MERTENSIELLA **18** | 237-244 | 20 September 2011 | ISBN 978-3-9812565-4-3

Monitoring a Large Population of Dice Snakes at Lake Sinoe in Dobrogea, Romania

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Abstract. Dice snakes (*Natrix tessellata*) can reach exceptionally large population densities where local conditions permit. Here we report on a study of one large population from Histria, the southern-most area of the Danube Delta in Romania. There the dice snakes forage in the brackish waters of Lake Sinoe. Many snakes are visibly infected by parasitic nematodes, which have piscivorous birds as definitive hosts. The nematode, *Eustrongylides excisus*, can be fatal to its snake host. In 2005, we began to study the dice snake population at Histria. In 2006 we initiated a monitoring study based on capture-mark-recapture methodology using PIT tag markers. This paper presents general aspects of this population and analyses the results to date in relation to fieldwork effort. We also discuss how external factors may affect the dynamics of the population. Even though it is generally considered that the population was larger in the past, we have not found evidence of a population decline. We estimate that the population has remained at or above 10,000 adult individuals during the three years of PIT tagging.

Keywords. Population census, *Natrix tessellata*, size, PIT tag, *Eustrongylides* parasites

Introduction

The dice snake, *Natrix tessellata*, can reach very large population densities, possibly larger than any other Eurasian snake (Bendel 1997, Gruschwitz et al. 1999). Where conditions permit and prey availability is high, single water bodies can house several to tens of thousands of this piscivorous species (e.g. central Italy, Luiselli et al 2007; Skadar Lake in Montenegro and Albania; Prespa Lake in Macedonia, Greece, and Albania, K. Mebert pers. comm.). These snakes are likely to utilise a number of geographically separated hibernation areas during winter. As mating occurs in the vicinity of hibernation areas, each hibernation/mating area will then effectively constitute a subpopulation and the entire lake population, thus, constitutes a metapopulation. The degree of genetic isolation between the subpopulations depends upon the migration frequencies among them. Here we report on a study from one single hibernation area, containing a very large number of specimens. The hibernation area is in direct connection with vast feeding grounds and, while likely, we are currently unaware of other hibernation sites in the area.

The western coastal strip of the Black Sea provides several areas suitable to harbour very dense snake assemblies including the dice snake, *Natrix tessellata* (e.g. in Bulgaria Nöllert et al. 1986, Thieme 1986). A large number of dice snakes populate the ancient ruins at Histria in Dobrogea, Romania (44° 54´N, 28° 77´E). This area has the status of a special conservation zone within the Danube Delta Biosphere Reserve. Situated 7.7 km from the Black Sea coast by the shore of the lagoon Lake Sinoe, Histria itself consists of the ruins of an old Hellenistic merchant town, founded in the seventh century B.C. Romans later conquered the city state and ruled it until it was abandoned around 700 A.D. By the time the ruin town was rediscovered and excavations of the site commenced in the early 20th century, the stone ruins were completely covered by sand and earth. Currently, Histria, presently covering seven hectares of unearthed ruins and serving as an open-air museum, is an active archaeological excavation site during summer. The uncovered and reconstructed stonewalls are used for hibernation by three species of snakes, Caspian whip snake (*Dolichophis caspius*), grass snake (*Natrix natrix*) and dice snake (*Natrix tessellata*). Many matings occur among the ruins. During the summer months the stone walls are utilised for shelter, shedding and also for ovipositing from mid June to mid July. By far the most numerous snake species in the area is *N. tessellata*.

Lake Sinoe is the southernmost lagoon of the Danube Delta. A shallow lake, mostly less than 2 m deep, and about 170 km² in size, with reed (*Phragmithes australis*) growing along most of the shoreline (Dorosencu et al. 2004). It is still connected with the Black Sea and thus contains brackish water. Salinity levels fluctuate and depend on freshwater from the Danube and varying influx of saline water from the Black Sea (Alexandrov et al. 2000). Less than 2 km west of Histria, there is another water body, Lake Istria, which is connected to Lake Sinoe by a channel starting only 200 m from the ruins. In addition, 4 km to the southwest there is a shallow fresh-water lake, Nuntași. In short, the hibernation site at Histria is surrounded by large areas of potential foraging grounds within easy reach for spring-migrating dice snakes.

As for Dobrogea in general, the basal colouration of *N. tessellata* in Histria is consistently some shade of olive green, varying from greyish to yellowish (M. Tudor pers.obs.). Ventral background colouration var-

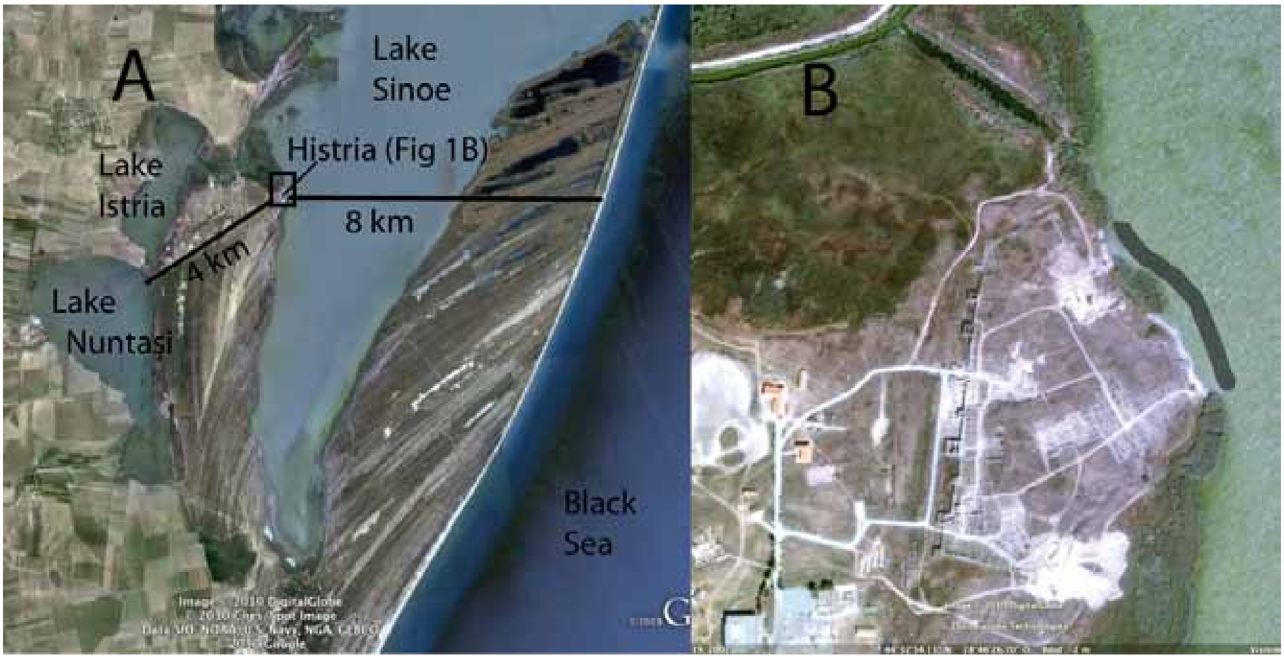

Fig. 1. Google Earth view of the ruins of Histria: above) Potential foraging lakes and summer habitat in the near vicinity. A channel connects Lake Istria to Lake Sinoe just north of the main ruins (the black square). Lake Nuntași is 4 km away across partial wetlands; below) Close-up of the study area (black square) and the stretch of 200 m shoreline surveyed during summer indicated in dark grey.

ies in extent and ranges from occasional white through (most commonly) different shades of yellow and orange (rarely pink or reddish) to the occasional olive-green with varying amounts and order of black spots superimposed (Carlsson et al. unpublished). In Histria the dice snakes display two dorsal colour pattern morphs, unicoloured (i.e. non-patterned) and chequered (diced) with darker spots dorsally, the latter being more common. Ventral pattern is chequered or unorderly spotted, although unicoloured individuals often have a more or less striped appearance with black mainly in the midventral region and flanked by the ventral background colour.

As has been reported also from Bulgaria (Biserkov 1995, Kirin 2002) and Turkey (Yildirimhan et al. 2007), the piscivorous snakes of Histria are suffering from relatively high levels of infestation by a parasitic nematode, *Eustrongylides excisus* (Mihalca et al. 2007, Carlsson et al. in prep.). Infection by *Eustrongylides spp*. is potentially lethal for snakes (e.g. Bursey 1986). The life cycle of this nematode is heteroxenous (i.e. dependent upon several hosts) involving piscivorous birds as definitive hosts and oligochaetes and fish as first and second intermediate hosts, respectively (Marcogliese 2004). In Histria, piscivorous birds have not been observed to eat snakes, their main predators being storks (*Ciconia ciconia*) nesting at the site (M. Carlsson pers. obs.). Snakes may therefore be considered accidental dead-end hosts for *Eustrongylides excisus* although some piscivorous birds can be expected to also catch snakes on occasion (e.g. herons, Marcogliese 2004).

The current capture-mark-recapture study of the snake populations of Histria was initiated in 2006 in order to monitor population size fluctuations and factors affecting them as a follow up of a pilot study conducted in 2005 (Kärvemo 2006). Population dynamics in relation to fluctuating climatic conditions is a topic that has been poorly addressed in herpetological studies (Seigel et al. 2002). Although we herein speculate how climate may have affected our results, we view this paper merely as an introduction to the fieldwork conducted at Histria and the future potential for studying this population. In the current paper we analyse the results in relation to fieldwork effort and discuss external factors that may affect the dynamics of the study system.

Material and Methods

Snakes were captured among the ruins or along a 200 m stretch of the adjacent shoreline for one to two hours at a time and were then processed in batches. They were marked and measured and later released within about 100 m from their point of capture. Snakes were measured for snout-vent length (SVL), tail length, dorsal pattern and ventral colour, sex, and number of visible tubercles of encapsulated subcutaneous parasitic nematodes ("nodules"). Prior to release, the snakes were marked with a passive integrated transponder (PIT-tag) from Trovan, for unambiguous identification (see e.g. Sutherland 1996, Gibbons & Andrews 2004). The sheer number of snakes potentially encountered in a single day makes immediate individual treatment of

Fig. 2. The ruins in Histria as seen in late summer: above) Facing south, with Lake Sinoe, as close as 20 m from the ruins, in the left part of the picture; below) In the southern part of the ruins facing northeast with the main wall to the far left.

each captured snake time consuming and ineffective, hence releasing the snakes exactly at the point of capture (e.g. within 10 m) has proven logistically difficult. However, capture-recapture data from other studies involving dice snakes indicates that the snakes exhibit a familiarity of their surroundings within a few hundred meters (Bendel 1997, Lenz & Gruschwitz 1993, Conelli & Nembrini 2007, Conelli et al. 2011, Neuman & Mebert 2011, Velensky et al. 2011), hence, the release of individuals some distance from their capture site can be justified.

Fieldwork was conducted during most of the active season 2006 and intermittently during 2007 and 2008, specifically between the following dates for each respective season: 27 March – 17 October 2006, 17 April – 18 October 2007 and 8 April – 19 October 2008. The intensity of fieldwork, i.e. total number of field days, varied between seasons and years (Tab. 2). In 2006 there was an almost daily presence of at least two persons, whereas the senior author conducted most fieldwork alone in the following two seasons, except during two weeks in spring and five days in July 2007 and four days in 2008. Fieldwork intensity is presented in Table 2 as days of successful snake capture. Thus, days of unsuccessful work due to weather are equated with days of no fieldwork due to absence. We have divided each season into two periods of equal length for analytical purposes. The date of separation, 8 July, roughly corresponds to the end of ovipositing by gravid females, these being the last to leave the waters in the vicinity of the ruins after hibernation, supposedly having been foraging nearby during pregnancy. All snakes, except gravid females, appear to be rather mobile and only stay along a given stretch of shoreline for a few days for foraging (Kärvemo et al. 2011). Hence, the first period (Period 1) approximates the time of dispersal from hibernation grounds to mid season, while the second period (Period 2) encompasses the time of return. We compared fieldwork success between years, between periods within years and within periods between years for total number of snakes caught compared to expectations derived from both mean values of captured snakes per day of capture (C/DOC) and captures per day per field worker (C/DOC/MNP, i.e. Capture per Day of Capture per Mean Number of Persons) using X^2-tests. To analyse capture rate (C/DOC) over periods and years, an ANOVA test was applied using the software package R (R Development Core Team 2006).

Only adult individuals are included in the present article. We defined adults as having a minimum snout-vent length (SVL) of 48 cm in males and 55 cm in females in accordance with Lusielli & Rugiero (2005).

Tab. 1. Statistic summary of SVL and tail length measurements for adult male and female *Natrix tessellata* from Histria, as defined in this report, from three consecutive field seasons combined. All individuals with severed tails have been removed.

	Females (*n* = 1522)		Males (*n* = 1810)	
	SVL	Tail Length	SVL	Tail Length
Mean	70.37	17.15	57.95	16.25
Mode	72.50	16.50	56.50	16.50
Median	69.50	17.10	57.70	16.30
Range	55.00–99.00	12.50–23.50	48.00–74.50	11.50–20.60
Stand. Dev.	±8.33	±1.88	±4.78	±1.42
Lower Quartile	64.30	15.70	54.52	15.30
Upper Quartile	76.10	18.50	61.10	17.20

For individuals whose sex was uncertain, the female adult minimum size, 55 cm, was applied in this study.

The population size of *N. tessellata* in and among the ruins of Histria was estimated for the three years separately and independently, using bias-adjusted Lincoln-Petersen estimates (Williams et al. 2002). For each year, the total number of individual snakes caught in Periods 1 and 2 as well as the number of recaptures in Period 2 of snakes caught in Period 1 were used to calculate the population estimate and variance thereof (Tab. 3).

Results

Our data suggests that the minimum size at sexual maturity in Histria is in compliance with estimates from Italy (i.e. 48 cm SVL for males and 55 cm SVL for females, Luiselli & Rugiero 2005). In fact, our admittedly scant data from four field seasons combined (2005–2008) suggest even larger sizes, with no male recorded in courtship below 50 cm SVL (n = 17) and only one mating, pregnant or postpartum female observed below 58 cm SVL (n = 122). However, as monitoring reproduction has not been a priority in this study and matings have been documented inconsistently, we apply the minimum sizes at maturity given by Luiselli & Rugiero (2005). Standard statistics for SVL and tail lengths of adult individuals, excluding individuals with damaged tails, are presented in Table 1. In Histria, 1.24% of the adult females caught had reached a SVL exceeding 90 cm and 0.72% of the adult males were longer than 70 cm. The largest animals measured were two females of total lengths 122.0 cm (99 cm SVL, 23.0 cm tail length) and 121.6 cm (98.5 cm SVL, 23.1 cm tail length), respectively. The two largest males were 92.7 cm (74.2 cm SVL, 18.5 cm tail length) and 92.4 cm (74.5 cm SVL, 17.9 cm tail length), respectively.

The prevalence of parasite infection by *Eustronglides excisus* in dice snakes from Histria is treated elsewhere, but has remained relatively constant over the years 2005-2008. In 2005 55% of the snakes were visibly infected (n = 595, Kärvemo 2006) and during the years 2006–2008 the observed proportion of infected snakes ranged between 54.6% and 60.1% (mean 58.2%, n = 4334, Carlsson et al. in prep). The dice snakes in Histria feed almost exclusively on bottom-dwelling Gobiid fish (see e.g. Sloboda et al 2010) and forage actively for food (M. Carlsson pers. obs). There have been few instances of other prey items recorded, i.e. of pelagic fish (Carlsson unpublished), suggesting that passive ambush predation is not common in the Histria population. To date, only a single record of amphibiophagy (*Pelophylax ridibundus*) has been registered.

In spring the first observed mating occurred on 30 March 2006 and the last observed was on 5 June 2006, with the most intense mating activity being observed during the second half of April (Carlsson unpublished). The only record of an autumn mating was 20

Tab. 2. Data illustrating fieldwork intensity divided into two periods, equal in length and approximately separated by the end of ovulation. Days of capture (DOC) refers to days of successful fieldwork, whereas mean number of persons (MNP) is a day-to-day average of fieldworkers present.

	Period 1 (27 Mar – 8 Jul)	Period 2 (9 Jul – 19 Oct)	Total/*Mean*
Total number of days	104	103	207
2006: Days of capture (DOC)	90	73	163
2006:Mean number of persons (MNP)	2.3	1.96	*2.15*
2007: DOC	27	26	53
2007: MNP	2.44	1.77	*2.11*
2008: DOC	30	35	65
2008: MNP	1.07	1.06	*1.06*

Tab. 3. Table showing average fieldwork success and population size estimates (Ñ) for three years of study. Total number of adult snakes caught (C) during the different periods. For DOC and MNP, see Table 2.

	2006		2007		2008	
Period	1	2	1	2	1	2
C (captures + all recaptures)	2018	841	590	214	564	592
C/DOC	22.40	11.5	21.85	8.23	18.80	16.91
C/DOC/MNP	9.74	5.88	8.96	4.65	17.57	15.96
Individuals captured (IC)	1643	715	441	178	402	532
Recaptures from Period 1		83		6		11
$\tilde{N}$ (population size estimate)	14,355		11,302		17,530	
$CI_{95\%}$	±26,147		±187,85		±31,202	

Tab. 4: Outcomes of X^2-tests between (2 degrees of freedom (d.f.)) and within years (1 d.f.). Abbreviations stand for snakes captured (C), days of capturing (DOC) and mean number of persons collecting (MNP). Significant results at $p < 0.01$ and $p < 0.001$ are indicated with ** and ***, respectively.

	Comparisons between years (2 d.f.)			Comparisons within years (1 d.f.)		
	Period 1	Period 2	1 and 2	2006	2007	2008
C based on C/DOC	13.80**	99.26***	15.09***	273.1***	157.1***	3.23
C based on C/DOC/MNP	180.3***	466.0***	519.8***	155.4***	68.46***	3.426

September 2006 (but see Kärvemo et al. 2011). Dates are only presented for 2006, when we had an almost permanent presence at the study site.

The intensity of the fieldwork effort has varied over seasons and between seasons (Tab. 2). The success of fieldwork does not appear to correlate closely with intensity of effort, as measured by number of people participating per day, and only somewhat positively to the number of days of fieldwork (Tabs. 3 and 4). As could be expected from the small sample size, which did not permit for analysis of interactions between classes, ANOVA analysis for C/DOC between periods ($F_{1,2} = 0.615$, $p = 0.13$) and years ($F_{2,2} = 0.219$, $p = 0.82$) yielded non-significant results. Statistical analyses of total success (C) given the different capture rate means (C/DOC, C/DOC/MNP) yielded highly significant results for all comparisons except for the comparison between periods of the year 2008 (Tab. 4).

The population size estimates Ñ of *Natrix tessellata* fluctuated from 14,355 to 11,302 and 17,530 across the three years of study, but with large 95% confidence intervals of more than twice the population estimates (Tab. 3).

Discussion

The dice snakes foraging in the brackish lagoon-lake Sinoe at Histria are predominantly feeding on bottom-dwelling Gobiid fish species (Sloboda et al. 2010). They utilise an active foraging technique, which can be readily observed along shallow parts of the shoreline. The occasional occurrence of other prey items from pelagic species suggests that the snakes may sometimes also apply passive ambush tactics reported for *Natrix tessellata* elsewhere (Gruschwitz et al. 1999). The clutch size of gravid females in Histria appears to be in the lower region of the range of 5–35 eggs reported for the species (Arnold & Ovenden 2003) and usually does not exceed 20 eggs (Carlsson unpublished).

We presume that the large population of dice snakes in and among the ruins of Histria has greatly benefited from the yearly activities of the archaeologists at the site since the 1920's. Their excavations may be temporally and locally disruptive to the snakes' preferences to shelter in the rock mounds and walls of the ruins (M. Carlsson pers. obs.). However, it is the activities of the archaeologists that have created a landscape of complex microstructure of rock mounds, stonewalls, pits and deep stone crevices on a previously earth-covered, little structured hill. The rock walls and deep rock mounds created by the excavations not only offer shelter from predators for digestion and ecdysis. They also offer suitable sites for ovipositing and embryogenesis and provide hibernation sites, as has been similarly observed and suggested for dice snakes elsewhere (e.g. Conelli & Nembrini 2007, Conelli et al. 2011, Velenský et al. 2011). These are all factors that positively influence the population size and contribute to the generation of dense populations of dice snakes. The habitat thus created is utilised by three species of snakes for hibernation, mating, shedding and by *N. tessellata* for ovipositing. In fact, every year, the archaeological research results in more favourable terrestrial habitat for *N. tessellata* and the other two snake species. The abundance of shallow waters in close proximity to the ruins suggests that prey availability may not be a key limiting factor for population size, but hibernation and ovipositing sites may well be.

As mentioned previously, the dice snakes in Histria appear to be under threat from a parasitic nematode, *Eustrongylides excisus* (Mihalca et al. 2007), which infects the fish in Lake Sinoe and probably those from the surrounding lakes as well. We now have evidence that suggests the parasite invaded the area, or at least became vastly more common, in recent times (Carlsson et al. in prep). Possibly, *E. excisus* is responsible for the apparently drastic reduction in population size of dice snakes over the past decade perceived by locals, although we have so far failed to detect a continuing decline. We occasionally observed snakes apparently suffering from nerve damage, resulting in partial paralysis of the posterior half of the body. This phenomenon was often associated with several nodules around the point of onset of paralysis (Carlsson unpublished). We presume that *E. excisus* is responsible for such partial paralysis. The prevalence of parasites in the snakes has remained relatively constant around 55–60% infected snakes since 2005, as measured by presence of visible subcutaneous encapsulations, or nodules. However, snakes can have several parasites inside the body cavity, without having visible nodules (Bursey 1986, M. Carlsson pers. obs.). An estimate based on visible nodules is therefore an underestimate of the true parasite prevalence, which may be anywhere between 55–100% of snakes infected.

Population size estimates are based exclusively on the captures and recaptures of adult individuals. Hence, anticipated size at maturity deserves consideration when the reproductive status of each individual cannot be gauged. Minimum size at sexual maturity for *Natrix tessellata* in Romania has been suggested by Fuhn & Vancea (1961) to be 47.5 cm SVL for males and 47.2 cm SVL for females. Our data indicate that this is an underestimate of minimum female sizes at maturity in our study site. Indeed, our data from Histria are more in line with records for Italian populations of *N. tessellata*. As we consider our dataset of observed matings and pregnancies too small to be conclusive, we have opted to use minimum SVL of 48 cm in males and 55 cm in females in accordance with Lusielli & Rugiero (2005). The study at Histria is continuing and more attention is currently being given to the reproductive age and status of individuals. The growth rate of juveniles suggests that males and females reach maturity by their third and fourth winter, respectively (M. Carlsson pers. obs.). As autumn matings appear to be relatively uncommon (Gruschwitz et al. 1999, Kärvemo et al. 2011), we suggest that in general males mature at 2.5 years (and approximately 46–52 cm SVL) and females at 3.5 years (and approximately 54–60 cm). There are bound to be exceptions to the age at maturity and the size generalisations, which are approximate (Carlsson unpublished), but ages are similar to e.g. *Natrix natrix* (Madsen 1983).

Independent Lincoln-Petersen population size estimates (Williams et al. 2002) for three consecutive years are in reasonable accordance with each other. A Lincoln-Petersen estimation yields a large variance. Hence, the 95% confidence interval is twice that of the estimated population size (Tab. 3). Furthermore a Lincoln-Petersen model assumes a closed population with no migration or mortality (Williams et al. 2002). As the snakes dispersing to their summer foraging grounds in Period 1 (see Fig. 1A) can be expected to return in Period 2 (see e.g. Conneli & Nembrini 2007, Conelli et al. 2011), a Lincoln-Petersen estimate can be applied to assess the population size, but it is certain to be an overestimate due to not compensating for migrants and mortalities. Therefore, until a more detailed population census is published, we consider the estimates presented herein to only offer a guiding figure of the scale of the population size.

In spite of a general impression of a population in decline shared by participants in the project as well as by locals and archaeologists excavating during July and August each year, we are not detecting a population decline in our data. However, according to the locals and archaeologists (e.g. A. Suceveanu pers. comm.), the population size appeared to be much bigger in the 1990s and early into this millennium. Yet, our results indicate that the population is still at or above 10,000 individuals. We can only speculate how big it might have been 10–20 years ago, given eyewitness accounts of spectacularly higher densities than are now encountered on any given day (e.g. I. Ghira pers. comm.).

It is apparent from the statistical analyses of fieldwork effort and capture results that number of active days in the field (days of capture, DOC, Tab. 2) does not serve well to predict the end-result of a season's capturing. However, it does give a decent indication of what to expect from an average day in the field. The intensity of fieldwork, i.e. how many people participate (MNP, Tab. 2) does not appear to matter as much as one would think, and is a poor predictor of even a day's outcome. The differences observed within and between years must be explained by other means than work effort. As most field herpetologists are bound to have experienced, the level of snake activity can vary greatly from day to day without any apparent change in weather conditions or for any other obvious reasons. Fluctuations in capturing success can therefore to some extent be attributed to chance (for lack of better understanding of snake behaviour and environmental parameters studied). However, if fieldwork is carried out over extended periods, daily differences should cancel out. There is also a human factor: collecting skills increase with experience. However, the senior author, who covered all field days in 2007 and conducted almost all fieldwork in 2008, did the same in 2009 with a very poor result and in 2010 with an extraordinary result (Carlsson unpublished). So, we must probably look elsewhere for an explanation. With less than two weeks per month covered during each season after 2006, there is of course the risk of bad luck with the weather during times of capture. Most snakes are found during spring or late in autumn, when they are gathering at the hibernation sites. There are usually a few days of peak activity when up to several hundred snakes may be encountered on a single day (capture records currently stand at 147 on 9 April 2010 and 168 on 11 October 2010 (Carlsson unpublished). Missing those days of peak activity may clearly affect the overall yearly result. Climatic differences over seasons and between years can certainly also affect the outcome. In the autumn of 2007, the weather conditions were rather wet, windy and cold during the times of fieldwork, considerably lowering fieldwork success, as evidenced in Table 3. Likewise, very few snakes were caught during May and June 2008, possibly because it was slightly colder than usual. In September and October 2008, on the other hand, weather conditions were excellent (i.e. calm, warm and sunny) during times of fieldwork and so was the capture success.

Another factor that may be of importance is water level and salinity fluctuations. The year 2006 was an exceptionally wet year with severe floods all along the Danube including its delta, whereas 2007 was drier than normal and 2008 received relatively normal precipitation levels. In spring 2006 most of Central Europe experienced heavy rains and flooding. The Danube reached record flood levels, and consequently the delta did likewise. In Lake Sinoe, the water level was about 50 cm higher than the following year. The fields to the South of the ruins were almost entirely inundated. The shoreline activity of foraging snakes during May and June was much higher than during the following two seasons. We do not know whether this correlated with higher than usual fish densities near the shore.

The year 2007 was drier than usual, with very low water levels in early July already. In September, large amounts of comb jellyfish (*Mnemiopsis leidyi*) were observed along the shore and the salinity appeared much higher than normal (M. Carlsson pers. obs.). Higher salinity levels and presence of jellyfish might be detrimental to snake activity. The jellyfish feed on zooplankton, including fish eggs, and so can be expected to decrease fish densities, as has been documented in the Black Sea (Kideys 2002, Skolka & Gomoiu 2004). However, this would not have an immediate effect on prey-fish densities for dice snakes. If either of these factors have adverse effects on dice snakes, the snakes may have relocated to the nearby freshwater lakes Nuntași and Istria. This could partially explain the low levels of capture obtained during Period 2 of 2007. Future research is intended to elucidate the effects of changing climate, water-level and salinity fluctuations as well as that of species that appear to have recently colonised Lake Sinoe, i. e. *Eustrongylides excisus* and the ctenophore species *M. leidyi*.

Although, further research is required to better understand the factors affecting the population size and fluctuations of *N. tessellata* in Histria, we here conclude that the population still appears to be of considerable size in spite of recent potential threats from an apparently invasive parasite and climatic stochasticity.

Acknowledgements

Carl Trygger's Foundation, Helge Ax:son Johnson's Foundation and the Foundation for Zoological Research have provided financial support for this project. Permission for conducting the field investigation has been given by the Danube Delta Biosphere Reserve Administration. Alexandru Suceveanu, director of the Archaeological Institute in Bucharest, and especially Constantin Chera, director of the Museum of National History and Archaeology in Constanța, have given us permission to work inside the museum area and provided invaluable assistance. We would like to thank Vlad Haisiuc, Tudor Ghira, David Modrý, Adrian Gliga, Paul Székely, Diana Butănescu, Béla Marosi, Paul Nemes, Štěpán Vencl, Jan Přerost, Alena Truhlářová, Miroslav Sucháček and Lenka Maidlová for field assistance. The project was initiated in collaboration with the Romanian Herpetological Society and is now a collaboration between Ovidius University of Constanța and Uppsala University, Sweden. Dan Cogalniceanu and an unknown reviewer provided valuable comments on the manuscript, whereas Konrad Mebert contributed with additional information and text improvements.

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