

Occurrence of *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 in Jordan (Squamata: Serpentes: Colubridae)

Vorkommen von *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 in Jordanien
(Squamata: Serpentes: Colubridae)

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KURZFASSUNG

Das Vorkommen der Zornnatter *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 in Jordanien wird anhand eines kürzlich aufgesammelten Exemplars belegt. Sequenzvergleiche des mitochondrialen Cytochrom b - Gens bestätigen die Identität der Schlange sowie den Artstatus von *C. (H.) schmidti* gegenüber *C. (H.) caspius* GMELIN, 1789. Morphologische und ökologische Charakteristika der Art werden vorgestellt.

ABSTRACT

The occurrence of the whip snake *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 in Jordan is documented through a recently collected specimen. A comparison of mitochondrial cytochrome b DNA sequences confirms the identity of the snake as well as the specific status of *C. (H.) schmidti* versus *C. (H.) caspius* GMELIN, 1789. Morphological and ecological characters of the species are presented.

KEY WORDS

Reptilia: Squamata: Serpentes: Colubridae; *Coluber*, *Hierophis*, *Coluber (Hierophis) schmidti*, Jordan, Near East, morphology, systematics, taxonomy, biogeography, molecular biology, cytochrome b

INTRODUCTION

Schmidt's Whip Snake, *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 is distributed over several Caucasian countries, Turkmenistan, northern Iran, Turkey and Syria (ŠČERBAK & BÖHME 1993b). Its occurrence in Jordan remained doubtful although DISI (1985) reported on a specimen referred to as *Coluber caspius schmidti* collected from Jawa, northeastern Jordan. Since then, no further specimens were collected from Jordan. LEVITON et al. (1992) mention the

snake's doubtful occurrence in Iraq, but not in Jordan. In their recent book on the herpetofauna of Jordan, DISI et al. (2001) consider *C. schmidti* as a species of questionable status for this country.

In the present study we report on an additional specimen of *C. (Hierophis) schmidti* from Jordan, verify its taxonomic status, and comment on the morphology, occurrence, and biology of the taxon in the Middle East.

MATERIALS AND METHODS

Ten specimens of *C. (H.) schmidti* from Jordanian, Austrian and German museums were examined or data were generous-

ly provided by their curators (Wolfgang BÖHME, Bonn and Heinz GRILLITSCH, Vienna). Measurements and counts includ-

ing the number of ventral (V) and subcaudal (SC) scales, number of labials (UL = upper labials, LL = lower labials), were recorded.

Specimens from the following museums were examined: Jordan University Museum, The University of Jordan, Amman, Jordan (JUMR); Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany (ZFMK) and Naturhistorisches Museum Wien, Austria (NMW). The specimen recently collected in Jordan has been deposited at Hessisches Landesmuseum, Darmstadt (HLMD).

Material examined

JUMR 673, Male, Jordan: Jawa, 1981. A. DISI.

HLMD RA-2971, Jordan: Jawa, 30.8.2000, M. ABU BAKER.

ZFMK 51890; Turkey: vilayet Kayseri: Pazarören; leg. H. SİĞ VIII.1989. ZFMK 5992; East-Turkey: west of Van and Ercek gölü; leg. H. KUMMERLOEVE 14.VI.1968. ZFMK 57994; Turkey, vil Maras: 32.5 km east of Gökşun; leg. U. & W. BISCHOFF & J. F. SCHMIDTLER 29.V.1994. ZFMK 38095; Juv.; Georgia: Mzcheta; leg. S. RYKINA & R. EIKHORST 10.X.1982. ZFMK 38942; Syria: Tel-Hadiya; leg. J. DIEKMANN III./IV.1983. ZFMK 38943; Juv.; Syria: Tel-Hadiya; leg. J. DIEKMANN III./IV.1983. ZFMK 44977; Syria: near Aleppo: Tel-Hadiya; leg. J. DIEKMANN V.1986.

NMW 15182:11, Nesebin, Syria, leg. PIETSCHMANN 1910.

Genetic investigation

Tissue or blood samples for molecular analysis were taken from the specimens below originating from the following localities:

C. (H.) schmidti: Jordan: Jawa; Armenia: Kumlah.

C. (H.) caspius GMELIN, 1789: Greece: Serifos.

C. (H.) jugularis LINNAEUS, 1758: Jordan.

C. (H.) gemonensis (LAURENTI, 1768): Croatia: Narina.

C. (H.) viridiflavus LACÉPÈDE, 1789: Switzerland, region of the Allondon river.

Tissue samples were stored until processing either in ca. 70% ethanol or EDTA buffer. The isolation of the total genomic DNA was carried out with proteinase K digestion, followed by cleaning steps with phenol-chloroform, guanidine-thiocyanat and ethanol SAMBROOK et al. (1989). The extracted DNA was dissolved and stored in Tris-EDTA (10 mM Tris and 1mM EDTA).

The complete cytochrome b gene was amplified by polymerase chain reaction (for primers and conditions see NAGY et al. in print). Sequencing products were analyzed in an automated sequencer ALFExpress II® (Amersham Pharmacia Biotech, Uppsala). Sequences were checked for errors using the electrophoretograms and aligned manually without any doubt, as no deletions or insertions occurred in this protein-coding gene and only few substitutions were to be expected.

RESULTS AND DISCUSSION

Systematics

Coluber schmidti NIKOLSKY, 1909 as well as *C. caspius* GMELIN, 1789 were considered as subspecies within the *C. jugularis* LINNAEUS, 1758 complex (e.g., BAŞOĞLU & BARAN 1980; DISI 1985; LATIFI 1991), however, BARAN (1976), ZINNER (1972) and ŠCERBAK & BÖHME (1993a, 1993b) considered them as separate species. In his treatment, SCHÄTTI (1988) assigned all the polytypic Asian forms of *C. jugularis* as well as some other European species (e.g., *C.*

schmidti, *C. caspius*, and *C. viridiflavus*) to the genus *Hierophis* FITZINGER, 1843. On the other hand, the systematic fate of other Southwestern Asian *Coluber* species remained unresolved. Although there can be no doubt that *Coluber* s. l. has to be subdivided into several genera (cf. NAGY et al. 2000), this approach seems not to be appealing for most herpetologists dealing with the *jugularis* complex (LEVITON et al. 1992; FRYNTA et al. 1997). Further phylogenetic analyses are still to be undertaken to resolve this problematic group of genera.

Table 1: Synonymy-chresonymy for *Coluber (Hierophis) schmidti* NIKOLSKY, 1909.Tab. 1: Synonymie-Chresonymie-Liste für *Coluber (Hierophis) schmidti* NIKOLSKY, 1909.

1832	<i>Coluber griseo-coeruleus</i>	DWIGUBSKY - Opyt estestvemoi istorii vsekh. zhivotnykh Rossiiskoi Imperii. Gady. St. Petersburg. p. 12.
1832	<i>Coluber erythrogaster</i>	FISCHER - Bull. Soc. Imp. Nat. Moscou, 4: 574.
1909	<i>Coluber schmidti</i>	NIKOLSKY - Mitt. Kaukas. Mus., Tiflis, 4: 303.
1930	<i>Zamenis gemonesis schmidti</i>	ROSTOMBEKOV - Materialy po gerpetofaune okrestnostej Tiflisa. p. 22.
1939	<i>Coluber jugularis schmidti</i>	MÜLLER - Zool. Anz. Jena, 127: 89.
1949	<i>Coluber jugularis erythrogaster</i>	TERENTIJEV & ČERNOV - Opređelitelj presmykajuschichsja I zemnowodnych. Moskwa, Nauka. p. 240
1972	<i>Coluber caspius schmidti</i>	ZINNER - Systematics and evolution of the species group <i>Coluber jugularis</i> LINNAEUS, 1758 - <i>Coluber caspius</i> GMELIN, 1789 (Reptilia, Serpentes). Ph. D. Thesis Univ. Jerusalem. p. 51.
1980	<i>Coluber schmidti</i>	BAŞOĞLU & BARAN - Reptiles of Turkey. Part II.. The snakes. p. 176.
1983	<i>Haemorrhois jugularis schmidti</i>	WELCH - Herpetology of Europe and Southwest Asia. p. 68.
1985	<i>Coluber caspius schmidti</i>	DISI - The Snake, Nittagun, 17: 36.
1988	<i>Coluber schmidti</i>	DISI & AMR & DEFOSSE - The Snake, Nittagun, 20: 44.
1988	<i>Hierophis schmidti</i>	SCHÄTTI - Systematik und Evolution der Schlangengattung <i>Hierophis</i> FITZINGER, 1843 (Reptilia, Serpentes). Ph. D. Thesis Univ. Zürich. p. 22.
1988	<i>Coluber caspius schmidti</i>	WERNER - The Zoogeography of Israel. p. 372.
1989	<i>Coluber (Hierophis) schmidti</i>	GRUBER - Die Schlangen Europas und rund ums Mittelmeer. p. 92 + plate
1991	<i>Coluber jugularis schmidti</i>	LATIFI - The Snakes of Iran. p. 101 + plate.
1993	<i>Hierophis schmidti</i>	ENGELMANN & FRITSCHÉ & GÜNTHER & OBST - Lurche und Kriechtiere Europas. p. 363.
1993	<i>Coluber schmidti</i>	ŠČERBAK & BÖHME - Handbuch der Reptilien und Amphibien Europas. Band 3/I. Schlangen (Serpentes). p. 167.
1995	<i>Coluber schmidti</i>	AMR & AL-ORAN - The Snakes of Jordan. p.39.
1996	<i>Coluber schmidti</i>	DISI - Herpetozoa, Wien, 9: 79.
1996	<i>Coluber schmidti</i>	DISI & BÖHME - Herpetozoa, Wien, 9: 68.
1997	<i>Coluber schmidti</i>	FRYNTA & MORAVEC & ČIHÁKOVÁ & ŠADLO & HODKOVÁ & AFTAN & KODYM & KRAL & PITULE & ŠEJNA - Acta Soc. Zool. Bohemicae, Praha, 61: 12.
2001	<i>Coluber cf. schmidti</i>	DISI et al., 2001. Amphibians and reptiles of the Hashemite Kingdom of Jordan. An atlas and field guide p. 366.

Our molecular results, based on the complete cytochrome b gene (for dendrogram see fig. 1) reveal that the recently collected specimen from Jordan is closest to *C. (H.) schmidti* from Armenia (2.8% differences in nucleotid base composition), whereas both have a much higher distance to *C. (H.) caspius* which is the next relative (6.6 and 6.8% difference). The former value is within the range usually found between subspecies in *Hierophis* [e.g., 2.95% between *C. (H.) v. viridiflavus* LACÉPÈDE, 1789 and *C. (H.) v. carbonarius* BONAPARTE, 1833, see NAGY et al. - in print]; the identification of the Jordanian specimen as *C. (H.) schmidti* is thus confirmed. On the other hand, the genetic difference between *cas-*

pius and *schmidti* is larger than any intraspecific difference; therefore the concept of *schmidti* as a separate species was adopted here. A synonymy-chresonymy for *C. schmidti* NIKOLSKY, 1909 is presented in table 1.

Pholidosis

ŠČERBAK & BÖHME (1993b) describe the general morphology of this snake as being very much similar to that of *C. (H.) caspius*. Head is distinct from neck. Eye with rounded pupil. Body scales are smooth, 1 loreal, 1 and rarely 2 preoculars, 1 subocular on the front edge of the eye, upper labials 8 and rarely 7 or 9, 4th and 5th entering

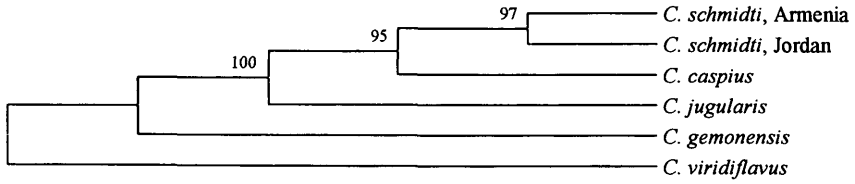


Fig. 1: Unrooted maximum parsimony dendrogram based upon cytochrome b gene sequences from *Coluber (Hierophis)* samples analyzed. Bootstrap values (1000 replicates) indicated at the bifurcations. The dendrogram was constructed with a heuristic search using the MEGA 2.1[®] software (SAMBROOK et al. 1989).

Abb. 1: Ungewurztes Maximum-Parsimony-Dendrogramm basierend auf Cytochrom-b Sequenzen der untersuchten *Coluber (Hierophis)* Stichproben. Bootstrap-Werte (1000 Replikationen) an den Verzweigungsstellen. Das Dendrogramm wurde mittels "heuristic search" im Programm MEGA 2.1[®] (SAMBROOK et al. 1989) berechnet.

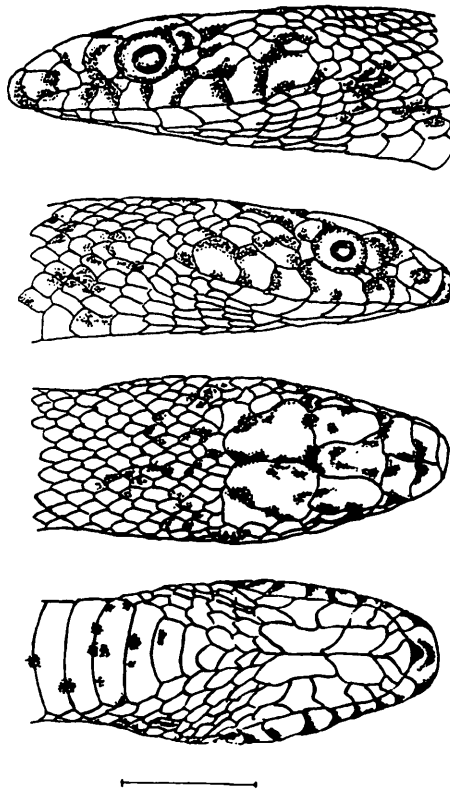


Fig. 2: Lateral, dorsal and ventral views of the head of *Coluber (Hierophis) schmidtii* NIKOLSKY, 1909 from Jawa, Jordan (HLMD RA-2791). Scale bar represents 14 mm.

Abb.2: Lateral-, Dorsal- und Ventralansicht des Kopfes von *Coluber (Hierophis) schmidtii* NIKOLSKY, 1909 von Jawa, Jordanien (HLMD RA-2791). Balkenlänge entspricht 14 mm.



Fig. 3: *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 from Jawa, Jordan (HLMD RA-2971).

Abb. 3: *Coluber (Hierophis) schmidti* NIKOLSKY, 1909 von Jawa, Jordanien (HLMD RA-2971).

the eye, lower labials 9/11, first five in contact with the anterior chin shields. Post-oculars 2/2, anterior temporals 2/2, posterior temporals 3/3. Dorsal scales are usually 17-19-15, with very few variations. Some specimens have 19-19-15 or 17-19-14 scales. 94.3% of specimens from Georgia have 19 midbody scales and only 5.7% have 17 midbody scales (ŠČERBAK & BÖHME 1993b). Ventral scales vary from 187-212. SCHÄTTI (1988) gave 203 scales for mature males and 212 for females among Iranian specimens. Subcaudals vary from 83-114. (table 2). Highest counts were recorded among Iranian specimens. The anal scale is entire or divided.

We re-examined the specimen JUMR 673, reported earlier (DISI 1985) as *C. caspius schmidti*. Upper labials 9/8 where the 4th and 5th enter the eye. Lower labials 9/10. Midbody scales 19, 192 ventrals, 103 subcaudals. Anal plate divided. Snout-vent length 950 mm, tail 360 mm. Scales light

medially and darker along the edges. Apparently, this specimen looks like a *C. (H.) caspius*.

Our new specimen (HLMD RA-2971), a female of 685 mm snout-vent length and 233 mm tail length, has 198 ventrals and 93 subcaudals. Supralabials 4 and 5 are merged on the right head side, making a reduced count of only 7 as opposed to 8 supralabials on the left side (fig. 2). Lower labials count 9/10. All other head scales are arranged as above. Dorsals around midbody 19. The anal plate is divided. Two apical pits, brown in colour, are present on each dorsal scale and they are clearly visible. Scales here are dark medially and lighter along the edges.

Colouration

According to GRUBER (1989) and ŠČERBAK & BÖHME (1993a), this is a snake with variable colours during different stages of its life. The background colouration is

Table 2: Pholidosis counts of the examined specimens of *Coluber (Hierophis) schmidti* NIKOLSKY, 1909. For Museum acronyms see 'Materials and Methods'. V - ventralia, SC - subcaudalia, D - dorsalia UL - supralabialia, LL - infralabialia, * - last piece of tail tip missing.

Tab. 2: Philodose-Zählwerte der untersuchten Exemplare von *Coluber (Hierophis) schmidti* NIKOLSKY, 1909. Museumsakronyme siehe 'Materials and Methods'. V - Ventralia, SC - Subcaudalia, D - Dorsalia UL - Supralabialia, LL - Infralabialia, * - letztes Stück der Schwanzspitze fehlt.

Specimen No. Inventarnummer	Locality Fundort	Counts / Zählwerte				
		V	SC	D	UL	LL
HLMD RA-2971	Jordan: Jawa	198	93	19	7/8	9/10
JUMR 673	Jordan: Jawa	192	103	19	8/9	9/10
NMW 15182:11	Syria: Nesebin	206	114	19	8/8	10/10
ZFMK 51890	Turkey: vilayet Kayseri: Pazarören	187	90	19	8/8	9/9
ZFMK 5992	Turkey: west of Van and Ercek gölü	187	90	19	8/8	9/9
ZFMK 57994	Turkey: vil Maras;; 32.5 km east of Göksun	187	95	19	8/8	9/9
ZFMK 38095	Georgia: Mzcheta	187	86	19	8/8	9/9
ZFMK 38942	Syria: Tel-Hadiya	195	104	19	8/8	9/9
ZFMK 38943	Syria: Tel-Hadiya	191	83	17	8/8	9/9
ZFMK 44977	Syria: near Aleppo: Tel-Hadiya	198	92*	19	--	--

often red-brown to brick red. In males the dorsum is usually brown to grey with longitudinal spots on its background. The most distinctive character of this snake is the colour and background of the dorsal scales; the scale center is red and dark, the upper and lower edges are light, giving the appearance of very fine longitudinal stripes. Juvenile specimens bear dark spots. In the anterior part of the body the spots are arranged forming a pattern of cross bars. This pattern persists among juveniles and young adults up to the total length of 140 cm. The ventral side is often shiny coral red to cherry red or pinkish.

Our specimen lacks reddish colours (fig. 3) and light scale edges are not very obvious, which makes it difficult to distinguish from *C. (H.) caspius* morphologically.

The general dorsal colouration is olive green with small, slender dark spots that extend along the entire dorsal side. However, only in the posterior half of the body these spots are arranged in longitudinal rows. The ventral side is yellowish, with only the underside of the neck and the lateral part of the venter with dark spots. The upper labials are yellowish with reddish brown posterior margins. The preoculars are also yellowish.

Zoogeographical comments

The distribution area of Schmidt's Whip Snake extends from the southern Cau-

casus and southern Turkmeniya over southern and eastern Turkey and northern Iran as far as northern Syria (ŠČERBAK & BÖHME 1993b). The southern relict populations in Syria and Jordan persisted in suitable habitats after the glacial retraction.

In Jordan, *Coluber (H.) schmidti* was collected from an area named Jawa, characterized by black lava rocks of various sizes. The area is about 1.000 m a. s. l., and represents the southern end of Jabal Al-Arab in Syria. Annual rainfall is about 150 mm, snow may fall several times per year in the area. Jawa overlooks a basalt desert that extends southwards to Saudi Arabia. ZINNER (1972) indicated that central Syria may represent the southernmost location for this species.

Schmidt's Whip Snake occurs sympatrically with *C. ravergeri* in Syria and Jordan, and with *C. (H.) caspius* in Turkey (ŠČERBAK & BÖHME 1993b). In Jordan, *C. ravergeri* is a relict species too, known only from this Jawa locality. It seems that Jawa is the southernmost outpost for these species of Palaearctic origin. Here, certain desert microhabitats apparently provide the minimum requirements that allow these species to persist and coexist in this very delicate and fragile habitat.

Incidentally, SINDACO et al. (1995) recorded "*C. caspius*", based on a road-killed specimen collected between Jarash and Mafraq, 6 km E of Rihab (32°19'N, 36°06'E, Jordan), without giving any scale

counts, descriptions or remarks. We believe that the snake they found was either *C. ravergeri* or *C. (H.) schmidti*, but cannot decide which, since the identity of this specimen (stored in the Museo Civico di Storia Naturale di Carmagnola - Italy, MCC/R613, 26.4.1994) was not verified.

Habitat

Coluber (H.) schmidti was found to inhabit a wide range of habitats in the former Caucasian states; it was found in plains and mountains up to 1.500 m a.s.l., in river valleys, rocky slopes, mountain steppes as well as densely vegetated and semi arid to dry regions. In Syria, a specimen was collected from a corn field near Aleppo (ŠČERBAK & BÖHME 1993a). BAŞOĞLU & BARAN (1980) stated that it inhabits areas similar to those inhabited by *C. jugularis*.

The area in which our specimen was found is a basalt desert covered by black lava rocks of different sizes, with wadi beds, gorges and very scarce vegetation. The western-facing boulders are covered by epilithic lichens forming white precipitates (SEARIGHT 1987).

Biology

Very little is known about the biology of this snake in the Middle East and almost all information given below had to be taken from observations made in the northern part of the species' range. *Coluber (H.) schmidti* seems to be an opportunistic feeder. It feeds on birds, small mammals, amphibians, reptiles and insects (MUS'CHELIŠWILI 1970; ALEKPEROW 1978; ŠAMMAKOW 1981).

The activity of this snake was summarized by ŠČERBAK & BÖHME (1993a) based on the available literature as follows: In Azerbajdzan, on rare occasions, specimens of this species are active in January or

February. Usually they leave their winter quarters here at the beginning of April, rarely already at the end of March; in Georgia the first observation is given towards the end of March, while in Turkmenistan at the beginning of March. Leaving for winter quarters occurs accordingly in Azerbajdzan in the middle of October, sometimes later, the last active snake was seen at the end of November, while in Georgia at the end of October.

Coluber (H.) schmidti is a strictly diurnal snake, with a peak of activity between March and May. A temperature of 25-30°C in the summer and of 20°C in autumn were recorded as the optimum temperature for its activity in Azerbajdzan (ALIJEV 1985).

The specimen HLMD RA-2971 was seen at 8:30 a.m. on 30.8.2000 on a desert dirt road near Jawa (32°20'20"N, 36°59'28"E, 1030 m a.s.l.). The animal was very active and aggressive. When cornered it jumps forward and will not release very easily when biting for defense, but instead keeps on chewing on the grasped body part.

Reptiles collected from the same area include the following taxa: *Ptyodactylus puiseuxi* BOUTAN, 1893, *Laudakia stellio picea* (PARKER, 1935), *Trapelus pallidus haasi* (WERNER, 1971), *Acanthodactylus tristrami* (GÜNTHER, 1864), *Pseudocerastes fieldi* SCHMIDT, 1930, *Coluber ravergeri* MÉNÉTRIÉS, 1832.

In Azerbajdzan mating season starts in the first half of May and lasts until the end of July; eggs are laid from mid-June until July (ALEKPEROW 1978). In Georgia, mating season starts at the end of March, while in Turkmenistan at the middle to the end of April (MUS'CHELIŠWILI 1970; ŠAMMAKOW 1981; ALIJEV 1985). According to MUS'CHELIŠWILI (1970), clutch size can be up to 20; hatchlings were observed in nature at the end of September / beginning of October, with a size of 337-339 mm TL (n = 3).

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