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Morphological differentiation of the Snake-eyed Skink *Ablepharus kitaibelii* (BIBRON & BORY, 1833), in the north-western part of the species' range: systematic implications
(Squamata: Sauria: Scincidae)

Morphologische Differenzierung bei der Johannisechse
Ablepharus kitaibelii (BIBRON & BORY, 1833) im Nordwesten des Artareals:
Systematische Folgerungen
(Squamata: Sauria: Scincidae)

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ABSTRACT

This study describes patterns of geographic variation in morphological traits of the Snake-eyed Skink *Ablepharus kitaibelii* (BIBRON & BORY, 1833), in the taxonomically indistinct north-western part of its distribution. Samples of 15 populations from Serbia and FYR Macedonia were analysed using univariate and multivariate statistics. We found considerable variation in morphometric, meristic and qualitative characters. Variability patterns, determined by multivariate statistics, suggest the existence of two subspecies in the study area - *A. k. fitzingeri* MERTENS, 1952 and *A. k. stepaneki* FUHN, 1970 - and two rather broad intergradation zones (*A. k. fitzingeri/stepaneki* and *A. k. stepaneki/kitaibelii*). Northern populations (*A. k. fitzingeri*) differed from the other "population groups" in nearly all characters analysed. Individuals of *A. k. stepaneki* were characterised by the highest measurement values of the head region, the greatest mean values in some meristic traits, and their distinguishing dorsal colour pattern. Evidence of intergradation between *A. k. fitzingeri* and *A. k. stepaneki* included intermediate values and increased variability of some morphometric and meristic traits. Intergradation patterns found in FYR Macedonian samples suggested gene flow between *A. k. stepaneki* and *A. k. kitaibelii*. These population samples were discriminated particularly due to dorsal colour pattern and some meristic characters and showed influences of *A. k. kitaibelii*. On the basis of the morphological variability and differentiation observed, the high evolutionary potential of *A. kitaibelii* peripheral populations is evident.

KURZFASSUNG

Die geographische Variabilität der morphologischen Merkmale der Johannisechse *Ablepharus kitaibelii* (BIBRON & BORY, 1833) im taxonomisch unklaren Nordwesten des Artareals wird dargestellt. 15 Stichproben aus Serbien und Mazedonien wurden mit univariaten und multivariaten statistischen Verfahren analysiert. Hinsichtlich der morphometrischen, meristischen und qualitativen Merkmale wurde hohe Variabilität festgestellt. Die Ergebnisse weisen das Vorkommen von zwei Unterarten im Untersuchungsgebiet aus: *A. k. fitzingeri* MERTENS, 1952 und *A. k. stepaneki* FUHN, 1970 mit zwei ziemlich breiten Intergradationszonen (*A. k. fitzingeri/stepaneki* und *A. k. stepaneki/kitaibelii*). Die nördlichen Populationen (*A. k. fitzingeri*) sind in nahezu allen Merkmalen eindeutig von den anderen "Populationsgruppen" unterschieden. Individuen von *A. k. stepaneki* sind charakterisiert durch die relativ größten Kopfabmessungen, erhöhte Mittelwerte in einigen meristischen Merkmalen und die spezifische Rückenfärbung. Der Nachweis einer Intergradation zwischen *A. k. fitzingeri* und *A. k. stepaneki* beruht auf dem Vorhandensein intermediärer Werte und erhöhter Variabilität einiger morphometrischer und meristischer Merkmale. Die Auswertung mazedonischer Stichproben weist auf einen Genfluß zwischen *A. k. stepaneki* und *A. k. kitaibelii* hin. Diese Stichproben unterscheiden sich von den anderen besonders in ihrer Rückenfärbung und in einigen meristischen Merkmalen, wobei ein Einfluß von *A. k. kitaibelii* erkennbar wird. Aufgrund der festgestellten morphologischen Variabilität und Differenzierung erscheint das hohe Evolutionspotential der peripheren Populationen von *A. kitaibelii* evident.

KEY WORDS

Reptilia: Sauria: Scincidae; *Ablepharus kitaibelii*, morphology, systematics, Serbia, FYR Macedonia, the Balkans

INTRODUCTION

The Snake-eyed Skink *Ablepharus kitaibelii* (BIBRON & BORY, 1833), is the only species of the genus in Europe, where it is represented by four subspecies. According to the literature (FUHN 1969, 1970; PASULJEVIC 1977; GRUBER 1981, 1997), the subspecies *A. k. fitzingeri* MERTENS, 1952 has been found in the southern Slovakian Republic and in Hungary, *A. k. stepaneki* FUHN, 1970 in Romania, Bulgaria, former Yugoslavia (Serbia, Bosnia and FYR Macedonia), Albania, *A. k. kitaibelii* (BIBRON & BORY, 1833) in Greece, including the Ionian and Aegean islands and *A. k. fabichi* ŠTEPÀNEK, 1937 in the Greek islands of Mikronisi (near Crete), Amathia, Kasos, and Karpathos.

However, there is a lot of obscurity concerning the distribution of and contact zones between subspecies in the Balkan Peninsula. This includes questions on the taxonomic status of former-Yugoslavian and Albanian populations "probably related to *A. k. stepaneki*" (FUHN 1969), and their contact with populations referred to *A. k. kitaibelii*. FUHN (1969) suggested that intergrades might occur in southern Yugoslavia, Albania and Bulgaria. PASULJEVIC (1973) presumed that southern populations in the territory of the former Yugoslavia are related to *A. k. kitaibelii,* eastern to *A. k. stepaneki* and northern to *A. k. fitzingeri.* The existence of intergradation zones had been presumed in previous analyses of intraspecific differentiation of the Snake-eyed Skink (FUHN 1969, 1970; GRUBER 1981, 1997). However, further investigations of these zones have not been done, until now. Furthermore, better understanding of the nature of distribution gaps (GRUBER 1981, 1997) is needed, especially of the wide gap between the northern (Slovakian and Hungarian) and the southern populations. Recently, those gaps were largely filled by new records (TOMOVIC et al. 2001; DZUKIC et al. unpublished data).

The main purpose of this study was to determine the morphological variation of *A. kitaibelii* populations in the north-western part of the range. We used a large sample of 15 populations covering the taxonomically most interesting areas (Serbia and FYR Macedonia), including presumed intergradation zones. Numerous morphometric, meristic and qualitative characters were scored and population relationships were established using multivariate statistics. On the basis of our results, we attempted to clarify the taxonomic status of the populations considering previous studies on intraspecific differentiation of the Snake-eyed Skink. Based on the results of this study, we have depicted a new map of the supposed ranges of the subspecies of *Ablepharus kitaibelii* in the north-western part of the species' range.

MATERIALS AND METHODS

Populations studied

In total, 386 specimens from 15 localities were analysed (fig. 1 and Appendix). Sex and maturity of each specimen were determined on the basis of gonadal investigations: a given specimen was defined as an adult if it had enlarged testes and/or epididymes (male), or yolked follicles and/or expanded oviducts (female) (OTA et al. 1999). Most samples were preserved in 3-4% formaldehyde, while the samples numbered 4, 5, 7 and 15 (see Appendix) were preserved in 70 % ethanol for varying periods of time. This heterogeneity might have caused some scoring errors, but hopefully not systematic ones. All samples from Serbia and the sample from Bogomila in FYR Macedonia were deposited in G. DZUKIC's Herpetological Collection, Institute for Biological Research, Beograd, Yugoslavia. The sample from Konecka planina in FYR Macedonia was deposited in the Herpetological Collection of the Macedonian Museum of Natural History, Skopje, FYR Macedonia.

Characters studied and data analysis

The following five meristic characters were analysed: SDG - number of digital lamellae under fourth digit of hindfoot, DV

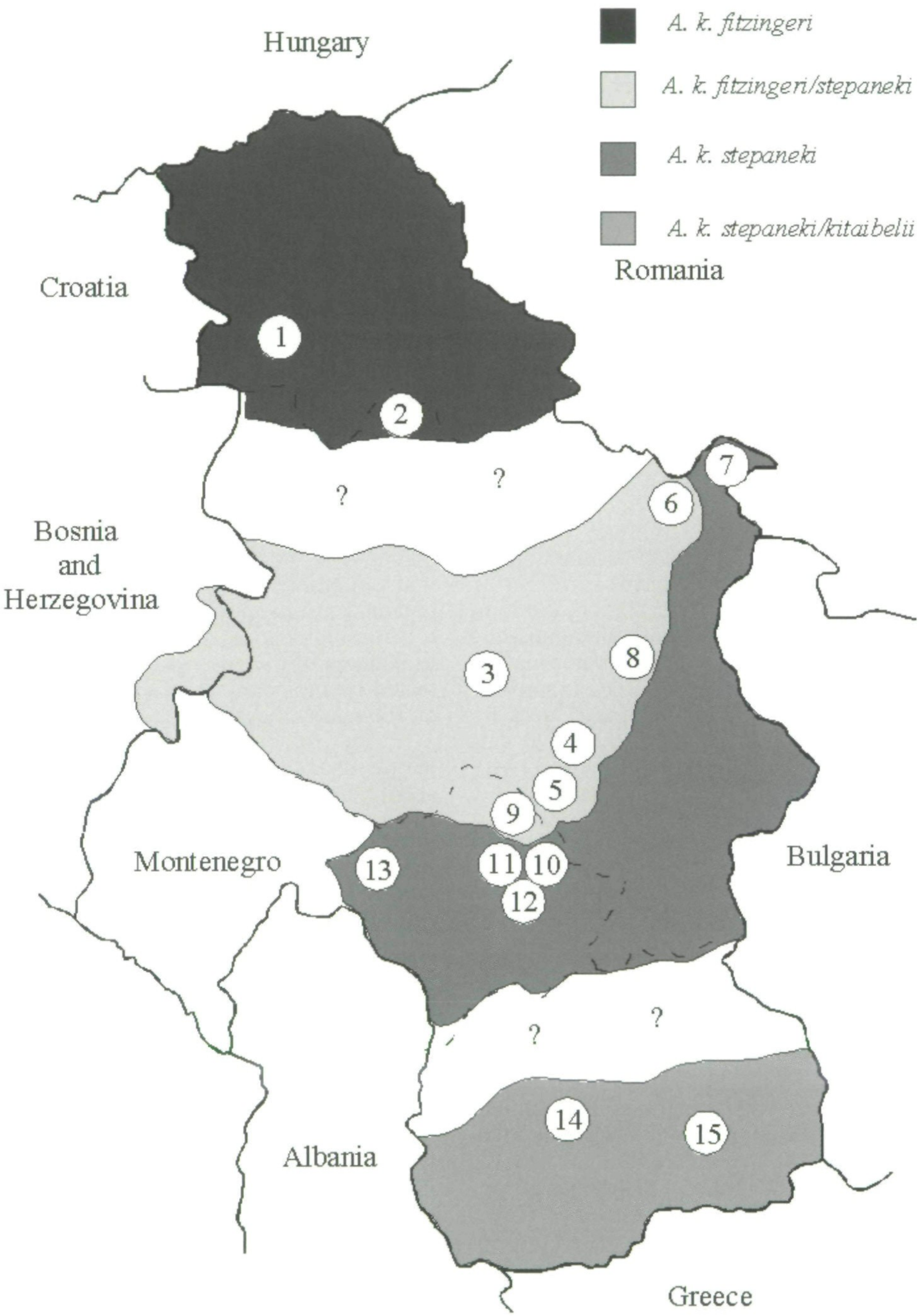

Fig. 1: Distribution of the sampling sites of *Ablepharus kitaibelii* included in the analysis (locality numbers explained in Appendix). Ranges of subspecies and intergradation zones are indicated by different patterns.

Abb. 1: Unterart-Areale und Intergradationszonen von *Ablepharus kitaibelii* im Untersuchungsgebiet, und die Verteilung der Fundorte der untersuchten Stichproben (Erklärung der Fundortnummern siehe Appendix).

- number of scales around midbody, PO1 - number of postocular scales in the first row posterior to eye, PO2 - number of postocular scales in the second row posterior to eye, SLB - number of supralabial scales anterior to subocular. Scale counts were made with a binocular microscope. Symmetrical characters were taken from either side of the body, and the means of right and left counts each were subject to analysis. Values or ranges of meristic characters were coded for correspondence analysis as follows: SDG - a (10, 10.5), b (11, 11.5), c (12, 12.5), d (13, 13.5); DV - a (18, 19), b (20), c (21, 22); PO1 - a (3, 3.5), b (4, 4.5), c (5, 5.5), d (6, 6.5); PO2 - a (2), b (2.5), c (3), d (3.5); SLB - a (3), b (3.5), c (4)

Concerning meristic characters, differences between sexes and among localities were analysed by Mann-Whitney U test and Kruskal-Wallis test because assumptions of parametric tests were violated.

For analysis of the scalation, the samples included male, female, and immature individuals, because neither sex nor maturity affected the number of scales in an individual or sample (Mann-Whitney U test, for all comparisons $P >> 0.05$, statistical data are available from the authors upon request). A total of 386 individuals were subjected to analysis of meristic characters. The average number per population sample was 25.73 ± 6.65 individuals.

Variation of the following qualitative traits was studied:

(i) pileus type - PIL (arrangement of prefrontals, as specified by WERMUTH 1950; VOIPIO 1968; DELY & STOHL 1982, for various lizard species): a (median), b (cross), c (transversal); (ii) dorsal pattern - DP (according to FUHN 1970, modified): a (composed of 4 unbroken double longitudinal lines), b (composed of 4 broken alternating double and single longitudinal lines), c (composed of 4 broken predominantly single longitudinal lines); (iii) colour of ventral side - VC: a (bluish-grey), b (blue), c (reddish-orange); (iv) colour of dorsal side - DC: a (brown), b (olive greenish-brown).

Statistical analysis of qualitative characters included only mature individuals. There was no significant sex-related within-sample variation in the frequencies of qualitative characters in all samples (Yates corrected χ^2 test, $df = 2$, for all comparisons $P > 0.05$, statistical data are available from the authors upon request). For analysis of these characters, data from the mature specimens within each population sample were pooled for the between-locality comparisons.

In total 276 individuals were subjected to analysis for pileus type and dorsal pattern. The average number per population sample was 18.40 ± 4.53 individuals. Only in the alcohol preserved four samples (Nos. 4, 5, 7, 15) coloration could be was analysed.

Variation of qualitative and meristic traits was examined using a correspondence analysis following the algorithm of GREENACRE (1984). The output of such an analysis were coordinates of rows (population samples) and columns (states of characters) on correspondence axes superimposed on the scatter diagram. Since distances between points have no straightforward interpretation in multiple correspondence analysis, the obtained results allowed only evaluation of relationships among populations according to features of the correspondence axes estimated by the positions of column variables on the scatter diagram.

The following twenty-five morphometric characters were measured: Lcor - snout-vent length (body length from tip of snout to vent), Lcap - head length (from tip of snout to posterior margin of ear opening), Altcap - head height (at position of parietal plates), Ltcap - head width (maximum transverse distance), Lfo - mouth length (from tip of snout to corner of mouth), Ltfo - mouth width (between corners of mouth), Lpan - forelimb length (from axilla to tip of longest finger), Lpp - hindlimb length (from groin to tip of the longest toe), Ldq - length of fourth toe on hindlimb (from basis to tip), Lpil - pileus length (from tip of snout to posterior margin of parietal plates), Ltpil - pileus width (at parietal plates), Lin - length of internasal plate, Ltin - width of internasal plate, Lfr - length of frontal plate, Ltfr - width of frontal plate, Lfp - length of frontoparietal plates, Ltfp - width of frontoparietal plates, Lip - length of interparietal plate, Ltip - width of interparietal plate, Lpa - length of parietal plates, Ltpa - width of parietal plates, Ltr - width of rostral scale, Ln - length of nasal scales, Doa - orbit to ear distance (from posterior margin of eye to anterior edge of ear opening), Pap - distance between fore and hind limbs (from posterior margin of forelimb insertion to anterior margin of hindlimb insertion). Some characters (Lcor, Lpan, Lpp, Ldq, Pap), as well as head dimensions, were taken to the nearest 0.01 mm with digital callipers. Dimensions of pileus and its scales were taken to the nearest 0.05 mm with dial callipers under a stereoscopic dissecting microscope. Symmetrical characters were taken from either side of the body, and data processing concerned the mean of right and left values.

Statistical analysis of morphometric characters included only mature individuals. A total of 288 individuals were subjected to analysis (159 females and 129 males). The average number of females and males per population sample was 12.23 ± 2.89, and 10.75 ± 2.90, respectively. To minimise the risk of overall shrinkage of variation among samples, we processed data only for samples consisting of more than three specimens each. Consequently, sample No. 3 was excluded from analysis, sample No. 12 was restricted to adult males, and samples Nos. 6 and 9 to adult females.

Analysis of variance for unbalanced data (ANOVA) revealed significant differences between sexes for most of the analysed morphometric characteristics. Consequently, data were analysed separately for females and males. To determine the amount of differences between the sexes and among samples, a multivariate analysis of variance (MANOVA) was used.

Canonical discriminant analysis (CDA) was performed to assess inclusive inter-population variation in morphometric characters. Canonical variates were calculated and centroids of each sample population were plotted on the first two canonical axes.

All statistical analyses were performed using STATISTICA procedures (StatSoft, Inc. 1997), considering $p < 0.05$ as the level for significance.

RESULTS

Meristic and qualitative characters

Values for the five meristic characters in each sample subjected to univariate analysis were summarised in table 1. The Kruskal-Wallis test revealed a significant geographic variation in all these characters except in DV (SDG $\chi^2 = 66.90$, $df = 14$, $P < 0.001$; DV $\chi^2 = 20.14$, $df = 14$, $P = 0.13$; PO1 $\chi^2 = 71.49$, $df = 14$, $P < 0.001$; PO2 $\chi^2 = 65.90$, $df = 14$, $P < 0.001$; SLB $\chi^2 = 113.98$, $df = 14$; $P < 0.001$). However, DV was retained in the following analysis of meristic traits, due to its importance in recognising subspecies erected by previous authors (STEPANEK 1944; FUHN 1969, 1970; GRUBER 1981). The northernmost sample analysed (No. 1) exhibited the smallest mean number of SDG, PO1 and PO2, while the greatest mean numbers of these characters were found in samples from Kosovo (No. 10, 11, 12, 13) and eastern Serbia (No. 7). Northern population samples (No. 1 and 2) had the greatest mean number of SLB, while the one sample from Kosovo (No. 13) and the southernmost sample examined (No. 15) had the lowest values for this trait.

Correspondence analysis of meristic characters found 14 dimensions in the correspondence table. The χ^2 of the first three singular values accounted for 76.4 % of the total χ^2.

The most northern population samples (Nos. 1 and 2) were characterised by small numbers of PO2 and SDG, and great numbers of SLB and DV, respectively (fig. 2). Small numbers of PO1 and DV were distinctive of the samples from FYR Macedonia (Nos. 14 and 15). The samples from central and southern Serbia (Nos. 5, 8, 9) had intermediate numbers of PO1 and PO2. Other samples from Kosovo (Nos. 10, 11, 12, 13) as well as the one from eastern Serbia (No. 7) were characterised by the greatest numbers of SDG, PO1 and PO2 and small numbers of SLB. Small numbers of SLB are also characteristic for FYR Macedonian samples. Twenty scales around midbody (DVb), the most frequent trait state in all samples, were in particular concentrated around the zero value of the first two correspondence axes.

Correspondence analysis of pileus type and dorsal pattern found that χ^2 of the first three singular values accounted for 99.2 % of the total χ^2. There is an apparent discrimination of the northern population samples (Nos. 1, 2) according to the presence of PILa, PILb, DPb and DPc (fig. 3). Higher frequency of DPb induced notable distinction of samples No. 3 and 9. Prevailing of DPa and PILc grouped the remaining samples.

Bluish-gray ventral coloration (VCa) prevailed in all samples where coloration was analysed. However, blue colour (VCb) was very frequent in the sample from eastern Serbia (No. 7) (44.4 %), while reddish-orange colour (VCc) was present in the samples from southern Serbia (22.2 % and 20.0 % in Nos. 4 and 5, respectively). Reddish-orange colour was found only in adult males. Therefore, this ventral coloration was apparently correlated with reproductive activity during the mating season when sampling occurred. In the sample from FYR Macedonia (No. 15), brown colour (DCa) on the dorsal side was frequently observed (69.6 %), while in other samples dorsal coloration was predominantly olive greenish-brown (DCb) (No. 7 - 66.7 %; No. 4 - 88.9 %; No. 5 - 100.0 %).

Morphometric characters

Descriptive statistics of body size measurements of adult females and males from population samples are presented in table 2. The largest females were from sample No. 4 (Lcor, $\bar{x}$ = 49.14 mm ± 0.74), while the largest males were from sample No. 8 (Lcor, $\bar{x}$ = 43.01 mm ± 0.54). The largest adult female measured was from sample No. 14 (Lcor = 55.56 mm), the largest male from sample No. 1 (Lcor = 46.72 mm). The smallest individuals were from sample No. 13, with average snout-vent length (Lcor) of 34.31 mm ± 1.11 for females and 35.07 mm ± 1.23 for males. The smallest individuals measured were also from this sample (Lcor = 32.10 mm for females, and 32.38 mm for males, respectively).

Multivariate analysis of variance (MANOVA) showed a significant variation both between samples and sexes (Wilks' Lambda = 0.28, df_1 = 250, df_2 = 2121, P = 0.01).

Concerning body measurements, the highest intersexual differences were found for snout-vent length (Lcor) and distance between fore and hind limbs (Pap) showing significantly higher values in females in most samples (table 2). For the remaining significantly different parameters, males had higher average values than females. Head width (Ltcap) and orbit to ear distance (Doa) showed small intersexual differences, being significantly different only in two samples (Ltcap – Nos. 1 and 8; Doa – Nos. 1 and 10). Females and males from all samples did not significantly differ according to head height (Altcap).

Differences between genders were greatest in northern population samples (Nos. 1 and 2). In samples numbered 4, 5, 11, 14 and 15, intersexual differences were found only in snout-vent length (Lcor) and distance between fore and hind limbs (Pap).

The canonical discriminant analysis (CDA) of 25 morphometric characters revealed 61.66 % and 61.04 % of the total variation in females and males, respectively, expressed in the first three canonical axes. Values of standardised coefficients given in table 3 indicate that in males, the greatest proportion of the variance was expressed on the first canonical axis by differences in mouth width (Ltfo) as negative, and snout-vent length (Lcor) on the second axis as positive factor, respectively. The greatest contribution to variance on the third axis was made by differences in pileus length (Lpil) as negative factor. In females the greatest proportion of the variance on the first canonical axis was expressed by differences in mouth length (Lfo) as negative factor. The greatest contribution to variance on the second axis was made by differences in width of parietal plates (Ltpa) as positive, and pileus width (Ltpil) as negative factor, respectively. Differences in distance between fore and hind limbs (Pap), and snout-vent length (Lcor) made the greatest contribution to variance on the third axis as positive and negative factors, respectively.

Distinctions on the ground of morphometric characters were not apparent, especially in females (fig. 4). However, differentiation between northern population samples and samples from Kosovo and FYR Macedonia appeared to a certain extent in both sexes on opposite sides of the first two canonical axes.

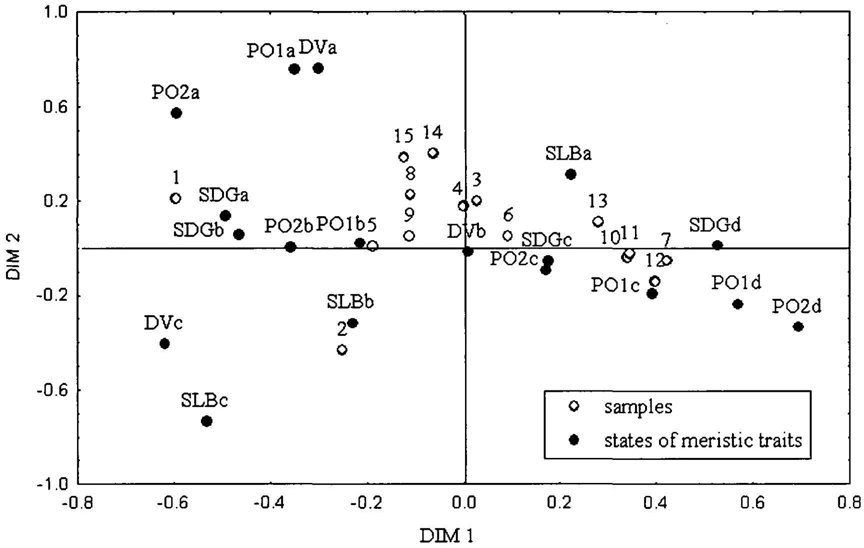

Fig. 2: Population samples (O) and states of meristic characters (●) in the plane of the first and second correspondence axes (DIM). For numbers of samples see Appendix, for abbreviations of characters see 'Materials and Methods'.

Abb. 2: Populationsstichproben (O) und Ausprägung meristischer Merkmale (●) in der Ebene der ersten und zweiten korrespondierenden Achse (DIM). Stichprobennummern siehe Appendix, Merkmale siehe 'Materials and Methods'.

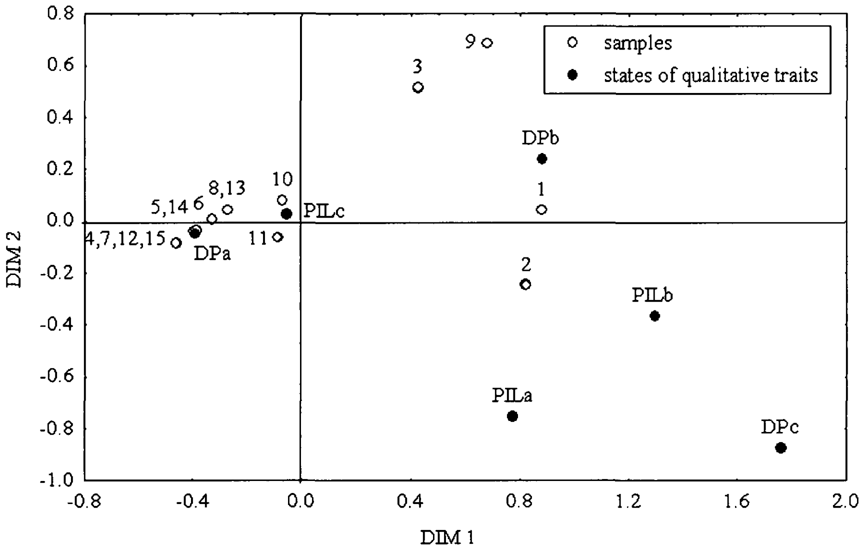

Fig. 3: Population samples (O) and states of qualitative characters (●) in the plane of the first and second correspondence axes (DIM). For numbers of samples see Appendix, for abbreviations of characters see 'Materials and Methods'.

Abb. 3: Populationsstichproben (O) und Ausprägung qualitativer Merkmale (●) *in der Ebene der ersten und zweiten korrespondierenden Achse (DIM).* Stichprobennummern siehe Appendix, Merkmale siehe 'Materials and Methods'.

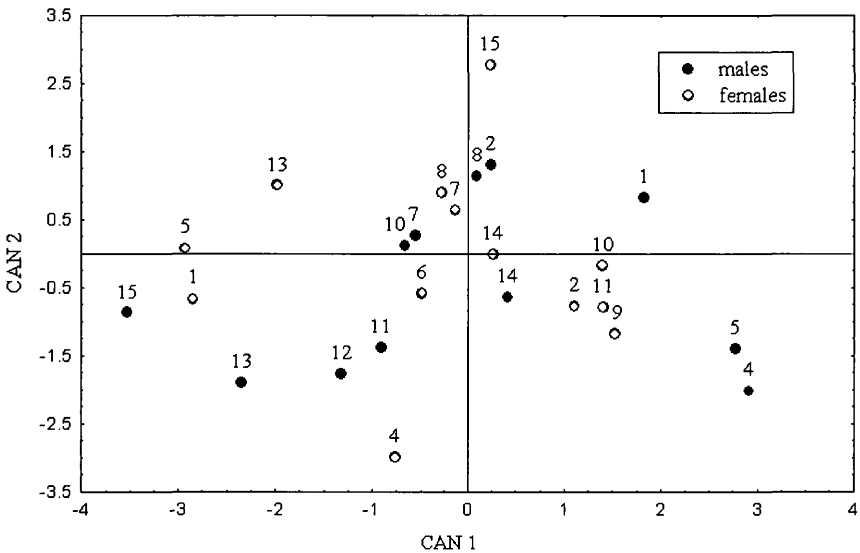

Fig. 4: Centroids of female and male *Ablepharus kitaibelii* samples studied.
CAN 1 and CAN 2 - first and second canonical axes. For numbers of samples see appendix.
Abb. 4: Zentroide der untersuchten Männchen- und Weibchen-Stichproben von *Ablepharus kitaibelii*.
CAN 1, CAN 2 - erste und zweite kanonische Achse.
Die Stichprobennummern entsprechen den Fundortzahlen im Appendix und in Abbildung 1.

DISCUSSION

Taxonomic assignment of the population samples examined was based on our results and on assumptions made by other authors (FUHN 1969, 1970; PASULJEVIC 1973; GRUBER 1981, 1997) (fig. 1): *A. k. fitzingeri* (N° 1, 2); hybrids *A. k. fitzingeri/ stepaneki* (N° 3, 4, 5, 6, 8, 9); *A. k. stepaneki* (N° 7, 10, 11, 12, 13); hybrids *A. k. stepaneki/kitaibelii* (N° 14, 15).

The northern population samples examined (N° 1, 2), to which the name *A. k. fitzingeri* has been assigned, formed a distinct group on the basis of multivariate analyses of both quantitative and qualitative characters. The males of *A. k. fitzingeri* were different from males of other "groups" by their long limbs (Lpan, Lpp), trunk (Lcor) and distance between limbs (Pap). However, the females were characterised by the low mean values of many morphometric characters (Lcor, Lcap, Ltcap, Ltfo, Lpan, Lpil, Ltpil, Doa, Pap), although they had longer hindlimbs (Lpp) than females from other "groups". These results were somewhat different from data of other authors (FUHN 1969, 1970; GRUBER 1981), probably because they did not analyse sexes separately. Numbers of supralabial scales (SLB), and scales around midbody (DV), were within the range described for this subspecies (FUHN 1969; GRUBER 1981). Pileus type C (PILc) was predominant as in all "groups" analysed. Furthermore, only in *A. k. fitzingeri* dorsal pattern of type B (DPb) prevailed over other types, while type C (DPc) which should be typical to this subspecies (FUHN 1969; GRUBER 1981) was found in a lower percentage only. Coloration was not analysed in these samples.

Males from population samples presumed as *A. k. stepaneki* had higher values for head dimensions (Ltcap, Altcap, Lcap, Ltfo, Lpil, Doa), and a very stout trunk in regard to males from other "groups". Females also had a very broad and deep had. All specimens had 20 scales around midbody, while about 78 % of individuals had 3 supralabial scales. Pattern of type A (DPa)

Table 1: Variation of 5 meristic characters in 15 samples of *Ablepharus kitaibelii*. Sample size (n), mean value ± standard error, and range are indicated. SDG - number of digital lamellae under fourth digit of hindfoot, DV - number of scales around midbody, PO1 - number of postocular scales in the first row posterior to eye, PO2 - number of postocular scales in the second row posterior to eye, SLB - number of supralabial scales anterior to subocular. The sample IDs correspond to the numbers of the localities in the Appendix and in figure 1.

Tab. 1: Variabilität 5 meristischer Merkmale in 15 Stichproben von *Ablepharus kitaibelii*. Angegeben sind Stichprobengröße (n), Mittelwert ± Standardfehler und Spannweite. SDG - Anzahl Lamellen an der Unterseite der vierten Hinterbeinzehe, DV - Anzahl Schuppenreihen um die Körpermitte, PO1 - Anzahl Postocularia in der ersten Reihe hinter dem Auge, PO2 - Anzahl Postocularia in der zweiten Reihe hinter dem Auge, SLB - Anzahl Supralabialia vor dem Suboculare. Die Nummern der Stichproben entsprechen den Fundortzahlen im Appendix und in Abb. 1.

Sample ID Stichprobe	n	SDG	DV	PO1	PO2	SLB
1	28	11.36 ± 0.11 10.00 – 12.50	20.00 ± 0.00 20.00 – 20.00	4.02 ± 0.10 3.00 – 5.00	2.38 ± 0.08 2.00 – 3.00	3.38 ± 0.08 3.00 – 4.00
2	71	11.85 ± 0.09 10.00 – 14.00	20.01 ± 0.01 20.00 – 21.00	4.51 ± 0.06 3.00 – 6.00	2.83 ± 0.04 2.00 – 3.50	3.70 ± 0.04 3.00 – 4.00
3	6	11.92 ± 0.24 11.00 – 12.50	19.83 ± 0.17 19.00 – 20.00	4.67 ± 0.21 4.00 – 5.00	2.58 ± 0.20 2.00 – 3.00	3.17 ± 0.17 3.00 – 4.00
4	11	11.82 ± 0.19 11.00 – 13.00	20.00 ± 0.00 20.00 – 20.00	4.50 ± 0.21 3.00 – 5.50	2.73 ± 0.12 2.00 – 3.00	3.09 ± 0.06 3.00 – 3.50
5	21	11.48 ± 0.15 10.00 – 12.50	19.90 ± 0.07 19.00 – 20.00	4.45 ± 0.11 3.50 – 5.50	2.88 ± 0.05 2.50 – 3.00	3.31 ± 0.09 3.00 – 4.00
6	10	11.80 ± 0.17 10.50 – 12.50	19.90 ± 0.10 19.00 – 20.00	4.75 ± 0.11 4.00 – 5.00	2.75 ± 0.13 2.00 – 3.00	3.20 ± 0.11 3.00 – 4.00
7	10	12.25 ± 0.19 11.50 – 13.00	20.00 ± 0.00 20.00 – 20.00	4.80 ± 0.13 4.00 – 5.50	3.00 ± 0.07 2.50 – 3.50	3.10 ± 0.07 3.00 – 3.50
8	21	12.07 ± 0.18 11.00 – 13.00	20.00 ± 0.14 18.00 – 22.00	4.19 ± 0.15 3.00 – 6.00	2.69 ± 0.09 2.00 – 3.00	3.24 ± 0.08 3.00 – 4.00
9	31	11.39 ± 0.09 10.50 – 12.50	19.94 ± 0.06 18.00 – 20.00	4.40 ± 0.08 4.00 – 5.50	2.90 ± 0.05 2.00 – 3.50	3.16 ± 0.06 3.00 – 4.00
10	98	12.23 ± 0.07 10.50 – 14.00	20.00 ± 0.00 20.00 – 20.00	4.69 ± 0.06 3.00 – 6.50	2.91 ± 0.03 2.00 – 4.00	3.17 ± 0.03 3.00 – 4.00
11	18	12.25 ± 0.13 11.50 – 13.50	20.00 ± 0.00 20.00 – 20.00	4.69 ± 0.12 3.50 – 5.50	2.92 ± 0.06 2.00 – 3.00	3.17 ± 0.09 3.00 – 4.00
12	5	12.20 ± 0.12 12.00 – 12.50	20.00 ± 0.00 20.00 – 20.00	4.80 ± 0.12 4.50 – 5.00	3.00 ± 0.00 3.00 –3 .00	3.20 ± 0.20 3.00 – 4.00
13	7	12.07 ± 0.30 11.00 – 13.00	20.00 ± 0.00 20.00 – 20.00	4.50 ± 0.15 4.00 – 5.00	3.00 ± 0.00 3.00 – 3.00	3.00 ± 0.00 3.00 – 3.00
14	23	11.98 ± 0.11 11.00 – 13.00	19.91 ± 0.09 18.00 – 20.00	4.04 ± 0.14 3.00 – 5.00	2.59 ± 0.10 2.00 – 3.00	3.15 ± 0.07 3.00 – 4.00
15	26	11.87 ± 0.20 9.50 – 14.00	19.85 ± 0.11 18.00 – 20.00	4.06 ± 0.09 3.00 – 5.50	2.73 ± 0.07 2.00 – 3.00	3.06 ± 0.03 3.00 – 3.50

and olive greenish-brown coloration prevailed on dorsal surface. Bluish-grey coloration predominated on ventral surface as well as in "hybrid" population samples. These results corresponded to data from other authors, and values of certain morphometric characters were approximately equal to those in Bulgarian populations of *A. k. stepaneki* (FUHN 1969; GRUBER 1981). Moreover, we found the greatest mean number of postocular and subdigital scales (PO1, PO2, SDG) in samples of *A. k. stepaneki.*

In this study, two rather broad intergradation zones became apparent.

(1) Intergradation zone between *A. k. stepaneki* and *A. k. kitaibelii*. Males from this zone were characterised by the shortness of forelimbs (Lpan), trunk (Lcor), and distance between limbs (Pap), and the rather small and narrow head, when compared to males from "groups", the data of which corresponded to *A. k. kitaibelii* (FUHN 1969; GRUBER 1981). However, females had higher values for these characters compared to females from other "groups". Samples from this zone had small mean numbers of postocular scales (PO1 and PO2). The range of 18 - 20 scales around midbody approached

Table 2 (part one): Descriptive statistics of 11 body measurements of adult female (f) and male (m) *Ablepharus kitaibelii* of the population samples studied. Sample size (n), mean value (in mm) ± standard error, *F* value and statistical significance of differences between sexes (ANOVA *P*, *df* = 1). For numbers of samples see Appendix. Abbreviations of characters are given in 'Materials and Methods'.

Tab. 2 (Teil eins): Beschreibende Statistiken der Körpermaße von adulten weiblichen (f) und männlichen (m) *Ablepharus kitaibelii* in den untersuchten Stichproben. Angegeben sind Stichprobengröße (n), Mittelwert (in mm) ± Standardfehler, *F*-Wert und die statistische Signifikanz der Unterschiede zwischen den Geschlechtern (ANOVA *P*, *df* = 1). Die Nummern der Stichproben entsprechen den Fundortzahlen im Appendix und in Abb. 1. Die Abkürzungen der Merkmale sind in 'Materials and Methods' angegeben.

Sample ID / Stichprobe	1	1	ANOVA		2	2	ANOVA		4	4	ANOVA		5	5	ANOVA	
	f (n = 20)	m (n = 8)	*F*	*P*	f (n = 17)	m (n = 28)	*F*	*P*	f (n = 3)	m (n = 6)	*F*	*P*	f (n = 11)	m (n = 9)	*F*	*P*
Character /Merkmal																
Lcor	42.77±0.64	41.58±1.15	0.91	.3483	44.36±0.66	40.67±0.45	22.70	.0000	49.14±0.74	39.30±1.87	12.49	.0095	45.41±1.34	38.27±1.33	13.90	.0015
Lcap	6.49±0.06	6.86±0.09	10.48	.0032	6.41±0.07	6.66±0.06	7.12	.0106	7.17±0.08	6.66±0.30	1.34	.2853	6.65±0.12	6.68±0.14	0.03	.8645
Altcap	3.10±0.07	3.24±0.07	1.43	.2429	3.42±0.13	3.34±0.06	0.33	.5670	3.10±0.08	2.93±0.13	0.76	.4125	2.89±0.06	2.89±0.09	0.00	.9710
Ltcap	4.00±0.04	4.40±0.11	16.13	.0004	4.33±0.06	4.43±0.06	1.11	.2975	4.80±0.18	4.31±0.18	3.11	.1213	4.31±0.09	4.15±0.10	1.35	.2601
Lfo	4.07±0.06	4.24±0.10	2.06	.1626	3.88±0.04	4.03±0.05	4.66	.0364	4.42±0.19	4.17±0.15	0.99	.3531	4.35±0.09	4.33±0.07	0.05	.8295
Ltfo	3.34±0.06	3.61±0.12	4.71	.0392	3.79±0.06	3.78±0.06	0.01	.9265	3.81±0.15	3.48±0.14	2.11	.1897	3.56±0.08	3.46±0.10	0.50	.4532
Lpan	6.59±0.06	7.10±0.17	13.85	.0009	6.83±0.06	7.23±0.07	16.08	.0002	7.40±0.23	7.10±0.31	0.40	.5457	6.74±0.14	7.03±0.16	1.88	.1874
Lpp	10.29±0.12	10.84±0.08	8.21	.0081	9.90±0.11	10.65±0.11	20.89	.0000	10.73±0.20	9.92±0.42	1.67	.2376	9.68±0.19	10.05±0.21	1.77	.1994
Ldq	3.36±0.03	3.61±0.04	26.67	.0000	3.43±0.05	3.61±0.04	8.40	.0058	3.43±0.09	3.33±0.11	0.31	.5933	3.31±0.06	3.40±0.09	0.80	.3839
Doa	2.59±0.03	2.79±0.03	16.07	.0004	2.62±0.02	2.66±0.02	1.04	.3128	2.80±0.08	2.75±0.10	0.11	.7456	2.66±0.04	2.71±0.09	0.23	.6341
Pap	26.67±0.57	24.37±0.81	4.90	.0358	28.64±0.60	24.47±0.37	39.00	.0000	33.25±1.30	23.59±1.13	26.99	.0012	29.85±1.19	22.45±0.86	23.52	.0001

Sample ID / Stichprobe	7	7	ANOVA		8	8	ANOVA		10	10	ANOVA		11	11	ANOVA	
	f (n = 5)	m (n = 4)	*F*	*P*	f (n = 12)	m (n = 9)	*F*	*P*	f (n = 42)	m (n = 35)	*F*	*P*	f (n = 9)	m (n = 6)	*F*	*P*
Character / Merkmal																
Lcor	41.48±3.50	42.25±0.63	0.04	.8521	44.06±1.23	43.01±0.54	0.49	.4913	46.28±0.52	41.73±0.35	48.08	.0000	45.20±0.81	38.67±1.06	24.66	.0002
Lcap	6.21±0.27	7.00±0.10	5.94	.0448	6.69±0.09	6.97±0.10	4.36	.0504	6.79±0.04	6.87±0.04	1.79	.1855	6.77±0.11	6.64±0.15	0.50	.4904
Altcap	3.15±0.16	3.55±0.06	4.49	.0722	3.19±0.07	3.34±0.05	2.21	.1538	3.48±0.04	3.50±0.04	0.09	.7632	3.51±0.07	3.33±0.09	2.73	.1225
Ltcap	4.27±0.23	4.88±0.05	5.31	.0545	4.26±0.06	4.56±0.05	14.73	.0011	4.51±0.04	4.57±0.05	0.77	.3826	4.41±0.08	4.26±0.09	1.59	.2296
Lfo	3.82±0.14	4.19±0.13	3.72	.0951	3.96±0.11	4.29±0.06	5.77	.0267	4.00±0.04	4.14±0.03	7.58	.0073	4.04±0.06	3.89±0.09	1.86	.1960
Ltfo	3.68±0.18	4.15±0.06	4.87	.0630	3.72±0.08	4.00±0.07	6.36	.0207	3.92±0.04	3.92±0.04	0.01	.9089	3.81±0.06	3.65±0.06	3.21	.0963
Lpan	6.55±0.25	7.37±0.24	5.37	.0535	6.61±0.09	7.08±0.04	18.17	.0004	6.94±0.05	7.18±0.06	9.26	.0032	7.02±0.12	7.07±0.17	0.06	.8123
Lpp	9.32±0.43	10.78±0.20	8.07	.0250	9.79±0.12	10.50±0.15	13.79	.0014	9.85±0.08	10.37±0.08	19.21	.0000	9.83±0.14	9.94±0.10	0.37	.5522
Ldq	3.24±0.11	3.68±0.12	7.19	.0314	3.40±0.04	3.64±0.06	10.11	.0049	3.44±0.03	3.61±0.03	14.60	.0002	3.48±0.03	3.49±0.07	0.01	.9153
Doa	2.46±0.13	2.76±0.07	3.61	.0990	2.63±0.05	2.73±0.02	3.10	.0945	2.68±0.02	2.74±0.02	5.69	.0195	2.67±0.04	2.70±0.07	0.23	.6398
Pap	26.69±3.23	24.69±0.39	0.29	.6037	27.51±0.97	25.42±0.31	3.28	.0861	29.88±0.43	24.72±0.27	94.42	.0000	28.93±0.67	22.48±0.67	42.55	.0000

Table 2 (part two): Descriptive statistics of 11 body measurements of adult female (f) and male (m) *Ablepharus kitaibelii* of the population samples studied. Sample size (n), mean value (in mm) ± standard error, *F* value and statistical significance of differences between sexes (ANOVA *P*, *df* = 1). For numbers of samples see Appendix. Abbreviations of characters are given in 'Materials and Methods'.

Tab. 2 (Teil zwei): Beschreibende Statistiken der Körpermaße von adulten weiblichen (f) und männlichen (m) *Ablepharus kitaibelii* in den untersuchten Stichproben. Angegeben sind Stichprobengröße (n), Mittelwert (in mm) ± Standardfehler, *F*-Wert und die statistische Signifikanz der Unterschiede zwischen den Geschlechtern (ANOVA *P*, *df* = 1). Die Nummern der Stichproben entsprechen den Fundortzahlen im Appendix und in Abb. 1. Die Abkürzungen der Merkmale sind in 'Materials and Methods' angegeben.

Sample ID / Stichprobe	13	13	ANOVA		14	14	ANOVA	
	f (n = 3)	m (n = 4)	*F*	*P*	f (n = 7)	m (n = 10)	*F*	*P*
Character / Merkmal								
Lcor	34.31±1.11	35.07±1.23	0.19	.6768	48.18±1.39	39.53±1.30	19.94	.0000
Lcap	5.75±0.13	6.15±0.12	5.17	.0720	7.04±0.13	6.82±0.12	1.53	.2348
Altcap	3.03±0.15	3.37±0.10	3.97	.1029	3.41±0.06	3.20±0.09	3.20	.0938
Ltcap	3.82±0.15	4.23±0.09	6.18	.0554	4.47±0.09	4.27±0.09	2.65	.1242
Lfo	3.47±0.03	3.78±0.17	2.40	.1818	4.29±0.14	4.15±0.12	0.65	.4329
Ltfo	3.20±0.16	3.70±0.08	9.19	.0290	3.93±0.07	3.68±0.11	3.42	.0841
Lpan	5.73±0.42	6.53±0.14	4.27	.0935	7.11±0.10	7.03±0.14	0.21	.6541
Lpp	8.81±0.34	9.42±0.27	2.06	.2107	10.34±0.15	10.37±0.25	0.01	.9290
Ldq	3.17±0.08	3.25±0.06	0.65	.4569	3.64±0.06	3.63±0.10	0.00	.9800
Doa	2.40±0.05	2.59±0.09	2.79	.1559	2.74±0.03	2.65±0.05	1.56	.2299
Pap	20.82±0.98	20.88±0.92	0.00	.9690	31.09±1.21	22.65±0.93	31.41	.0000

Sample ID / Stichprobe	15	15	ANOVA		6	9	12
	f (n = 16)	m (n = 7)	*F*	*P*	f (n = 8)	f (n = 6)	m (n = 3)
Character / Merkmal							
Lcor	44.78±0.76	38.13±1.05	24.55	.0000	44.83±1.58	46.70±1.68	39.39±1.29
Lcap	6.51±0.07	6.55±0.12	0.10	.7519	6.93±0.11	6.72±0.11	7.03±0.17
Altcap	3.42±0.06	3.49±0.13	0.34	.5633	3.21±0.08	3.35±0.10	3.32±0.08
Ltcap	4.25±0.07	4.35±0.12	0.54	.4684	4.17±0.08	4.47±0.07	4.62±0.14
Lfo	3.77±0.05	3.70±0.08	0.49	.4903	3.96±0.10	3.87±0.14	4.08±0.13
Ltfo	3.81±0.07	3.85±0.10	0.12	.7313	3.68±0.08	3.72±0.07	4.09±0.01
Lpan	6.87±0.09	6.89±0.19	0.01	.9098	6.90±0.08	7.18±0.10	6.91±0.16
Lpp	9.86±0.10	10.15±0.25	1.78	.1966	10.23±0.19	10.08±0.19	9.95±0.23
Ldq	3.34±0.04	3.48±0.08	3.08	.0937	3.37±0.07	3.50±0.09	3.44±0.03
Doa	2.55±0.03	2.64±0.07	2.03	.1683	2.82±0.05	2.68±0.04	2.83±0.06
Pap	28.56±0.60	22.25±0.69	38.31	.0000	28.09±1.27	29.28±0.99	23.13±1.02

these population samples to *A. k. kitaibelii*, while the percentage of specimens with 3 supralabial scales (about 78 %) placed them close to *A. k. stepaneki*. It should be pointed out, that the authors mentioned above called the state of 3 supralabials diagnostic for both subspecies. Moreover, dominant dorsal pattern of type A, approached these population samples to *A. k. stepaneki*, while brown dorsal coloration (about 70 %) corresponded to the diagnosis for *A. k. kitaibelii*.

(2) Intergradation zone between *A. k. fitzingeri* and *A. k. stepaneki*. These hybrid population samples were characterised by the great length and small width as well as height dimensions of the head, in both sexes. Males were very small, with shorter hindlimbs (Lpp) compared to males from other "groups". The females had long trunks (Lcor) and hindlimbs (Lpp) like females of *A. k. stepaneki*. Samples from this zone were characterised by the great range (18 - 22) of scales around midbody, and the intermediate numbers of postocular and subdigital scales (PO1, PO2, SDG). Mean number of supralabial scales (3.20 ± 0.04) placed these samples between *A. k. fitzingeri* and *A. k. stepaneki*. Dominant dorsal pattern of type A (about 83 %), made them appear close to *A. k. stepaneki*. Olive greenish-brown dorsal coloration (about 97 %) corresponded to the diagnoses of both *A. k. fitzingeri* and *A. k. stepaneki* (FUHN 1969; GRUBER 1981).

The recombination of diagnostic character states of presumed parental forms in individual putative hybrids is convincing

Table 3: Standardised coefficients of variation of 25 morphometric characters studied in male and female *Ablepharus kitaibelii* population samples. Coefficients of the first three canonical axes (CAN–1 – CAN–3) are indicated. For the abbreviations of characters see 'Materials and Methods'.

Tab. 3: Standardisierte Variationskoeffizienten von 25 morphometrischen Merkmalen bei den untersuchten männlichen und weiblichen *Ablepharus kitaibelii*. Die Koeffizienten der ersten drei kanonischen Achsen (CAN–1 bis CAN–3) sind angegeben. Die Abkürzungen der Merkmale sind in 'Materials and Methods' erklärt.

Sample / Stichprobe	Males / Männchen (n = 129)			Females / Weibchen (n = 159)		
	CAN–1	CAN–2	CAN–3	CAN–1	CAN–2	CAN–3
Character / Merkmal						
Lcor	0.255	1.026	–0.571	–0.060	0.719	–1.108
Lcap	–0.064	–0.520	0.504	0.049	0.189	–0.794
Altcap	–0.655	–0.134	0.038	0.101	0.137	0.053
Ltcap	0.783	–0.077	0.575	0.233	–0.730	0.784
Lfo	0.968	–0.121	–0.060	–1.039	–0.047	0.367
Ltfo	–1.040	0.274	–0.443	0.709	0.813	–0.139
Lpan	0.190	–0.349	0.757	0.493	–0.199	–0.040
Lpp	0.414	0.769	–0.693	–0.716	0.004	–0.309
Ldq	–0.415	0.195	0.199	0.389	0.085	0.190
Lpil	–0.037	–0.256	–1.036	–0.234	0.266	–0.084
Ltpil	–0.275	–0.795	–0.229	0.614	–1.442	0.235
Lin	–0.468	0.174	–0.446	–0.007	0.322	–0.339
Ltin	0.437	0.190	0.736	0.218	–0.219	0.205
Lfr	–0.074	–0.528	0.380	0.350	–0.512	–0.022
Ltfr	–0.416	0.119	–0.641	–0.161	0.574	0.060
Lfp	–0.167	–0.474	–0.246	0.106	–0.072	–0.104
Ltfp	–0.070	0.039	0.417	0.080	0.123	–0.159
Lip	0.360	0.545	–0.019	0.183	0.048	–0.323
Ltip	0.275	0.025	–0.001	–0.003	–0.021	0.253
Lpa	0.025	–0.080	–0.770	0.219	–0.320	0.106
Ltpa	–0.369	0.690	0.755	–0.768	1.704	–0.520
Ltr	0.119	0.431	–0.276	0.335	–0.365	–0.194
Ln	–0.035	0.187	0.446	0.264	–0.481	0.044
Doa	0.007	–0.562	0.101	–0.274	–0.664	–0.341
Pap	0.140	–0.114	0.874	–0.183	–0.349	1.697
Eigenvalue	2.443	1.304	0.972	2.798	1.383	1.162
Variance explained (%) Erklärte Varianz (%)	31.60	48.47	61.04	32.23	48.26	61.66

evidence of hybridisation. Additional evidence involves the coincidence of phenotypic intermediacy and increased variability in samples of putative hybrids (TAYLOR 1990 and references therein). All these phenomena were present in samples from central Serbia, indicating the existence of at least one intergradation zone (between *A. k. fitzingeri* and *A. k. stepaneki*) in the study area.

However, variability was not increased in some morphological characters of the samples of the presumed *A. k. stepaneki* - *A. k. kitaibelii* contact zone. These samples were close to *A. k. stepaneki* only in two qualitative characters – pileus type (character of low variability), and dorsal pattern. In all other characters examined, these FYR Macedonian population samples were clearly differentiated from the other ones. On the basis of this fact they could be referred to *A. k. kitaibelii*.

Some authors argued that the primary patterns of geographic variation in scalation were strongly correlated with geographic altitude and latitude and with the concomitant climatic variation (THORPE & BAEZ 1987 and references therein). Nevertheless, there were also suggestions that scalation characters could be influenced by both environmental and genetic sources. Unlike the body proportions, the scalation is fixed from an early stage and is not subject to later environmental conditions (THORPE & BAEZ 1987). A cline may be established for several reasons. Among these are interbreeding between formerly isolated populations, and geographic variation in selection pressures that affect the character (FUTUYMA 1986).

The upper limit of the vertical distribution of the Snake-eyed Skink increases from north to south (200 - 600 - 800 m) (PASULJEVIC 1965, 1976) following specific climatic, edaphic, and biotic factors.

The population samples studied indicated clinal distribution of some meristic characters. While the number of supralabials showed a completely clinal distribution with gradual reduction in sample mean from north to south, the number of postoculars revealed a distribution of the "step cline" type with abrupt decrease in FYR Macedonian samples. In the latter case, variation also could be "categorical" (THORPE 1987). Furthermore, we did not find clinal variation in morphometric characters.

Skinks are animals living in "worlds" dominated by olfactory or other chemical cues. In these cases, it is probable that no particularly relevant morphological changes take place during the processes of microtaxonomic differentiation. Thus, general morphology may remain almost unchanged for millions of years (CAPUTO et al. 1993).

The populations studied were located at the north-western limit of the species' range. Many authors discussed the role and potential of peripheral populations in the process of allopatric (geographic) speciation (MAYR 1963; WILEY 1981; FUTUYMA 1986). They argued that many peripheral demes were preconditioned for differentiation, and therefore pre-existing differences would be consolidated more rapidly, and would be fixed in a shorter period of time. This could be one possible explanation for the morphological variability detected in the *Ablepharus* populations analysed.

For various species, the Balkans represented refugia for the inter- and post-glacial re-colonisation of Central and North Europe (HEWITT 1999). Through the climatic cycles of the Pleistocene, the Balkans' variety in topography, climate and habitat must have provided a multitude of suited habitats for the Snake-eyed Skink and, consequently, harboured various small, isolated, more or less 'in situ' refugial populations of this lizard. Probably during the interglacials and post-glacial periods, *A. kitaibelii* expanded its range farther north, where it exclusively occupied habitats characterised by a very specific combination of ecological factors.

GRUBER (1981) and PASULJEVIC (1976) pointed to the differences in the habitats of various *A. kitaibelii* subspecies. We found that *A. k fitzingeri* is associated with the biomes of steppes and woodland steppes where it inhabits places of transitional (ecotone) character with Common and Sessile oak, towards the biomes of south European mostly broad-leaved woodlands (JOVANOVIC et al. 1986; MATVEJEV & PUNCER 1989). Other populations studied were found in the biomes of Submediterranean broad-leaved woodlands and shrubs. Interestingly, populations from the *A. fitzingeri/stepaneki* intergradation zone were usually found in somewhat different plant communities compared to populations recognised as *A. k. stepaneki*. While the former occupied habitats in which vicarious landscapes of south European mostly broad-leaved woodlands (Hungarian oak, Turkey oak) predominated, the latter ones mainly preferred somewhat drier habitats (ecotones of steppic biomes) with Common oak and Tattarian maple. Macedonian populations were found in forests of Pubescent oak and Eastern hornbeam.

These differences in coeno-ecological features of populations examined can support the morphological criteria and provide additional evidence for intraspecific differentiation of the Snake-eyed Skink.

However, further biochemical and molecular genetic approaches are desired to verify these taxonomic conclusions, as well as to test our above-mentioned hypothesis of the historical biogeography of this species.

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APPENDIX

Localities of population samples, including altitude, UTM code (10 km x 10 km), and sample size (given as numbers of female adults + subadults, and male adults + subadults, respectively).

Die Fundstellen der Stichproben einschließlich Seehöhe, UTM-Raster (10 km x 10 km) und Stichprobengröße (angegeben als Anzahl adulter + subadulter Weibchen sowie adulter + subadulter Männchen).

1 Testera - Fruska Gora (Vojvodina, Serbia, 140 m above sea level, CR 90, 20 adult + 0 subadult females, 8 adult + 0 subadult males);

2 Kosutnjak - Beograd (Serbia, 190 m, DQ 55, 17 + 8, 28 + 18);

3 Vrnjacka Banja (Serbia, 320 m, DP 93, 1+2, 2+1);

4 Rudare - Kursumlija (Serbia, 450 m, EN 26, 3 + 1, 6 + 1);
5 Vica - Prokuplje (Serbia, 420 m, EN 38, 11 + 1, 9 + 0);
6 Mosna - Donji Milanovac (Serbia, 200 m, EQ 92, 8 + 0, 2 + 0);
7 Velesnica (Serbia, 130 m, FQ 23, 5 + 1, 4 + 0);
8 Barudzija - Sokobanja (Serbia, 300 m, EP 63/EP 73, 12 + 0, 9 + 0);
9 Velika reka - Podujevo (Kosovo, Serbia, 640 m, EN 15, 6 + 9, 1 + 15);
10 Grmija (Kosovo, Serbia, 700 m, EN 12, 42 + 8, 35 + 13);
11 Pristina (Kosovo, Serbia, 660 m, EN 21, 9 + 0, 6 + 3);
12 Kisnica (Kosovo, Serbia, 650 m, EN 11, 2 + 0, 3 + 0);
13 Pec (Kosovo, Serbia, 715 m, DN 42, 3 + 0, 4 + 0);
14 Papradiste - Bogomila (FYR Macedonia, 850 m, EM 30, 7 + 3, 10 + 3);
15 Pesternica - Konecka planina (FYR Macedonia, 435 m, FM 00, 16 +2, 7 +1).

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