acanthodactylus Living in the Same. Sands. M.Sc. Thesis. Hebrew University of Jerusalem, Israel.Xxxxx pp. (In Hebrew.)

Baig, K. J., et al. (2012): A morphology-based taxonomic revision of Laudakia Gray, 1845 (Squamata: Agamidae).Vertebrate Zoology 62(2) 213-60.

Bergman, R. A. M. (1957): The erythrocytes of snakes. Folia haemal.,Lpz. 75,92-111.

Bernstein, R. E. (1938): Blood cytology of the tortoise, Testudogeometrica. S. Afr.J. Sci. 35,327-331.

Bhattacharya, D. R. and Brambell, R. (1924).The Golgi body in the erythrocytes of the Sauropsidae.Q_J. microsc.Sci. 69, 357-359.Cairo.

Cuadrado, M. & Diaz-paniagua, c. &QueveDo, M. a. &aguiLar, J. M. &prescott, i. M. (2002): Hematology and clinical chemistry in dystocic and healthy post-reproductive female chameleons.- Journal of Wildlife Diseases, ames; 38 (2): 395-401.

Duguy, r. (1970): numbers of blood cells and their variation; pp. 1-72. in: gans, c. & parsons, t. s. (eds.): biology of the reptilia. vol. 3.Morphology c.new york (academic press).

Friar W. (1964): Turtle family relationships as determined by serological tests. In: Leone CA, Ed. Taxonomic Biochemistry and Serology. New York: Ronald Press; pp. 535-44.

Harr k. &aLLeMan, a. r. & Dennis, p. M. &MaxWeLL, L. k. & Lock, b. a. &bennett, r. a. & Jacobson, e. r. (2001): Morphologic and cytochemical characteristics of blood cells and hematologic and plasma biochemical reference ranges in green iguanas.- Journal of the american veterinary Medical associ - ation (JavMa), schaumburg; 208 (6): 915-921.

Hartman FA, Lessler MA. (1964): Erythrocyte measurements in fishes, amphibian, and reptiles. Biol Bull Mar Biol Lab; 126: 83-8.

HartMan, F. a. &LessLer, M. a. (1964): ery - throcyte measurements in fishes, amphibians and rep - tiles.- biological bulletin, Woods Hole; 126: 83-88.

Hirschler, J. (1928). Studienüber die Plasmakomponenten (Golgi Apparat u. a.) an vital gefärbtenmännlichenGeschlechtszelleneinigerTierarten. Z. Zellforsch. mikrosk. Anat. 7,62-82.

HutcHison, H. v. &szarski, H. (1965): number of erytrocytes in some amphibians and reptiles. copeia, Washington; (3): 373-375.

Jackson OF. (1991): Chelonians. In: BeynonManualof exotic pets, P.H., Cooper JE (Eds.). British Small Animal Veterinary Association, Cheltenham, UK 1991; pp. 221-43.

Jacobson ER, Origgi F. (2002): Use of serology in reptile medicine. Semin Avian Exotic Pet Med; 11(1): 33-45.

Jordan, H. E. & FLIPPIN, J. C. (1913).Hematopoiesis in Chelonia.Folia haematol. 15, 1-22.

Jordan, H. E. (1925): A study of the blood of the leopard frog, by the method of supravital staining. Am. J. Anat. 35,105-132.

Kelényi, G. and Németh Â. (1969): Comparative histochemistry and electron microscopy of the leosinophil leucocytes of vertebrates. I. A study of avian, reptile, amphibian and fish leucocytes. Acta biol. Acad. Sei.Lung. 20(4), 405-422,

Khalifa, S.A. (2003): Comparative ultrastructure study on spermiogenesis in two lizards, Tarentolaannularis and Agama stellio. Journal of Union of Arab Biologists Cairo A Zoology 20: 29-40. ISSN: 1110-5372.

Komocki, W. (1936): Nouvelles observations sur la désagrégationphysiologique des leucocytes granuleuxainsiquesur les leucocytes du sang de Sphenodonpunctatus, Gray (Hatteria). Bull. Histol. Tech. Micr. 13,194-201.

Loewenthal, N. (1928): Etude sur les globules blancs du sang dans la série des Vertèbres. Reptiles. Arch. Anat. 8,255-273.

Loewenthal, N. (1930). Nouvelles observations sur les globules blancs du sang chez lesanimauxvertébrés. Reptiles. Arch. Anat. 11, 283-297.

Loewenthal, N. (1931): Des variétés de globules blancs du sang chez l'orvet et la hulotte. Arch. Anat. 13,225-245.

MerMer, a. (1999): anadolu'dakiChalcidesocellatus (sauria scincidae) populasyonlarınınkanhücrelerininsayısıbakımındanincelen mesi.- Turkish Journal of zoology, ankara; 23 (1): 55-58.

Metin K, Türkozan O, Kargin, F, Basimogglu Y, Taskavak E, Koca S.(2006) Blood cell morphology and plasma biochemistry of the captiveeuropean pond turtle (Emys orbicularis). Acta Vet Brno ; 75: 49-55.

Michels, N. A. (1923): The mast cell in lower vertebrates. Cellule 33,339-462. Milne-Edwards, A. (1856). Notes sur les dimensions des globules du sang chez quelquesvertébrés. Annls.Sci. nat. 5,165-167.

morphology of some tortoises and turtles from turey. Zoologic Stud

Muro J, Ramis A, Pastor J, Velarde R, Tarres J, Lavin S. (1998): Chronic rhinitis associated with herpesviral infection in captive spurthighedtotoise from Spain. J Wildl Dis; 34: 487-95.

Nat. Biodiver. Unit., No. 1: 302pp.

PaL, a. &pariDa, s. b. &sWain, M. M. (2008): Hematological and plasma biochemistry in Fan throated Lizard Sitanaponticeriana (sauria: agamidae).-russian Journal of Herpetology, Moscow; 15 (2): 110-116.

Pappenheim, A. (1909): EinigeinteressanteTatsachen und theoretischeErgebniss der vergleichendenLeukozytenmorphologie. Folia haemat.,Lpz. 8, 504-563.

Pena Roche, H. (1939): Contributiones à la morphologiacomparada de la fauna Chilena. Boln. Soc. Biol. Concepciôn 13,133-146.

Pienaar, de V. (1962): Haematology of Some South African Reptiles. Witwatersrand University Press, Johannesburg, S.A.

Pienaar, U. de V. (1962): "Haematology of some South African Reptiles." Witwatersrand Univ. Press, Johannesburg.

ponsen, s. &narkkong, n. &paMok, s. &sappaso, k. &aengWanicH,W.(2008): Hematological values and morphological observation of blood cells in ballong Frog, Glyphogloossusmolossus.- Journal of the Microscopy society of thailand; 22 (1-2): 71-75. WWW document <http://www.mstthailand.com/Journals /2008/sp08JMstp71_75.pdf >.

Reichenbach-Klinke, H. H. (1963): "Krankheiten der Reptilien." G. Fischer, Stuttgart.

Ryerson, D. L. (1943): Separation of the two acidophilic granulocytes of turtle blood, with suggested phylogenetic relationships. Anat. Rec. 85, 25-48.

Ryerson, D. L. (1949): A preliminary survey of reptilian blood. Journal of Entomology and ^oology, 41, 49-55.

Ryerson, D. L. (1949).A preliminary survey of reptilian blood. J. Ent. Zool. 41,49.

SaccHi, r. &pupin, F. &zuFFi, M. a. L. &boncoMpagni, e. &binDa, a. &gaLeotti, p. &FasoLa, M. (2007): blood cell morphology of the Moorish gecko, Tarentolamauritanica.- amphibiareptilia, Leiden; 28: 503-508.

Saint Girons , M. C. (1961): Etude de l'Erythropoièse chez la Vipèreberus (Viperaberus) en fonction de l'activitéthyroïdienne et des phénomènescycliques de la mue. Bulletin de la SociétéZoologique de France, 86: 59-67.

Saint girons, M. c. (1970): Morphology of the circulating blood cells; pp. 73-91. in: gans, c. & parsons, t. s. (eds.): biology of the reptilia. vol. 3. Morphology c. new york (academic press).

Seal US. (1964): Vertebrate distribution of serum ceruloplasmin and sialicacid and the effects of pregnancy. Comp BiochemPhysiol; 13: 143-59.

Sevinç, M. &uğurtaş, i. H. &yiLDiriMHan, H. s. (2000): erytrocyte measurements in Lacertarudis (reptilia, Lacertidae).- turkish Journal of zoology, ankara; 22: 89-81.

Sevinç, M. &uğurtaş, i. H. &yiLDiriMHan, H. s. (2004): Morphological observation on the erythrocyte and erythrocyte size of some gecko species, turkey.- asiatic Herpetological research, berkeley; 10: 217-223.

Sevinç, M. &uğurtaş, i. H. (2001): the morphology and size of blood cells of Lacertarudisbithynica.-asiatic Herpetological research, berkeley; 9: 122- 129.

Slonimski, P. (1934): Sur les élémentsfigurés du sang chez Viperarusselliet Python regius. C.r. Ass. Anat. (1), 25-28.

Slonimski, P. (1935): Sur les éléments du sang chez les crocodiles, Crocodilusrhombifer. C.r. Ass. Anat. 15-17.

Szarski, H. &czopek, g. (1966): erythrocyte diameter in some amphibians and reptiles.- bulletin de l'académie polonaise des sciences, classe ii., varsovie; (série des sciences biologiques) 14 (6): 433- 437.

Thomson, P. E. and Huff, C. G. (1944): A saurian malarial parasite, Plasmodium mexicanum n. sp. with both elongatum- and gallinaceum-types of exoerythrocytic stages. J. infect. Dis. 74,48-67.

Thorson TB. (1968):Body fluids partitioning in reptilia.Copeia; 592-601.

TosunoğLu, M. &ayaz, D. &tok, c. v. &DüLger, b. (2004): an investigation on the blood cells of the Leopard gecko Eublepharisangramainyu (reptilia: sauria: eublepharidae).- asiaticHerpeto - logical research, berkeley; 10: 230-234.

Troiano, J. c. &gouLD, e. g. &gouLD, i. (2008): Hematological reference intervals in argentine lizard Tupinambismerianae (sauria-teiidae).- comparative clinical pathology, London; 17: 93-97.

Ug˘urtas SH, Sevinc M, Yldrmhan H. (2003):Erythrocyte size and
morphology of some tortoises and turtles from turey. Zoologic Stud
; 42(1): 173-78.

Werner Y.L. et al .(1998): Conservation-Oriented Herpetological Research in Israel.

Werner Y. L. (1992), «Identity and distribution of Agama stellio picea Parker (Sauria: Agamidae), endemic to the volcanic desert of Jordan», Zool. Middle East, 6, 41 – 44.

WOOD, S. F. 1935. Variations in the cytology of the blood of geckos (Tarentolamauritanica) infected with Haemogregarinaplatydactyli and Pirhemocytontarentolae. University of California Publications in Zoology, 41: 9-22.

Zylberszac, S. (1937). Sur la nature des leucocytes réticulairesetspongieux du sang des reptiles. C. r. Séanc. Soc. Biologie. 126,97-98.