

Influence of Environmental Factors on the Morphology of the Snake-Eyed Skink *Ablepharus kitaibelii* (Reptilia: Scincidae) in Eastern Balkans

Vladislav S. Vergilov¹, Nikolay D. Tzankov²

¹ Department of Anthropology and Zoology, Faculty of Biology – Sofia University "St. Kliment Ohridski", blvd. Dragan Tsankov 8, 1164 Sofia, Bulgaria; E-mail: vladislav8807@gmail.com

² National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria; E-mail: ntzankov@gmail.com

Abstract: The snake-eyed skink (*Ablepharus kitaibelii* Bibron & Bory de Saint-Vincent, 1833) is the only species of the family Scincidae in Bulgaria and the northernmost species of this family on the continent. The present study covers material from 52 UTM squares in the entire country. The dataset (n=226) includes 90 males, 90 females and 46 juveniles. Four meristic and nine metric traits were studied, and the metric ones were converted into 17 indices. Five climatic and geographic factors were taken into account for each specimen. The meristic and metric traits were tested for correlation against the environmental factors. The strongest relation was found in regard to the geographic longitude and climate zones. The rainfalls also had an influence, yet to a smaller extent. According to the fact that these zones have a northwest-southeast orientation, this factor partly corresponds to the geographic longitude. The main conclusion is that there is a geographic intraspecific variability of clearly expressed zonal character.

Keywords: Climate, intraspecific, morphological variability, scincids

Introduction

The family Scincidae Grey, 1825 is the most numerous lizard family in the world with a total of 1516 species (UETZ 2012). In Bulgaria there is one species (*Ablepharus kitaibelii*) of this family which is the northernmost skink species on the continent (GRUBER 1997). An earlier study on this species focused only on its descriptive morphology and general biology (FEJERVARY 1912). Later, STEPANEK (1937) in his study separated the main species populations in two groups, northern and southern, and suggested that there was an intraspecific variability in longitudinal direction. He did not give a taxonomic rank of those groups, although he described a new subspecies (*A. pannonicus fabichi*) from the islets located in the northeast of Crete. The same author (STEPANEK 1944) considered the northern group as *A. pannonicus pannonicus*, while the southern group was recognised as another subspecies, *A. pannonicus kitaibelii*. MERTENS (1952) considered that *A. pannonicus* was

an incorrect taxonomic name and the proper name of the species should be *A. kitaibelii*. Respectively, *A. p. pannonicus* became *A. kitaibelii fitzingeri* and *A. p. kitaibelii* became the nominotypical subspecies *A. kitaibelii kitaibelii*. FUHN, VANCEA (1961) regarded the populations from the Balkan Peninsula, except those in its southernmost parts, as *A. k. fitzingeri*, and the remaining populations of the species range as *A. k. kitaibelii* – a statement which was in concordance with the previously established scheme of longitudinally directed morphological variability. According to FUHN (1970), who presented taxonomic data for geographic differentiation of the snake-eyed skink, the subspecies *A. k. fitzingeri*, *A. k. stepaneki* (newly described) and *A. k. kitaibelii* differ by some meristic and metric characters. The new subspecies by its morphology takes a transitional place between the other two. His data showed that the supralabials and the scales around the midbody decrease in

number from the northernmost to the southernmost subspecies, and that the territories inhabited by these subspecies are divided following the north–south model. FUHN (1969) once again advocated the north–south distribution pattern of the three subspecies (*A. k. fitzingeri*, *A. k. stepaneki* and *A. k. kitaibelii*). GRUBER (1981) examined the two groups within the species range and assigned *A. k. fitzingeri* and *A. k. stepaneki* to the northern group, while the other subspecies – to the southern group. He suggested that the territories of Albania, South Yugoslavia and South Bulgaria are a potential contact zone between the two groups. EREMCHENKO, SZCERBAK (1986) maintained the pattern of differentiation in north–south direction but they did not take into account the subspecies *A. k. stepaneki*. Unlike the other authors they associated the specimens they had from Bulgaria (three specimens from the Karakuz forest and three specimens from Primorsko) with the nominotypical subspecies *A. k. kitaibelii*, i.e. the southern group. SCHMIDTLER (1997) divided his studied material in two groups and introduced a scheme which partially corresponds with the previously known patterns: a southwestern group (Rhodos and Kos Islands, Kusadasi, Koycegiz, Ula and Fetiye) and a northern group (North Asia Minor, one locality in Continental Greece and one in Bulgaria – Ruse district). The data presented by LJUBISAVLJEVIĆ *et al.* (2002) confirmed those from the preceding studies by other authors and suggested that there is a geographic intraspecific morphological variability with expressed zonality for the snake-eyed skink on the territories of Serbia and Macedonia. LJUBISAVLJEVIĆ *et al.* (2002) separated the studied specimens by sex and grouped them into areas divided in north–south direction as follows: *A. k. fitzingeri*, *A. k. fitzingeri*/*A. k. stepaneki* intergradation zone, *A. k. stepaneki*, and *A. k. stepaneki*/*A. k. kitaibelii* intergradation zone. On studying the phylogeography of the species, POULAKAKIS *et al.* (2005) revealed a new picture which did not fit in the known concepts, since it disclosed an east–west disjunction. TZANKOV (2005) also provided data supporting this new concept.

Patterns of morphological variation related to the environmental factors have also been observed in the family Scincidae. According to BROWN, THORPE (1991), the primary cause of the large intraspecific within-island microgeographic variations in color pattern, body dimensions and the scalation of *Chalcides sexlineatus* Steindachner, 1891, were the ecological conditions of the island (the combination between the latitude and the altitude-related elements). Later BROWN *et al.* (1993) found an evidence of a similar north–south geographic vari-

ation in *Chalcides viridanus* (Gravenhorst, 1851) within the island of Tenerife. The main conclusion of their study was that the ecogenesis is the cause for the geographic variation in the lizards. SUMNER *et al.* (1999) revealed a picture which shows that there are differences in the abundance and morphology between individuals of the prickly forest skink *Gnypetoscincus queenslandiae* (DE VIS, 1890) from fragmented and continuous forests. Multiple external factors seem to influence morphological differentiation, such as predator press and changes in microhabitat conditions. CHEN *et al.* (2001) suggested that external quantitative characters in either of two species *Scincella boettgeri* (Van Denburgh, 1912) and *Scincella formosensis* (Van Denburgh, 1912) have rapidly changed under the operation of differential selective pressure from some local environmental factors. In *Sphenomorphus maculatus* (BLYTH, 1853), a geographically related pattern with expressed south–north directional gradient was observed by YAMASAKI *et al.* (2001). Studying the morphological and genetic diversification of *Lamprolepis smaragdina* (Lesson, 1826), SCHMITT *et al.* (2000) revealed the existence of some weak geographic patterning related to latitude and longitude, and found no geographic-associated patterning for *Mabuya multifasciata* (Kuhl, 1820). OUBOTER (1986) mentioned that different causes and environmental factors as climate conditions influence the morphology of near populations of *Scincella* (s.l.) *ladacensis* (GÜNTHER, 1864).

The relations between climatic and geographic parameters and morphological features have not been studied in the snake-eyed skink. This study aims to clarify the relations between the above-mentioned parameters as well as to reveal the pattern of intraspecific variability within the eastern parts of the Balkan Peninsula.

Material and Methods

The current study covered the whole territory of Bulgaria. The three climatic regions, Continental-mediterranean, Transitional-continental and Moderate-continental (KOPRALEV 2002), were equally sampled. The total number of studied specimens coming from 52 UTM grid cells 10 x 10 km from all over the country (Fig. 1; Appendix I) was 226 (90 males, 90 females and 46 juveniles).

The sex of the specimens was determined by dissection. The smallest individual with fully developed reproductive organs was a male with Lcor=30.7 mm. According to the published data, the individuals of over 32 mm of body length were stated as adults

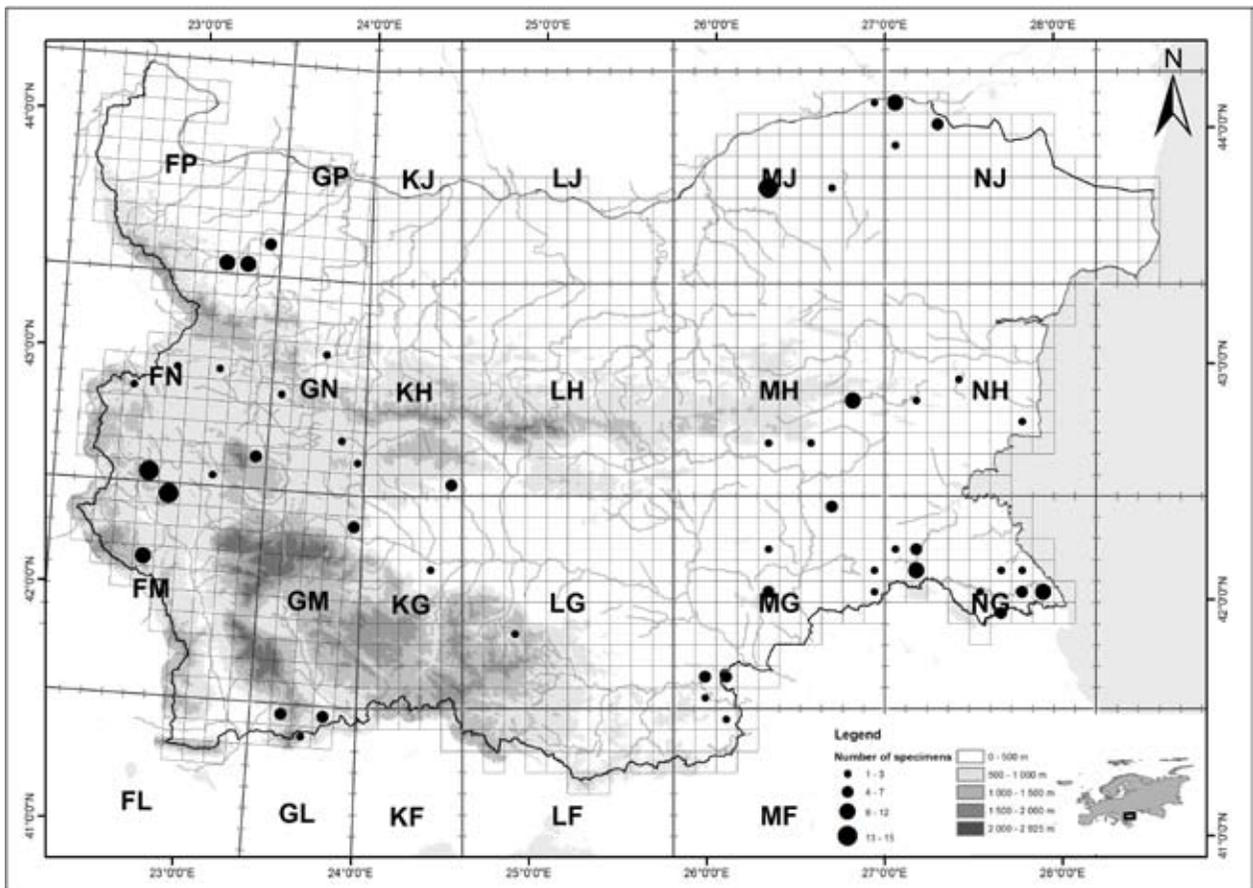


Fig. 1. Sampling sites and abundance

(SCHMIDTLER 1997, LJUBISAVLJEVIĆ *et al.* 2002). The lower value reported in the present study was taken into account when the age classes were assigned. The individuals with fully developed reproductive organs were considered as adults. All specimens in this study were from the collection of the National Museum of Natural History, Bulgarian Academy of Sciences (numbers from NMNHS101 to NMNHS284 and from NMNH287 to NMNH330). As preliminary analyses revealed a pronounced age and sexual related dimorphism, adults were processed separately in both sexes, while the juveniles were excluded. A total of nine metric and four meristic traits were stated (Appendix II). The body length (L_{cor}) was taken with a ruler and the other metric traits (L_{cap} , L_{pil} , L_{atcap} , Alt_{cap} , Pa , Pp , Pp_2 and Lo) and meristic traits were ascertained by using Stereomicroscope SM XX of Carl Zeiss Jena (with magnification 12.5×0.63 for L_{cap} , L_{pil} , L_{atcap} , Alt_{cap} , Pa , Pp , and Pp_2 ; and 12.5×2.5 for Lo). Some meristic and metric traits (L_{cor} , $Slab$, V , D and N_{uh}) were according to data presented by SCHMIDTLER (1997), while the others, excepting L_{atcap} , corresponded to those in LJUBISAVLJEVIĆ *et al.* (2002). The values from the micrometer were converted into millimeters with accu-

racy to hundredths. The length of the tail was not included in this study because very few specimens had a full size tail which had not been regrown as a result of breaking. The metric traits were converted into 17 indices (Appendix II). The standard descriptive statistics, which included mean, range and standard deviation, were calculated for all morphological traits. Five climatic and geographic variables were chosen: geographic latitude (Y) and longitude (X), altitude (Z), geographic climatic zones (clima) and rainfalls (mm). X , Y and Z were obtained from the specimens' locality positions. Z values were converted into five classes. Clima and mm were taken from KOPRALEV (2002) and converted respectively into three and four classes (Appendix II). Morphological traits were tested against the continuous environmental parameters (X and Y) with Partial linear correlation (r) that measured the degree of association between two random variables, with the effect of a set of controlling random variables removed, in order to obtain summarised data for their influence on the morphological traits. Respectively, the ordinal environmental parameters (Z , clima and mm) were tested against the morphological traits with Polyserial correlation (ρ), designed for correlating a normally

distributed continuous/ interval variable with an ordinal variable, that bins a normally distributed variable. Then a Monte Carlo permutation test, based on 9999 random replicates, was run. The statistic procedures were performed with STATISTICA, version 7 (STATSOFT INC. 2004) and PAST 2.17 (HAMMER *et al.* 2001).

Results

In respect of the body length, the males were characterised by a relatively bigger heads and longer legs than females. The results of the descriptive statistics are presented in Table 1.

On analysing the correlation between environmental parameters and morphological traits the relationship was found to be stronger in the males than in the females. In the males, a moderate relation, respectively six, ten, eight and four statistically significant correlations, was found with Y, X, clima and mm (Table 2). In the females, moderate relation was found respectively only with X.

Common statistically significant positive or negative correlations in both sexes were found for six traits, mostly related to insignificant body characteristics with little or no explanatory power (Nuhai, Pp2/Pp, Lpil/Lcap, Latcap/Lcap, and Lo/Lpil). Most of the head indices in males are statistically significantly negatively correlated with Y and clima. This is true also for the relative length of the hind foot, which was negatively correlated with clima, but positively correlated with X. Although most significant correlations were with X (in both sexes), they were better performed and had higher scores with clima. An exception was the relative length of the pileus, which is the only correlated (negatively) with X. The only trait in females explained by two parameters was the relative difference between the pileus and head length.

Discussion

The environmental factors could influence the morphology of scincid lizards and change it (OUBOTER 1986, BROWN, THORPE 1991, BROWN *et al.* 1993, SUMNER *et al.* 1999, SCHMITT *et al.* 2000, CHEN *et al.* 2001, YAMASAKI *et al.* 2001). Different climate conditions can cause disjunction in some species as in *Scincella* (s.l.) *ladacensis* (OUBOTER 1986). Our results support, in a way, that conclusion, with showing that some traits of *A. kitaibelii* changed following the geographic longitude in correlation to climatic zones. CHEN *et al.* (2001) suggested that the external morphology of some skinks can be changed by the

pressure of local environmental factors. According to SUMNER *et al.* (1999), the morphological differentiation can begin as a result of the influence of some microhabitat conditions. BROWN, THORP (1991) revealed a picture of latitude and altitude-related elements with morphological traits in *Chalcides sexlineatus* in a local insular population. Our study revealed statistically significant correlations of morphological traits of the snake-eyed skink mostly with the longitude, but on a small scale also with co-varying longitude and rainfalls, and was better explained with climate zonation. A macro-scale related pattern in term of single (BROWN *et al.* 1993, YAMASAKI *et al.* 2001) or complex (SCHMITT *et al.* 2000) geographic gradients of morphological diversification was mentioned for different scincid species.

Until now studies were focused mainly on external morphological variability of *A. kitaibelii* paying attention only to its taxonomic importance (STEPANEK 1944, FUHN, VANCEA 1961, GRUBER 1981, EREMCHENKO, SZCERBAK 1986). Through the years the ideas of the intraspecific variability in the snake-eyed skink was strongly influenced by the concept of a well expressed longitudinal gradient diversification (FUHN 1970, LJUBISAVLJEVIĆ *et al.* 2002). This concept was inferred only by some authors (STEPANEK 1937, 1944, EREMCHENKO, SZCERBAK 1986). This study presents a slightly expressed, but statistically significant, correlation between the morphological traits and climate zones. This concept is in agreement with some of the previous studies (POULAKAKIS *et al.* 2005, TZANKOV 2005). The molecular evolutionary approach preceded the morphological one (PATTERSON 1987, AVISE 2000). That is why the phylogeographic scheme revealed in POULAKAKIS *et al.* (2005) should be recognised as primal in interpreting the morphological changes over the geographic scale. The morphological variability across the geographic longitude does not follow necessarily the climatic zonation. This fact put to question the previously known picture of intraspecific structure with expressed north-south directional zonality and suggested a new interpretation. The proposed new scheme took into account the influence of environmental factors on the snake-eyed skink's external morphology. Even if the differentiation tends to have some geographic orientation and gets some statistically significant support, the relationships are slightly expressed.

In general the European postglacial pathways were already established (HEWITT 1999, 2000, 2004). Some reptiles with common ranges in Central Europe, such as the snake-eyed skink, seem to have their glacial refugia situated most often in the southern part of

Table 1. Descriptive statistics (n – sample size, mean ± standard deviation, minimal and maximal values) of morphological traits (mt) for both sexes (m - males, f - females). For abbreviations see Appendix II

| mt | m | F | mt | m | F |
|-------------|---------------|---------------|---------------|-------------|-------------|
| V | n = 90 | n = 85 | Lo/Lcor | n = 90 | n = 85 |
| | 61.56 ± 2.93 | 66.61 ± 3.95 | | 0.03 ± 0.00 | 0.03 ± 0.00 |
| | 54.00 - 71.00 | 54.00 - 74.00 | | 0.02 - 0.03 | 0.02 - 0.04 |
| D | n = 88 | n = 85 | Pa/Pp+Pp2 | n = 89 | n = 85 |
| | 20.00 ± 0.48 | 20.11 ± 0.67 | | 0.48 ± 0.02 | 0.48 ± 0.02 |
| Slab | n = 89 | n = 85 | Pa/Pp | n = 89 | n = 85 |
| | 6.08 ± 0.46 | 6.09 ± 0.40 | | 0.70 ± 0.03 | 70 ± 0.03 |
| | 4.00 - 8.00 | 6.00 - 8.00 | 0.61 - 0.76 | 0.63 - 0.77 | |
| Nuhai | n = 88 | n = 85 | Pp2/Pp | n = 89 | n = 85 |
| | 6.65 ± 0.86 | 6.62 ± 0.95 | | 0.45 ± 0.02 | 0.45 ± 0.03 |
| Pa/Lcor | n = 90 | n = 85 | Lpil/Lcap | n = 89 | n = 85 |
| | 0.18 ± 0.01 | 0.16 ± 0.01 | | 0.89 ± 0.04 | 0.89 ± 0.03 |
| | 0.16 - 0.21 | 13.00 - 22.00 | 0.72 - 1.02 | 0.81 - 0.98 | |
| Pp/Lcor | n = 89 | n = 85 | Latcap/Lcap | n = 88 | n = 85 |
| | 0.26 ± 0.02 | 0.23 ± 0.02 | | 0.69 ± 0.04 | 0.70 ± 0.04 |
| Pp2/Lcor | n = 89 | n = 85 | Altcap/Lcap | n = 89 | n = 85 |
| | 0.22 - 0.29 | 0.20 - 0.30 | | 0.52 ± 0.04 | 0.53 ± 0.04 |
| | 0.12 ± 0.01 | 0.10 ± 0.01 | 0.44 - 0.66 | 0.44 - 0.66 | |
| Lcap/Lcor | n = 89 | n = 85 | Altcap/Latcap | n = 89 | n = 85 |
| | 0.15 ± 0.01 | 0.13 ± 0.01 | | 0.76 ± 0.06 | 0.76 ± 0.07 |
| | 0.14 - 0.17 | 0.11 - 0.19 | 0.66 - 1.00 | 0.60 - 1.02 | |
| Lpil/Lcor | n = 90 | n = 85 | Lo/Lcap | n = 89 | n = 85 |
| | 0.13 ± 0.01 | 0.12 ± 0.01 | | 0.18 ± 0.01 | 0.19 ± 0.02 |
| | 0.11 - 0.15 | 0.09 - 0.17 | 0.15 - 0.22 | 0.15 - 0.30 | |
| Latcap/Lcor | n = 89 | n = 85 | Lo/Lpil | n = 90 | n = 85 |
| | 0.10 ± 0.01 | 0.09 ± 0.01 | | 0.21 ± 0.01 | 0.21 ± 0.02 |
| | 0.08 - 0.12 | 0.08 - 0.13 | | 0.17 - 0.25 | 0.17 - 0.33 |
| Altcap/Lcor | n = 90 | n = 85 | | | |
| | 0.08 ± 0.01 | 0.07 ± 0.01 | | | |
| | 0.06 - 0.11 | 0.05 - 0.11 | | | |

the Balkan Peninsula, but they, e.g., *Lacerta viridis* (BÖHME *et al.* 2007), *Dolichophis caspius* (NAGY *et al.* 2010), *Zamenis longissimus* (MUSILOVÁ *et al.* 2010), have different lineages in southernmost part of the peninsula and Asia Minor. Since POULAKAKIS *et al.* (2005) sampling covered only the southern part of the distribution range of *A. kitaibelii*, for now the phylogenetic attribution of the northern populations remains questionable.

On a global scale, the influence of the environmental factors on the evolution of external morphological traits was advocated for different lizard families: iguanids - *Anolis* (Losos 2004), *Sceloporus*

(OUFIERO *et al.* 2011), lacetids and teiids (VITT, PIANKA 2004). In the scincid lizards those processes are less expressed and without a well exposed correlation to particular environmental factors, and most probably are linked to a local scale microhabitat adaption and characteristics (SUMNER *et al.* 1999, CHEN *et al.* 2001). This provides further fields for studying these relationships on a local scale in order to reveal some patterns of geographic variability in the snake-eyed skink. A comprehensive phylogeographic study covering the species range is necessary for clearing out the evolutionary processes and to clarify their role and significance for the morphology of *A. kitaibelii*.

Table 2. Partial linear and polyserial correlation values of environmental parameters (for abbreviations see chapter Material and Methods) versus morphological traits (for abbreviations see Appendix II). Values for males are in left columns and those for females in the right columns. Statistically significant values are bold and italic and those shared in both sexes are marked with grey. Respective levels of statistical significance: * - P<0.05. ** - P<0.01. *** - P<0.001

| | Y | | X | | Z | | clima | | mm | |
|---------------|----------------|-------|-----------------|-----------------|--------------|---------------|-----------------|---------------|---------------|--------------|
| V | 0.19 | 0.10 | 0.02 | 0.06 | -0.13 | -0.10 | 0.17 | 0.09 | -0.02 | 0.03 |
| D | 0.00 | -0.17 | 0.11 | 0.21 | -0.10 | -0.12 | 0.00 | -0.25* | -0.25* | -0.10 |
| Slab | 0.21* | 0.04 | -0.09 | -0.02 | 0.04 | -0.02 | 0.12 | 0.11 | -0.17 | -0.06 |
| Nuhal | -0.03 | -0.05 | -0.31** | -0.26* | 0.23* | 0.21 | 0.10 | 0.05 | -0.05 | 0.09 |
| Pa/Lcor | -0.05 | -0.04 | 0.21* | 0.17 | -0.16 | -0.10 | -0.14 | -0.13 | -0.05 | 0.06 |
| Pp/Lcor | -0.03 | 0.01 | 0.19 | 0.23* | -0.12 | -0.18 | -0.14 | -0.09 | -0.09 | 0.02 |
| Pp2/Lcor | -0.16 | -0.02 | 0.30** | 0.16 | -0.11 | -0.12 | -0.35** | -0.12 | 0.08 | 0.12 |
| Lcap/Lcor | -0.31** | 0.03 | 0.09 | -0.04 | -0.02 | -0.07 | -0.41*** | 0.00 | 0.33** | 0.12 |
| Lpil/Lcor | -0.09 | 0.08 | -0.26* | -0.20 | 0.15 | -0.03 | 0.01 | 0.12 | 0.08 | 0.09 |
| Latcap/Lcor | -0.25* | 0.02 | 0.26* | 0.14 | 0.01 | -0.20 | -0.36** | -0.08 | 0.06 | 0.12 |
| Altcap/Lcor | -0.29** | -0.00 | 0.08 | -0.07 | 0.02 | -0.04 | -0.32** | 0.02 | 0.09 | 0.05 |
| Lo/Lcor | -0.29** | -0.06 | 0.22* | 0.11 | 0.10 | -0.16 | -0.42*** | -0.10 | 0.26* | 0.06 |
| Pa/Pp-Pp2 | 0.07 | -0.10 | -0.07 | -0.08 | -0.05 | 0.13 | 0.13 | -0.04 | -0.04 | 0.01 |
| Pa/Pp | -0.02 | -0.13 | 0.04 | -0.11 | -0.08 | 0.15 | 0.01 | -0.08 | 0.05 | 0.10 |
| Pp2/Pp | -0.20 | -0.06 | 0.26* | -0.05 | -0.04 | 0.03 | -0.34** | -0.09 | 0.24* | 0.24* |
| Lpil/Lcap | 0.18 | 0.13 | -0.40*** | -0.46*** | 0.21 | 0.10 | 0.38** | 0.37** | -0.18 | -0.08 |
| Latcap/Lcap | -0.08 | -0.02 | 0.25* | 0.33** | -0.04 | -0.25* | -0.15 | -0.15 | -0.06 | 0.01 |
| Altcap/Lcap | -0.20 | -0.02 | 0.04 | -0.08 | 0.05 | 0.02 | -0.16 | 0.04 | -0.02 | -0.05 |
| Altcap/Latcap | -0.15 | 0.00 | -0.12 | -0.24* | 0.06 | 0.16 | -0.06 | 0.12 | -0.00 | -0.05 |
| Lo/Lcap | -0.13 | -0.12 | 0.17 | 0.20 | 0.13 | -0.15 | -0.17 | -0.14 | 0.08 | -0.05 |
| Lo/Lpil | -0.24* | -0.16 | 0.44*** | 0.35*** | -0.03 | -0.19 | -0.44*** | -0.24 | 0.19 | -0.02 |

Acknowledgements: We would like to thank S. Dimitrov, D. Duhalov, S. Georgieva, G. Hristov, N. Ivanova, S. Lukanov, M. Marinov, P. Mitov, B. Naumov, S. Popova, M. Slavchev, A. Stojanov and E. Vacheva for providing material and for the field-

work assistance. We also thank N. Nachev for assisting in dissection processes, and B. Zlatkov for providing equipment for the morphometrical procedures. We are grateful to M. Savchovska for the language improvement.

Appendix I

UTM grid cells (10x10 km): FM46, FM59, FN34, FN40, FN55, FN70, FN75, FN91, FP70, FP80, FP91, GL19, GL28, GL39, GM48, GN04, GN26, GN32, GN41, KG86, KH90, LG23, MF29, MG10, MG11, MG21, MG45, MG47, MG79, MG95, MG96, MH42, MH62, MH84, MJ44, MJ74, MJ98, NG07, NG16, NG17, NG45, NG54, NG56, NG65, NG66, NG75, NH14, NH35, NH63, NJ06, NJ08, NJ27

Appendix II

Meristic traits: V – number of ventral scales; D – number of dorsal scales around the midbody; Slab – total number of supralabial scales (from both sides); Nuhal – total number of nuhal scales

Metric traits: Lcor – snout-vent length (from snout of the head to the end of the cloacal scales); Pa – fore leg length (length of the fore leg from the base to the tip of the longest finger); Pp – hind leg length (length of the

hind leg from the base to the tip of the longest finger); Pp2 – hind foot length (length of the hind foot from the base to the tip of the longest finger); Lcap – head length (from snout of the head to the beginning of the ear canal); Lpil – pileus length (from snout of the head to the end of pileus); Latcap – head width (width of the head in the widest point in jugale region); Altcap – head height (height of the head in the midpoint between the eye and the ear); Lo – longitudinal eye diameter

Indices: Pa/Lcor, Pp/Lcor, Pp2/Lcor, Lcap/Lcor, Lpil/Lcor, Latcap/Lcor, Altcap/Lcor, Lo/Lcor, Pa/Pp+Pp2, Pa/Pp, Pp2/Pp, Lpil/Lcap, Latcap/Lcap, Altcap/Lcap, Altcap/Latcap, Lo/Lcap, Lo/Lpil

Z: 0-200 – 1; 200-400 – 2; 400-600 – 3; 600-800 – 4; 800-1000 – 5

Clima: Continental Mediterranean – 1; Transitional continental – 2; Moderate continental – 3

Mm: 500-600 – 1; 600-700 – 2; 700-800 – 3; 800-900 – 4

References

- AVISE J. C. 2000. Phylogeography: The History and Formation of Species. Cambridge, Massachusetts (Harvard University Press). 464 p.
- BÖHME M. U., U. FRITZ, T. KOTENKO, G. DŽUKIĆ, K. LJUBISAVLJEVIĆ, N. TZANKOV, T. U. BERENDONK 2007. Phylogeography and cryptic variation within the *Lacerta viridis* complex (Lacertidae, Reptilia). – *Zoologica Scripta*, **36**: 119-131.
- BROWN P. R., R. S. THORPE 1991. Within-island microgeographic variation in body dimensions and scalation of the skink *Chalcides sexlineatus*, with testing of casual hypotheses – *Biological Journal of the Linnean Society*, **44**: 47-64.
- BROWN P. R., R. S. THORPE, M. BAEZ 1993. Patterns and causes of morphological population differentiation in the Tenerife skink, *Chalcides viridanus* – *Biological Journal of the Linnean Society*, **50**: 313-328.
- CHEN S.-L., H. OTA, T. HIKIDA 2001. Geographic Variation in the Two Smooth Skinks, *Scincella boettgeri* and *S. formosensis* (Squamata: Scincidae), in the Subtropical East Asian Islands – *Zoological Science*, **18**: 115-130.
- EREMCHENKO K. V., N. N. SZCERBAK 1986. The Ablepharid Lizards of the fauna of USSR and Near Countries. Frunze (Ilim publish house). 172 p. (in Russian)
- FEJERVARY G. J. 1912. Über *Ablepharus pannonicus* Fitz. – *Zoologische Jahrbuch Abteilung für Systematik, Geographie und Biologie der Tiere, Jena*, **33**: 547-574.
- FUHN I. E. 1969. Revision and redefinition of the genus *Ablepharus* Lichtenstein, 1823. (Reptilia, Scincidae). – *Revue Roumaine de Biologie, Zoologie, Bucarest*, **14** (1): 23-41.
- FUHN I. E. 1970. Über die Unterarten von *Ablepharus kitaibelii* (Bibron & Bory de St. Vincent, 1833) (Sauria, Scincidae). – *Věstník Československé zoologické společnosti, Praha*, **34** (1): 9-17.
- FUHN I. E., ST. VANCEA 1961. Reptilia. – The fauna of the People's Republic of Romania. Reptilia. XIV, fascicola II. București (Academiei R.P.R.). 182 p.
- GRUBER U. 1981. *Ablepharus kitaibelii* Bibron and Bory 1883 – Johannisechse. In: Böhme, W. (ed): Handbuch der Reptilien und Amphibien Europas, Echsen. I. Wiesbaden, (Akademische Verlagsgesellschaft), **1**: 292-307.
- GRUBER U. 1997. *Ablepharus kitaibelii* Bibron and Bory, 1883. In: GASC J.-P., CABELA, A., CRNOBRNJA-ISAILOVIĆ, J., DOLMEN, D., GROSSENBACHER, K., HAFFNER, P., LESCURE, J., MARTENS, H., MARTINEZ RICA, J. P., MAURIN, H., OLIVEIRA, M.E., SOFIANIDOU, T.S., VEITH, M., ZUIDERWIJK, A. (eds.): Atlas of amphibians and reptiles in Europe. XXIX. Collection Patrimoines Naturels. Paris (Societas Europaea Herpetologica, Muséum National d'Histoire Naturelle & Service du Patrimoine Naturel), 306-307.
- HAMMER Ø., D. A. T. HARPER, P. D. RYAN. 2001. PAST: Paleontological Statistics software package for education and data analysis. – *Paleontologia Electronica*, **4**: 9
- HEWITT G. M. 1999. Post-glacial re-colonization of European biota. In: Racey et al. (eds.): Molecular genetics in animal ecology. – *Biological Journal of the Linnean Society*, **68**: 87-112.
- HEWITT G. M. 2000. The Genetic Legacy of the Quaternary Ice Ages. – *Nature*, **405**: 907-913.
- HEWITT G. M. 2004. Genetic consequences of climatic oscillations in the Quaternary. – *Philosophical Transactions of the Royal Society of London, B*, **359**: 183-195.
- KOPRALEV I. (ed.) 2002. Geography of Bulgaria. ForComPublishers, Sofia (in Bulgarian).
- LJUBISAVLJEVIĆ K., G. DŽUKIĆ, M. L. KALEZIĆ 2002. Morphological differentiation of the Snake-eyed Skink *Ablepharus kitaibelii* (Bibron & Bory, 1833), in the north-western part of the species' range: systematic implications. – *Herpetozoa*, **14** (3/4): 107-121.
- LOSOS J. B. 2004. Evolutionary Diversification of Caribbean Anolis Lizards. In: Dieckmann et al. (eds.): Adaptive Speciation. Cambridge (Cambridge University Press). **16**: 335-350.
- MERTENS R. 1952. Über den Glattechsen-Namem *Ablepharus pannonicus*. – *Zoologische Anzeiger*, **149** (1/2): 48-50.
- MUSILOVÁ R., V. ZAVADIL, S. MARKOVA, P. KOTLIK 2010. Relics of the Europe's warm past: Phylogeography of the Aesculapian snake. – *Molecular Phylogenetics and Evolution*, **57**: 1245-1252.
- NAGY Z. T., M. BELLAAGH, M. WINK, A. PAUNOVIĆ, Z. KORSÓS 2010. Phylogeography of the Caspian whipsnake in Europe with emphasis on the westernmost populations. – *Amphibia-Reptilia*, **31**: 455-461.
- OUBOTER E. P. 1986. A revision of the genus *Scincella* (Reptilia: Sauria: Scincidae) of Asia, with some notes on its evolution – *Zoologische Verhandlungen, Leiden*, **229**: 1-66.
- OUIFIERO E. C., G. E. A. GARTNER, S. C. ADOLPH, T. GARLAND, JR. 2011. Latitudinal and climatic variation in body size and dorsal scale counts in *Sceloporus* lizards: A phylogenetic – *Evolution* **65** (12): 3590-3607.
- PATTERSON C. 1987. Molecules and Morphology in Evolution: Conflict or Compromise? New York, Melbourne, (Cambridge University Press). 240 p.
- POULAKAKIS N., P. LYMBERAKIS, C. S. TSIGENPOULOS, A. MANGOULAS, M. MYLONAS. 2005. Phylogenetic relationships and evolutionary history of snake-eyed skink *Ablepharus kitaibelii* (Sauria: Scincidae). – *Molecular Phylogenetics and Evolution*, **34**: 245-256.
- STATSOFT INC. 2004. STATISTICA (data analysis software system), version 7. www.statsoft.com.
- SCHMIDTLER J. F. 1997. Die *Ablepharus kitaibelii* – Gruppe in Süd-Anatolien und benachbarten Gebieten. – *Herpetozoa*, **10** (1/2): 35-63.
- SCHMITT H. L., R. A. HOW, J. GOLDBERG, I. MARYANTO 2000. Geographic Patterns in Genetic and Morphological Variation in Two Skink Species along the Banda Arcs, Southeastern Indonesia – *Journal of Herpetology*, **34** (2): 240-258.
- STEPANEK O. 1937. Zweiter Beitrag zur Herpetologie der Insel Kreta. – *Věstník Československé zoologické společnosti, Praha*, **5**: 77-79.
- STEPANEK O. 1944. Zur Herpetologie Griechenlands. – *Věstník Československé zoologické společnosti, Praha*, **9**: 123-147.
- SUMNER J., C. MORITZ, R. SHINE 1999. Shrinking forest shrinks skink: morphological change in response to rainforest fragmentation in the prickly forest skink (*Gnypetoscincus queenslandiae*) – *Biological Conservation*, **91**: 159-167.
- TZANKOV N. 2005. Studying on the subspecies affinity of five population of *Ablepharus kitaibelii* (Byron & Bory, 1833) in Bulgaria. – *Annuaire de l'Université de Sofia "St. Kliment Ohridski" 2004, 10ème session scientifique, Sofia '03*, **96**, **4** (2): 281-300.
- UETZ P. (ed.), The Reptile Database, <http://www.reptile-database>.

org, accessed Nov 15, 2012.

VITT L. J., R. E. PIANKA 2004. Historical Patterns in Lizard Ecology: What Teiids Can Tell Us About Lacertids. In: Pérez-Mellado et al. (eds.): The Biology of Lacertid lizards. Evolutionary and Ecological Perspectives. Recerca (Institut Menorquí d'Estudis). **8**: 139-157.

YAMASAKI T., T. HIKIDA, J. NABHITABHATA, S. PANHA, H. OTA 2001. Geographic Variations in the Common Skink *Spheonomorphus maculatus* (Blyth, 1853) in Thailand, with Re-validation of *Lygosoma mitanense* Annandale, 1905 as Its Subspecies – *The Natural History Journal of Chulalongkorn University*, **1** (1): 23-31.

Received: 15.01.2013

Accepted: 26.03.2014