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Demography and conservation of an isolated Spur-thighed tortoise Testudo graeca population in Dobrogea (Romania)

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Abstract. Spur-thighed tortoise is a vulnerable species. The local declines of populations led to an imperative need for conservation. *Testudo graeca* reaches its northern range limit in Dobrogea region, Romania. We studied a population from this region, which occupies an enclosed area of 32 ha within Histria Archaeological Complex. Based on a capture-mark-recapture study we estimated the population size of 221 ± 12.2 individuals. The observed density was 5.1 individuals/ha. The predicted population size suggests a relatively high density in relation to the area thus raising attention for a future conservation strategy. The population structure shows reduced sexual dimorphism and an unbiased sex ratio, implying a young population structure. We suggest correlating the future archaeological studies with conservation requirements of tortoises.

Key words: *Testudo graeca*, estimating population size, density, Romania.

Introduction

Demographic traits of animal populations offer useful information about their conservation status (WILLIAMS *et al.*, 2002) influencing their viability and persistence over time (BOYCE, 1992). The demography and population density are important as they guide the decision making process to establish if a population is suitable for conservation (AKÇAKAYA & SJÖGREN-GULVE, 2000), and help to implement the conservation measures at both local and wider geographical area (BERTOLERO *et al.*, 2007; ROZYLOWICZ & DOBRE, 2010).

Reptiles are a key component of ecosystems as predators, prey, grazers, seed dispersers and/or commensal species. Reptiles are declining worldwide, requiring extensive conservation measures (GIBBONS *et al.*, 2000). European reptiles and especially tortoises are mostly influenced by habitat loss (COX & TEMPLE, 2009). The demographic traits differ among the species of *Testudo* genus and even between populations of the same species (WILLEMSEN & HAILEY, 2003).

The most of demographic studies concerning *Testudo graeca* report the size or the density of the studied population (e.g., KADDOUR *et al.*, 2006; RACHID *et al.*, 2007). However, density can be viewed as a measure of habitat occupancy and is the result of direct observation, dependent of field activity and study site, without offering an estimation of population size or its dynamic in time (INMAN *et al.*, 2009). Therefore, a reliable assessment of population size is required. The size of a reptile population is estimated using different methods (HILL *et al.*, 2007) because of the dissimilarities in activity patterns

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(LAMBERT, 1981) and detectability of adults and juveniles (LAGARDE *et al.*, 2002). One of the widely used techniques is the capture-recapture (KENDALL & POLLOCK, 1992) since is straightforward to implement in small areas (KADDOUR *et al.*, 2006). This method is implemented in population size estimation oriented software (e.g., Mark, U-Care, POPAN; SUTHERLAND, 2006) and allows estimating the size of tortoise population, and detecting patterns of population structure (BESBEAS *et al.*, 2002) and survivability (BERTOLERO *et al.*, 2007).

The Spur-thighed tortoise, *Testudo graeca* Linneaus, 1758, is a flagship species for conservation (WALPOLE & LEADER-WILLIAMS, 2002) due to its ability to attract public attention for conservation measures (BARUA *et al.*, 2011). It is considered a vulnerable species in Europe (COX & TEMPLE, 2009), and a species of community interest that requires the designation of special areas of conservation (HABITATS DIRECTIVE 92/43/EEC).

The populations of this tortoise are spread on a wide range around the Mediterranean Sea living in both dry and Mediterranean wet climate, reaching at altitudes up to 2000 m a.s.l. (ANADÓN *et al.*, 2012). The population densities vary between 2-6 individuals ha^{-1} (HAILEY, 2000; DÍAZ-PANIAGUA *et al.*, 2001; KADDOUR *et al.*, 2006; ROUAG *et al.*, 2007) being reduced when compared to *T. hermanni* populations (i.e., with densities reaching 6.3 ha^{-1} tortoises in France and 12 tortoises/ha in Romania; BERTOLERO *et al.*, 2011).

The fragmented range of *T. graeca* populations is the result of widespread agricultural activities and land use changes that led to the isolation of tortoises in island-like favourable habitats (ANADÓN *et al.*, 2007; SAUMURE *et al.*, 2007; PREDA *et al.*, 2009). Reduced size populations are at risk from being destroyed by vegetation fire (STUBBS *et al.*, 1985; SANZ-AGUILAR *et al.*, 2011) or from illegal collecting for pet trade (LJUBISAVLJEVIĆ *et al.*, 2001; TÜRKOZAN *et al.*, 2008).

In Romania, *T. graeca* is found exclusively in the Dobrogea province (FUHN & VANCEA, 1961) at the northern limit of its distribution range (COGĂLNICEANU *et al.*, 2010), with greatly dispersed populations. The largest population is in the north of the region and a second large population in the forested hills in the south (COGĂLNICEANU *et al.*, 2007, 2008).

This study is assessing the situation of an isolated population of *T. graeca* from Dobrogea. The objectives of this study were (1) to estimate the population structure, size and density, and (2) to provide adequate conservation measures for this isolated tortoise population.

Material and methods

Site description. The studied population is located in an enclosed 32 ha perimeter within the Histria Archaeological Complex (HAC; 44°32'56'' N and 28°45'56'' E), an area of grasslands surrounded by wetlands in the south of the Danube Delta Biosphere Reserve (Fig. 1). The HAC includes an active archaeological and touristic area with exposed ruins, and an archaeological site without touristic activity. The past archaeological activities have resulted in numerous pits, slops and exposed ruins which in conjunction with tumuli and vegetation provide a variety of habitats for tortoises.

Estimation of demographic parameters. Monitoring and inventory were carried out during 2010-2012, throughout the active period of the tortoises (i.e., 29 visits from April to October, between 8 AM and 3 PM) using a capture-mark-recapture design. Animals were captured by active search along transects and marked on a marginal, posterior scute with a small indentation (STUBBS *et al.*, 1984). The animals were sexed based on external morphological characters (CARRETERO *et al.*, 2005), measured for straight carapace length (SCL) and curved carapace length (CCL), weighed and photographed for later identification (TICHÝ & KINTROVÁ, 2010). We used a threshold of 10 cm in SCL for separating juveniles/subadults from adults (STUBBS *et al.*, 1984). Individuals with underdeveloped sexual characters were considered subadults (WILLEMSEN & HAILEY, 2003). We transformed the obtained data in a binary

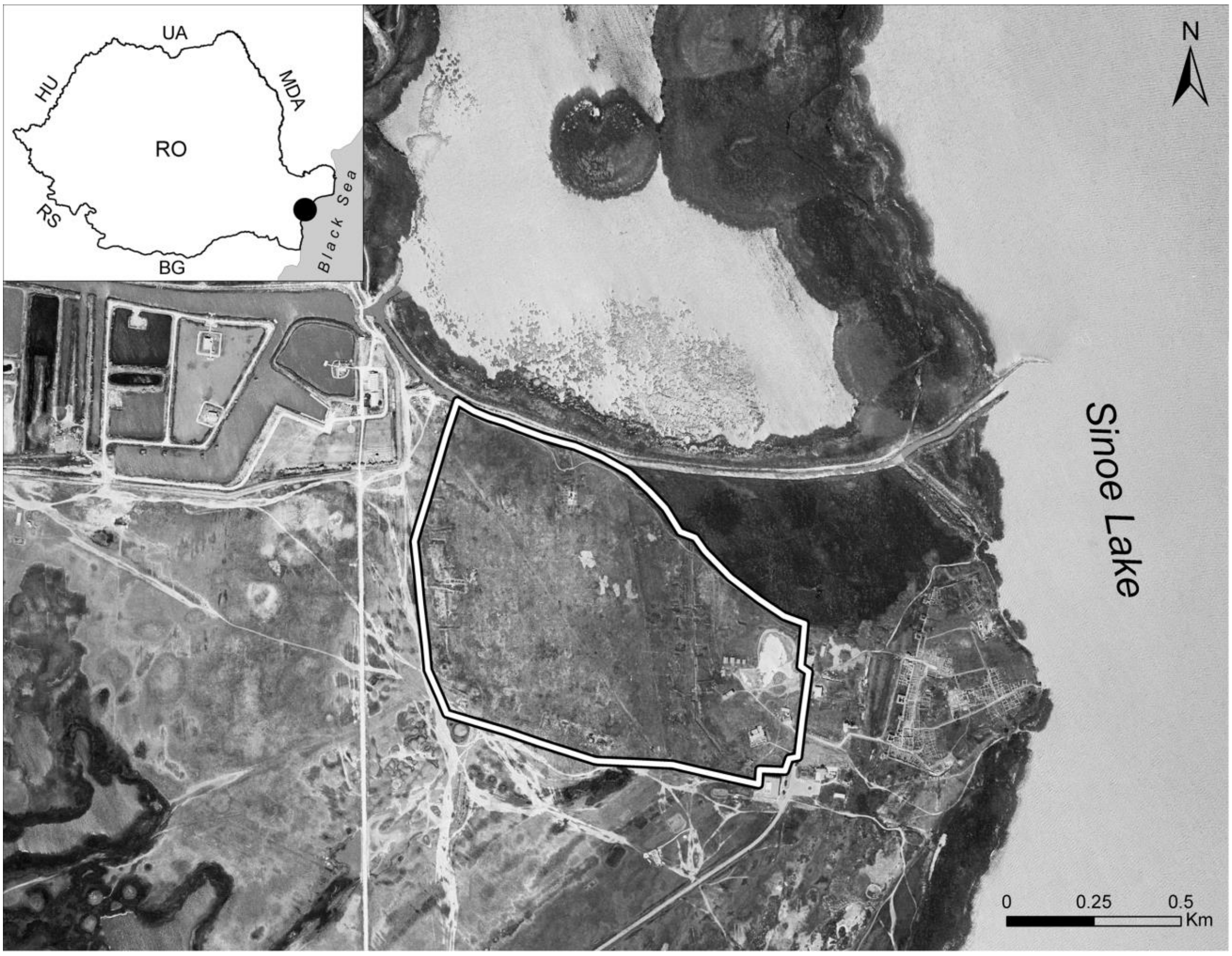

Fig. 1. Location of the study area in Romania (black dot in the upper left map) and the enclosure of Histria Archaeological Complex (white line contour).

string for each tortoise, forming the succession of capture/recapture (1) and the lack of capture (0) events. The number of events is equivalent to the number of occasions of capture-recapture.

The adult population structure was analysed using three biometric parameters (i.e., SCL, CCL and weight). The age (i.e., estimated from scutes growth ring counting; BERTOLERO *et al.*, 2005) was excluded from analyses because good estimation can be obtained only for juveniles and subadults, under 15 years (GERMANO, 1988). We tested for gender specific differences in SCL, CCL and weight using non-parametric Mann-Whitney U test.

We used the capture-mark-recapture design to estimate the population size (WHITE *et al.*, 1982) and analysed the data using Mark 6.2 software (WHITE & BURNHAM, 1999) and Capture module. The population was assumed closed during the study due to: (i) unsuitable habitat surrounding the HAC which limits the emigration or immigration of tortoises, (ii) no dead tortoises observed during the study and (iii) low detectability for juveniles makes the assessment of population growth difficult (GUYOT & CLOBERT, 1997).

We used the models for the estimation of N included in Mark (POLLOCK *et al.*, 1990), the application being able to point to the more appropriate one (SUTHERLAND, 2006). Three estimators were selected to estimate N: a null model Mo, Daroch Mt, and Jacknife Mh. Each of these models is characterised by different features for the estimation of N (OTIS *et al.*, 1978): (1) Null model Mo requires constant probability of capturing for the entire period of the survey, (2) Mt Daroch model assumes variation of captures with time during the survey period, (3) Jacknife Mh implies the variation of captures as function dependent on the individual, other than the capture probability for the entire population. We used these models to estimate the total population size, adult population size and separately for each sex, thus taking into consideration the gender specific differences in behaviour and different capture opportunities of adults and juveniles. Also, for this species there is no positively or negatively subsequent response to capture (PIKE *et al.*, 2005).

We also estimated the population size using temperature at the time of capture as an environmental covariate (HUGGINS, 1989). Only the adult population was estimated, using Mt model and the Huggins Closed Captures data type in the covariation model.

Density estimation was computed using the number of individual captures and the estimated population size obtained from the Mark application in respect to the area being studied.

Results

We inventoried 164 tortoises in the study area and had 72 recaptures. Males had a higher recapture rate than females (males=58.11%, females=34.21%), which instead, attained a higher individual recapture rate. Only 14 juveniles were observed during the survey (Table 1).

Table 1. Number of captured and recaptured *T. graeca* from Histria Archaeological Complex.

	Males	%	Females	%	Juveniles	%	Total	%
Unique captures	74	45.12[a]	76	46.34[a]	14	8.54[a]	164	***
Recaptures (n)	43	58.11[b]	26	34.21[b]	3	21.43[b]	72	43.90[a]
Recaptures n=1	25	58.14[c]	13	50.00[c]	3	1.83[c]	41	56.94[c]
Recaptures n=2	14	32.56[c]	4	15.38[c]	0	0.00[c]	18	25.00[c]
Recaptures n=3	3	6.98[c]	5	19.23[c]	0	0.00[c]	8	11.11[c]
Recaptures n=4	1	2.33[c]	3	11.54[c]	0	0.00[c]	4	5.56[c]
Recaptures n=5	0	0.00[c]	1	3.85[c]	0	0.00[c]	1	1.39[c]

[a] - % of total captures; [b]- % of all captures for each sex; [c] - % of all recaptures for each sex.

Individuals with body weight between 1500-2000 g dominated the population (37.8% of all females and 63.3% of all males; Fig.2). The adult tortoises showed no significant differences between sexes in both SCL (Mann-Whitney U = 2803.50, p = 0.97; $mean_{males}$ = 18.95 cm, $mean_{females}$ = 18.87 cm), CCL (Mann-Whitney U = 2418.00, p = 0.136; $mean_{males}$ = 24.73 cm, $mean_{females}$ = 25.05 cm, Fig. 2) and body weight (Mann-Whitney U = 2492.50, p = 0.23; $mean_{males}$ = 1679.53 g, $mean_{females}$ = 1763.39 g).

Mt model was the most suitable for the used data set (Table 2) and estimated the adult population of tortoises at 197 ± 10.7 individuals, close to the cumulative estimation for sexes (89 ± 5.7 males and 107 ± 9.2 females). The total population, including the juveniles, was estimated at 221 ± 12.2 (Table 2).

There were no differences in estimation, for adults and individually for males and females, when Huggins Closed Capture data type is used, with temperature as covariate (Table 3).

Using direct observations, we estimated a density of 4.8 adult individuals/ha and a total density of 5.1 tortoises/ha including juveniles. Both observed and estimated densities stands within the range observed for other populations of this species (Table 4). Direct observation revealed a balanced sex ratio of 0.97, lower than that observed in other populations of the species (e.g., 1.26 in KADDOUR *et al.*, 2006).

Discussions

Although the population is isolated in a reduced area, our results reveal a population with a high density. The population structure displays a young population with unbiased sex.

Population density is comparable with that found in other populations occupying a reduced area, and similar to the results from other studies from Spain, Greece (HAILEY & WILLEMSEN, 2000) and Morocco.

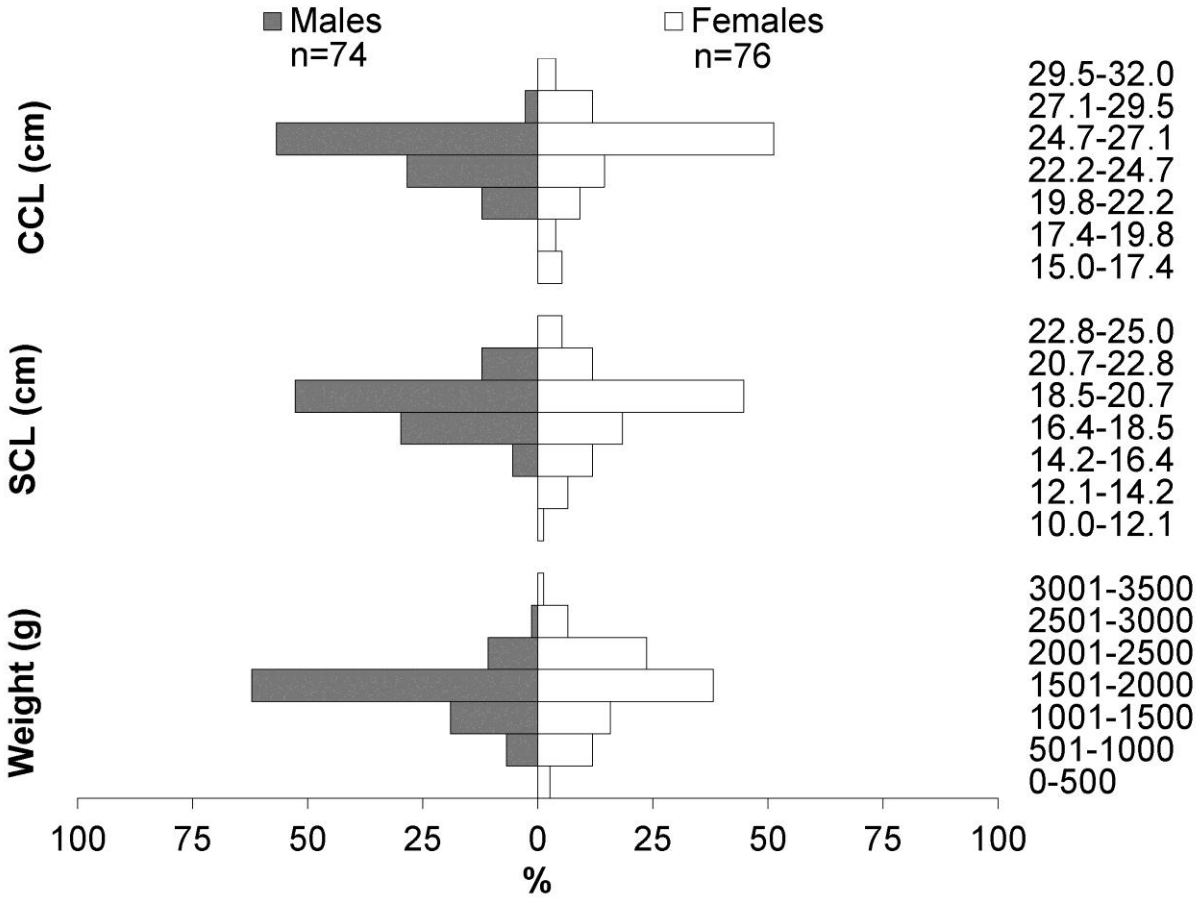

Fig. 2. The distribution of *T. graeca* adults in relation to classes of body weight, SCL and CCL.

Table 2. Estimation of *T. graeca* population size (N) (SD = standard deviation, CI = confidence interval, Mt +1 = number of unique captures and n = total number of captures, including recaptures).

	The used model	M(t+1)	n	N ± SD	CI (95%)	Maximum likelihood range
Adults and juveniles	Mo			255 ± 12.9	205-255	203-253
	Mt*	164	286	**221 ± 12.2**	**202-250**	**200-249**
	Mh[1]			301 ± 31.3	253-377	***
Males	Mo			92 ± 6.5	83-109	82-108
	Mt*	74	139	**89 ± 5.7**	**82-105**	**80-103**
	Mh[1]			100 ± 8.0	88-120	***
Females	Mo			110 ± 9.9	96-135	94-133
	Mt*	76	129	**107 ± 9.2**	**94-131**	**92-130**
	Mh[1]			176 ± 26.4	137-242	***
Adults	Mo			201 ± 11.4	183-228	182-226
	Mt*	150	268	**197 ± 10.7**	**181-223**	**179-221**
	Mh[1]			264 ± 25.6	224-326	***

* Mark-application -Capture module suggested model; [1] interpolated estimation of *N*; in bold the estimation model considers most appropriate.

Table 3. Estimation of *T. graeca* population size (*N*) for adults using as estimation model of N M_t and Huggins Closed Capture data type with temperature as covariate (SD = standard deviation, CI = confidence interval, Mt +1 = number of unique captures and n = total number of captures, including recaptures).

	M (t+1)	n	N ± SD	95% CI
Adults	150	268	197.9 ± 10.9	180.7-224.6
Males	76	139	90.2 ± 6.0	81.7-106.6
Females	74	129	108.0 ± 9.5	94.2-133.1

Table 4. Density of *T. graeca* population in the study area compared with observed and estimated densities of other populations (individuals/ha).

Location	Method for estimation	Observed density	Estimated density (range)	Source
HAC (Romania)	Directly observed	5.1		This study
	Estimated - M_t model (including juveniles)	6.9	6.2-7.7	
	Estimated - M_t model (without juveniles)	6.1	5.5-6.9	
Spain	Directly observed	4.2-12	--	ANDREU *et al.*, 2000; BALLESTAR *et al.*, 2004
Greece	Directly observed	6.2	--	HAILEY, 2000
Morocco	Directly observed	5-7	--	SLIMANI *et al.*, 2002; KADDOUR *et al.*, 2006

The population sex ratio of 0.97 is unbiased than the reported value in other studies (KADDOUR *et al.*, 2006) and lower compared to similar studies on *T. hermanni* reporting values of 1.5 (HAILEY & WILLEMSEN, 2000).

The Histria Archaeological Complex population showed no significant sexual size dimorphism (SSD). A lack of SSD was also observed in Mardin Province, Turkey (TÜRKOZAN *et al.*, 2003), while other studies showed a significant SSD (e.g., DÍAZ-PANIAGUA *et al.*, 2001; KADDOUR *et al.*, 2008).

The data shows a young tortoises population and the differences observed in this study from other population of this species should be correlated with history of the area inhabited by the tortoises. The isolated area offers favourable habitat and protection against human impact. Before this area was part of Danube Delta Biosphere Reserve the human impact was greater with negative impact on the survival of tortoises because of on-going industrial development and agricultural practices limiting their habitat (DOROFTEI *et al.,* 2011; GIOSAN *et al.*, 2012).

The sandy habitats surrounding the study area are overgrazed and covered partly by bare soil are unfavourable for tortoise, providing little or no hiding places. This limits the dispersal of tortoises and contributes to its isolation.

The small number of juveniles captured and the lack of juveniles under age of three is the result of numerous factors and a situation encountered in other studies. The survivability rate for juveniles of tortoises is reduced (GARCIA *et al.*, 2003; DÍAZ-PANIAGUA & ANDREU, 2009) and they exhibit a more reduced activity pattern. In addition, their dimensions and the camouflage colour of carapace makes them hard to be observed (LAGARDE *et al.*, 2002).

The method for population size estimation used in this study is adversely affected by reduced recapture rate, under 50%, and especially by the low number of juveniles. This pattern is not unusual and is determined by age, activity periods (DÍAZ-PANIAGUA *et al.*, 1995) and sex of adults (DÍAZ-PANIAGUA *et al.*, 1996), environmental conditions, vegetation, temperature and precipitations (KADDOUR *et al.*, 2006).

The isolation of the studied population and its relatively high density requires specific conservation measures in the future for its survival. The favourable habitat may be reduced by archaeological activities or touristic development. The collecting of individuals and vegetation fires are risks that may lead to high mortality (STUBBS *et al.*, 1985) and ultimately to the loss of an isolated population.

We consider as conservation measure: (1) the strictly delimitation of the grazing areas closed to HAC to prevent the sheep from accidentally entering inside the tortoises' perimeter, (2) the controlled burning of vegetation (STRICKLAND, 2012) in winter month to reduce the risk of fire, of natural origin or human-made, and (3) a correlation of future archaeological studies with conservation requirements of tortoises. Stray dogs may pose a high risk to juveniles and hatchlings and limiting their access in the area is desirable.

The persistence of a population living in an enclosed area may be altered by the disturbance of a single landscape factor (e.g., changings in land use; RUGIERO & LUISELLI, 2006). Similar, the persistence and viability of our isolated population may depend on the presence of abundant vegetation that offer shelter in midsummer or of the exposed ruins that offer crevices for wintering.

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References

AKÇAKAYA H.R., P. SJÖGREN-GULVE. 2000. Population viability analysis in conservation planning: an overview. - *Ecological Bulletins*, 48: 9-21.

ANADÓN J.D., A. GIMENEZ. E. GRACIA. I. PEREZ. M. FERRANDEZ. S. FAHD. H. EL MOUDEN. M. KALBOUSSI. T. JDEIDI. S. LARBES. R. ROUAG. T. SLIMANI. M. ZNARI. U. FRITZ. 2012. Distribution of *Testudo graeca* in the western Mediterranean according to climatic factors. - *Amphibia-Reptilia*, 33: 285-296.

ANADÓN J.D., A. GIMÉNEZ. M. MARTÍNEZ. J.A. PALAZÓN. M.A. ESTEVE. 2007. Assessing changes in habitat quality due to land use changes in the spur-thighed tortoise *Testudo graeca* using hierarchical predictive habitat models. - *Diversity and Distributions*, 13: 324-331.

ANDREU A.C., C. DÍAZ-PANIAGUA. C. KELLER. 2000. *La tortuga mora (Testudo graeca L.) en Doñana. Monografias de Herpetologia*. Vol.V. Barcelona. Asociación Herpetológica Española. 70p.

BALLESTAR R., J.D. ANADÓN. A. GIMÉNEZ. G. LÓPEZ. I. PÉREZ. 2004. Variaciones locales en parçametros poblacionales de tortuga mora (*Testudo graeca graeca*) en el sureste ibérico. Málaga. *VIII Congreso Luso-Español de Herpetologia, Libro de resúmenes*. 64 p.

BARUA M., M. ROOT-BERNSTEIN R.J. LADLE P. JEPSON. 2011. Defining flagship uses is critical for flagship selection: a critique of the IUCN climate change flagship fleet. – *Ambio*, 40(4): 431-435.

BERTOLERO A., M.A. CARRETERO. G.A. LLORENTE. 2005. An assessment of the reliability of growth rings counts for age determination in the Hermann's Tortoise *Testudo hermanni*. - *Amphibia-Reptilia*, 26: 17-23.

BERTOLERO A., D. ORO. A. BESNARD. 2007. Assessing the efficacy of reintroduction programmes by modelling adult survival: the example of Hermann's tortoise. - *Animal Conservation*, 10: 360-368.

BERTOLERO A., M. CHEYLAN A. HAYLEY B.

LIVOREIL R. WILLEMSEN. 2001. *Testudo hermanni* (Gmelin 1789) – Hermanns Tortoise. – In Rhodin A.G.J., P.C.H. Pritchard P.P. Van Dijk R.A. Mittermeir (Eds.): *Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group*. Chelonian Research Monographs No. 5., pp. 059.1-059.20. Available at: [www.iucn-tftsg.org/cbftt]. Accessed: 03.03.2013.

BESBEAS P., S.N. FREEMAN. B.J.T. MORGAN. E.A. CATCHPOLE. 2002. Integrating mark–recapture–recovery and census data to estimate animal abundance and demographic parameters. – *Biometrics*, 58: 540-547.

BOYCE M.S. 1992. Population viability analysis. - *Annual Review of Ecology and Systematics,* 23: 481-506.

CARRETERO M.A., M. ZNARI. D.J. HARRIS. J.C. MACÉ. 2005. Morphological divergence among populations of *Testudo graeca* from west-central Morocco. - *Animal Biology,* 55: 259-279.

COGĂLNICEANU D., M. TUDOR. R. BĂNCILĂ. R. PLĂIASU. 2007. Amfibienii şi reptilele din Parcul Naţional Munţii Măcinului. Inventarierea florei şi faunei, descrierea şi cartarea habitatelor din Parcul Naţional Munţii Măcinului şi evaluarea populaţiilor de interes pentru conservare, Proiect UNDP/GEF No. 4711. Available at: [www.parcmacin.ro]. Accessed: 08.10.2012.

COGĂLNICEANU D., C. SAMOILĂ. M. TUDOR. M. SKOLKA. 2008. Amphibians and reptiles from the Black Sea coast area between Cape Midia and Cape Kaliakra. – In: Făgăraş M. (Ed.): *Studii comparative privind biodiversitatea habitatelor costiere, impactul antropic si posibilitătile de conservare si restaurare a habitatelor de importantă europeană intre Capul Midia si Capul Kaliakra*. Constanta. Ex Ponto, pp. 71-89.

COGĂLNICEANU D., C. SAMOILĂ M. TUDOR O. TALLOWIN. 2010. An extremely large spur-thighed tortoise male (Testudo graeca) from Măcin Mountains National Park, Romania. - *Herpetology Notes*, 3: 45-48.

COUNCIL DIRECTIVE 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

COX N.A., H.J. TEMPLE. 2009. *European Red List of Reptiles*. Luxembourg. Office for Official Publications of the European Communities. Available at: [www.iucn.org/publications]. Accessed: 08.10.2012.

DÍAZ-PANIAGUA C., C. KELLER A.C. ANDREU. 1995. Annual variation of activity and daily distances moved in adult spur-thighed tortoises, Testudo graeca, in southwestern Spain. - *Herpetologica*, 51: 225-233.

DÍAZ-PANIAGUA C., C. KELLER A.C. ANDREU. 1996. Clutch frequency, egg and clutch characteristics, and nesting activity of spur-thighed tortoises, *Testudo graeca*, in southwestern Spain. - *Canadian Journal of Zoology*, 74(3): 560-564.

DÍAZ-PANIAGUA C., A.C. ANDREU. 2009. Tortuga mora – *Testudo graeca* In: Salvador A., A. Marco (Ed.). *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. Available at: [www.vertebradosibericos.org]. Accessed: 01.04.2012.

DÍAZ-PANIAGUA C., C. KELLER. A.C. ANDREU. 2001. Long-term demographic fluctuations of the spur-thighed tortoise *Testudo graeca* in SW Spain. – *Ecography*, 24: 707-721.

DOROFTEI M., M. MIERLA. G. LUPU. 2011. Approaches to habitat disturbances in the Danube Delta Biosphere Reserve. *Studii şi cercetări, Biologie, Universitatea din Bacău*, 20: 46-56.

FUHN I.E., S. VANCEA. 1961. *Fauna R.P.R.* Vol. XIV, Fascicola II, Reptilia. Bucureşti. Editura Academiei R.P.R., 352 p.

GARCIA C., A. GOROSTIZA. R. BALLESTAR. N. YELO. J.D. ANADÓN. I. PREZ. J.A. SANCHEZ-ZAPATA. F. BOTTELA. A. GIMÉNEZ. 2003. Predation of the spur-thighed tortoise *Testudo graeca* by carnivorous fauna in Southeastern Spain. *2nd International Congress on* *chelonian conservation*. Senegal.

GERMANO D.J. 1988. Age and growth histories of Desert Tortoises using scute annuli. – *Copeia*, 4: 914-920.

GIBBONS J.W., D.E. SCOTT. T.J. RYAN. K.A. BUHLMANN. T.D. TUBERVILLE. B.S. METTS. J.L. GREENE. T. MILLS. Y. LEIDEN. S. POPPY. C.T. WINNE. 2000. The global decline of reptiles, déjà vu amphibians. – *BioScience*, 50: 653-666.

GIOSAN L., M.J.L. COOLEN J.O. KAPLAN S. CONSTANTINESCU F. FILIP M. FILIPOVA-MARINOVA, A.J. KETTNER N. THOM. 2012. Early Anthropogenic Transformation of the Danube-Black Sea System. - *Scientific Reports*, 2: 582.

GUYOT G., J. CLOBERT. 1997. Conservation measures for a population of Hermann's tortoise *Testudo hermanni* in southern France bisected by a major highway. - *Biological Conservation*, 79: 251-256

HAILEY A., 2000. Implications of high intrinsic growth rate of a tortoise population for conservation. - *Animal Conservation*, 3: 185-189.

HAILEY A., R.E. WILLEMSEN. 2000. Population density and adult sex ratio of the tortoise *Testudo hermanni* in Greece: evidence for intrinsic population regulation. - *Journal of Zoology*, 251: 325-338.

HILL D., M. FASHAM. M. TUCKER. G. SHEWRY. M.P. SHAW. 2007. *Handbook of biodiversity methods*. New York. Cambridge University Press, 588 p.

HUGGINS R.M. 1989. On the statistical analysis of capture experiments. – *Biometrika*, 76:133-140.

INMAN R.D., K.E. NUSSEAR. C.R. TRACY. 2009. Detecting trends in desert tortoise population growth: elusive behavior inflates variance in estimates of population density. - *Endangered Species Research*, 10: 295-304.

KADDOUR K.B., E.H.E. MOUDEN. T. SLIMANI. X. BONNET. F. LAGARDE. 2008. Sexual dimorphism in the Greek tortoise: A test of the body shape hypothesis. – *Chelonian Conservation and Biology*, 7:21-27.

KADDOUR K.B., T. SLIMANI. E.H.E. MOUDEN. F. LAGARDE. X. BONNET. 2006. Population structure, population density and individual catchability of *Testudo graeca* in the Central Jbilets (Morocco). - *Vie et Milieu*, 56(1): 49-54.

KENDALL W.L., K.H. POLLOCK. 1992. The robust design in capture-recapture studies: a review and evaluation by Monte Carlo simulation. In: Mc Cullough D.R. & R.H. Barrett (Ed.): *Wildlife 2001: populations*. pp. 31-43.

LAGARDE F., X. BONNET. K. NAGY. B. HENEN. J. CORBIN. G. NAULLEAU. 2002. A short spring before a long jump: the ecological challenge to the steppe tortoise (*Testudo horsfieldi*). - *Canadian Journal of Zoology*, 80: 493-502.

LAMBERT M.R.K. 1981. Temperature, activity and field sighting in the mediterranean spur-thighed or common garden tortoise *Testudo graeca* L. - *Biological Conservation*, 21: 39-54.

LJUBISAVLJEVIĆ K., G. DŽUKIĆ. M.L. KALEZIĆ. 2001. The commercial export of the land tortoises (*Testudo* spp.) from the territory of the former Yugoslavia: a historical review and the impact of overharvesting on wild populations. - *North-Western Journal of Zoology*, 7: 250-260.

OTIS D.L., K.P. BURNHAM. G.C. WHITE. D.R. ANDERSON. 1978. Statistical inference from capture data on closed animal population. In: Krumholz L.A. (Ed.): *Wildlife Monographs*. University of Louisville, Wildlife Society. Louisville. 135 p.

PIKE D.A., A. DINSMORE. T. CRABILL. R.B. SMITH. R.A. SEIGEL. 2005. Short-term effects of handling and permanently marking gopher tortoises (*Gopherus polyphemus*) on recapture rates and behavior. - *Applied Herpetology*, 2: 39-147.

POLLOCK K.H., J.D. NICHOLS. C. BROWNIE. J.E. HINES. 1990. Statistical inference for capture-recapture experiments. - *Wildlife Monographs 107*, 97 p.

PREDA C., I. CHIRILĂ. M. SKOLKA. D. COGĂLNICEANU. 2009. The role and importance of habitat patches in conservation. *Studii şi cercetări, Biologie,* *Universitatea din Bacău*, 17: 39-42.

RACHID R., B. SLIM. L. LUCA. E.M. EL HASSAN. M. GHOULEM. F.T. CHAHIRA. 2007. Population structure and demography of an Algerian population of the Moorish tortoise, *Testudo graeca*. - *Animal Biology*, 57: 267-279.

ROUAG R., S. BENYACOUB. L. LUISELLI. E.H.E. MOUDEN. G. TIAR. C. FERRAH. 2007. Population structure and demography of an Algerian population of the Moorish tortoise, *Testudo graeca*. - *Animal Biology*, 57: 267-279.

ROZYLOWICZ L., M. DOBRE. 2010. Assessing the threatened status of *Testudo hermanni boettgeri* Mojsisovics, 1889 (Reptilia: Testudines: Testudinidae) population from Romania. - *North-Western Journal of Zoology*, 6: 190-202.

RUGIERO L., L. LUISELLI. 2006. Ecological modelling of habitat use and the annual activity patterns in an urban population of the tortoise, *Testudo hermanni*. - *Italian Journal of Zoology*, 73: 219-225.

SANZ-AGUILAR A., J.D. ANADÓN. A. GIMÉNEZ. R. BALLESTAR. E. GRACIÁ. D. ORO. 2011. Coexisting with fire: The case of the terrestrial tortoise *Testudo graeca* in mediterranean shrublands. - *Biological Conservation*, 144: 1040-1049.

SAUMURE R.A., T.B. HERMAN. R.D. TITMAN. 2007. Effects of haying and agricultural practices on a declining species: The North American wood turtle, *Glyptemys insculpta*. - *Biological Conservation*, 135: 565-575.

SLIMANI T., E.H.E. MOUDEN. K.B. KADDOUR. 2002. Structure et dynamique de population de *Testudo graeca graeca* L. 1758 dans les Jbilets Centrales, Maroc. – *Chelonii*, 3: 200-207.

STRICKLAND B., 2012. Prescribed burning in Southern Pine Forests:Fire Ecology, Techniques, and uses for wildlife management, Mississippi State University Extension Service. Available at: [http://msucares.com]. Accessed: 01.04.2012.

STUBBS D., A. HAILEY. E. PULFORD. W. TYLER. 1984. Population ecology of European Tortoises: review of field techniques. - *Amphibia-Reptilia*, 5: 57-68.

STUBBS D., I.R. SWINGLAND. A. HAILEY. E. PULFORD. 1985. The ecology of the mediterranean tortoise *Testudo hermanni* in northern Greece (the effects of a catastrophe on population structure and density). - *Biological Conservation*, 31: 125-152.

SUTHERLAND W.J. 2006. *Ecological census techniques: A handbook*. New York. Cambridge University Press. 450 p.

TICHÝ L., K. KINTROVÁ. 2010. Specimen identification from time-series photographs using plastron morphometry in *Testudo graeca ibera*. - *Journal of Zoology*, 281: 210–217.

TÜRKOZAN O., D. AYAZ. V. TOK. D. CIHAN. 2003. On *Testudo graeca* Linnaeus, 1758 specimens of Mardin Province. - *Turkish Journal of Zoology*, 27: 147-153.

TÜRKOZAN O., A. ÖZDEMIR. F. KIREMIT. 2008. International *Testudo* Trade. - *Chelonian Conservation and Biology*, 7: 269-274.

WALPOLE M.J., N. LEADER-WILLIAMS. 2002. Tourism and flagship species in conservation. - *Biodiversity and Conservation*, 11: 543–547.

WHITE G.C., D.R. ANDERSON. K.P. BURNHAM. D.L. OTIS. 1982. *Capture–recapture and removal methods for sampling closed populations*. Los Alamos Nat Lab Report LA-8787-NERP. 235 p.

WHITE G.C., K.P. BURNHAM. 1999. Program MARK: Survival estimation from populations of marked animals. - *Bird Study*, 46: 120-138.

WILLEMSEN R.E., A. HAILEY. 2003. Sexual dimorphism of body size and shell shape in European tortoises. - *Journal of Zoology*, 260: 353-365.

WILLIAMS B.K., J.D. NICHOLS. M.J. CONROY. 2002. *Analysis and management of animal populations: modeling, estimation, and decision making*. San Diego. California.Academic Press. 817 p.

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