

Snakes of the genus *Eirenis* in Jordan (Reptilia: Squamata: Colubridae)

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Received on April 7, 2008, accepted on April 30, 2009.

Published online at www.vertebrate-zoology.de on May 15, 2009.

> Abstract

Four species of the genus *Eirenis* that occur in Jordan were studied. Distribution and ecology of these species was investigated. *Eirenis coronella* was collected from the Mediterranean and Irano-Turanian biotopes. Jordan represents the most southern range of distribution for *E. decemlineata*, *E. lineomaculata* and *E. rothi*. Sexual dimorphism is evident in *E. rothi* where as females attain larger body size, but shorter tail and accordingly higher ventral and lower caudal scales. The hemipenes of the four examined species were similar to each other; with minor differences. All have cylindrical simple hemipenis; with a single sulcus; with macro-ornamentation of large spines; also with micro-ornamentation of small spines and calyculate. Food remains from examined snakes showed that all four species feeds on arthropods (spider, centipede, scorpions, Acrididae, caterpillars and unidentified beetles).

> Key words

Eirenis, systematics, hemipenes, diet, Jordan.

Introduction

Snakes of the genus *Eirenis* are referred to as dwarf racers or peace snakes. So far, 16 species of this genus were reported and distributed from southern former Soviet Union States, through Iran to Pakistan eastward, to Greece, Cyprus, Turkey, Iran through the Levant and extending into Sinai (MARX, 1968; GASPERETTI, 1988; LEVITON *et al.*, 1992; BAHA EDIN, 2006; SCHMIDTLER *et al.*, 2009). Turkey has the highest number of species (SCHMIDTLER & EISELT, 1991, SCHMIDTLER, 1993, 1997). Other studies revised the genus *Eirenis* including DOTSENKO (1989) where he subdivided this genus into two subgenera: *Eirenis*, containing species with 17 dorsals at mid-body; and *Collaria*, including species with 15 dorsals. SCHMIDTLER & EISELT (1991) argued the validity of this revision, and stated that 17 dorsals reflects the original state of *Eirenis*, while 15 dorsals may have evolved many times in the past. SIVAN & WERNER (2003) revised the status of *Eirenis coronella* in the Middle East, employing principal coordinate analysis. They recognized two main groups assigned as: *Eirenis coronella*, for specimens from Sinai, Palestine, western Saudi Arabia, Jordan,

Iraq and Syria, and *E. coronelloides*, characterized by dark crown, ventral stripe or both; in all specimens examined from Turkey and some specimens from Jordan, Iraq and Syria.

In Jordan, this genus is represented by four species distributed in mountainous and arid dry regions. In this study, we investigated the distribution, meristic characteristics, hemipenial morphology, and food contents for four species of the genus *Eirenis* in Jordan.

Materials and methods

A total of 136 preserved snake specimens from different localities were examined. The examined specimens were kept at the Jordan University Museum, Amman (JUM), Mu'tah University Museum, Mu'tah (MUM), the Jordan Natural History Museum, Irbid (JNHM) and the Jordan University of Science and Technology Museum, Irbid (JUSTM).

Morphometric and meristic measurements

Three meristic characteristics were examined: Dorsal scale rows at mid-body (MDS), ventral scales (VS), subcaudal scales (SCS), and three measurements were recorded: Total length (TOL), snout-vent length (SVL) and tail length (TL).

Hemipenis preparation

The following method for hemipenis preparation was modified after PESANTES (1994). The hemipenis was removed from the tail region by using fine and sharp scalpel through a careful incision from the vent along the midline section between the subcaudal scales and the tail. The hemipenis was freed from the surround tissues and soaked in 2 % potassium hydroxide solution for about two weeks at room temperature. The hemipenis was removed and washed with distilled water and kept in distilled water for one day, and was soaked in 0.1 N hydrochloric acid solution at 20° C for one day. The following day, the hemipenis was washed and soaked in distilled water for one day. A syringe was filled with distilled water and its needle was introduced into the hemipenis through its base. The water was gently forced in while the organ was pressed between the fingers to help the distension of the walls. The muscle, rectus caudae should be cut to facilitate its eversion. For hemipenis eversion, a very fine forceps was used. During this procedure the hemipenis must be kept wet. Then, the everted hemipenis was kept in 75% ethyl alcohol in a small glass vials. All the prepared hemipenes were examined by using dissecting microscope. At the end of preparation photographs were taken for the hemipenis of each species, using black and white films (Ilford Pan-F 135, 50 ASA, 18 DIN, Ciba-Geigy, England). Then, drawings for the hemipenes were made.

Stomach and intestine contents of the snakes:

106 alcohol-preserved specimens belonging to the genus *Eirenis* at the deposition of the Jordan University Museum (Reptiles Collection) were dissected and examined for the presence of food remains in their stomachs and intestines. The collections were made during 1978–1998. Ingesta were separated, kept in small vials with the original specimens and then analyzed.

Results

Key to Species of the Genus *Eirenis* in Jordan.

1. Dorsal scale rows at midbody 15 2
Dorsal scale rows at midbody 17 3
2. Subcaudals, 40–72, ventrals 133–200, 7 (8) supralabials; head with 3 dark transverse and independent bands: the 1st extends across the eyes, the 2nd covers the parietal shields, the 3rd band, across the neck and often with light margin, long and well visible from ventral side, sometimes joined to form a collar; dorsal scales often with very small dark dots at tip. *Eirenis rothi*
 - Subcaudals 29–55, ventrals 118–156, transverse bands on the dorsum
..... *Eirenis coronella*
3. Subcaudals 40–83, ventrals 136–183, with two thin pairs of dark stripes running the length of body and tail, or with a uniform dorsum without stripes *Eirenis decemlineata*
 - Subcaudals 32–47, ventrals 110–145, pale brown above, body pattern with brown spots arranged in 4 rows; ventral parts dotted *Eirenis lineomaculata*

Eirenis coronella Schlegel, 1837

Material examined. JUM 247, ♀, Ibbin, 5.6.1978. JUM 857, ♂, Az Zarka, 7.4.1982. JUM 888, ♂, Ar Ramtha, April 1982. JUM 892, ♂, Ar Ramtha, April 1982. JUM 895, ♀, Ar Ramtha, April 1982. JUM 907, ♂, Jawa., May 1982. JUM 934, ♂, Jawa, 7.1.1982. JUM 1144, ♀, Amman, June 1982. JUM 1148, ♀, Awajan, October 1982. JUM 1208, ♀, Sahab, April 1983. JUM 1211, ♀, Sahab, April 1983. JUM 1212, ♀, Sahab, April 1983. JUM 1216–1217, 2 ♀♀, Sahab, April 1983. JUM 1217, ♀, Sahab, April 1983. JUM 1256, ♂, Ar Ramtha, September 1982. JUM 1328, ♂, Ar Ramtha, May 1983. JUM 2027, ♀, Petra, 20.4.1995. JUM 2031, ♀, Petra, 4.5.1995. JUM 2034, ♀, Amman, April 1995. JUM 2083, ♀, Petra, 20.4.1995. JUM 2276, ♀, W. Safawi, 14.10.1996. JUM 2326, ♀, Dana, 17.6.1997. JNHM 338, ♀, Al Karak, 15.5.1994. JNHM 339, ♂, Dana, no date. JNHM 78, ♀, Wadi Musa, 12.6.1991. JNHM 96, ♀, Al-Quera, 11.7.1991. JNHM 337, ♀, Al Karak, 8.5.1993. JUSTM 111, ♀, Al Mafrag, no date. JUSTM 112, ♀, Jordan Valley, no date. JUSTM 113, ♂, As Salt, no date. JUSTM 132, ♂, Sahab, 15.5.1995.

Tab. 1. Scale counts and measurements for *Eirenis coronella*.

	♂			♀		
	N	Range	Av & SD	N	Range	Av & SD
VS	9	121–142	129.8±10.7	22	118–156	143.3±11.82
SCS	9	34–48	38.7±9.48	22	29–55	41.3±6.63
SVL	11	10–19.8	15.85±4.4	22	11–29	22.7±4.57
TL	11	1.2–4.8	3.52±1.67	22	2.1–7.5	4.4±1.26
TOL	11	12.3–27	20.51±3.98	22	13.1–36.5	24.24±5.15

**Fig. 1.** *Eirenis coronella* from Sahab, Jordan.**Fig. 2.** Distribution of *Eirenis coronella* in Jordan.

Previous records. Jabal el Ashaqif (Mafraq) (SCHMIDT, 1939), between Ma'an and sisah (HAAS, 1943), Ptera (BARBOUR, 1914), Ramtha (ar-Ramtha), Yajoz (Yajuz), Jawa, Ibeen (Ibbin), Awajan, Amman, Sahab, Mafraq (al Mafraq) (DISI *et al.*, 1988), Jawa (DISI *et al.*, 1999), Wadi Musa, Shawbak (Ash Shawbak), Quwayra (al Quwayrah), Al Muraygha (AMR *et al.*, 1994), Wadi Musa, Ash Showbak (Ash Shawbak), Al Quwayra (al Quwayrah), At Tyyba (At Tayyibah), Rakeen (Rakin), Kathreba (Kathrabba), Ay, Wadi Bin Ham-mad (EL ORAN *et al.*, 1994).

Description. Body is cylindrical; mainly with regular narrow transverse dark brown bands on the dorsum (Fig 1); collar is present. Lips are yellowish; a blackish vertical streak below the eye and another between the last two labials. One loreal; nasal single; one pre-ocular; two postoculars; 1+2 temporals; seven upper labials, third and fourth entering the eye; 7–8 lower labials, the fourth in contact with anterior chin shields; anterior chin shields are larger in size than posterior chin shields, The latter may be separated by one small scale; 17 or 19 scale rows around the neck; scales smooth; anal scale and subcaudals are divided.

The ventral and subcaudal scales count was 118–156 and 29–55 respectively. Additional information about the

scale count and measurements for both sexes are summarized in Table 1.

Specimens collected from southern parts of Jordan showed higher scale counts and body measurements than those collected from northern and middle parts of Jordan.

Distribution. The Crowned Dwarf Snake has a wide range of distribution extending from southern Turkey to western Iran to Iraq, across Syria, Lebanon, Jordan and Palestine, to Saudi Arabia to the south and Sinai to the West. This species is distributed in the Mediterranean, and the Irano-Turanian biotopes. Also, it is a common species in the southern part of Jordan. It appears that this species is aridophilous (Fig. 2).

Remarks. One specimen collected from Dana Wildlife Reserve had laid 5 eggs in July; the average length of the eggs was 2.2 cm and 0.6 cm in width. The activity pattern for this is diurnal in moderate spring and autumn; while crepuscular or nocturnal during June-September. They are found mainly under small stones without a defined burrow.

Eirenis decemlineata DUMÉRIL, BIBRON & DUMÉRIL, 1854

Material examined: JUM 250, ♂, Ibbin, 1.5.1978. JUM 254, ♂, Ibbin, 17.5.1978. JUM 316, ♂, Ibbin, 3.6.1978. JUM 1129, ♀, Irbid, August 1981. JUM 1146, ♀, Irbid, 1982. JUM 1163-1164, 2 ♀♀, Dayr Abu Sa'id, 1982. JUM 1174, ♀, Dayr Abu Sa'id, 1982. JUM 1178, ♀, Dayr Abu Sa'id, 1982. JUM 1179, ♀, Dayr Abu Sa'id, 1982. JUM 1182, ♀, Dair Abu Sa'id, 1982. JUM 1273, ♀, Dair Abu Sa'id, May 1983. JUM 1274, ♂, Dayr Abu Sa'id, May 1983. JUM 1285, ♀, Dayr Abu Sa'id, May 1983. JUM 1286, ♀, Dayr Abu Sa'id, May 1983. JUM 1297, ♂, Dayr Abu Sa'id, May 1983. JUM 1923, ♂, Jordan Valley, 1989. JUM 2021, ♂, Amman, 5.10.1997. JUM 2038, ♂, Irbid, 1995. JUM 2040, ♂, Irbid, March 1996. JUM 2045, ♂, Az Zarqa, 22.10.1994. JUM 2322, ♀, Jarash, 19.10.1997. JUM 2324, ♂, Jarash, 7.9.1997. JNHM 1145, ♂, Irbid, no date. JNHM 115, ♂, Irbid, no date. JNHM 1151, ♀, Irbid, May 1996. JNHM 1152, ♀, Irbid, May 1996. JNHM 1153, ♂, Irbid, no date. JNHM 1158, ♀, Irbid, May 1996. JNHM 43, ♀, Um Qeis, no date. JNHM 439, ♂, Irbid, 1979. JNHM 529, ♂, Irbid, no date. JUSTM 108, ♂, Irbid, no date. JUSTM 135, ♀, Irbid, June 1995. JUSTM 136, ♂, Irbid, June 1995. JUSTM 137, ♀, Irbid, June 1995. JUSTM 220, ♀, Zubiya, 7.4.1993. JUSTM 239, ♀, Irbid, no date. JUSTM 283, ♂, Sakhra, no date. JUSTM 325, ♂, Aqraba, 1993.

Previous records. Ibeen (Ibbin), Irbid, Ajlune (Ajlun), Dair Abu Said (Dayr Abu Sa'id), Madaba, Anjarah, Al-korah, Hartha, Sakhra, Amman (Disi *et al.*, 1988).

Description. Body is brown above, uniform or with two thin, dark stripes running the length of the body



Fig. 3. *Eirenis decemlineata*, above: striped form from Jarash, below: non-striped form from Aqraba.

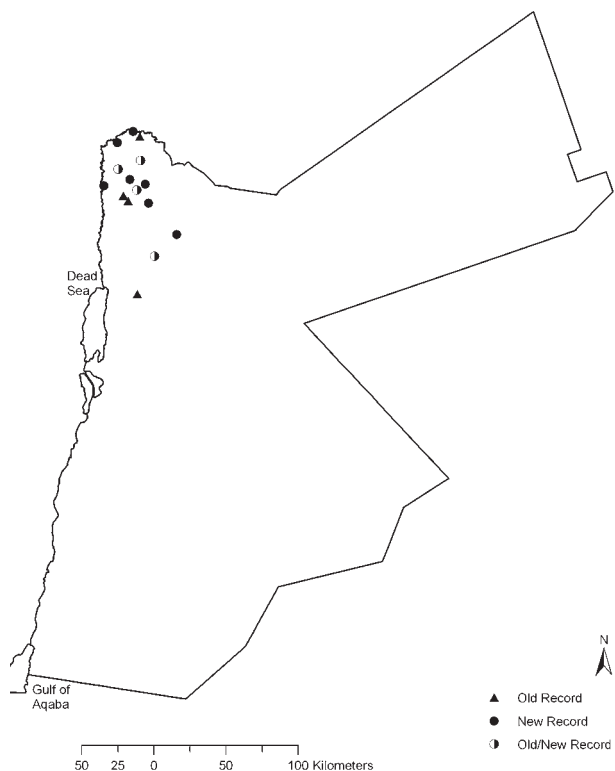
and tail (Fig. 3). Lower parts uniform white. The neck is distinct from the body. Seven upper labials, third and fourth entering the eye; eight lower labials, the fourth in contact with the anterior chin shield; one loreal; one preocular and two postoculars; six scales around the eye; dorsal scales in 17 rows at mid body; anal and subcaudals divided. Scale counts for all the studied specimens are presented in Table 2. The ventral and subcaudal scale counts in 40 specimens was 136–183 and 40–83 respectively.

Distribution. The Narrow-striped Dwarf Snake has a distribution range extending from Turkey to the north, reaching Iran and Iraq to the east and extends across Syria and Lebanon to Jordan and Palestine to the south. The species are distributed mainly in northern areas of Jordan (Fig. 4). It is restricted to the Mediterranean biotope.

Remarks. In the early spring and late autumn it is active in the early morning and late afternoon, while during the hot months it becomes nocturnal. It inhabits the vegetated areas, and is usually found under stones where humidity is high.

Tab. 2. Scale counts and measurements for *Eirenis decemlineata*.

	♂			♀		
	N	Range	Av & SD	N	Range	Av & SD
VS	23	136–183	165.7±9.31	17	168–180	172.8±4.97
SCS	23	66–83	73.9±5.18	17	40–79	73.3±3.84
SVL	23	27.5–51.5	41.1±6.53	17	16–22	33.1±10.68
TL	23	5–18.4	13.9±2.23	17	5–16.5	10.7±4.07
TOL	23	21–64.5	54.5±8.17	17	37.5–68	41.6±16.45

**Fig. 4.** Distribution of *E. decemlineata* in Jordan.

Eirenis lineomaculata SCHMIDT, 1939

Material examined. JUM 2330, ♂, Amman, no date. JUM 162, ♂, Suwaylih, 3.5.1978. JUM 919, ♂, Mahis, 16.5.1992. JUM 1222, ♀, Irbid, no date. JUM 2331, ♀, Irbid, 22.4.1998. JUSTM 37, ♀, Irbid, no date. JUSTM 275, ♂, Irbid, no date. JUSTM 295, ♀, Al Mafraq, 29.11.1994. JUSTM 321, ♀, Jordan Valley, 24.4.1995. MUM 280–281, 2 ♀♀, Mu'tah, 8.5. 1994. MUM 432, ♂, Al Karak, 22.5.1993.

Previous records. Swieleh (Suwaylih), Al Zarqa (Az Zarqa), Mahis, Dier Abu Said (Dayr Abu Sa'id), Habkha-Irbid (Disi, 1985; Disi *et al.*, 1988).

Description. The dorsum is spotted; while the ventral is white with small spots; (Fig.5); one loreal present or absent; one preocular; 1–2 postocular; 5–6 scales around the eye; One anterior temporal; 1–2 posterior temporals; seven upper labials, third and fourth entering the eye; it has a round pupil; 7–8 lower labials, four in contact with the anterior chin shields; 17 mid-dorsal scale rows; anal and subcaudals divided.

Scale counts for the studied specimens are presented in Table 3. The ventral and subcaudal scales count

**Fig. 5.** *Eirenis lineomaculata* from Irbid, Jordan.

Tab. 3. Scale counts and measurements for *Eirenis lineomaculata*.

	♂			♀		
	N	Range	Av & SD	N	Range	Av & SD
VS	4	110–123	116.8±5.56	4	126–145	136±8.6
SCS	4	33–41	37.5±3.41	4	29–47	35.3±8.01
SVL	4	15–17.5	16.2±1.03	4	15.5–25	20.13±4.21
TL	4	4.2–4.8	4.5±0.24	4	3.2–5	3.98±0.8
TOL	4	19.2–22.3	20.68±1.04	4	18.7–30	24.1±4.84



Fig. 6. Distribution of *Eirenis lineomaculata* in Jordan.

in 12 specimens was 110–145 and 32–47 respectively.

Distribution. The distribution of the Striped Dwarf Snake extends from SE Turkey, Iraq across Syria and Lebanon, reaching its most southern range of distribution in Jordan and Palestine. In Jordan, this species has a limited distribution to the Mediterranean biotope of Jordan (Fig. 6).

Eirenis rothi JAN, 1863

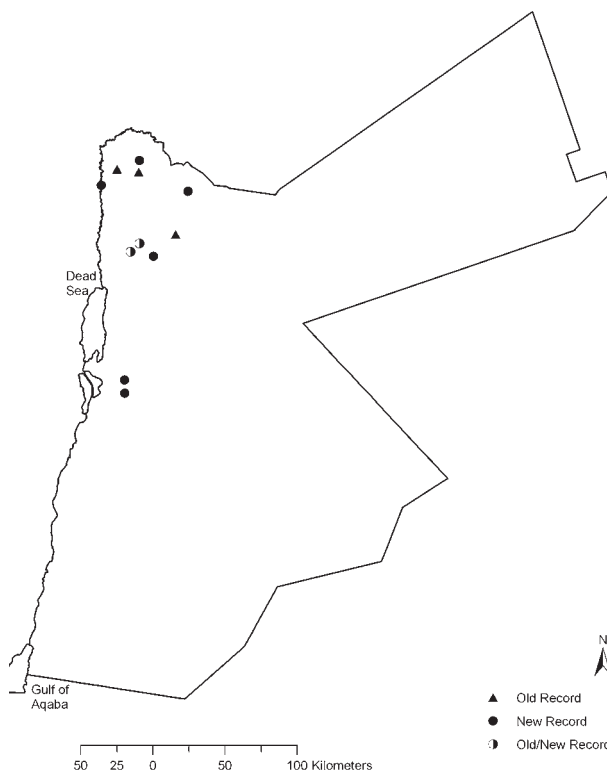
Material examined. **JUM 166**, ♀, Amman, April 1983. **JUM 182**, ♀, Umm Al Dananir, April 1983. **JUM 444**, ♂, At Tafilah, May 1988. **JUM 632**, ♂, Al'al, 12.5.1981. **JUM 1124**, ♂, Amman, 10.4.1982. **JUM 1158**, ♂, Ajlun, 10.2.1983. **JUM 1365**, ♀, Amman, April 1983. **JUM 1334**, ♂, Amman, April 1983. **JUM 1347**, ♂, Umm Al Dananir, April 1983. **JUM 1364**, ♂, Amman, April, 1983. **JUM 1325**, ♀, Ar Ramtha, May 1983. **JUM 1329**, ♂, Ar Ramtha, May 1983. **JUM 1362**, ♀, Madaba, June 1983. **JUM 1590**, ♀, Amman, 23.9.1983. **JUM 1596**, ♂, Jarash, 18.5.1985. **JUM 1667**, ♂, Amman, April 1986. **JUM 1843a**, ♂, As Salt, November 1986. **JUM 1843b**, ♂, As Salt, November 1986. **JUM 1876**,



Fig. 7. *Eirenis rothi* from Ajlune, Jordan.

Tab. 4. Scale counts and measurements for *Eirenis rothi*.

	♂			♀		
	N	Range	Av & SD	N	Range	Av & SD
VS	25	133–182	173.8±9.186	13	171–200	186.4±8.87
SCS	25	40–72	59.3±7.06	13	50–62	57.4±3.91
SVL	25	16.7–30	22.07±2.96	13	15–26.3	21.65±3.49
TL	25	5–8.1	6.19±0.98	13	4–6.4	5.45±0.86
TOL		21.7–33.4	28±3.29	13	19–32.6	27.18±4.28

**Fig. 8.** Distribution of *Eirenis rothi* in Jordan.

♂, Zizia, April 1988. JUM 1867, ♀, Wadi Mujib, 21.2.1988. JUM 1873, ♀, Hashemia, 5.4.1988. JUM 1913, ♀, Yajuz, 15.9.1989. JUM 2041, ♂, As Salt, 20.4.1996. JUM 2042, ♀, Slehi, 15.6.1992. JUM 2044, ♂, As Salt, 18.7.1995. JUM 2095, ♀, As Salt, 15.4.1993. JUM 2325, ♂, At Tafilah, March 1998. JUM 2327, ♂, As Salt, February 1996. JUM 2329, ♀, At Tafilah, March 1998. JUM 2332, ♂, Safawi, 1.6.1998. JUSTM 292, ♀, Irbid, April 1991. JUSTM 297, ♀, Irbid, April 1991. JUSTM 365, ♀, Irbid, 6.5.1995. JUSTM 132, ♂, Sahab, no date. JUSTM 217, ♂, Ar Ramtha, 17.4.1993. JUSTM 389, ♂, Irbid, 4.8.1995. MUM 361, ♂, Mu'tah, no date. JNHM 1150, ♂, Irbid, No date. JNHM 1157, ♂, Irbid, No date. JNHM 1156, ♀, Irbid, No date.

Pervious records. Jarash (=Jerash), HAAS (1951), Ain Lahtha, Jubyha (Al Jubayhah), Ajlune (Ajlun), Ael, Swileh (Suwaylih), Hisban, Amman, Ma'an, Ramtha (Ar Ramtha), Um Al dananeer (Umm Al Dananir), Anjarah, Dair Abu Said (Dayr Abu Sa'id), Ain Ghazal, Madaba, Irbid, Salt (As Salt) (DISI *et al.*, 1988), Wadi Musa, Er Rajif, Karak (Al Karak), Ayl (AMR *et al.*, 1994), Wadi Musa, Er Rajif, Ash Shawbak, Ghwair, Al Mazar, Mutah, El Adananeyeh, Ar Ra'ba (EL ORAN *et al.*, 1994), Az Zarqa, Dana, Wadi Al Hashad (DISI *et al.*, 2001).

Description. Three dark bands are on top of the head of 43 studied, preserved specimens (Fig. 7); body is brownish yellow above; the lower part of the body is uniform white; 7 upper labials, third and fourth entering the eye; 7 lower labials, four in contact with the anterior chin shields; one loreal; one preocular; two postoculars; one anterior temporal; two posterior temporals; six scales around the eye; dorsal scales in 15 rows at midbody; anal and subcaudals divided. Scale counts for the studied specimens are presented in Table 4.

Distribution. The distribution range of the Roth's Dwarf Snake extends from Turkey in the north across Syria and Lebanon to reach its most southern range in Jordan and Palestine. This species inhabits both the Mediterranean and the Irano-Turanian biotops of Jordan (Fig. 8).

Remarks: *E. rothi* has a wider range of distribution than any other species of this genus in Jordan.

Dietary contents of stomach and intestine of the studied *Eirenis* species

Food remains were recovered from 106 specimens belonging to the four studied species of the genus *Eirenis* (Table 5). The food remains consists mainly of arthropods. Ingested preys in all examined snakes were taken by the head first.

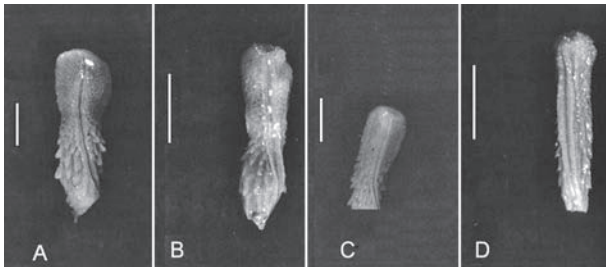
Of the 30 *E. coronella* specimens, 5 were found to contain food remains. In three snakes, a single spider was found in each, the other two contained a centipede of the genus *Scolopendra*, and an unidentified scorpion respectively. Six specimens of *E. decemlineata* were found with ingesta consisting of a spider, Acrididae, caterpillars and unidentified beetles. Two specimens of *E. rothi* yielded centipedes.

Hemipenial Morphology

The hemipenes of the four examined species were similar to each other; but minor differences were ob-

Tab. 5. Ingest recovered from four species of the genus *Eirenis*.

Species	No. examined	No. with ingesta	% with ingesta.	Food remains recovered
<i>E. coronella</i>	30	5	16.6	Spiders, centipedes, scorpions
<i>E. decemlineata</i>	31	6	19.3	Acrididae, spiders, caterpillars
<i>E. lineomaculata</i>	4	1	25.	<i>Scorpio maurus fuscus</i> .
<i>E. rothi</i>	41	2	4.8	Centipedes (<i>Scolopendra</i> sp.)
total	106	14	13.2	

**Fig. 9.** Hemipenial morphology for species of the genus *Eirenis*; A. *Eirenis decemlineata*, B. *Eirenis coronella*, C. *Eirenis lineomaculata*, D. *Eirenis rothi*. Scal bar: 4 mm.

served. All have cylindrical simple hemipenis; single sulcus; with macro-ornamentation of large spines; also micro-ornamentation of small spines and calyculate.

Eirenis decemlineata has cylindrical hemipenes with single sulcus which turns left; it has macro-ornamentation of three rows of large spines. Micro-ornamentation of a calyculate and spinulate. Total Length 10–20 mm (Fig. 9A).

Eirenis coronella has cylindrical hemipenes with single sulcus which turns right and rarely left (Fig 9B). The hemipenis with ornamentation of four rows of large spines or medium spines; finer ornamentation is calyculate with short spines. Total Length: 10–12 mm.

Eirenis lineomaculata has cylindrical hemipenes with single sulcus which turns left; they have macro-ornamentation of three rows of large spines; and micro-ornamentation of a calyculate and spinulate. Total length 7–19 mm (Fig. 9C).

Eirenis rothi has cylindrical hemipenis with single sulcus which turns left or right; macro-ornamentation of 3–4 rows of large spines. In one snake, the hemipenis was covered with spines all of the same size. Micro-ornamentation is calyculate and spinulate. Total length 5–10 mm (Fig 9D).

Discussion

The genus *Eirenis* seems closely related to the whip snakes and, according to different authors, is consid-

ered as a sister taxon either of the genus *Hierophis* s.s. (NAGY *et al.*, 2003) or of the clade composed by “*Coluber*” *caspius*, “*C.*” *jugularis* and “*C.*” *schmidtii* (SCHÄTTI & UTIGER, 2001). NAGY *et al.* (2003) propose a phylogeny based on molecular data, allocating the species to four subgenera: *Eirenis* JAN, 1863, including *modestus* and *aurolineatus*, the new subgenus *Eo-seirenis* for *decemlineatus*, *Pseudocyclophis* BOETTGER, 1888 for *persicus* and *Pediophis* FITZINGER, 1843 for all remaining taxa.

The nominate subspecies *ibrahimi* SIVAN & WERNER, 2003 is endemic to the southern Sinai, *fennelli* ARNOLD, 1982 is known from W Saudi Arabia and *coronelloides* (JAN, 1862) occurs in Jordan, Syria, SE Turkey and NE Iraq. Populations from SW Iran, S Iraq and NE Saudi Arabia cannot be assigned with certainty to any subspecies, although so far are considered to belong to *E. c. coronella*. SIVAN & WERNER (2003) raise *Eirenis coronelloides* at the species level, but this point of view requires confirmation (VENCHI & SINDACO, 2006).

The obtained results suggest that there is a clear difference in the scale counts and total body length within the same species of *Eirenis coronella*. Specimens collected from southern part of Jordan have a higher scale counts and higher body length than specimens collected from other parts of Jordan. It seems clear that there is a positive correlation between scalation and ambient temperature. The mean annual temperature in the south is higher than that in the north and middle parts of Jordan. These findings are in agreement with FOX (1948) who indicated that there are reductions in several scale characters from warm to cooler regions. Moreover, KLAUER (1941) reported that there is an almost universal tendency toward a higher number of ventrals in the desert specimens, as compared to those collected from more humid region in San Diego. Also, these findings are in agreement with the reported scale counts in the Eastern Mediterranean region. *E. coronella* is the only taxon of the genus *Eirenis*, which penetrates into dry habitats of southern and eastern Jordan (Fig. 2). LEVITON *et al.* (1992) reported the highest scale counts (>180 in females; >200 in males) in comparison with previous reports, as well as the present investigation without specification to any given country. ARNOLD (1982) described *Eirenis coronella fennelli* from Arabia.

This taxon is larger and more robust than the nominal form. Also, pholidosis (131–154 ventrals) and color (pale grayish brown) patterns are different from those studied specimens. GASPERETTI (1988) described *E. c. coronella* from Arabia (123–163 ventrals, and 37–52 subcaudals), and also posterior chinshields were separated by a single scale.

Eirenis coronella has a wide range of distribution. It was collected from the Mediterranean and Saharo-Sindian biotopes in Jordan. This is the only taxon that can inhabit the desert region in Arabia while the other three studied species are mainly restricted to the Mediterranean habitats. Similar observations were made by HAAS (1951) in Palestine.

Jordan represents the most southern range of distribution for *E. decemlineata*. Scale counts of the studied specimens from Jordan are within the range of the reported studies in the Eastern Mediterranean countries (SCHMIDTLER & SCHMIDTLER, 1978). *E. decemlineata* have two form of coloration, striped and non-striped. The striped color pattern may act as protective mechanism from biotic dangers. It would be expected that striped color patterns are more effective in diurnal snakes since the visual confusion is caused by movement (WOLF & WERNER, 1994). Moreover, KARK *et al.* (1997) indicated that the distribution of striped/non-striped *Psammophis schokari* is correlated to rainfall, solar radiation and vegetation. *Eirenis decemlineata* is restricted to the Mediterranean habitats, which has almost similar characteristics in neighboring countries. This may explain the reason of the minimum variations in scale counts along its range of distribution. It seems that the striped form is more common in forested areas while the non-striped form is common to open rocky areas of the Mediterranean ecozone.

The scale counts for *E. lineomaculata* are within the reported ranges for the eastern Mediterranean countries. However, higher scale counts (VS 126–168, SC 32–48) were reported from Turkey (SCHMIDTLER & SCHMIDTLER, 1978). Jordan represents its most southern range of distribution. It inhabits humid areas and avoids deserts. HAAS (1951) and DISI (1987) stated that *E. lineomaculata* reacts positively with humidity parameters and negatively with temperature.

The reported scale counts in this study for *E. rothi* are in agreement with previous studies from the Eastern Mediterranean countries (BARAN, 1978). Examining both pholidosis and measurements of *E. rothi* from Jordan suggests sexual dimorphism. Females attain larger body size, but their tails are shorter than in males (Table 4). Accordingly, the ventral scales are 171–200 in females, while 133–182 in males. Moreover, the subcaudal scale counts are 50–62 for females and 40–72 in males. Jordan represents its most southern outpost of distribution and it penetrated into the Irano-Turanian biotope.

The Hemipenis Morphology

The hemipenis is a diagnostic feature often used in supraspecific systematic investigations of snakes (UTIGER *et al.*, 2002). The hemipenes of the four studied species of the genus *Eirenis* are very similar to each other. All have single, subcylindrical hemipenis with a single sulcus, which may turn left or right. In addition, they have macro-ornamentation of large spines and micro-ornamentation of acalycate, and spinulate structures ZIEGLER & RASMUSSEN (2002) stated that despite variation, size and ornamentation of the hemipenes among species of the genus *Crotaphopeltis*, they serve to distinguish between sympatric and parapatric species.

The hemipenis morphology in this study for *Eirenis coronella* is similar to that given by ARNOLD (1982) for the Arabian population of this species. COPE (1895) indicated that *Eirenis* has a naked organ, but POPE (1935) demonstrated that COPE was in error. This study shows that the four studied species have a calyculate organ covered with a complex ornamentation of retiform ridges as in typical colubrids.

Dietary contents of the genus *Eirenis* in Jordan

A total of 106 snakes were examined for food contents, only 14 specimens (13.2%) were found to contain ingesta. The four studied species preyed mainly on small arthropods and insects (Table 5). In Turkey ÇIÇEK & MERMER (2007) found that *Eirenis modestus* fed mainly on arthropods including Coleoptera, Orthoptera, and Scolopendromorpha, as well as other small lizards. They did not recover scorpions or spiders. Previous studies have reported prey from the taxa such as Orthoptera, Coleoptera, Isopoda, Myriapoda, Scorpiones, and Aranea (TERENTJEV & CHERNOV, 1949; BANNIKOV *et al.*, 1977). It seems that snakes of the genus *Eirenis* feed mainly on various rock-dwelling arthropods. This investigation shows a positive correlation between the size of the snake and its prey. For example the large *E. rothi* was found to feed on large centipede while the small *E. rothi* feeds on smaller centipedes. Also, most of the snakes examined feed on spiders and Acrididae.

Examining the food contents show that these snakes are opportunistic feeders and depend on the availability of prey and their size in the surrounding environment. Ingested preys in all examined snakes were taken by the head first. Same results were obtained by AMR and DISI (1998).

Further molecular studies should address the phylogenetic relationship for species of the genus *Eirenis* in Jordan and the Middle East and relate their relationship from an evolutionary perspective.

Acknowledgments

We wish to thank ANNA BACHMANN for revising the language.

References

- AMR, Z.S. & DISI, A.M. (1998): Diet of some snakes from Jordan. – *Amphibia-Reptilia*, **19**: 436–439.
- AMR, Z.S., AL-ORAN, R. & DISI, A.M. (1994): Reptiles of southern Jordan. – *The Snake*, **26**: 41–49.
- ARNOLD, E.N. (1982): Reptiles of Saudi Arabia. A new semaphore gecko (*Pristurus*: Gekkonidae) and a new dwarf snake (*Eirenis*: Colubridae) from southwestern Arabia. – *Fauna of Saudi Arabia*, **4**: 468–477.
- BAHA EL DIN, S. (2006): A Guide to the Reptiles and Amphibians of Egypt. – The American University in Cairo Press. Cairo and New York.
- BANNIKOV, A.G., DAREVSKY, I.S., ISHCHENKO, V.G., RUSTAMOV, A.K. & SHCHERBAK, N.N. (1977): Ophredelitel zemnovodnykh i presmykayushchikhysya fauny SSSR [A Guide to the Amphibians and Reptiles of the U.S.S.R.]. – *Prosveshchenie Publ.*, Moscow.
- BARAN, I. (1978): Some rare species of snakes from Turkey. – *Annalen des Naturhistorischen Museums in Wien*, **81**: 261–265.
- BARBOUR, T. (1914): Notes on some reptiles from Sinai and Syria. – *Proceedings of the New England Zoological Club*, **5**: 73–92.
- Çiçek, K. & MERMER, A. (2007): A preliminary study of the food of the Dwarf Snake, *Eirenis modestus* (Martin, 1838) (Serpentes: Colubridae), in Izmir and Manisa Provinces. – *Turkish Journal of Zoology*, **31**: 399–402.
- COPE, E.D. (1895): The classification of Ophidia. – *Transaction of the American Philosophical Society* (new series), **28**: 186–219.
- DISI, A.M. (1985): Contribution to the herpetofauna of Jordan. II. New records and systematic list of snakes from Jordan. – *The Snake*, **17**: 31–42.
- DISI, A.M. (1987): Environmental factors affecting snake distribution in Jordan. In: KRUPP, F., SCHNEIDER, W. & KINZELBACH, R. (eds), *Proceedings of the Symposium on the and Zoogeography of the Middle East*, Mainz, 1985. Beihefte zum TAFO A. Wiesbaden, **28**: 296–310.
- DISI, A.M., AMR, Z.S. & DEFOSSÉ, D. (1988): Contribution to the herpetofauna of Jordan. III. Snakes of Jordan. – *The Snake*, **20**: 40–51.
- DISI, A.M., MODRY, D., BUNIAN, F., AL-ORAN, R. & AMR, Z. (1999): Amphibians and reptiles of the Badia region of Jordan. – *Herpetozoa*, **12**: 135–146.
- DISI, A. M., MODRY, D., NECAS, P. & RIFAL, L. (2001): Amphibians and Reptiles of the Hashemite Kingdom of Jordan – An Atlas and Field guide. Chimaira, Frankfurt. 408pp.
- DOTSENKO, I.B. (1989): A review of the genus *Eirenis* (Reptilia, Colubridae). – *Vestnik-Zoologii*, **1989**(5): 23–29.
- EL-ORAN, R.M., AL-MELHEM, W.N. & AMR, Z.S. (1994): Snakes of southern Jordan. – *Bollettino di Zoologia*, **61**: 359–367.
- FOX, W. (1948): Effect of temperature on development of scutellation in the garter snake, *Thamnophis elegans atratus*. – *Copeia*, **1948**: 252–262.
- GASPERETTI, J. (1988): Snakes of Arabia. – *Fauna of Saudi Arabia*, **9**: 169–450.
- HAAS, G. (1943): On a collection of reptiles from Palestine, Transjordan and Sinai. – *Copeia*, **1943**: 10–15.
- HAAS, G. (1951): On the present state of our knowledge of the herpetofauna of Israel. – *Bulletin of the Research Council of Israel*, **1**: 67–95.
- KARK, S., WARBURG, I. & WERNER, Y.L. (1997): Polymorphism in the snake *Psammophis schokari* on both sides of the desert edge in Israel and Sinai. – *Journal of Arid Environments*, **37**: 513–527.
- KLAUER, L.M. (1941): The correlation between scalation of life zones in San Diego County snakes. – *Bulletin of the Zoological Society of San Diego*, **17**: 73–79.
- LEVITON, A.E., ANDERSON, S.C., ADLER, K. & MINTON, S.A. (1992): Handbook to Middle East Amphibians and Reptiles. – *Contributions to Herpetology* 8. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 252 pp.
- MARX H. (1968): Checklist of the Reptiles and Amphibians of Egypt. – *Special Publication US Naval Medical Research Unit 3, Cairo*. 91 pp.
- NAGY, Z.T., SCHMIDTLER, J.F., JOGER, U. & WINK, M. (2003): Systematik der Zwergnattern (Reptilia: Colubridae: *Eirenis*) und verwandter Gruppen anhand von DNA-Sequenzen und morphologischen Daten. – *Salamandra*, **39**: 149–168.
- PESANTES, O. (1994): A method for preparing the hemipenis of preserved snakes. – *Journal of Herpetology*, **28**: 93–95.
- POPE, C. H. (1935): The reptiles of China. In: *Natural History of Central Asia*. Ed. REEDS, C.A. – *American Museum of Natural History*, **10**: 1–604.
- SCHÄTTI, B. & UTIGER, U. (2001): *Hemerophis*, a new genus for *Zamenis socotrae* Günther, and a contribution to the phylogeny of Old World racers, whip snakes, and related genera (Reptilia: Squamata: Colubrinae). – *Revue suisse de Zoologie*, **108**: 919–948.
- SCHMIDT, K. P. (1939): Reptiles and amphibians from Southwestern Asia. – *Publ. Field Mus. nat. Hist., zool. Ser.*, **24**: 49–92.
- SCHMIDTLER, J.F. & EISELT, J. (1991): Zur Systematik und Verbreitung ostanatolischer Zwergnattern; mit Beschreibung von *Eirenis hakkariensis* n.sp. – *Salamandra*, **27**: 225–237.
- SCHMIDTLER, J.F. (1993): Zur Systematik und Phylogenie des *Eirenis-modestus*-Komplexes in Süd-Anatolien (Serpentes, Colubridae). – *Spixiana*, **16**(1): 79–96.
- SCHMIDTLER, J.F. (1997): Die Zwergnattern (*Eirenis modestus*-Komplex) des Antitaurus in Süd-Anatolien und ihre geographischen Beziehungen zur begleitenden Herpetofauna. – *Salamandra*, **33**(1): 33–60.
- SCHMIDTLER, J.J. & SCHMIDTLER, J.F. (1978): Eine neue Zwergnatter aus der Türkei; mit einer Übersicht über die Gattung *Eirenis* (Colubridae, Reptilia). – *Annalen des Naturhistorischen Museums in Wien*, **81**: 383–400.

- SCHMIDTLER, J.F.; GÖCMEN, B.; ZÜLFÜ YILDIZ, M.; AKMAN, B.; YALCINKAYA, D. & NAGY, Z.T. (2009): Wiederentdeckung der Schlangengattung *Eiremis* auf der Insel Zypern (Reptilia: Colubridae). – *Der Salamander*, Rheinbach, **5**(1): 15–23.
- SIVAN, N. & WERNER, Y. L. (2003): Revision of the Middle-Eastern dwarf-snakes commonly assigned to *Eirenis coronella* (Colubridae). – *Zoology in the Middle East*, **28**: 39–59.
- TERENTJEV, P.V. & CHERNOV, S.A. (1949): Ophredelitel zemnovodnykh I presmykayushchikhysya SSSR [Guide to amphibians and reptiles of USSR], Uchpedgiz Publ., Moskow.
- UTIGER, U., HELFENBERGER, N., SCHÄTTI, B., SCHMIDT, C., RUF, M. & ZISWILER, V. (2005): Molecular systematics and phylogeny of Old and New World ratsnakes, *Elaphe* Auct., and related genera (Reptilia, Squamata, Colubridae). – *Russian Journal of Herpetology*, **9**: 105–124.
- VENCHI, A. & SINDACO, R. (2006): Annotated checklist of the reptiles of the Mediterranean countries, with keys to species identification. Part 2. – Snakes (Reptilia, Serpentes). – *Annali del Museo Civico di Storia Naturale "G. Doria"*, Genova, **98**: 259–364.
- WOLF, M. & WERNER, Y. (1994): The striped colour pattern and striped/non-striped polymorphism in snakes (Reptilia: ophidian). – *Biological Reviews*, **69**: 599–610.
- ZIEGLER, T. & RASMUSSEN, J.B. (2002): Hemipenial variation in the African snake genus *Crotaphopeltis* Fitzinger, 1843 (Serpentes, Colubridae, Boiginae). – *Bulletin of the Natural History Museum. Zoology Series*, **68**, pp 51–55