

Rediscovered and critically endangered: *Vipera anatolica* EISELT & BARAN, 1970, of the western Taurus Mountains (Turkey), with remarks on its ecology (Squamata: Serpentes: Viperidae)

Wiederentdeckt und stark gefährdet: *Vipera anatolica* EISELT & BARAN, 1970
aus dem westlichen Taurus-Gebirge (Türkei), mit Angaben zur Ökologie dieser Art
(Squamata: Serpentes: Viperidae)

OLEKSANDR ZINENKO & AZIZ AVCI & FRIEDERIKE SPITZENBERGER
& ANDRIY TUPIKOV & KONSTANTIN SHIRYAEV & EMIN BOZKURT
& ÇETIN ILGAZ & NIKOLAUS STÜMPEL

KURZFASSUNG

Das Vorkommen von *Vipera anatolica* EISELT & BARAN, 1970 im Gebiet der *terra typica* (dem Zedernwald-reservat "Çiğlıkara Ormanı" im westlichen Taurus-Gebirge, Südtürkei) wurde 29 Jahre nach der letzten Feststellung bestätigt. An drei, nur zwei Kilometer voneinander entfernten Orten wurden 19 Individuen gefunden. Alle Fundplätze befanden sich in Karstdolinen oberhalb der Baumgrenze zwischen 1840 - 1950 m Seehöhe. Beobachtungen aktiver Schlangen erfolgten bei Tag zu Anfang Mai, Mitte Juli und in der zweiten Septemberhälfte. Weibchen mit Körperlängen von 242-360 mm waren bereits geschlechtsreif; die Trächtigkeit kann sich mindestens bis in die Septembermitte erstrecken. Das gleichzeitige Vorkommen trächtiger und nicht trächtiger Weibchen im Sommer scheint darauf hinzuweisen, daß Weibchen sich nicht jedes Jahr fortpflanzen. Außerhalb der *terra typica* wurden zwei potentiell geeignete Berge in der Umgebung untersucht. Neue Vorkommen wurden jedoch nicht gefunden. Überweidung dürfte der wesentlichste Gefährdungsfaktor für diese nur aus dem Gebiet der *terra typica* bekannte Art sein, da alle Fundplätze in gering beweideten Gebieten lagen.

ABSTRACT

The occurrence of *Vipera anatolica* EISELT & BARAN, 1970, in the territory of the type locality (cedar forest reserve "Çiğlıkara Ormanı" in the western Taurus Mountains of southern Turkey) was confirmed 29 years after the last observation. Nineteen specimens were found in three localities, situated two kilometers from each other, and located in karst dolines above the tree line between 1,840 and 1,950 m a. s. l. Active snakes were observed during daytime in the beginning of May, mid July and the second half of September. *Vipera anatolica* is characterized by small maturation size in females (242-360 mm); gravid females were found until the middle of September. The simultaneous presence of pregnant and non-pregnant females in summer indicates that females may not give birth each year. Two neighboring mountain massifs within the altitudinal range of *V. anatolica* were visited, but additional populations were not found. Overgrazing seems to be the main threat to the species since the record localities were associated with low grazing activity and contrasted with potentially suitable habitats where high grazing pressure was present.

KEY WORDS

Reptilia: Squamata: Serpentes: Viperidae; *Vipera anatolica*, distribution, ecology, conservation; Kohu Dağ, "Çiğlıkara Ormanı", Elmalı, Antalya, western Taurus Mountains, Turkey

INTRODUCTION

Vipera anatolica EISELT & BARAN, 1970, is the rarest and least known species of small vipers of the subgenus *Pelias* MERMER, 1820, with only five specimens described in the scientific literature (EISELT &

BARAN 1970; BILLING 1985; SIGG 1987; NILSON & ANDRÉN 2001), all found in one locality, the Kohu Dağ Massif in the western Taurus Mountains south of Elmalı, Antalya, southwest Turkey. It is also listed in the

IUCN Red List of Threatened Species as Critically Endangered (TOK et al. 2009). The species represents an old evolutionary lineage that split off from the stem of the *Vipera ursinii* (BONAPARTE, 1835), *V. renardi* (CHRISTOPH, 1861) and the *V. kaznakovi* NIKOLSKY, 1909 complexes (KALYABINA-HAUF et al. 2004; STÜMPEL 2012; ZINENKO et al. 2015). It is the relict representative of the subgenus *Pelias* in southwest Turkey, isolated from other species of the group by several hundred kilometers. It is similar in external morphology to *V. ursinii* and was initially described as *V. u. anatolica* and later treated as a member of the *V. ursinii* complex (NILSON & ANDRÉN 2001). In spite of the big interest in this species, the precise description of the area in which the type

specimens were collected (SPITZENBERGER in EISELT & BARAN 1970) and of localities in which the species was observed (BILLING 1985; SIGG 1987) as well as several attempts to find it (NILSON, ANDRÉN & FLÄRDH 1988; NILSON & ANDRÉN 2001; MARIO SCHWEIGER, pers. comm.), it was not found for almost three decades until its recent rediscovery in 2014 (GÖÇMEN et al. 2014; ZINENKO et al. 2014). The aim of the present research was to confirm the presence of *V. anatolica* in the area of the type locality, search for additional populations in potential habitats within the altitudinal range of *V. anatolica* and collect primary information about the ecology of this species, necessary for evaluating its current status and further development of conservation measures.

MATERIALS AND METHODS

Field work was conducted during four periods (3-10 May, 11-17 July and 13-19 September, 2013 and 14-20 September, 2014) in the territory of the type locality of *V. anatolica*, the cedar forest reserve "Çiğlıkara Ormanı" and adjacent parts of the Kohu Dağ Massif, as well as in adjacent Alaça Dağ and Bey Dağ Massifs (Fig. 1) in the western Taurus Mountains, south of Elmali, Antalya, Turkey. In July, special attention was paid to those places where the first specimen was observed during the fieldwork of one of the authors (FS) in 1969. In total, an area of approximately 420 hectares was surveyed there, consisting of mountain grasslands grazed by sheep and goats during the summer months, and near natural grassland near the upper tree line within the protected area of the forest reserve.

The authors searched for active snakes on the surface, under stones and among vegetation during daytime (searches were conducted between 07:00 and 20:00 h), in dif-

ferent habitats at altitudes between 1,550 and 2,220 m a. s. l. Time and circumstances of 19 snake observations were recorded, including search effort (amount of fieldwork in person-hours), sex, age, reproductive and physiological status of the observed specimens. Presence or absence and amount of developing embryos and food objects in the stomachs were checked by palpation. Grazing load was estimated indirectly by the level of vegetation degradation and proportion of poisonous (*Daphne* sp. and *Euphorbia* sp.) and spiny shrubs (*Astragalus* sp., *Acantholimon* sp. and *Berberis* sp.) versus grasses. The area was considered highly grazed if poisonous and spiny vegetation, and a large surface proportion of bare soil prevailed. Air temperatures in the shade were measured at 0.1 m above the ground.

Neither pictures nor coordinates of the localities are provided here due to conservation reasons.

(*) – 6.9 (nine karst dolines within an area of 420 ha on the Kohu Dağ); 7.64 (seven karst dolines within an area of 337 ha on the Bey Dağ); 0.07 (one karst doline within an area of 190 ha on the Alaça Dağ).

(*) – 6.9 (neun Karst-Dolinen innerhalb eines Areals von 420 ha auf dem Kohu Dağ); 7.64 (sieben Karst-Dolinen innerhalb eines Areals von 337 ha auf dem Bey Dağ); 0.07 (eine Karst-Doline innerhalb eines Areals von 190 ha auf dem Alaça Dağ).

Table 1: Characteristics of the localities of *Vipera anatolica* EISELT & BARAN, 1970, relative to those of the total studied area in Kohu-Dağ, "Çığlıkara Ormanı", Alaça Dağ and Bey Dağ, Elmali, Antalya, Turkey. (*) - See footnote on the opposite page.

Tab. 1: Merkmale der Fundorte von *Vipera anatolica* EISELT & BARAN, 1970 im Vergleich zu den Verhältnissen im gesamten Untersuchungsraum des Kohu-Dağ, des Zedernreservates "Çığlıkara Ormanı", Alaça Dağ und Bey Dağ, Elmali, Antalya, Türkei. (*) - Siehe Fußnote auf der gegenüberliegenden Seite.

	Locality 1 / Fundort 1	Locality 2 / Fundort 2	Locality 3 / Fundort 3	Other localities in the region / andere Stellen im Gebiet
Dates of observations / Beobachtungsdaten	May 8-9, 2013	July 14-16, September 13-18, 2013; September 18-19, 2014	July 13, 2013	May 3-10, July 11-17, 2013 September 14-20, 2014
Type of landscape / Landschaftstyp	Karst doline	Karst doline	South facing slope of internal ridge inside massif / Südhang innerhalb des Gebirgsstockes	Flat bottoms of karst dolines surrounded by forest; open areas, slopes and karst dolines above tree line; boulders and stony areas; forest edges, clearings inside forest / die flachen Böden der Karstdolinen sind von Wald umgeben; offene Landschaften, Hänge und Dolinen liegen oberhalb der Baumgrenze; in den Wäldern felsig-steinerne Stellen und Lichtungen
Altitude, m a.s.l. / Seehöhe m ü. M.	1,844-1,900	1,935-1,952	1,927	1,550-2,000 (Kohu Dağ); 1,885-2,220 (Bey Dağ); 2,059 (Alaça Dağ)
Area (ha) / Gebietsgröße (ha)	0.7	1.1	Not estimated / keine Angabe	(*)
Type of vegetation / Vegetationstyp	Grass, <i>Berberis</i> bushes, cedar forest at one side of locality / Gras, <i>Berberis</i> -Büsche, Zedernwald an einer Fundortseite	Grass, cushions of spiny <i>Astragalus</i> and <i>Acantholimon</i> , cedar forest at one side / Gras, polsterförmige <i>Astragalus</i> und <i>Acantholimon</i> , Zedernwald an einer Seite	Cushions of spiny <i>Astragalus</i> and <i>Acantholimon</i> , poisonous <i>Daphne</i> sp. and <i>Euphorbia</i> species / polsterförmige <i>Astragalus</i> und <i>Acantholimon</i> , giftige Pflanzenarten (<i>Daphne</i> sp. und <i>Euphorbia</i>)	Cedar and <i>Juniperus</i> forest, grasslands, spiny cushions of vegetation with substantial amount of poisonous <i>Daphne</i> sp. and <i>Euphorbia</i> species / Zedern- und <i>Juniperus</i> -Wald, stachelige, polsterbildende Vegetation mit beträchtlichem Anteil an giftigen Arten (<i>Daphne</i> sp. und <i>Euphorbia</i>)
Number of snakes observed - (search effort in person-hours) / Anzahl beobachteter Schlangen - (Suchaufwand in Personenumstunden)	5 (15)	July: 6 (11) September 2013: 4 (not measured) / September 2013: 4 (nicht erfasst) September 2014: 3 (6)	1 (2.87)	Kohu Dağ - May: 0 (96.5), July: 0 (6) Bey Dağ - September: 0 (10) Alaça Dağ - September: 0 (2)
Grazing / Beweidung	Low, occasionally / Schwach, gelegentlich	Low / Schwach	High / Stark	Usually low or absent in forest localities, high in open grasslands / in Waldgebieten meist schwach oder fehlend, im offenen Grasland stark
Other human activity / andere anthropogene Aktivitäten	Picnic place, apiary, road stöcke, Straßen	High density and diversity of Orthoptera species / arten- und individuenreiche Orthopterenfauna	Few tens of meters from the karst, doline with low grazing and dense grass / wenige Dutzend Meter von der Karstdoline bei schwacher Beweidung und dichtem Grasbestand	—
Notes / Anmerkungen	Many rodents burrows / Zahlreiche Nagerbaue	—	—	—

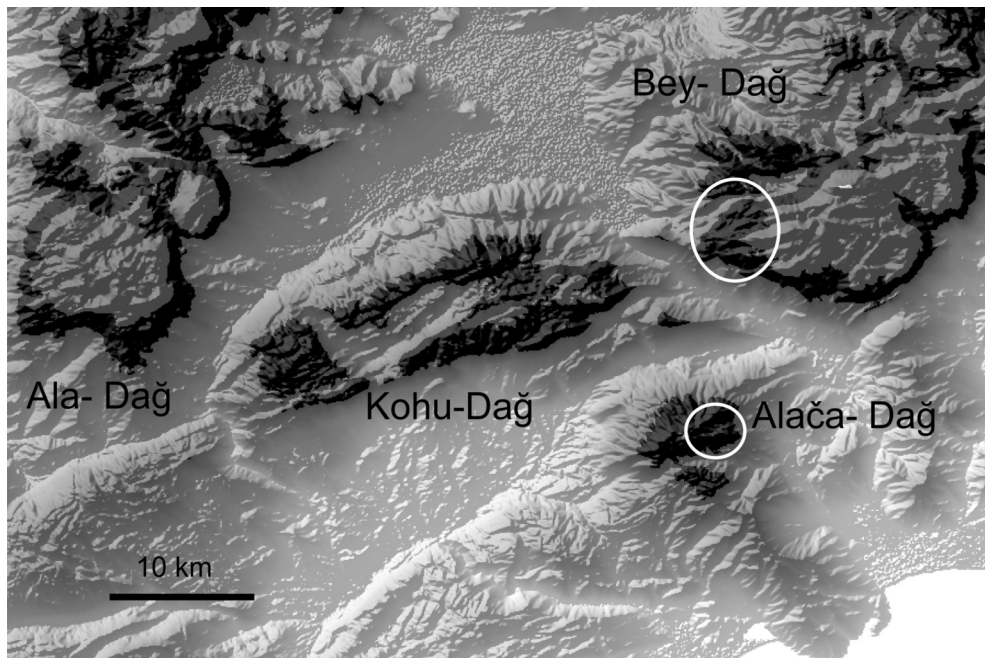


Fig. 1: Zones at altitudes between 1,840 and 2,265 m a. s. l. in the western Taurus Mountains (Elmalı, Antalya, Turkey), potentially habitable for *Vipera anatolica* EISELT & BARAN, 1970. The authors searched for the viper in the encircled areas east of the type locality (Kohu Dağ). The habitable area between 1,840 and 2,265 m is shown by black.

Abb. 1: Die Höhenzone zwischen 1840 und 2265 m ü. M. im westliches Taurus-Gebirge (Elmalı, Antalya, Türkei), potentieller Lebensraum von *Vipera anatolica* EISELT & BARAN, 1970. Umrandet sind die östlich der Typuslokalität (Kohu Dağ) gelegenen Untersuchungsgebiete der Autoren. Die ökologisch präferierte Zone zwischen 1840 und 2265 m ü NN ist schwarz dargestellt.

RESULTS AND DISCUSSION

Habitat. - *Vipera anatolica* individuals were found in three localities situated at a distance of about two km from each other in the Kohu Dağ Massif only. Their characteristics, along with those of areas where snakes were not found, are given in Table 1. All the observations were made either on the bottom, on slopes or in close vicinity of karst dolines, surrounded by drier hills, separating populations in the dolines from one another. The maximum distance between animals observed within localities did not exceed 60 meters (locality 1) and 130 meters (locality 2), respectively.

The three new localities match the earlier descriptions by EISELT & BARAN (1970),

BILLING (1985) and SIGG (1987), except that they are at higher altitudes and always associated with open mountain grasslands (Table 1). GÖÇMEN et al. (2014) gave a very similar description of the habitats but raised the upper border of the vertical distribution to 2,265 m a.s.l. In addition to the sympatric reptiles and amphibians mentioned by SIGG (1987) and GÖÇMEN et al. (2014), *Montivipera xanthina* (GRAY, 1849) was observed just a few tens of meters away from the first *V. anatolica* locality, at the same elevation but on drier stony slopes.

Seasonal and diurnal activity. - The observations of the snakes covered the period between May 8 and Sep-



Fig. 2: Dorsal view of an adult female (a) and an adult male (b) specimen of *Vipera anatolica* EISELT & BARAN, 1970, from Kohu-Dağ and “Çiğlikara Ormanı”, Elmalı, Antalya, Turkey.
 Abb. 2: Dorsalansicht eines adulten Weibchens (a) und eines adulten Männchens (b) von *Vipera anatolica* EISELT & BARAN, 1970. Fundorte: Kohu-Dağ und “Çiğlikara Ormanı”, Elmalı, Antalya, Türkei.

tember 19, while previous published findings occurred in June-July (EISELT & BARAN 1970; SIGG 1987). According to GÖÇMEN et al. (2014) snakes stay outside till the first week of October. In May, adult males and females (Fig. 2) and one juvenile male specimen were found outside their shelters between 10:00 and 12:50 h at air temperatures of 21-23 °C. During nights, temperatures fell to 5.2 °C. Adult males were freshly shed, indicating that the snakes must have emerged from hibernation places between three to five weeks earlier, at the beginning to middle of April and the spring molting of males was already completed, as is typical for all small vipers (NILSON 1980; LICHT 1984). Active individuals were, however, never found in April (GÖÇMEN et al. 2014). The authors of the present paper observed shedding males and found shed skins in the habitat at the end of September, close to the beginning of hibernation. At the same time, it is difficult to believe that males of *V. anatolica* could have developed an exceptional shedding cycle in lacking an early spring molt unlike all other small Eurasian vipers (NILSON 1980; KOTENKO 1989; SOKOLOV 1989; PAVLOV 2003). The subsequent mating activity or traces of recent copulations were not observed.

In July, basking and foraging snakes (adult females and subadult specimens of both sexes; seven snakes in total) were observed between 8 a. m. and 11 a. m., at air

temperatures between 18-25 °C. An adult female found on 13 July was in the last stages of shedding. Night temperatures in July fell to 13 °C and even 5 °C near the bottom of deep dolines. Notably, the maximum observed activity of *V. anatolica* occurred at midsummer (Table 1), coinciding with the highest density of the prey, mainly different species of orthopterans, available at this time.

On the contrary, during the autumn observations of 2013, three of four snakes (two adult males and two adult females) were found active in the second half of the day, at different days between 17:35 and 17:40 h; only one male snake was found at 09:55 h. Air temperatures at that time were higher than in summer and fluctuated between 22.4-29 °C. The lowest night temperature was 7.5 °C. All three males found in 2014 were observed outside their hiding places at midday between 13:00-15:00 h, probably due to lower ambient temperatures, not exceeding 15 °C.

Thus, the mountain habitats of Kohu Dağ and “Çiğlikara Ormanı” provide to some extent temperate thermal regimes, which explains the existence of small viper species in southwest Turkey. The seasonal activity of *V. anatolica* (see also GÖÇMEN et al. 2014) seems to be comparable to the activity patterns of other taxa of the subgenus *Pelias*, especially *V. ursinii* (BARON 1992; BEA et al. 1992; BARON et al. 1996) and the montane

species of steppe vipers, for example *Vipera erivanensis* (REUSS, 1933).

Feeding.- No prey was found in the stomachs of the snakes in May, but four out of seven snakes caught in July contained remnants of prey in their stomachs, presumably orthopterans, and remnants of grasshoppers were revealed in the faeces of two specimens in July and September. Different species of Orthoptera (Caelifera: genera *Caliptamus*, *Euchorthippus*, *Chorthippus*, *Docostaurus*, *Stenobothrus*; Ensifera: genera *Poecilimon*, *Tettigonia*, *Paradrymadusa*, *Metriopera*) were very abundant in the sites where snakes were observed in July. A higher abundance of grasshoppers differentiates habitats where snakes were found from neighboring territories where snakes were not found. The authors believe that *V. anatolica* can specialize in eating representatives of the order Orthoptera, like *V. ursinii* (BARON 1992; BEA et al. 1992). The authors often encountered *Ablepharus chernovi* DAREVSKY, 1953, and more rarely *Anotolacerta oertzeni* WERNER, 1904, in the habitat of *V. anatolica*. Apparently, these lizards could be additional feeding objects for vipers in spring and autumn when there are very few insects. This would especially concern young individuals (see also SIGG 1987). Observations by GÖÇMEN et al. (2014) of *V. anatolica* feeding on *A. chernovi* and *Chorthippus* and attempts of grasping of *A. oertzeni* are in line with the above suggestions.

Reproduction.- Both adult females found in May were well fed, but no eggs could be palpated. One of three adult females in July, and one of two adult females in September, showed no signs of pregnancy, whereas three females found at the same times had well developed eggs. The smallest pregnant females had total body lengths of 242 mm (19 September) and 256 mm (15 July) with three eggs each. Another snake found on 17 July, with a body length of 295 mm, contained six eggs. Compared to other small vipers, females of *V. anatolica* enter maturity at remarkably small size. Again, it resembles most closely the maturity size of *V. u. ursinii*, and the number of embryos also fits the range of the latter species (31.5 cm; 1-7 embryos according to BARON et al. 1996 and BARON 1997). The occurrence of non-

pregnant but well fed females indicates a reproductive cycle which lasts more than one year, which is usual in vipers (SAINT GIRONS & KRAMER 1963; BARON 1992; BARON et al. 1996; LOURDAIS et al. 2002). The reproductive period also seems to shift to the late season in high altitude habitats, and as a result, parturition in *V. anatolica* can take place as late as in the second half of September, similar to *V. ursinii* (BARON 1992; BEA et al. 1992; BARON et al. 1996).

Conservation.- The highest apparent abundance of *V. anatolica* (0.45 specimens per person-hour spent in the field – Table 1) is similar to other mountain populations of the *V. ursinii* complex (LUISELLI 2004), which seem to be ecologically very similar to *V. anatolica*. Despite extensive searching, no snakes were found in nine carefully investigated, more intensively grazed neighboring valleys (Table 1). Overgrazing is considered a strong threat to *V. ursinii* in Italy and Romania (LUISELLI 2004; FILIPPI & LUISELLI 2004; ZAMFIRESCU et al. 2011) but it is not mentioned as a threat in the IUCN assessment of the species state by TOK et al. 2009). SIGG (1987) already drew attention to the degradation of the natural vegetation in the Kohu Dağ area due to overgrazing. The authors of the present paper consider overgrazing, with consequent depletion of the insect fauna, to cause the absence of vipers in open slopes outside the protected areas and represent a main threat for the species. Restricting the livestock in the open grasslands in the area could positively influence the population situation in the Kohu Dağ Mountain. Both potential areas visited (Bey Dağ and Alaça Dağ), although similar in altitude, geology and vegetation to the Kohu Dağ record localities, lacked sites unaffected from grazing and thus, represented different stages of degradation of the natural vegetation with low density of potential prey and no vipers found. It is not known if these sites were ever inhabited by the snake in the recent (historical) past or at any time after the isolation of *V. anatolica* in south-west Turkey about five Mya at the Miocene-Pliocene boundary (ZINENKO et al. 2015). Today, the deep valleys separating these mountain massifs are absolutely insurmountable for vipers which are strictly adapted to high

altitude environment, constraining them to persevere on sky islands. In the case of proper habitat management they could represent sites where mirror populations could be introduced.

Nonetheless, the Kohu Dağ population of *V. anatolica* still exists today in the area of the type locality where there are no systemic changes in habitat distribution or level of human activity from the 1980s when the discovery of the species occurred (SIGG

1987; NILSON, ANDRÉN & FLÄRDH 1988) through the 1990s (Göran NILSON, pers. comm.) until today. For the conservation of this species it is therefore most important to maintain the *status quo* of human influence in the area of Çıglıkara and adjacent Kohu Dağ mountains. Further search for additional populations on adjacent mountain massifs and consequent protection is very desirable for a long lasting perspective on *V. anatolica* conservation.

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AUTHORS: Oleksandr ZINENKO (Corresponding author < zinenkoa@yahoo.com >)¹, Aziz AVCI², Friederike SPITZENBERGER³, Andriy TUPIKOV⁴, Konstantin SHIRYAEV⁵, Emin BOZKURT⁶, Çetin ILGAZ⁷ & Nikolaus STÜMPEL⁸

¹ The Museum of Nature at V. N. Karazin Kharkiv National University, Trinkler str. 8, Kharkiv, 61058, Ukraine; Dvorichansky National Park, Privokzalna str. 51, Dvorichna, 62701 Kharkiv Region, Ukraine; < zinenkoa@yahoo.com >;

² Adnan Menderes University, Faculty of Art and Science, Department of Biology, Aydın, 09010 Aydın, Turkey; < aavci09@yahoo.com >;

³ BatLife Austria, c/o Naturhistorisches Museum Wien, Säugetiersammlung, Burgring 7 1010 Wien, Austria; < friederike.spitzenberger@aon.at >;

⁴ Dvorichansky National Park, Privokzalna str. 51, Dvorichna, 62701 Kharkiv Region, Ukraine; < a.i.tupikov@gmail.com >;

⁵ Tula Regional Exotarium, 300002, Oktyabr'skaya str. 26, Tula, Russia; < naturalistzoo@mail.ru >;

⁶ Adnan Menderes University, Faculty of Art and Science, Department of Biology, Aydın, Turkey; < eminbozkurt20@hotmail.com >;

⁷ Dokuz Eylül University, Faculty of Science, Department of Biology, Buca-İzmir, 35150 Turkey; < cetin.ilgaz@deu.edu.tr >;

⁸ Staatliches Naturhistorisches Museum, Gausstraße 22, D-38106 Braunschweig, Germany; < nikolaus.stuempel@gmx.de >