

AUGUSTO CATTANEO

MORPHO-ECOLOGY OF THE BLACK WHIP SNAKE  
*DOLICHOPHIS JUGULARIS* (LINNAEUS, 1758) OF THE  
SOUTHEAST AEGEAN AREA (DODECANESE, SW TURKEY),  
INCLUDING PREVIOUSLY UNPUBLISHED GROWTH RATE DATA  
(*Reptilia Serpentes*)

SUMMARY

The black whip snake *Dolichophis jugularis* is a polytypic species represented by four subspecies, two continental (Eastern Mediterranean), the nominate subspecies and *D. j. asianus*, and two insular, *D. j. zinneri* (archipelago of Rhodes) and *D. j. cypriacus* (Cyprus), distinguished by their chromatic peculiarities and pholidosis. During the month of May, the population of the central-southern Dodecanese were for the most part saurophagous and teriophagous, while on the southwest coast of Turkey they tend to ophiophagy, perhaps seasonally, probably due to the different, more complex interactions that characterise continental rather than insular ecosystems. In the areas researched, *D. jugularis* and *D. caspius* appear to present a complementary distribution, but this does not exclude areas of syntopy. Temporal differences in their activities and different modes of hunting could allow for the coexistence of the two species in these areas. According to studies carried out in captivity, ♂♂ specimens of *D. jugularis* appear to reach sexual maturity at three years of age and the final adult habitus at four; the ♀♀ have slower growth rates.

*Key words:* *Dolichophis jugularis*, *Dolichophis caspius*, Dodecanese, SW Turkey, ophiophagy, syntopy, developmental stages

RIASSUNTO

Specie politipica, *Dolichophis jugularis* è rappresentata da quattro sottospecie, due continentali (mediterraneo-orientali), la sottospecie nominale e *D. j. asianus*, e due insulari, *D. j. zinneri* (arcipelago di Rodi) e *D. j. cypriacus* (Cipro), che si distinguono fra loro soprattutto per peculiarità cromatiche e di folidosi. Durante il mese di maggio le popolazioni del Dodecaneso centromeridionale si sono rivelate essenzialmente sauro-teriofaghe, mentre quelle della costa turca sudoccidentale sembrano tendere all'ofiofagia, comportamento quest'ultimo, forse stagionale, dovuto probabilmente alle diverse, complesse interazioni che caratterizzano gli ecosistemi

continentali rispetto a quelli insulari. Nell'area indagata *D. jugularis* e *D. caspius* sembrano presentare una distribuzione complementare, che però non impedisce zone di sintopia. In tali zone divergenze nell'attività temporale e diverse modalità di caccia potrebbero consentire la coesistenza alle due specie. In base a studi in cattività gli esemplari ♂♂ di *D. jugularis* sembrano raggiungere la maturità sessuale a tre anni e l'habitus definitivo dell'adulto a quattro anni; le ♀♀ presentano ritmi di accrescimento più lenti.

*Parole chiave:* *Dolichophis jugularis*, *Dolichophis caspius*, Dodecaneso, Turchia SW, ofiofagia, sintopia, fasi di sviluppo

## INTRODUCTION

The geographic distribution of *Dolichophis jugularis* includes SW Turkey and various offshore islands, Cyprus, East Caucasian, Northern Iran and Iraq, Syria, Jordan, Lebanon, Israel, Egypt (GRUBER, 1989; GLANDT, 2010; BAHHA EL DIN, 2006), from sea level up to 2000 metres (WALLACH *et al.*, 2014) (chorotype: SW Asian). This paper studies the morpho-ecology of the populations of the central-southern Dodecanese Islands and along the southwest coast of Turkey. *D. jugularis* has been studied by the author since 2003, when the focus was on the population of the island of Kos (CATTANEO, 2005). For the sake of completeness, I decided to compile this study with previously unpublished growth rate data relating to the species, comprising several parameters and fully illustrating the characteristics and behaviour of this whip snake. Particular emphasis has been placed on the study of interspecific relationships with the sister species *Dolichophis caspius*, from geographical distribution (mostly complementary) to syntopy interactions, which allow the two species to be ecologically compatible.

## STUDY AREA

Aegean islands of Leros, Kos, Rhodes, Symi, Halki, Tilos (Dodecanese) and several inland areas of Kuşadasi, Bodrum and Marmaris (SW Turkey).

## MATERIALS AND METHODS

For the examined material, see Table 1.

In relation to methods, this paper is primarily based on field observations, supplemented by data obtained from captured specimens and their prey, kept for short periods in special collection bags or study boxes

Table 1

*Dolichophis jugularis* (L.): maximum dimensions and pholidosis noted in 67 specimens and 2 exuviae of SW Turkey and various Dodecanese Islands (Greece). Linear dimensions and corresponding weight refer to the same animal. Pholidosis values shown in brackets are the arithmetic mean. \* = incomplete tail

	Max. ToL (HTL) in cm		Max. W (g)		D <sup>1</sup>	V		Sc	
	♂♂	♀♀	♂♂	♀♀		♂♂	♀♀	♂♂	♀♀
SW Turkey (11 ♂♂, 5 ♀♀)	191.2* (138)	140* (103.5)	1130	425	19	199-205 (201.5)	198-205 (201)	113-121 (118) <sup>2</sup> n = 8	104-111 (107.5) n = 4
Kos (10 ♂♂, 4 ♀♀)	204* (168.2)	137.2* (106)	1938	390	19	200-204 (202.5)	200-204 (201.5)	114 n = 1	105 n = 1
Leros (4 ♂♂, 1 ♀ juv.)	198.1* (156.3)		1230		19	202-204 (203)	203	116 n = 1	109
Rhodes (10 ♂♂)	202* (154)		1288		19	192-201 (195.4)		118 n = 1	
Symi (4 ♂♂)	178.8* (130.4)		810		19	197-200 (199)		115 n = 1	
Halki (6 ♂♂)	152.6* (121.5)		712		19	193-196 (194.5)		121 n = 1	
Tilos <sup>3</sup> (7 ♂♂, 5 ♀♀)	198.8* (146.2)	102 (74)	1128	149	19	194-200 (196.5) <sup>2</sup>	197-200 (198.8)	119 n = 2	105-109 (107.2)

<sup>1</sup>Same value in both genders.

<sup>2</sup>Overall values including a datum derived from exuviae.

<sup>3</sup>At birth four young measured 32.5-34 (33.2) centimetres and weighed 5-6 (5.5) grams (see "Reproduction").

(these boxes have proved to be suitable for photographing the subjects). Once the faeces and/or *ingesta* were obtained, the snakes were weighed and released at their respective points of capture, but only after making a note of their measurements, scale count (however difficult), and description. From an examination of the figured part of the faeces (bones, nails, hair, feathers, scales, chitinous remains) and/or *ingesta*, we obtained data on their natural diet.

A ♀ from Tilos Island was bred until spawning, then released there; one of its ♂ descendants and a young Leros ♀ were then raised to beyond sexual maturity, and subsequently released respectively to Tilos and Leros. The eggs were then incubated, giving us data on the incubation term and, after hatching, on the morphological and behavioural characteristics of the young.

Particular attention was given to certain ethological factors (levels of aggressive behaviour, escape and hunting methods) and ecological factors (trophic spectrum, habitat) of this species.

Abbreviations: ToL = total length; HTL = head + trunk length; TaL = tail length; TaR = tail ratio (head + trunk length/tail length); W = weight; PW = Prey weight ; TI = trophic index (prey weight/weight); D = number of dorsal scales on mid-trunk; V = number of ventral scales (counted using the classical method, counting medium-ventral scales that are wider than they are long); Sc = number of subcaudal scale pairs.

### ***DOLICHOPHIS JUGULARIS* (LINNAEUS, 1758)**

ETYMOLOGY - *Dolichophis*: from the Greek “dolichós” = long and “óphis” = snake (long snake); *jugularis*: from the Latin “iugulum” = throat, which is red in this species.

LOCAL NAMES – Greece: *mávro phídi*; Turkey: *kara yılan*.

MAIN SYNONYMS - *Coluber jugularis* Linnaeus, 1758; *Zamenis viridiflavus* var. *asiana* Boettger, 1880; *Zamenis gemonensis tauricus* Venzmer, 1919; *Coluber caspius eiselti* Zinner, 1972; *Hierophis jugularis* Schätti & Utiger, 2001.

HOLOTYPE - The holotype is a specimen 141.5 centimetres in length, collected by F. Hasselquist in 1749-52 and is preserved at the Department of Vertebrate Zoology in Stockholm (Sweden) under the number NHR Lin-28.

TYPE LOCALITY - Egypt: on the basis of error according to FLOWER (1933); replaced with Palestine or Syria by FLOWER (1933), with Syria by BODENHEIMER (1944), and with the Selçuk and Ephesus hinterland (SW Turkey) by ZINNER (1972).

THE GENUS *DOLICHOPHIS* GISTEL, 1868

SCHÄTTI'S (1986, 1988) revision of the *Coluber* genus was revisited by SCHÄTTI & UTIGER (2001) on a genetic and morphological basis. *Coluber s. str.* was limited to Nearctic examples, while there were several different Palearctic genera (*Hemorrhois*, *Hierophis*, *Platyceps*, for European species). However, assigning *jugularis* to *Hierophis* (SCHÄTTI & UTIGER, 2001) proved problematic because some dwarf snakes of the *Eirenis* genus were also included in the same *Hierophis* clade. Therefore NAGY *et al.* (2004) proposed revalidating the *Dolichophis* genus Gistel, 1868, assigning it to the large species of southeast Europe and the Middle East, first included in the *Hierophis* genus (*caspius*, *jugularis*, *schmidti*).

## SUBSPECIES AND THEIR GEOGRAPHIC DISTRIBUTION

– *Dolichophis jugularis jugularis* (Linnaeus, 1758) (Syst. Nat., ed. 10, 1: 225) [SW Turkey, Aegean islands of Leros and Kos (Northern Dodecanese), Eastern Caucasus, Northern Iran and Iraq, Central-Northern Syria, Egypt (Sinai Peninsula)] (GRUBER, 1989; GLANDT, 2010; BAHA EL DIN, 2006).

For identifying information, see below [described by LINNAEUS (1758) as “niger, jugulo sanguinolento”].

– *Dolichophis jugularis asianus* (Boettger, 1880) (Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfurt am Main, p. 151, nn. 3 and 4) (southern Syria, Jordan, Lebanon, Israel) (GRUBER, 1989; GLANDT, 2010).

Undesignated holotype. Type locality: “Haifa” and “Jerusalem”, Israel. Adults of this subspecies are completely black, dorsally and ventrally, except for the side and lower parts of the head, which are yellow or white. Young specimens have a transversely marked and lightly speckled back and their belly displays a chequered black and yellow pattern [based on this juvenile colouring BOETTGER (1880) established them as belonging to the *asiana* variety; adults were considered to belong to the *carbonaria* variety, quite distinct from the previous].

– *Dolichophis jugularis zinneri* Cattaneo, 2012 (Naturalista sicil., 36: 81) [Aegean islands of Rhodes, Symi, Halki, Tilos (Dodecanese) and, perhaps, Kastellorizo (southeast of Rhodes)].

The holotype is part of the Herpetological collection at the Alexander Koenig Museum (Bonn): ZFMK 92945; ♂ ad.; loc. “Laerma”, southern Aegean island of Rhodes, Dodecanese, 300 m a.s.l.; A. Cattaneo leg.; 27/V/2005.

For the identification, see below.

– *Dolichophis jugularis cypriacus* (Zinner, 1972) (Cyprus).

Adults have a black back and belly, with a yellow neck. Young specimens have a darkly speckled white belly (GÖÇMEN *et al.*, 2009).

Today only a few authors consider this subspecies valid, not only because it was described in an unpublished text (a degree thesis, Hebrew University, Jerusalem; the possible holotype is preserved in the Natural History Museum in Vienna under No. NMW 15186:3), but also because in 1960 Turkish specimens of this species were imported into Cyprus to counter the spread of rodents harmful to farming (Baran in SCHÄTTI & SIGG, 1989a; GÖÇMEN & YILDIZ, 2006). This could have caused the emergence of composite characters, due to the combination of different gene pools, which would explain the large variability of the population of Cyprus (SCHÄTTI & SIGG, 1989b; BAIER *et al.*, 2009).

## **THE TWO SUBSPECIES FOUND IN THE STUDY AREA (*DOLICHOPHIS J. JUGULARIS* AND *DOLICHOPHIS J. ZINNERI*)**

### **1 - IDENTIFICATION**

**MORPHOLOGY** - Large, sturdy and well-proportioned snake. Relatively small head, with round pupils. Tail is 1/3 – 1/4 of the total length. Smooth scales.

**DIMENSIONS** - see Table 1.

**PHOLIDOSIS** - see Table 1.

**COLOURING** - *Dolichophis jugularis jugularis* (Leros, Kos, SW Turkey).  
♂♂ **adults**: upper parts (head included) with a compact gloss black colouring; the salmon red pigment tends, with age, to colonize more extensively and intensely on the lateral-lower surface of the head; lower parts bright red-tawny (never yellow) with numerous dark specks, of variable form and distribution, which do not appear on the lower surface of the head and neck. ♀♀ **adults** are less intense in colour than the ♂♂. **Young specimens**: the adult habitus begins to appear with sexual maturity, in males therefore at 2-3 years of age, at about one metre in length (cf. SCHÄTTI, 1988; FRANZEN *et al.*, 2008), later in ♀♀. Until then, the chromatic dorsal appearance of young specimens is reminiscent of that of the young *Dolichophis caspius*, olive grey with dark spots or bars (habitus *asianus*). The dorsal pattern appears increasingly postero-anterior. At birth the belly appears white with reddish speckles; soon the white turns to yellow, then orange, while the speckling becomes darker (a slower process in ♀♀). In sub-adults the belly already shows reddish and extensively mottled with dark hues. A case of axanthochroism (black

phenotype with white belly) was recently reported in a young specimen in SW Turkey (GÖÇMEN *et al.*, 2015).

*Dolichophis jugularis zinneri* (Rhodes, Symi, Halki, Tilos), differing from the typical form for its wider head, shorter and pointed snout, and a cephalic index (max. length/width of the head) less than two (greater than two in *D. j. jugularis*); lower side parts of the head almost always yellow instead of salmon red; and less intensely dark dorsal colouring (the darkening of the dorsal parts decreases postero-anterior). There are also a several yellow-bellied phenotypes (the nominate subspecies normally has red belly), a lower number of ventrals (almost always less than 200), and for lingering juvenile habitus in specimens of over one metre in length. On Tilos some ♂♂ adults show a bright red upper head surface (CATTANEO, 2009, 2012a).

It is worth noting that in ♀♀ of both forms and in Tilos ♂♂ (*zinneri*), the intensity of colouring can be subject to seasonal variations (in hot months, when the species is less exposed to sunlight, the dorsal pattern can become more evident when the background lightens: Fig. 1). In all populations and in both genders, pigmentation appears to increase with exposure to the sun. In addition, in certain populations (like Tilos), the



Fig. 1 — Adult ♂ specimen of *Dolichophis jugularis zinneri* on Tilos with summer appearance (the background lighter, markings are highlighted).

young specimens may lack the posterior dorsal pattern or, at the very least, it can be much less pronounced (Fig. 2). In the *zinneri* subspecies especially, the degree of darkening seems to depend very little on age and more on individual factors, so older individuals can be lighter than the younger. There does not appear to be a correlation between the dorsal and ventral chromatic variability, for example some very dark back specimens may have a yellow ventral surface, others (with the same dorsal characteristics) red and so on.

SEXUAL DIMORPHISM - ♀♀ are smaller and have less intense colours than ♂♂. In comparison to ♂♂, the ♀♀ retain the *asianus* habitus for longer, especially true for those of SW Turkey.

SIMILAR COEXISTING SPECIES - As stated, young individuals of *D. jugularis* closely resemble those of *D. caspius*; the latter, however, unlike congeners, do not have reddish or dark specks on their bellies, so their ventral area appears light (whitish or yellowish) and unblemished. Some individuals can still have some small reddish spots on the most lateral parts of the ventral side.

*Dichotomic table to identify the different subspecies of Dolichophis jugularis (L.) primarily based on ventral colouring: ♀♀ and the young have more faded colouring in this part of their bodies; for the ventral colouring of the D. j. asianus and the Cyprus specimen we used the descriptions, not always consistent, taken from literature.*

<b>1. Belly from yellow-orange to red with dark speckles</b>		<b>2</b>
2. More than 200 ventrals	<i>D. j. jugularis</i>	
– Less than 200 ventrals	<i>D. j. zinneri</i>	
<b>3. Yellow belly with dark speckles</b>	<i>D. j. zinneri</i>	
<b>4. Black belly</b>		<b>5</b>
5. Cyprus Population	<i>D. j. cypriacus</i> *	
– Populations of southern Syria, Jordan, Lebanon, Israel	<i>D. j. asianus</i>	
<b>6. White belly</b>		<b>7</b>
7. Dark speckles	<i>D. j. cypriacus</i> (young) *	
– Reddish speckles	<i>D. j. jugularis</i> (young) **	
<b>8. Belly with black and yellow chequered pattern</b>	<i>D. j. asianus</i> (young)	

\*Fide GÖÇMEN *et al.* (2009).

\*\* The white belly soon turns to yellow, then orange, while the speckles become darker (slower process in ♀♀).





Fig. 2 — Young specimen of *Dolichophis jugularis zinneri* on Tilos (the posterior dorsal pattern is absent).

## 2 – ECO-ETHOLOGY

**HABITAT** - In May, *D. jugularis* seemed typically tied to certain microhabitats, depending on the area researched and independently of the subspecies. This includes, for example, the lentiscus shrub (*Pistacia lentiscus*), the elective microhabitat of the species in Rhodes and Leros, and the laburnum (*Anagyris foetida*) in Halki and on the inland of Kuşadası, and in general the stony pathways covered by deadwood tangles in all of the explored islands. Their reference habitat is still agricultural-pastoral, crossed by trenches and bordered by hedges, walls, metal fencing, gravel roads, ditch, paths, embankments, and even rows of trees. The continuity of these linear topographic elements, which act as a visual reference, may be used by the species as migration “corridors” for reaching their partners (CATTANEO, 2005, 2007). For more details on the type of environment, see Table 2.

**ACTIVE PERIODS** - It appears to be active mainly in the early morning.

**MOVEMENT** - It is one of the fastest snakes in the Mediterranean area, possibly second only to *Malpolon* spp. and *Platyceps najadum*. It is a ground snake which was sometimes observed moving at height in shrubs.

Table 2

*Types of environment most frequented by Dolichophis jugularis (L.) in some areas of SW Turkey and in various islands of the Dodecanese (Greece) based on research conducted in May 2003, 2005-8, 2010-12*

	Habitat	Microhabitat
SW Turkey	Ecotone strips (with dirt roads, hedges, fences) between hilly slopes and cultivated areas; olive groves and wooded areas bordered by active watercourses; swampy environments also	Stony stretches with large scattered boulders, and holes in the ground, taking refuge mainly in those located at the base of olive trees and laburnum ( <i>Anagyris foetida</i> ) shrubs
Kos	Olive groves and slopes down to valley floors on active waterways	Large stones covered with tangled dried branches
Leros	Slopes with shrub vegetation and drystone walls	Mastic shrubs ( <i>Pistacia lentiscus</i> )
Rhodes	Valley sides covered with shrub vegetation and bordered by paths	Mastic shrubs ( <i>Pistacia lentiscus</i> )
Symi	Agricultural-pastoral areas with dry stone walls and fences	Stony stretches covered by tangled dry branches
Halki	Stony slopes with shrub vegetation	Stony stretches covered by extensive tangled dry branches, compacted by the laburnum ( <i>Anagyris foetida</i> ) roots
Tilos	Agricultural-pastoral areas with dry stone walls flanking paths, roads, fences, erosion canyons; often also fields cultivated to grasses	Dry stone walls with extensive vegetation covering the base

POPULATION DENSITY - In all the researched areas the species seemed to be present in high numbers. *D. jugularis* is listed in the IUCN Red List of Threatened Species (IUCN 2012) in the “Last Concern” (LC) category.

TROPHIC SPECTRUM - As shown in Table 3, during May the *D. jugularis* populations of the Dodecanese Islands, both northern and southern, seem to be substantially saurophagous and teriophagous, while on the southwest Turkish coast the specimens seem to be ophiophagous. It seems appropriate to provide more details on the latter observation.

In the faeces and *ingesta* of four ♂♂ adults collected at Gökçe (southwest Turkish coast), remains of snakes with keeled scales were found. Judging from the considerable size of these remains (scales, bones), the snake prey must have been adults of a fairly large species. It was not possible to achieve a more complete identification. In Gökçe, the only snake with these characteristics I observed is the *Montivipera xanthina*. In fact, on more than one occasion I was able to observe this viper in close syntopy with *D. jugularis*. However, that environment (wet and partially swampy) also provides good living conditions for *Natrix natrix* and *Natrix tessellata*, species which also have keeled scales (CATTANEO, 2011).

It is likely that the pure ophiophagy observed in this part of SW Turkey is seasonal and must be interpreted against the backdrop of the interactions that characterise continental ecosystems, which are much more complex than those of insular ecosystems. In May, the availability of ophidian prey is established to be higher (snakes are more active for sexual and trophic reasons) and during this month some usually nocturnal species do emerge during the day (for example, *Montivipera xanthina*), and therefore interact with *D. jugularis*, a diurnal snake.

Moreover, it should also be noted that the collected *Dolichophis* specimens lived near a large cultivated area, on the edge of the type of environment that snakes normally seek out due to the abundance of small mammals. Certainly, the teriophagous snakes often had mutilated tails, from rat bites, while all the *Dolichophis* specimens had intact tails.

Information on *D. jugularis* ophiophagy (referring to both poisonous snakes and those of its own species) can be found in BUTTLE (1995), CATTANEO (2007), GÖÇMEN *et al.* (2008), BAIER *et al.* (2009), KAŞOT (2016).

In conclusion, it seems useful to reiterate that the interesting diphagia which occurs in May in the *D. jugularis* populations of the Dodecanese Islands (substantially saurophagous and teriophagous) and those of the southwestern coast of Turkey (ophiophagous) can be seen to be in correlation with ecological-seasonal factors.

PREDATORY METHODS - On the island of Halki (southern Dodecanese) *D.*

Table 3

*Dolichophis jugularis* (L.): prey found in 39 specimens of several areas of SW Turkey and various islands of the Dodecanese (Greece) during May 2003, 2005, 2007, 2008, 2010, 2011, 2012 (numerical values and percentages refer to snakes with prey)

	SW Turkey	Kos	Leros	Rhodes	Halki	Tilos
<b>REPTILIA</b>						
<b>SAURIA</b>						
<i>Laudakia stellio</i>				1	1	4
<i>Laudakia stellio</i> + <i>Ablepharus kitaibelii</i>					1	
<i>Blanus strauchi</i> + <i>Ablepharus kitaibelii</i>			1			
<i>Ablepharus kitaibelii</i>						1
<i>Heremites auratus</i>	1					
<b>SERPENTES</b>						
<i>Dolichophis jugularis</i> juv.	1					
<i>Platyceps najadum</i>				1		
Spp. indet	4 <sup>1</sup>					
<i>Eirenis modestus</i>	1					
<b>AVES</b>						
<i>Sylvia melanocephala</i> ad.					1	
<b>MAMMALIA</b>						
<i>Crocidura</i> sp.			1			
Muridae	1					
<i>Rattus rattus</i>						1
<i>Rattus</i> sp.			1	1		
<i>Rattus</i> sp. young		9	1	3		
Sp. indet.	1					
SAURIA: 10 = 27.0 %	1		1	1	2	5
SERPENTES: 7 = 18.9 %	6			1		
AVES: 1 = 2.7 %					1	
MAMMALIA: 19 = 51.3 %	2	9	3	4		1
No. snakes with prey	9/16	9/14	4/5	6/10	3/6	6/9

<sup>1</sup> The *ingesta* of one specimen included the remains of one ♂ adult *Lacerta trilineata*.

*jugularis* was actively seen to hunt its prey (*Stellagama stellio*), chasing it into the open. Given its tendency to slip into holes below ground, it is highly likely that it also hunts in tunnels (see below “Anti-predatory behaviour”). Like all members of the *Coluber* (*s.l.*) genus, it kills larger prey by suffocation before swallowing it starting from the head; conversely, it initially grabs smaller prey and holds it with its teeth, then slowly consumes it alive. This latter technique seems to have been adopted to allow it to consume non-venomous snakes, even of its same size and species; in such cases the victim is swallowed and placed in a zigzag position in the stomach, deduced from the alternating ridges along the sides of the predator snake (see GÖÇMEN *et al.*, 2008). A different technique seems to be used to capture vipers; it begins by grabbing the victim’s head with its jaws, which prevents the viper from biting (ANGEL, 1950; BAIER *et al.*, 2009); apart from being toxic, bites are also painful and therefore best avoided. Alternate movements with the two branches of the mandible, directed forwards, allow the attacker to complete its predatory action. Certainly *D. jugularis* (like all viperophagous snakes) must be at least partially immune to poison. This immunity would reflect its appropriate adaptation to the habitat and occur only in certain contexts, where colubers and vipers coexist.

**MORTALITY** - *D. jugularis* very often falls victim to road traffic, particularly in certain phases of its reproductive cycle (partner search, post-copulatory dispersal). Even birds of prey and various mammals (including, in some areas, the wild boar *Sus scrofa*, the badger *Meles meles*, the fox *Vulpes vulpes*, the golden jackal *Canis aureus*) can present a threat to this species.

**ANTI-PREDATORY BEHAVIOUR** - When in danger, this snake usually escapes quickly; when cornered, it bites repeatedly. Its most frequent and preferred way to escape, however, is to go to ground in holes, from which it never seems to stray very far.

**PESTS/DISEASES** - Mites, nematodes and cestodes are the types of parasite found by me in *D. jugularis*. The elderly often have cysts, come very large, on different parts of the body.

**COEXISTENCE WITH RELATED SPECIES** - In Ephesos, Prov. Izmir, west Turkey, in May 2012, I came across a large *Dolichophis caspius* ♂ (ToL over 180 cm) intent on digesting his prey in the sun, an adult *Montivipera xanthina* specimen of considerable size (CATTANEO, 2012b). The coluber was found at the very same site (a stretch of hillside) where a large ♂ of *Dolichophis jugularis* and an exuviae of the same species had been observed a few days earlier. This indicates that the two species, although very similar, can live in close syntopy.

It is known that *D. caspius* and *D. jugularis* live in sympatry in the southern Turkish territory (SCHÄTTI, 1988) and on the Aegean island of Kos

(CATTANEO, 2005; BRUEKERS *et al.*, 2009). According to my own studies, the two colubers seem to settle different parts of Kos: *D. caspius* is more frequently found along the humid coastlines, while *D. jugularis* in more hilly inland areas, although this location dissimilarity, being generic, does not exclude areas of syntopy. In western coastal Turkey (between the deltas of the Küçük and Büyük Menderes rivers), as noted for the *D. jugularis*, the habitat where some of *D. caspius* specimens are found is usually brackish, namely a type of environment also frequented by *D. caspius* on Kos. It is plausible that the non-overlapping habitat found on the Greek island could also exist in other interactive contexts, such as the western coast of Turkey, without excluding the possibility of areas of syntopy, such as that in Ephesos.

However, in relation to these considerations it should be noted that the Turkish coastline, between the final stretches of the rivers Küçük Menderes (= Little Meander) northbound and Büyük Menderes (= Large Meander) southbound, has unique ecological characteristics. Due to the sandy soil, seawater comes inland, changing the soil chemistry to saline-alkaline and helping to form extensive brackish marshes with typical tamarisk vegetation (MÜLLENHOFF *et al.*, 2004; BOLCA *et al.*, 2005). This hydro-geological condition is actually a serious limiting factor for life and for the dispersion of animals and plants. This area may represent a sort of “filter” between areas north of K. Menderes and south of B. Menderes, where selective interchange can occur between species (SIMPSON, 1940). In this specific case, *D. jugularis*, very frequently found throughout the southwestern coast of Turkey, becomes increasingly rare from Milas and to the north (the northern coastal limit seems to be the delta of the river Gediz, Izmir: ARSALAN *et al.*, 2018), while the presence of *D. caspius*, commonly found on the northern coast of Turkey, thins out to the south (southernmost reporting covers the Lycian territory: KUMLUTAŞ *et al.*, 2004). This filter-area could act as a type of ecological barrier between the two species, with the result of defining geographical distribution and hindering their coexistence. Indeed, the distribution of these species along the islands that make up the East Aegean Archipelago seems to reflect that found along the western coast of Turkey. *D. caspius* is found from Lesvos to Patmos-Agathonisi, as expected given the prevailing north-central distribution of this species in the Anatolian peninsula (BARAN & ATATÜR, 1998; FRANZEN *et al.*, 2008). *D. jugularis* is found in the archipelago of Rhodes (Rhodes, Symi, Halki, Tilos, Kastelorizo), reflecting the presence of the species in southern Turkey (BARAN & ATATÜR, 1998; FRANZEN *et al.*, 2008). Both species alternate from Leros to Nysiros or coexist (Kos). The latitude of these islands corresponds to the decreasing presence of one species (*caspius*) on the Turkish mainland and the start of the distribution of the other (*jugularis*), generally in line with the aforementioned filter-area (Fig. 3).

On the Greek island of Symi (Dodecanese) it appears that *D. jugularis*



Fig. 3 — Distribution of *Dolichophis caspius* (dotted) and *Dolichophis jugularis* (in black) in the Eastern Aegean Islands. The two species coexist on the island of Kos. The dashed area indicates the islands where *Dolichophis jugularis zinneri* lives. The dashed continental area between the Menderes rivers indicates the “filter” area (see text).

feeds on *Montivipera xanthina* (BUTTLE, 1995). In Cyprus, the trophic spectrum of *D. jugularis* also includes *Macrovipera lebetina* (BAIER *et al.*, 2009; KAŞOT, 2016) and in southwestern Turkey I have personally witnessed the ophiophagy of this species directed to snakes with keeled scales, most likely *Montivipera xanthina* (see “Trophic spectrum”). Considering the proven viperophagy of *D. caspius*, mentioned at the beginning of this paragraph, *D. caspius* and *D. jugularis* also demonstrate some extraordinary points of convergence in their trophic spectrum.

According to the principle of competitive exclusion, two related species with similar niche should compete in situations of coexistence, unless divergent characteristics at a morphological, physiological or behavioural level have evolved, enabling them to use the habitat and available trophic resources differently (BULLINI, 1985). In this sense, a different timeframe may exist for the activity of two colubers. The black colouring and consequent shortened thermoregulation period of *D. jugularis* may allow it to be active earlier than its congener (see “Active periods”). This would involve exploitation of resources at different times, therefore lessening their interspecific competition. Moreover, despite having a substantially similar trophic niche, the hunting habits of the two species seem to be different. *D. caspius* tends to stalk its prey on sight, covering long distances (personal observation); *D. jugularis*, instead, given its tendency to seek and take refuge in holes (see “Antipredatory

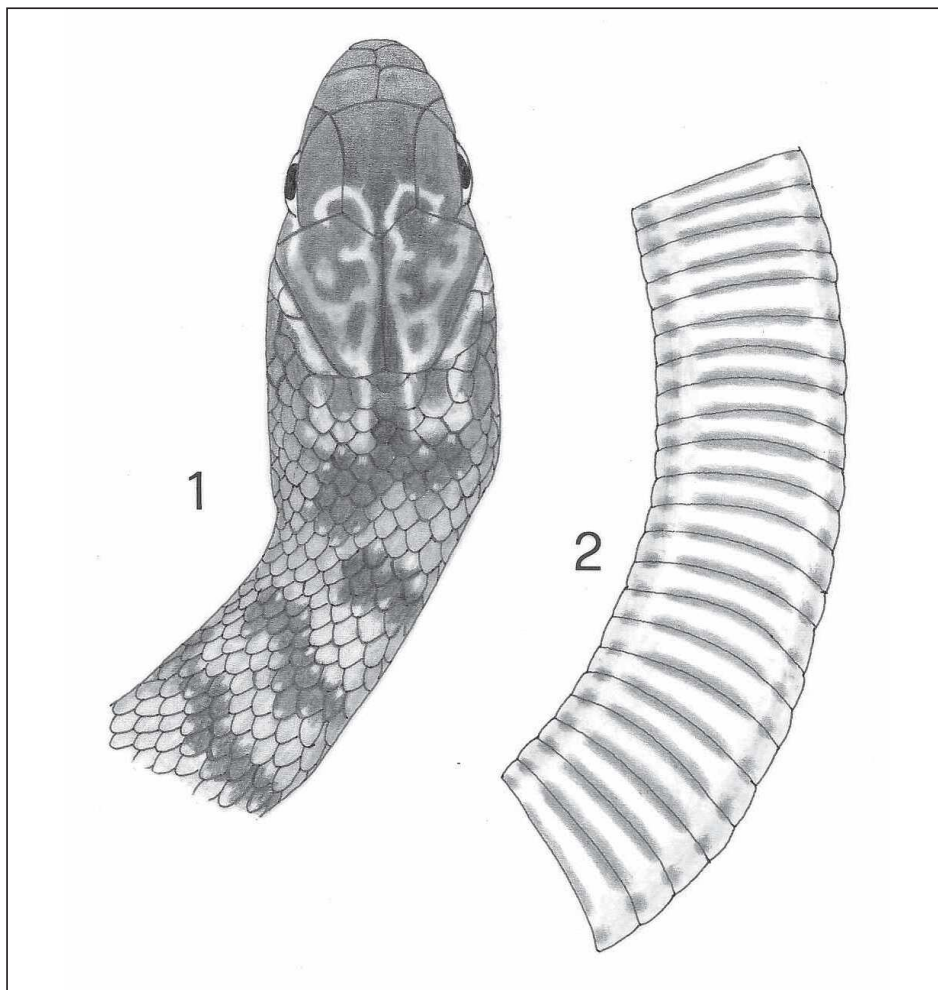


Fig. 4 — The drawing represents a young ♂ specimen of *Dolichophis jugularis zinneri* on Tilos, seen dorsally (1) and ventrally (2). Note the peculiar and complicated cephalic pattern.



behaviour”), presumably hunts more frequently in tunnels, which would mean it would often eat nestlings of small mammals. These eco-ethological differences are of great micro-evolutionary importance, since they are essential for survival and constitute potential insulating mechanisms (MAYR, 1963). Even ZINNER (1972) noticed a certain behavioural divergence between the two species: “In contrast to *C. caspius*, which is mainly a ground dweller, *C. jugularis* is usually found in and on bushes, on trees and walls, and gives the impression of an *Elaphe* in behaviour more than a *Coluber*. It seems it is not usually an active hunter but rather ambushes birds, rodents and lizards.” In areas of syntopy, these and other strategies could be responsible for a recession of the trophic overlap between the two whip snakes. It is plausible to assume that similar behaviours can even be found in the most eastern areas, in this case referred to *D. jugularis* and the other sister species *D. schmidti*.

REPRODUCTION - A young *D. jugularis* ♀ (ToL 102 cm) was captured while pregnant on Tilos (southern Dodecanese), in May 1978, and bred in captivity. After moulting on 11/06/1978 it laid six eggs (two abortive) on 23/06/1978 (palpation of other pregnant ♀♀ of the same species suggested 2–7 eggs, both in microinsular and continental specimens). From the four viable eggs, 25 x 45 mm in size, after about 55–56 days of incubation, the same number of young snakes were born (1 ♂, 3 ♀♀), 32.5–34cm (33.2) long, and 5-6 g (5.5) in weight. The upper parts of their bodies showed the habitus *asianus*; the lower had a light olive-grey hue, though the sides and the distal edges of the ventral scales were darkly marked. The top of the head had a very complex pattern, with light and dark swirls, probably aposematic (Fig. 4).

Of the four new-borns, the three ♀♀ did not survive winter, while the surviving ♂ was raised and fed with lizards, mice, rats and rabbits at varying stages of development, depending on the age of the snake. Table 4 shows the data relating to the trophic-growth cadences of this coluber during its first seven years of life. Sexual maturity (sperm production) was reached on completion of its third year of life; the definitive adult habitus occurred a year later, on completion of its fourth year of life. For comparison, Table 5 shows the data relating to growth in captivity of a young ♀ of the nominate form, captured on the island of Leros (Dodecanese) on May 1977 (and presumably born the previous year). For *D. jugularis*, sexual maturity is reached later by ♀♀ than by ♂♂, and the colouring scheme is different in timing and also in part in appearance, so that the final habitus (intense brown-black) appears very late.

MOULTING - Based on my own experience of captive specimens, adults of *D. jugularis* moult between 2-4 times during an active cycle. Elderly individuals even just once. Young individuals, engaged in more sustained

Table 4  
*Dolichophis jugularis zinneri*: variation of linear dimensions and body mass of a young ♂ specimen from birth to beyond sexual maturity (until completion of the seventh year of age). Data were collected at the end of each year's trophic cycle.

DATA	ToL (CM)	TaL (CM)	TaR	W (G)	PW (G)	TI	N. ECDYSES	COLOURING
18/08/1978 (birth)	32.5	9.5	2.4	6	-	-	-	Back: light olive-grey with dark transversal stripe. Pale belly with dark marking on distal and lateral ventral scale parts. Dorsal part of head with light and dark whirls (Fig. 4)
04/11/1978	37	10.5	2.5	8	12	1.5	2	As at birth
08/12/1979	69.5	21.5	2.2	54	90	1.6	6	Back: darker than at birth, but with transversal striping still very visible. Belly: lemon yellow background; pattern present on front part of body and tail
01/01/1981 (sexual maturity in August)	93	28	2.3	116	230	1.9	4	Back: darker than the previous year but with pattern still visible. Belly: yellow background; pattern practically unchanged compared to a year ago
15/11/1981	116	35	2.3	229	380	1.6	3	Back: darkening of the background continues, but the pattern is still visible, especially laterally. Belly unchanged.
20/11/1982	133	42	2.1	376	570	1.5	3	Back: dark olive brown. Belly: yellow with dark pattern widespread on the first 2/3 of the trunk (also laterally) and under the tail
15//11/1983	148	44	2.3	542	595	1.0	3	Upper parts dark brown (not intense black). Lower parts unchanged
07/11/1984	158.5	48	2.3	691	595	0.8	3	Dark dorsal shades and dark belly patches more intense and widespread compared to the previous year
09/11/1985	165	49	2.3	824	747	0.9	3	Dark dorsal shades and dark belly patches more intense and scattered compared to the previous year

Table 5  
*Dolichophis jugularis jugularis*: variation of linear dimensions and body mass of a young ♀ specimen from capture (probably born the year before) until the presumed ninth year of age. Data were collected at the end of each year's trophic cycle.

DATA	ToL (CM)	TaL (CM)	TaR	W (G)	PW (G)	TI	N. ECDYSES	COLOURING
09/05/1977 (capture; born in 1976)	47	12	2.9	21	-	-	-	Habitus <i>asianus</i>
13/12/1977	-	-	-	22	15	0.6	2	Idem
10/01/1979	59	15	2.9	31	60	1.9	3	Very evident back spots. The background begins to darken. Yellow belly with numerous spots, except in the last part of the trunk. On the tail they tend to line up
14/11/1979	66.5	17	2.9	45	44	0.9	3	Unchanged dorsal parts. Yellow belly parts with fawn colouring. Undertail unchanged
23/02/1981	84	21	3	92	158	1.7	3	Dark-olive upper parts with more developed speckling than previous year. Light-orange lower parts with not very noticeable dark speckling, distributed as in previous years. Lower surface of the head and the first trunk section are white
11/01/1982	-	-	-	143	207	1.4	4	Very similar to above
11/12/1982	103	27	2.8	189	235	1.2	3	Greater development of spots and darkening of background
03/01/1984	112	30	2.7	264	361	1.3	3	Upper parts very dark, but with youthful pattern still visible, especially on sides. Tawny-orange lower parts, with dark spots arranged in the first half of the trunk and on the tail
05/01/1985	116	31.5	2.6	341	333	0.9	3	Upper parts are increasingly less dark from the back to the sides, where noticeable dark youth spots remain. Lower parts orange, with dark speckling, especially in the latter half of the trunk and on the tail. Yellow lips, chin and throat
16/02/1986	122	32	2.8	395	336	0.8	3	Very similar to above

growth cycles, can moult even six times in one year. The reproductive ♀♀, in correlation with hormonal processes related to ovulation, have supplementary moulting compared to ♂♂.

#### CONCLUDING REMARKS

In the past, *D. jugularis* and *D. caspius* have often been considered mutual subspecies. The two species are closely related and are sometimes (the young, sub-adults and females) so morphologically ambiguous as to give rise to errors of identification and consequent taxonomic ambiguities. Actually, *D. jugularis*, *D. caspius* and *D. schmidtii* make up a monophyletic group of species, essentially allopatric, whose juvenile development stages (as stated above) converge remarkably in terms of colouring. The young of all three species display what is commonly and traditionally described and defined as habitus “*asianus*” (see “Identification”/“Colouring”). Only the young *D. jugularis* can be distinguished from the young individuals of the other two species by the presence of dark specks along its belly (FRANZEN *et al.*, 2008). The final appearance of the adult *D. caspius* is a similar habitus to the “*asianus*”, but with no pattern. This similar colouring in the juvenile development stages of the aforementioned “superspecies” probably has a phyletic aspect (as a primitive character) and could imply the prominent role of the *D. caspius* in the evolutionary history of this group, as the most representative of the ancestral species.

#### REFERENCES

- ANGEL F., 1950. Vie et Moeurs des Serpents. *Payot*, Paris, 319 pp.
- ARSALAN D., OLIVIER A., YAŞAR Ç., ISMAIL İ.B., DÖNDÜREN Ö, ERNOUL L., BECK N. & ÇIÇEK K., 2018. Distribution and current status of herpetofauna in the Gediz Delta (Western Anatolia, Turkey). *Herpetology Notes*, 11: 1-15.
- BAHA EL DIN S., 2006. A guide to the reptiles and amphibians of Egypt. *The American University in Cairo Press*, Cairo-New York, XVI + 359 pp.
- BAIER F., SPARROW D.J. & WIEDL H.-J., 2009. The Amphibians and Reptiles of Cyprus. *Edition Chimaira*, Frankfurt am Main, 364 pp.
- BARAN I. & ATATÜR M.K., 1998. Turkish herpetofauna (Amphibians and Reptiles). *Republic of Turkey, Ministry of the Environment*, Ankara, 214 pp.
- BODENHEIMER F.S., 1944. Introduction into the knowledge of the Amphibia and Reptilia of Turkey. *Revue de la Faculté des Sciences de l'Université d'Istanbul*, 9: 1-93.
- BOETTGER O., 1880. Die Reptilien und Amphibien von Syrien, Palaestina und Cypren. *Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfurt am Main*, 1879/1880: 132-219.
- BOLCA M., ALTINBAŞ Ü., KURUKU Y. & TOLGA ESETLILI M., 2005. Determination of Change Detec-

- tion of Landscape of the Kucuk Menderes Delta Using GIS and the Remote Sensing Techniques. *Journal of Applied Sciences*, Faisalabad, 5: 659-665.
- BULLINI L., 1985. Biologia di popolazioni e speciazione. Pp. 145-159 in: Bullini L., Ferraguti M., Mondella F. & Oliverio A. (eds.), *La vita e la sua storia: stato e prospettive degli studi di genetica*. *Scientia*, Milano.
- BUTTLE D., 1995. Herpetological notes on the Dodecanese Islands of Chalki and Symi, Greece. *Brit. Herpetol. Soc. Bull.*, London (52): 33-37.
- BRUEKERS J., UIJTTERSCHOUT G. & BROUWER A., 2009. De Kapische toornslang (*Dolichophis caspius*) en de Aziatische toornslang (*Dolichophis jugularis*) op het Griekse eiland Kos. *Lacerta*, Den Haag, 67: 10-15.
- CATTANEO A., 2005. Osservazioni sull'erpetofauna dell'isola greca di Kos (Sporadi meridionali) con un inedito caso di simpatria microinsulare fra due specie affini di Colubridi: *Hierophis caspius* (Gmelin) e *Hierophis jugularis* (L.). *Atti Mus. Stor. Nat. Maremma*, Grosseto, 21: 79-91.
- CATTANEO A., 2007. Appunti di erpetologia rodiota. *Atti Mus. Civ. Stor. Nat. Trieste*, 53: 11-24.
- CATTANEO A., 2009. L'ofidiofauna delle isole egee di Halki e Tilos (Dodecaneso) con segnalazione di un nuovo fenotipo di *Dolichophis jugularis* (Linnaeus) (Reptilia Serpentes). *Naturalista sicil.*, Palermo, 33: 131-147.
- CATTANEO A., 2011. Risultati di ricerche erpetologiche condotte nell'entroterra di Marmaris (Turchia sud occidentale). *Naturalista sicil.*, Palermo, 35: 133-155.
- CATTANEO A., 2012a. Il colubro gola rossa dell'arcipelago di Rodi: *Dolichophis jugularis zinneri* subsp. nova (Reptilia Serpentes). *Naturalista sicil.*, Palermo, 36: 77-103.
- CATTANEO A., 2012b. Osservazioni sull'erpetofauna di alcune località della Turchia costiera occidentale comprese tra i fiumi Küçük e Büyük Menderes. *Atti Mus. St. Nat. Maremma*, Grosseto, 23: 15-24.
- FLOWER S.S., 1933. Notes on the recent reptiles and amphibians of Egypt, with a list of the species recorded from that kingdom. *Proc. Zool. Soc. London*, 103: 735-851.
- FRANZEN M., BUSSMANN M., KORDGES T. & THIESMEIER B., 2008. Die Amphibien und Reptilien der Südwest-Türkei. *Laurenti Verlag*, Bielefeld, 328 pp.
- GLANDT D., 2010. Die Amphibien und Reptilien Europas. Alle Arten im Porträt. *Quelle & Meyer Verlag*, Wiebelsheim, 716 pp.
- GÖÇMEN B., ATATÜR M.K., BUDAK A., BAHAR H., YILDIZ M.Z. & ALPAGUT-KESKIN N., 2009. Taxonomic notes on the snakes of Northern Cyprus, with observations on their morphologies and ecologies. *Animal Biology*, Leiden, 59: 1-30.
- GÖÇMEN B., NAGY Z.T., ÇIÇEK. K. & AKMAN B., 2015. An unusual juvenile coloration of the whip snake *Dolichophis jugularis* (Linnaeus, 1758) observed in Southwestern Anatolia, Turkey. *Herpetology Notes*, 8: 531-533.
- GÖÇMEN B., WERNER Y.L. & ELBEYLI B., 2008. Cannibalism in *Dolichophis jugularis* (Serpentes: Colubridae): more than random? *Current Herpetology*, Kyoto, 27: 1-7.
- GÖÇMEN B. & YILDIZ M.Z., 2006. Snakes and their relations with humans. *Kıbrıs Bilim (Cyprus Science)*, 2: 28-31 (in Turkish).
- GRUBER U., 1989. Die Schlangen Europas und rund ums Mittelmeer. *Kosmos Naturführer*, Stuttgart, 248 pp.
- KAŞOT N., 2016. Field notes on trophic spectrum of *Dolichophis jugularis* from Northern Cyprus. *Bihorean Biologist*, Oradea, Romania, 10: 153-155.
- KUMLUTAŞ Y., ÖZ M., DURMUŞ H., TUNÇ M.R., ÖZDEMİR A. & DÜŞEN S., (2004). On some lizard species of the western Taurus range. *Turk. J. Zool.*, 28: 225-236.
- LINNAEUS C., 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tomus I. Editio decima, Reformata. *Laurenti Salvii*, Holmiae, 824 pp.

- MAYR E., 1963. Animal Species and Evolution. *Harvard University Press*, Cambridge, Mass., XIV + 797 pp.
- MÜLLENHOFF M., HANDL M., KNIPPING M. & BRÜCKNER H., 2004. The evolution of Lake Bafa (Western Turkey) - Sedimentological, microfaunal and palynological results. Pp. 55-66 in: Schernewski G. & Dolch T. (eds.), *Geographie der Meere und Küsten, Costaline Reports 1*.
- NAGY Z.T., LAWSON R., JOGER U. & WINK M., 2004. Molecular systematics of racers, whip snakes and relatives (Reptilia: Colubridae) using mitochondrial and nuclear markers. *J. Zool. Syst. Evol. Research*, Berlin 42: 223-233.
- SCHÄTTI B., 1986. Morphologie und Systematik von *Coluber algirus* und *C. hippocrepis* (Reptilia: Colubridae). *Bonner zool. Beitr.*, 37: 281-293.
- SCHÄTTI B., 1988. Systematik und Evolution der Schlangengattung *Hierophis* Fitzinger, 1843 (Reptilia, Serpentes). *Inaug. Diss. Univ. Zürich*, 50 pp.
- SCHÄTTI B. & SIGG H., 1989a. Die Herpetofauna der Insel Zypern. Teil 1: Die herpetologische Erforschung/Amphibien. *Herpetofauna*, Weinstadt, 11: 9-18.
- SCHÄTTI B. & SIGG H., 1989b. Die Herpetofauna der Insel Zypern. Teil 2: Schildkröten, Echsen und Schlangen. *Herpetofauna*, Weinstadt, 11: 17-26.
- 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). *Rev. suisse Zool.*, Genève, 108: 919-948.
- SIMPSON G.G., 1940. Mammals and land bridges. *J. Washington Acad. Sci.*, 30: 137-163.
- WALLACH V., WILLIAMS K.L. & BOUNDY J., 2014. Snakes of the world: a catalogue of living and extinct species. *CRC Press, Taylor & Francis Group*, Boca Raton, XXVII + 1209 pp.
- ZINNER H., 1972. Systematics and Evolution of the Species Group *Coluber jugularis* Linnaeus, 1758 - *Coluber caspius* Gmelin, 1789 (Reptilia, Serpentes). Thesis, *Univ. Jerusalem*.

*Indirizzo dell'Autore* — A. CATTANEO, Via Cola di Rienzo, 162 - 00192 Roma (I); e-mail: augustocattaneo@hotmail.com