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Eco-morphological notes on the sarmatian rat snake, *Elaphe sauromates* (Pallas, 1814) (Reptilia Serpentes Colubridae), from Greek Thrace

Augusto Cattaneo

Via Cola di Rienzo, 162 - 00192 Rome, Italy; augustocattaneo@hotmail.com

ABSTRACT This paper aims to provide original information on the eco-morphology of Sarmatian rat snake, *Elaphe sauromates* (Pallas, 1814) (Reptilia Serpentes Colubridae), which inhabits Greek Thrace. To this end, research was conducted in May, from 2013 to 2017, along the coastline of north-eastern Greece. Regarding morphology, numerous data on size (of both juveniles and adults), pholidosis (head, trunk and tail) and color development are provided. The absence of *E. sauromates* on the arid Aegean Islands underscores its reliance on high humidity conditions for survival, a trait further evident in the various environments it frequents on the continent. The trophic spectrum of *E. sauromates* primarily consists of birds (mostly nestlings) and their eggs, as also evidenced by the structure of its cervical tract; similar dietary tendencies appear to be present in its sister species, *E. quatuorlineata*. As for its reproductive cycle, three females were followed from copulation to oviposition; four of the offspring (2 males, 2 females) were reared until sexual maturity, and variations in length, weight and habitus were recorded annually. Information is also provided on behavior, predators, parasites and conservation problems. Finally, the three species of the group *E. sauromates* (s.l.), *E. sauromates, E. urartica, E. druzei* are compared, with comments on cryptic species.

KEY WORDS *Elaphe sauromates*; Greek Thrace; morphology; habitat; ornithophagy; reproductive cycle; growth rates.

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INTRODUCTION

Elaphe sauromates (Pallas, 1814) (s.l.) (Reptilia Serpentes Colubridae) is a cryptic and very elusive entity with its typical form distributed in Eastern Europe and Asia Minor. In this paper, original information on the eco-morphology of the Sarmatian rat snake population inhabiting Greek Thrace is provided. Research was conducted in May from 2013 to 2017 along the coastal strip of north-eastern Greece, from the hinterland of Kavala, in eastern Greek Macedonia, eastwards to the Greek-Turkish border along the banks of the Evros River. Partial results of these surveys, including other herpetological species in the area, can be found in Cattaneo & Cattaneo (2013, 2014, 2016) and in Cattaneo (2015, 2017b).

Recognizing the importance of in-depth study for the effective protection of rare species, some specimens were temporarily collected and bred to study their reproductive cycle, development times and physical needs. Detailed studies of certain aspects of reproductive biology are not possible with observations done solely in the wild, making the information obtained through breeding necessary for the development and implementation of conservation strategies aimed at protecting these rare and understudied snakes (Polyakova et al., 2019).

MATERIAL AND METHODS

Study area (Fig. 1)

Eastern Greek Macedonia (Kavala hinterland). See Cattaneo & Cattaneo (2016).

Central Greek Thrace (Rhodope Prefecture). This region, which has as its capital Komotini, borders Bulgaria to the north, Xanthi Prefecture to the west and Evros Prefecture to the east. It occupies an area of 2550 km^2. The name "Rhodope" comes from the Rhodope Mountains range, which extends into its northern part. Research was limited to the southern part of Rhodope Thrace (south of Komotini, between Lake Ismarida to the west and the municipality of Maronia to the east); this region faces the Thracian Sea, is flat, and is characterized by an extensive watershed comprising significant rivers, such as the Lissos, and coastal lagoons. Due to its flat terrain and abundant water resources, the region of eastern Macedonia and Thrace has primarily been exploited for intensive cultivation of cotton, tobacco, sugar beets and cereals. It has a transitional climate, between the Mediterranean and Central European climates, likely influenced by the Rhodope Mountains range. For further details about this area, please refer to Cattaneo & Cattaneo (2014).

Eastern Greek Thrace (Evros prefecture, SW sector). See Cattaneo (2017b).

Eastern Greek Thrace (Evros Prefecture, SE Sector). Evros Prefecture is one of the three prefectures that make up the Greek Thrace and is named after the Evros River, which marks an extensive

Figure 1. Greek Thrace with its three Prefectures: Xanthi, Rhodopes, Evros.

stretch of the eastern border with Turkey. The southeast area of this prefecture is characterized by the presence of a considerable amount of water thanks to the extensive river basin of the Evros Delta, which covers an area of about 700 km^2. Evros is the easternmost of the three prefectures and its capital city is Alexandroupoli. It is bordered to the north by Bulgaria, to the east by Turkey, to the south by the Aegean Sea and to the west by the Rhodope Prefecture. Research was conducted in the areas east of Alexandroupoli, ranging from sea level to modest hill elevations. This part of Thrace is also characterized by extensive cereal crops, cultivated up to an altitude of 300 m above sea level. The area under investigation is of considerable geothermal interest. In the locality of Aristino, a geothermal field covering an area of about 30 km^2 was identified with water temperatures reaching 86 °C at a depth of 360 m. These geothermal waters have a chemical composition rich in sodium chloride due to the mixing of rainwater with deep marine waters. For more details regarding this area, see Cattaneo & Cattaneo (2013).

Material

A total of 33 specimens of Sarmatian rat snake, *Elaphe sauromates* were studied, 9 found in the wild (some raised in captivity) (Table 1) and 24 born in captivity (Table 2). 4 juveniles were raised to sexual maturity (Tables 3, 4). Juveniles not used for the study were immediately released at the mother's place of capture. The studied specimens were subsequently released where they had been found.

For field study and research methods, see Cattaneo & Cattaneo (2013, 2014, 2016) and Cattaneo (2015, 2017b).

ABBREVIATIONS. OL = overall length; TL = tail length; W = weight; PW = prey-weight; TI = trophic index; D = number of mid-trunk dorsal scales (counted in a transverse line at the height of half of the total number of ventral scales, the latter counted with the classic method); V = number of ventral scales (counted with the classic method, which considers as ventral the mid-ventral scales that are wider than they are long); Sc = number of pairs of subcaudal scales (counted starting from the first postcloacal scale that is in contact with the contralateral along the caudal midline); M = number of mid-dorsal spots on the trunk.

RESULTS AND CONSIDERATIONS

16 specimens of the Sarmatian rat snake, *Elaphe sauromates* were found in the wild (of which 7 found run over and dead) + 24 born in captivity.

		OL (cm)	TL (cm)	W (g)	D	V	Sc
1	♀	117*	-	433	25	217	29*
2	♀	156	27	531	25	221	68
3	♂	133.5*	25*	467	25	206	68*
4	♀[1]	143 (160.6)	24.5 (28.2)	748 (1036)	25	215	67
5	♂	143*	25*	666	25	202	55*
6	♂	130*	19*	483	25	203	51*
7	♂	120*	22*	354	25	204	71*
8	♀	130	23	420	27	213	68
9	♂ juv.	51.1	9.1	-	25	208	73

Table 1. *Elaphe sauromates* (Pallas, 1814), Greek Thrace: size and pholidosis of 9 specimens found in the wild; * = incomplete tail. [1] = with well-developed eggs. In parentheses, the measurements taken after captive breeding.

		OL (cm)	TL (cm)	W (g)	D	V	Sc	M
1	♀	43	7	18	25	211	65	63
2	♂	44	8.2	17	25	210	75	61
3	♀	42	6.7	18	25	212	65	53
4	♀	42	6.8	18	25	216	67	61
5	♂	44	7.9	17	25	206	73	57
6	♂	43.5	7.9	17	25	204	76	57
7	♂	42.5	7.3	17	25	205	74	56
8	♂	42	7.6	17	25	206	76	59
9	♂	44	8.1	17	25	206	77	63
10	♀	43.5	7	17	25	218	67	59
11	♀	46	7	22	25	223	67	45
12	♂	40.5	7.5	18	25	205	76	46
13	♂	42.5	8	20	25	206	77	47
14	♂	43	7.5	21	25	204	76	47
15	♂	44	7.5	21	25	209	75	56
16	♂	44	8.3	23	25	207	78	50
17	♀	45	7	24	25	216	62	65
18	♂	45	8.5	24	25	203	74	54
19	♀	44	7	22	25	214	60	54
20	♀	44	7	24	25	214	64	55
21	♂	46	8.5	23	24 (23)	206	75	52
22	♀	42	6.5	17	25	215	62	57
23	♀	44	6.5	22	25	217	62	54
24	♂	46	8.5	25	25	203	72	56

Table 2. *Elaphe sauromates* (Pallas, 1814), Greek Thrace: size (at birth, in captivity) and pholidosis of 24 young specimens.

At the end of the study, all the specimens were released into their original locations. These specimens came from various locations in the study area (in brackets the number of specimens found): Rhodopes: Dioni-Strimi (1), Maronia (1), Imeros, marsh (1), Near Lake Ismarida (2), Platanitis (4), Proskinites (1), Prf. Ilias (1), Dioni-Palea Krovili (1). Evros: Anthia (3), Agnantia (1). The toponyms represent locations in plains or low hills.

Chondropoulos (1989) mentions the species for Pandrosos, a locality north of Komotini (Rhodopes). Schulz (2013) provides images of specimens from Lake Ismarida (Rhodopes).

Morphology

Dimensions. See Tables 1, 2. Maximum overall

Data	OL (cm)	TL (cm)	W (g)	PW (g)	TI	N. molts	Chromatic intonation
2014-08-17 (birth)	44	8.1	17	-	-	-	greyish
2015-02-27	54	9.8	37	45	1.2	2	greyish
2015-11-10	100	21	209	385	1.8	4	yellowish (from summer 2015)
2017-01-07	130	26	454	664	1.4	2	yellowish
2017-12-17 (sexual maturity May 2017)	139	28	572	516	0.9	2	dark yellow
2014-08-17 (birth)	44	8.2	17	-	-	-	greyish
2015-02-16	52	9.7	30	34	1.1	1	greyish
2016-02-22	100	20	196	369	1.8	4	yellowish (from summer 2015)
2017-02-02	-	-	364	482	1.3	2	dark yellow
2018-01-24	133	26	418	300	0.7	2	dark yellow
2018-12-28 (sexual maturity May 2018)	abt. 140	-	489	482	0.9	2	dark yellow

Table 3. Timeline of changes in linear dimensions and weight of two young ♂♂ specimens from birth to sexual maturity. Data were collected at the end of each annual trophic cycle.

Data	OL (cm)	TL (cm)	W (g)	PW (g)	TI	N. molts	Chromatic intonation
2014-08-17 (birth)	43.5	7	17	-	-	-	greyish
2015-02-27	53	8.9	37	59	1.5	2	greyish
2015-11-04	100	18	206	390	1.8	4	yellowish (from summer 2015)
2017-01-04	130	24	486	781	1.6	3	dark yellow
2017-12-06	140	25	706	793	1.1	2	yellowish
2014-08-17 (birth)	42	6.8	18	-	-	-	greyish
2015-02-16	49.5	8.2	34	44	1.2	2	greyish
2016-02-21	98	18	192	336	1.7	4	yellowish (from summer 2015)
2017-01-11	125	23.5	451	658	1.4	3	dark yellow
2018-01-07	148	25.5	712	753	1.0	2	dark yellow
2019-01-17	> 150	-	799	650	0.8	2	dark yellow

Table 4. Chronology of the variations in the linear dimensions and weight of two young ♀♀ specimens from birth to beyond the age of four. Data were collected at the end of each annual trophic cycle.

length found: 143 cm (incomplete tail) in the males, 156 cm in the females (respective weights: 666 g, 531 g).

The young, at birth, measured 42–46 cm and weighed 17–25 g.

There is strong sexual dimorphism: males have smaller dimensions compared to females and significantly divergent ventral and subcaudal scale values; moreover, they often lack posterior temporal shields (see below).

Head pholidosis (for a more exhaustive examination of the values found, see Table 5). Preoculars: 1. Postoculars: 2. Suboculars: 1. Loreals 1–3. Supralabials: 8, sometimes 9. Supralabials in contact with the eye: 4^a–5^a, sometimes 5^a–6^a. Sublabials: 10–12. Sublabials in contact with the anterior mental shields: 5. Anterior temporals: 2–3. Posterior temporals: 1–3, often missing (especially in males, the scales located posterior to the anterior temporals very often do not correspond with this type of scale, showing characteristics of dorsal scales or, at most, of transitional scales between dorsals and the temporal shields; in Table 5 their absence is indicated by a dash; Figs. 2–5).

Pholidosis of the trunk and tail (Tables 1, 2). Mid-trunk dorsals (keeled): 25 [27 in one individual and 24(23) in another]. Ventrals: 202–223 (209.8); 202–210 (205.4) in 19 ♂♂; 211–223 (215.8) in 14 ♀♀. Subcaudals: 60–78 (70.3) in 28 individuals; 72–78 (75.1) in 15 ♂♂; 60–68 (64.9) in 13 ♀♀.

Coloration. The juvenile's appearance closely resembles that of the juvenile *E. quatuorlineata* (see Cattaneo, 1999); though the latter seems to have more developed ornamentation. During the summer of the first year following birth, the general and overall chromatic intonation takes on a yellowish hue, thus replacing the previous greyish tones (Tables 3, 4).

In the adult specimens studied, the dorsal background color ranges from pale to intense yellow, up to fulvous. Along the dorsal median belt there are 45–65 large dark spots or bars, laterally accompanied by smaller spots of the same color. Each dorsal scale (including those that compose the dark pattern) has a median black line, creating an overall yellow-black reticular pattern. The pileus is diffusely black (also seen in the exuvia)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Preoculars	1 / 1	2 / 2	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1
Postoculars	2 / 2	2 / 2	2 / 2	2 / 2	2 / 2	2 / 2	2 / 2	2 / 2	2 / 2	3 / 2	2 / 2	2 / 2
Suboculars	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / 1	1 / -
Loreals	1(2) / 1	3 / 3	1 / 1	1 / 1	1 / 1	1 / 1	2 / 2	3 / 2	2 / 2	2 / 2	3 / 2	3 / 3
Supralabials	8 / 8	8(9) / 8	8 / 8	8 / 8	8 / 8	8 / 8	8 / 8	8 / 9	8 / 9	9 / 9	8 / 8	9 / 9
Supralabials in contact with the eye	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $4^a,5^a$	$4^a,5^a$ / $5^a,6^a$	$4^a,5^a$ / $5^a,6^a$	$5^a,6^a$ / $5^a,6^a$	$4^a,5^a$ / $4^a,5^a$	$5^a,6^a$ / $4^a,5^a,6^a$
Sublabials	12/12	11/13	11/11	10/11	10/10	11/10	10/11	12/12	11/11	12/12	12/11	12/11
Sublabials in contact with the anterior chin shields	5 / 5	5 / 6	5 / 5	5 / 6	5 / 5	5 / 5	5 / 5	5 / 5	5 / 5	5 / 5	5 / 5	4 / 5
Anterior temporals	2(3) / 3	3 / 3	2 / 2	2 / 2	3 / 2	2 / 2	2(3) / 2(3)	2 / 2	3 / 2	3 / 2	2 / 2(3)	3 / 3
Posterior temporals	3 / 3	2 / 2	- / -	3 / -	1 / 1	- / -	- / -	3 / 2	- / 2	3 / 2	1 / 1	3 / 2

Table 5. Head pholidosis of 12 specimens of *Elaphe sauromates* (Pallas, 1814) from Greek Thrace.
The numbers in parentheses include very small scales.

Figures 2, 3. Temporal region in two male specimens of *Elaphe sauromates* of Greek Thrace (Rhodope); 1 = anterior temporal shield, d = dorsal scale. Figures 4, 5 - Temporal region of two female specimens of *Elaphe sauromates* from Greek Thrace (Rhodopes); 1 = anterior temporal shield, 2 = posterior temporal shield, d = dorsal scale.

and continues posteriorly with a large black V-shaped spot, with its posterior traits connected to the dorsal pattern. A black temporal band runs behind the eye. The supralabials are yellow with intersecting dark lines between the scales. The ventral surface is yellow, often a very bright shade, marked by dark spots (often crescent-shaped) progressing from front to back. The females appear to have a darker hue.

Based on the data provided by the literature, the pattern tends to fade as one goes from west to east within the species range; moreover, the erythristic and melanistic phenotypes seem to increase. Albino specimens have been described for Bulgaria (Petzold, 1975; Jablonski et al., 2019a) and patternless specimens for western Turkey (Bodenheimer, 1944).

Systematics

The genus *Elaphe* Fitzinger in Wagler, 1833 includes several species of Eurasian snakes. The type species of the genus is *E. parreyssi* Fitzinger in Wagler, 1833 = *E. sauromates* (Pallas, 1814) (Fig. 6). Locus typicus: Crimea and bordering southern Russian provinces (see also Mertens & Müller, 1928: Isthmus of Perekop, Crimea, Ukraine).

In the Western Palearctic the genus is represented by four species constituting the *E. quatuorlineata* complex: *E. quatuorlineata* Lacepède, 1789, *E. sauromates*, *E. urartica* Jablonski, Kukushkin, Avcı, Bunyatova, Kumlutaş, Ilgaz, Polyakova, Shiryaev, Tuniyev et Jandzik, 2019 and *E. druzei* Jablonski, Ribeiro-Júnior et Meiri, 2023.

History

In the early 2000s, based on the morphology of hemipenes, vertebral characteristics and biochemical data, Helfenberger (2001), Lenk et al. (2001) and Utiger et al. (2002) established the species status of *E. sauromates,* previously considered a subspecies of *E. quatuorlineata*. In fact, *E. sauromates* has an independent evolutionary history from *E. quatuorlineata*, as suggested by its distinct morphology and distribution. It is presumed that the two species had different centers in the initial divergence, likely occurring in the Upper Miocene, with

E. quatuorlineata in the Balkans, and *E. sauromates* in western Anatolia (Jablonski et al., 2023).

Lenk et al. (2001) also intuited the possibility of further distinct species within the *sauromates/quatuorlineata* complex. In fact, two other species closely related to *E. sauromates* have recently been described: *E. urartica*, typical of the sarmatic region (Jablonski et al., 2019b), and *E. druzei* of the southern Levant (Jablonski et al., 2023). The four species of the complex seem to form four profoundly divergent clades. Molecular phylogeny has identified three clearly divergent sibling lineages within *E. sauromates*, all forming a sister lineage to *E. quatuorlineata*. It is plausible that the diversity of the various species was shaped by the climatic oscillations of the Pleistocene, with glacial refuges spread from the Balkans through Anatolia and the Caucasus to the Levant (Jablonski et al., 2019b, 2023).

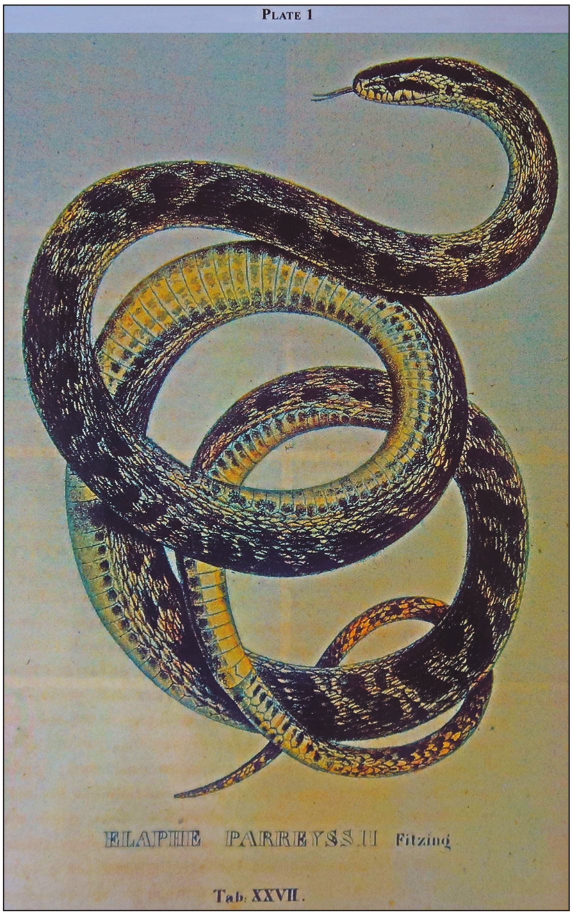

Figure 6. Plate XXVII in Wagler (1833) showing the type species of the genus *Elaphe*: *Elaphe parreyssii* Fitzinger = *Elaphe sauromates* (Pallas, 1814).

Distribution

Elaphe quatuorlineata: central-southern Italy, eastern Adriatic coasts, Balkan Peninsula, various Adriatic, Ionian and Aegean islands.

Elaphe sauromates group.

Elaphe sauromates (western form): Ukraine, Moldova, Romania, Bulgaria, northeastern Greece, western Turkey. *Chorotype*: Eastern Mediterranean.

Elaphe urartica (Eastern form): Eastern Turkey, North Caucasus (Dagestan, Russian Federation), Georgia, Armenia, Azerbaijan, Iran, Northern Iraq.

Elaphe druzei (Middle Eastern form): Syria, Lebanon, Israel.

Based on coloration patterns and their disjoint distribution, it is possible that an additional, even more eastern form, exists in Turkmenistan and Kazakhstan.

Habitat

Ukraine/Crimea. It inhabits wormwood steppes, desert-like steppes, as well as steppes with wooded areas. It has also been found in foothill forests and oak, birch or poplar groves. It has occasionally been observed in rocky regions and on stony slopes (Ščerbak, 1966).

Romania. Mostly found in steppe environments with rare shrubs or oak trees, abandoned structures and waste material (Fuhn & Vançea,1961; Sahlean et al., 2016).

Bulgaria. The species can be found in open areas with steppe vegetation, sparse deciduous forests, garrigue environments, pastures and often in very humid locations along riverbanks, lakes, ponds and marshes (Beškow & Beron, 1964; Stojanov et al., 2011; Marinova et al., 2022). It has also occasionally been found in heavily anthropized areas (Naumov & Natchev, 2016).

Northeastern Greece (personal observations). The species seems to be associated with open, grassy coastal areas withwater and various structures (abandoned or deserted buildings and patches of uncultivated land, particularly within village settings) (Fig. 7). More specifically, it has almost always been found in close proximity to wetlands (rivers, marshes, lakes, shady ditches) (Figs. 8, 9). In one case, it was observed on a hillside covered with xerophilic vegetation (mainly *Quercus coccifera*). Along rivers, its coloration blends well with the

Figure 7. Habitat of *Elaphe sauromates*: Platanitis locality (Rhodopes).

Figure 8. Habitat of *Elaphe sauromates*: Imeros marsh (Rhodopes).

Figure 9. Habitat of *Elaphe sauromates*: mouth of Evros river.

Figure 10. Habitat of *Elaphe sauromates*: riparian environment in Loutra (Evros).

lights and shadows cast by the sun on the fallen oriental plane tree leaves (*Platanus orientalis*) (Fig. 10). A similar cryptic effect is also observed in marshy areas; here, *E. sauromates* positions itselfat the edge of brambles, in the shade of large willows (*Salix* spp.) and amongst reeds (*Phragmites australis*) and nettles (*Urtica dioica*). Kordges (1984) reports its presence in a riparian forest along the Nestos River.

Western Turkey. It has been observed in a wide range of rather humid habitats such as lakes, marshes and similar environments with willows, reeds and rushes (Franzen et al., 2008).

Remarks. Based on the various types of environments frequented by *E. sauromates*, it is evident that the species requires high humidity conditions. Perhaps for this reason the species is absent from the arid Eastern Aegean islands (generic and undocumented reports exist for Thassos and Samothraki: Gruber, 1979; Wettstein, 1953). Recently, Yakin et al. (2018) reported its presence on Imbros, an island in the northeastern Aegean. However, Yakin himself (pers. comm.) indicated that the report was based on a single specimen and the species has not subsequently been found on the island. Moreover, eminent herpetologists have consistently asserted the absence of *E. sauromates* from the Eastern Aegean islands (e.g., Werner, 1933, 1937). The arid conditions of these islands are therefore unsuitable for the survival of this snake, which, in addition to high humidity, seems to require the presence of marshy areas and generally moist environments, supported by appropriate climatic conditions (frequent rainfall, mostly gentle winds). In summary, the climate and ecological conditions of these islands hinder the adaptation of this snake to life in these environments. A similar argument could be made for other hygromesophilic reptiles living on the Greek or Turkish mainland, but not on the arid Aegean islands (e.g., *Anguis* spp., *Zamenis longissimus*). Thus, the presence on the Aegean islands serves as a kind of "litmus test" to determine the degree of hygrophilia of the herpetological species in question.

In contrast to *E. sauromates,* its sister species *E. quatuorlineata* tolerates high xero-thermic conditions well. Based on personal observations, it appears that the striped habitus correlates with a greater and better resistance to these extreme conditions; for example, *Zamenis lineatus* is more xerothermophilic than *Z. longissimus*; the striped morph of *Z. situla* more so than the spotted morph; even the striped phenotype of *Chalcides chalcides* seems to confirm this trend. The adaptive nature of these geographical variations should perhaps be sought in the phenotypic (e.g., physiological) expression of cryptic pleiotropic factors or co-adapted gene complexes (supergenes).

Trophic spectrum

Ukraine/Crimea. Ardamac'kaja (1960) reports that in southern Ukraine *E. sauromates* preys on the eggs and juveniles of *Sturnus vulgaris* and *Parus major* and that in the Black Sea National Park, in two weeks, chicken coops were looted and 34 nests were raided by the species. Seasonal migrations for trophic purposes have also been noted; in March–April, the species remains in steppe habitats, in May–June, the most intense nesting period, *E. sauromates* moves to forested areas and farms in search of nestling birds.

Ščerbak (1966) examined the stomach contents of 11 specimens of *E. sauromates* from the Crimean Peninsula; four had preyed on birds (*Upupa epops*) and two on small mammals (*Microtus* sp.).

Böhme & Ščerbak (1993) report that 22 individuals of *E. sauromates* from Ukraine had remnants of reptiles in their stomachs, accounting for 7.4% of the total prey items (including *Lacerta agilis*, *Eremias arguta*, *Natrix tessellata*). Small mammals made up 9.2% (*Microtus* spp.) and birds and their eggs 83.3% (*Falco tinnunculus*, *Perdix perdix*, chicken eggs, *Sturnus vulgaris*, *Passer montanus*).

Bulgaria. Beškow & Nankinow (1979) found that in 18 specimens of one mountain population of *E. sauromates*, birds and their eggs accounted for 95% of the total number of consumed prey. The most frequently preyed species were *Turdus merula*, *Pica pica* and *Turdus philomelos*.

The strong tendency of *E. sauromates to* consume birds and their eggs was also later confirmed by Göhler (1981).

In addition to birds, rodents, shrews and lizards are also consumed (Ananyeva et al., 1998; Beškow & Nanev, 2002).

Northeastern Greece (personal observations). Two males of the nine specimens found had preyed on small mammals and a third individual female had consumed an *Apodemus* sp. and a young bird (data from May). In some specimens (including those found dead) the tail was mutilated, possibly indicating the tendency of local populations to interact with rats for trophic purposes. Moreover, the frequent presence of *E. sauromates* in settlements could be related to the abundance of rodents, such as mice and rats, which thrive in human-inhabited environments. Residents also report the frequent appearance of the species in poultry yards, often found lying on not yet consumed chicken eggs.

Remarks. According to data from the specific literature, *E. sauromates* appears to feed predominately on birds and their eggs. The predation of birds primarily involves nestlings (Fig. 11). Moreover, the anatomical organization of the snake corresponds to its functional needs. In fact, in *E. sauromates* the hypoapophyses of the cervical tract are directed forwards and are lanceolate in shape; they thus resemble those of *Dasypeltis scaber*, which traditionally is the snake species best adapted to consuming egg (Fig. 12). In *E. quatuorlineata*, a related species, the hypoapophyses are flat with only a small forward-directed process (Böhme & Ščerbak, 1993) (Fig. 13).

In captivity, however, *E. sauromates* also readily accepts small mammals, although some sexual diphagism has been observed. The ♂♂ show a qualitatively wider trophic range linked to the seasons; whereas the ♀♀ are more voracious and their feeding seems closely tied to the reproductive cycle (personal observations).

As genetic dictates require, the sister species *E. quatuorlineata* also appears to be predominantly ornithophagous. For many years, I have been conducting a bio-ecological study on the population of *E. quatuorlineata* that inhabits the Presidential Estate of Castelporziano. From this study, it emerged that the food cycle of *E. quatuorlineata* is characterized by two distinct trophic phases which concluded by molting; the first, which spans spring and early summer, is directed towards birds (eggs and nestlings), while the second involves the predation of small mammals in mid-summer. However, this latter phase does not seem to involve all adults, only those with insufficient energy reserves due to limited bird consumption. I believe that the seasonal diphagism found in this species is an expression of

Figure 11. Specimen of *Elaphe sauromates* preying on a nestling of *Corvus monedula* in an old warehouse in the village of Messouni (Komotini, Rhodopes) (photo kindly provided by Stelios Ispikoudis). Figure 12. Specimen of *Elaphe sauromates* consuming chicken eggs in a chicken coop (Milia, northern Evros) (photo kindly provided by Nikos Apostolakoudis).

true, genetically encoded trophic rhythms (Cattaneo, 2017a). Veith (1991) reports that in Bosnia *E. quatuorlineata* feeds mainly on birds and only secondarily on small mammals. The population inhabiting the marsh near Metković preys on young ducks, grebes, rails, buntings and their eggs. Certainly, populations of *E. quatuorlineata* living in environments altered in their biotic composition can gradually manifest different food trends, linked to the new selective pressures operating in the ecosystem (ecological release: Ricklefs, 1990).

Figure 13. Specimen of *Elaphe quatuorlineata* intent on consuming chicken eggs in a chicken coop (Aigio, Achaea, northern Peloponnese) (photo by Apostolis Triantopoulos).

Reproductive cycle

Based on the data in my possession, mating is expected to occur in April–May (Table 6). Approximately 15 days before oviposition, the ♀ molts as a conclusion to ovulation e consequent fertilization, which probably occurred about ten days earlier (in snakes moulting indicates hormonal changes). Oviposition is expected to occur in June. The eggs, about 10–15 in number, are smaller than those produced by *Elaphe quatuorlineata* (Fig. 14). Hatching is expected in August, following an incubation period of 50–55 days (variable depending on microenvironmental temperatures). The hatchlings, about 40 cm long and weighing around 20 g, shed their skin 7–10 days after birth. The males reach sexual maturity at the age of 3–4 years, while females appear to mature later.

Figure 14. Newly hatched *Elaphe sauromates* eggs; the largest egg measured 3x7 cm.

Behaviour

Elaphe sauromates typically inhabitants open areas covered with herbaceous vegetation, such as steppes and meadows. In these environments, its coloration provides an extraordinary cryptic effect (Fig. 15). In summary, it is a typical “grass snake”. The only refuges that the species can find in these habitats are underground galleries dug by voles. Personally, I have often observed the snake protruding its head and neck from these underground holes and then retreating back inside. In this way, among other things, the black coloration of the dorsal surface of its head could act as a solar panel, useful for thermoregulatory purposes. If this were the case, we would be witnessing an adaptive characteristic. In *E. quatuorlineata*, its western counterpart, I have frequently observed a similar behavior. In fact, along paths and forest edges, *E. quatuorlineata* tends to position itself with its head and anterior part of the trunk emerging from the vegetation. This behavior certainly has a thermoregulatory purpose, but it can also be understood as adaptive towards predators; in such cases, if threatened, the snake can retreat into the dense vegetation without losing sight of its potential aggressor.

	♀a - OL 143 cm	♀b - OL 156 cm	♀c* - OL 148 cm
Mating	<30 May (in the wild)	27 March (in captivity)	2 May
Ovulation/Fertilization	about 01 June	about 08 June	about 19 May
Postovulation molting	10 June	18 June	29 May
Gestation	about 23 days	about 26 days	about 25 days
Oviposition	23 June	4 July	13 June
Number of eggs	13	11	14
Egg dimensions (cm)	2.5-3 x 4-5.3	-	3-3.3 x 5-7
Incubation (at 27-30 °C)	55-56 days	49 days	52 days
Hatching	16-17 August	21 August	3 August
Number of offspring	10	6	8
Offspring characteristics	Tab. 2, nn. 1-10	Tab. 2, nn. 11-16	Tab. 2, nn.17-24
Duration until 1st offspring molting	8-11 days	5-6 days	8-9 days
Offspring molting	25-27 August	26-27 August	11-12 August

Table 6. Reproductive cycle observed in 3 *Elaphe sauromates* females from Greek Thrace;
* = born and raised in captivity.

In these open environments, in addition to voles, *E. sauromates* can feed on ground-nesting birds, such as buntings and larks, thus satisfying its more specific trophic tendencies.

When cornered, *E. sauromates* opens its mouth wide and emits loud hisses (personal observations).

Predators

On the shores of Lake Ismarida (Rhodopes), the remnants of a predatory act against a female specimen of *E. sauromates* were found. What remained of the snake was the posterior part of its body (Fig. 16). In both the Evros and Rhodope regions (especially around Lake Ismarida) I have often observed golden jackals (*Canis aureus*). It is therefore possible that this Canid preyed on the snake. A similar incident, also in the Rhodope region, was found with *Telescopus fallax* (see Cattaneo & Cattaneo, 2014).

Parasites

Some specimens have been found with ascaridiasis.

Etymology

Pallas (1814) proposed the name *sauromates* for the species in question, most likely referring to the Sarmatians (Sauromatae), a confederation of nomadic peoples inhabiting the Sarmatic Region (Jablonski et al., 2019b). Zoogeographically speaking, the Sarmatic Region includes the entire area of the Black Sea, the Sea of Azov, the Caspian Sea and the Aral Lake, which in the upper Miocene formed the Sarmatic Inland Sea, derived from the Tethys.

For this rare and elusive snake, inhabitant of the steppes of the western Black Sea, I therefore propose the name “Sarmatian rat snake” (called “θρακιώτικο λαφιάτης” in Greek Thrace).

Figure 15. Specimen of *Elaphe sauromates* thermoregulating, in homochromy with the grassy substrate (Komotini, Rhodopes) (photo by Stelios Ispikoudis).

Conservation

Factors that negatively affect the survival of *Elaphe sauromates* in the investigated areas are also common to other snake species. Especially in the Evros region, I witnessed a veritable massacre of snakes hit by vehicles along paved roads. According to local residents, such a massacre seems to occur every year, at least in spring. It seems appropriate to highlight this unfortunate phenomenon in the hope, however remote, that solutions or even partial solutions can be found, such as placing warning signs, reducing speed limits, and constructing tunnels or road passages (see Nilson, 2019), etc. The numerous wetlands hosted by Greek Thrace are habitual habitats for many plant and wildlife species, including, as we have seen, *E. sauromates*. Unfortunately, the massive use of fertilizers and pesticides in agriculture represents a serious threat to these ecosystems and their representatives. The ability to survive may be reduced by the facilitated and subsequent development of epizootic diseases, which, by limiting immune defenses, allow for the abnormal development of parasites (individuals infested with roundworms have been found).

CONCLUSIONS

Observing Table 7 one can see that the morphological differences between the three species of the *E. sauromates* group are not so evident. Certainly *E. urartica* is distinguished by its smaller size and the smaller number of ventral scales but, considering the other phenotypic characteristics (such as pigmentation), the three species are morphologically very similar. For example, *E. urartica* has 50–65 dark mid-dorsal spots; the specimens of *E. sauromates* (s. str.) I studied from Greek Thrace have 45–65.

Understanding a cryptic species as one whose species status has long been neglected because overall, it is very similar to other closely related species, differing only in some genetic-molecular characteristics, it can be concluded, as is generally accepted, that *E. urartica* and *E. druzei* represent cryptic taxa within *E. sauromates* (s.l.).

	E. sauromates Greek Thrace (see text)	*E. sauromates* Romania (Sahlean et al., 2016)	*E. urartica* (Jablonski et al., 2019)	*E. druzei* (Jablonski et al., 2023)
OL max. (cm)	about 145 ♂♂, 156 ♀♀	180 ♂♂, 185 ♀♀	120	> 180
Preoculars	1	1	1	1
Postoculars	2	2	2	2-3
Suboculars	1	1	1	often absent
Loreals	1-3	1-2	1	1
Supralabials	8 (9)	8-9	8	8-9
Supralabials in contact with the eye	4ª,5ª (5ª,6ª)	4ª,5ª	4ª,5ª	4ª,5ª
Sublabials	10-12	10-11	10-11	10-12
Sublabials in contact with the an-terior chin shields	5	5	5	5
Anterior temporals	2-3	2-3	2	2-4
Posterior temporals	1-3 (often absent)	3-4	3-4	2-4
Mid-trunk dorsals	25	25	23-25	23-25 (21)
Ventrals ♂♂	202-210 (**205.4**)	201-212 (**205.8**)	154-206 (**196**)	202-214 (**205.6**)
Ventrals ♀♀	211-223 (**215.8**)	214-217 (**215.6**)	194-211 (**204**)	200-222 (**211.2**)
Subcaudals ♂♂	72-78 (**75.1**)	75-79 (**77**)	65-74 (**70**)	66-78 (**69.8**)
Subcaudals ♀♀	60-68 (**64.9**)	63-70 (**65.6**)	60-72 (**64**)	57-70 (**63.8**)

Table 7. *Elaphe sauromates* groupe: meristic characters compared among populations of the western form (*E. sauromates* s. str.), of the Sarmatic region (*E. urartica*) and of the Levant (*E. druzei*). The most frequent values are reported.

Among the numerous examples of cryptic species, it is also worth mentioning *Montivipera xanthina*. In this regard Stümpel et al. (2016) write: "*In the light of our genetic data, M. xanthina appears to constitute a cryptic species complex with three or four new taxa*".

This phenotypic uniformity could be the result of similar environmental conditions and, consequently, the absence of diverse selective pressures towards other types of coloration, dimensions or proportions [what Fišer et al. (2018) call "morphological convergence"].

It is also possible that the separation between the species occurred relatively recently and therefore the effects of the new genetic composition have not yet fully manifested in the phenotype [the "recent divergence" of Fišer et al. (2018)]. It is as if the new species is reluctant to abandon its traditional habitus due to a kind of adaptive inertia induced by natural selection. It is like relying on a

Figure 16. Posterior part of the body of a female specimen of *Elaphe sauromates*, likely the result of predation by *Canis aureus* (Lake Ismarida, Rhodopes).

"used safe" over something new which has unknown outcomes.

I would like to conclude this article with a tribute to a great herpetologist: Klaus-Dieter Schulz.

On 14 September 2014, in a letter, Schulz told me the following: "*Concerning* Elaphe sauromates *I have to tell you that there are probably 3 distinct forms, perhaps even distinct species: the typical form, distributed from Ukraine (and northern Caucasus) to Greece and western Turkey* [*Elaphe sauromates* (s.str.)]*, another from Kazakhstan south to Iran and eastern Turkey (including southern Caucasus)* [*Elaphe urartica*] *and a third in Lebanon and Israel* [*Elaphe druzei*]. *I do not have definitive research on them, this is only my opinion based on the color pattern and their disjunct distribution*".

Five years after this letter was written, Jablonski et al. (2019b) described *Elaphe urartica* and nine years later it was time for *Elaphe druzei* to be recognized (Jablonski et al., 2023). The morphological peculiarities of both species have been legitimized by biochemical investigation.

Schulz died on 9 January 2022.

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