

Cannibalism in *Dolichophis jugularis* (Serpentes: Colubridae): More than Random?

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Abstract: Four cases of cannibalism among *Dolichophis jugularis* (Serpentes: Colubridae) are reported from Cyprus and Turkey. The number of cannibalism records for this species thus rises to at least six. Due to its opportunistic euryphagy, *D. jugularis* is potentially cannibalistic. Although pure opportunism cannot be ruled out, cannibalistic behaviour may be enhanced in this species by conditions such as starvation.

Key words: Cannibalism; Cyprus; *Dolichophis jugularis*; Food; Intraspecific predation; Turkey.

INTRODUCTION

Cannibalism, intraspecific predation, is an important and widespread process and may be a major factor influencing population structure, life history, competition for mates and resources, and behavior (Polis, 1981; Polis and Myers, 1985; Mitchell, 1986; Mitchell and Walls, in press). A comprehensive compilation of intraspecific predation specifically among reptiles and amphibians was conducted by Polis and Myers (1985). Among reptiles, cannibalism appears to be relatively common in snakes, as these authors listed it from 20 species, compared with 19 species of lizards, despite the generally lower encounter rate of snakes, due to their sparser population, as eco-

logically higher-ranking predators. Mitchell (1986) collected reports of cannibalism in 191 species of reptiles, including 101 species of snakes. Mori and Moriguchi (1988) reviewed the food of 32 species and subspecies of snakes in Japan, in nature. The food of 12 of these taxa included snakes, and in three of these [the colubrids *Dinodon semicarinatum* and *Elaphe climacophora*, and the viperid *Protobothrops flavoviridis* (as *Trimeresurus flavoviridis*)] the prey snakes included conspecifics.

In nature cannibalism is especially frequent among fossorial snakes and among ophiophagous snakes (Gasc, 1994); a typical example of this combination in the Middle East is *Atractaspis engaddensis* (Werner, 1985: figure 1). Cannibalism is particularly known in the colubrid genera *Clelia* and *Malpolon* and the elapid genera *Bungarus* and *Ophiophagus* (Saint-Girons, 1994). Many Australian elapids eat other snakes, including other elapids,

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and several species have been listed by Greer (1997) as having eaten conspecifics [this author quotes Shine (1987) for cannibalism in *Austrelaps* although that paper contains no such evidence]. In captivity cannibalism is easily evoked in additional species (Whitaker, 1970; Hailey, 1981; Saint-Girons, 1994), as also happens in lizards, such as the lacertid *Acanthodactylus schreiberi* (Werner, 1952: figure 3).

Actual field reports on cannibalism in colubrid snake species are scarce (Polis, 1981; Polis and Myers, 1985; Mori and Moriguchi, 1988). Consequently sometimes marginal or putative cases are reported, such as oophagy by *Coluber viridiflavus* (Schmidlin et al., 1996) or what could easily have been consumption of carrion by *Natrix natrix* (De Wijer and Janssen, 2002). An example of clear cannibalism in natural conditions has been reported by Mienis (1986) between juveniles of *Coluber jugularis* [now *Dolichophis jugularis* (see Nagy et al., 2004)] in Israel. Mienis' observation involved a juvenile 443 mm in total length eating a conspecific juvenile of 410 mm. Cannibalism in the field in subadult *Coluber viridiflavus*, now *Hierophis viridiflavus* (see Nagy et al., 2004) was reported by Naulleau (1987): a male of 130 cm regurgitated a male of 60 cm in the Réserve Nationale de Chizé (SW France) on 14 August 1968. For *D. jugularis*, Disi (2002) also reported (without details) cannibalism in Jordan. On this background we report here four additional cases of actual or attempted cannibalism in *D. jugularis* that occurred in Cyprus and Turkey.

MATERIALS AND METHODS

Dolichophis jugularis, up to 2.5 m total length, almost uniformly black when adult but grey peppered black and white when young (up to ca. 1 m), is an active diurnal snake. It is widespread in Cyprus, Turkey, Syria, Iraq, Lebanon, Jordan and Israel with a vertical distribution up to 1400 m (Göçmen et al., 1996; Disi et al., 2001; Disi, 2002; Baha El Din, 2006). It lives in dry, open places, such as

rocky river banks, rocky-stony slopes, fields, and swamps; can also be seen in gardens, vineyards, and cemeteries. It shelters under stones and in rodent galleries. It is known to feed mainly on rodents (especially mice and rats) and lizards; sometimes even on other snakes (Atatür and Göçmen, 2001; Disi et al., 2001). Since it consumes crop-harming rodents, it was used for agricultural pest control in Cyprus (Göçmen and Yıldız, 2006).

The intra-specific taxonomy may be relevant. Zinner (1972), who commented on the relatively docile behavior of "*Coluber jugularis*" compared with the "ferocious" behaviour of "*C. caspius*", recognized three subspecies of the former: *C. j. jugularis* Linnaeus, 1758, with red throat, in Anatolia and northern Syria (he proved the terra typica, Egypt, as erroneous); *C. j. asianus* Boettger, 1880, with black and white throat, in southern Syria, Lebanon, Jordan and Mediterranean Israel; and *C. j. cypriacus* Zinner, 1972, with mostly black venter, anteriorly speckled with some red, on Cyprus. Unfortunately the Cyprus population may be polluted by artificial introductions from the Aegean in the 1960s (Göçmen and Yıldız, 2006).

Observations in the field and in captivity were conducted in Cyprus and Turkey during several field projects between the years of 1995 and 2007. All specimens that showed cannibalistic behavior were euthanized with ether, fixed by 10% ethanol-formaldehyde mixture injection into the body cavity, and stored in 70% ethanol, except for the last couple which was retained alive. The specimens were numbered and deposited in the Zoology Department of Ege University (ZDEU) Museum. The total length measurements of the specimens were taken by a millimeter ruler. Color photographs of one of the cannibalistic cases were obtained using a mobile phone.

RESULTS

We observed four separate cases of cannibalism in *Dolichophis jugularis*, in Cyprus and Turkey, as follows.

Observation 1: In Gönyeli-Nicosia, Cyprus, in spring (probably early May) 1995, a subadult female of *D. jugularis* (ZDEU 35/1995), total length 795 mm, and a juvenile of the same species, ca. half that size, were caught and placed in a common cloth bag. About a week later, when the bag was opened to take their photographs, only the subadult snake remained there. Its inspection revealed that it had eaten the juvenile.

Observation 2: During field work in the semi-arid environment of Serdarli-Famagusta, Cyprus, in the end of July 2003, we observed an adult female (ZDEU 38/2003), total length 1665 mm, its ventral coloration anteriorly speckled reddish, trying to swallow another adult but somewhat smaller conspecific of unknown sex. Apparently due to our disturbance, she regurgitated the conspecific prey

and both fled. We caught the predator but the prey escaped. Therefore, we could not determine the sex of the latter.

Observation 3: In Kalamaki-Kusadası, Izmir, Turkey, in the beginning of May 2007, we collected two juvenile specimens (ZDEU 200/2007) of somewhat different total length (324 and 394 mm) and placed them in one terrarium. During one month we fed them with hairless baby mice and at the end of this time two portions were given. A week later (10 June 2007) when we returned to feed all laboratory amphibians and reptiles, we observed that the larger *D. jugularis* appeared very strange with undulated flanks and swollen body (Fig. 1a, b), whereas the smaller specimen had disappeared. The surviving presumed predator soon died, retaining its unusual shape (Fig. 1c). Its dissection verified that indeed it

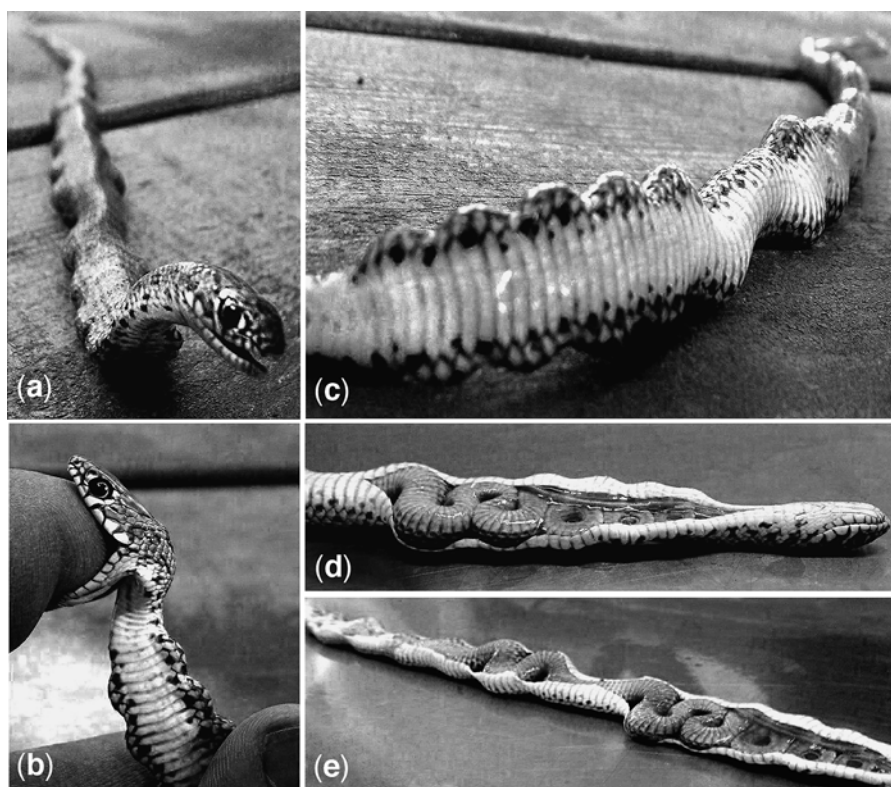


FIG. 1. Cannibalism between the juveniles of the black whip snake, *Dolichophis jugularis jugularis* from the Kalamaki-Kuşadası, Izmir, Turkey. a–c: Predator (a–b in life, c after death); d–e: Prey in the intestine of the dissected predator.

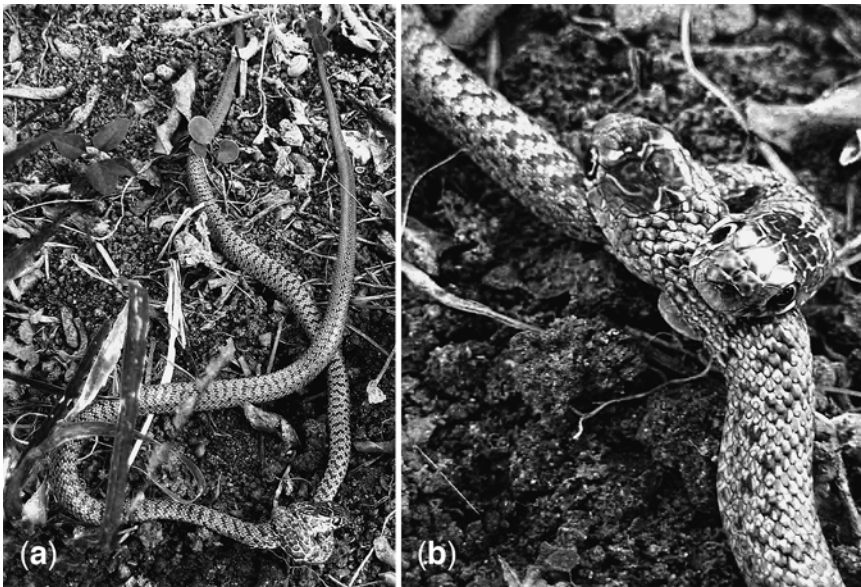


FIG. 2. Cannibalism between the juveniles of black whip snake, *Dolichophis jugularis cypriacus* from Yeşilyurt-Lefke, Cyprus. a: Superiority behaviour between the predator and the prey; b: A close-up view from the same animals.

had eaten the smaller conspecific, which completely filled its intestine and body cavity and disfigured the predator's outline (Fig. 1d, e). Presumably in this case the excessive prey caused the death of the predator.

Observation 4: During field work in the Mediterranean ecozone of Yeşilyurt (=Pendeya)-Güzelyurt, N Cyprus, in the middle of September 2007, we observed and photographed a fourth case of cannibalistic behavior between two juveniles in a natural habitat (citrus grove) (Fig. 2a, b). The two were biting each other behind the head, and although they responded to our presence they did not separate and continued to bite each other. We observed them for ca. 15 minutes in situ. Each seemed to try to overpower the other. Although we took them in our hands, they did not stop this behavior. After additional 15 minutes of this contest we separated them and placed them in separate bags. They measured (total length) 368 and 342 mm. Later we tested them again, putting them in one bag and they resumed the same mutual behavior. Approximately after one hour the larger one started to swallow the

smaller one from the head on. Thereupon we separated them again, and placed them alive in separate laboratory terraria.

DISCUSSION

In view of the scarcity of records of cannibalism in colubrid snakes, certainly in the Middle East, the accumulation of at least six cases for *Dolichophis jugularis*, presumably involving all three subspecies, is intriguing. [Juveniles cannot easily be identified to subspecies on their own merit but by location (Zinner, 1972), observation #3 from Izmir would concern *D. j. jugularis* and the records from Israel (Mienis, 1986) and Jordan (Disi, 2002) would concern *D. j. asianus*. In contrast, observation #2 reported an identifiable *D. j. cypriacus* (Zinner, 1972).] Polis (1981) and Polis and Myers (1985) have listed age, size, sex, density of conspecifics, available food, degree of relatedness, and some other factors as possibly affecting the occurrence and magnitude of cannibalism. While in amphibians cannibalism sometimes appears to be part of

the feeding strategy, in reptiles these authors regarded it as more likely randomly occurring within euryphagous, opportunistic, foraging. More recently, however, some cases of cannibalism in reptiles seem to reflect a strategy of demographic importance (Rootes and Chabreck, 1993; Castilla and Van Damme, 1996).

The concentration of observations involving *D. jugularis* may be related to the cumulative probability of observers to encounter this widespread and euryoecic, thus common, snake. Its conspicuousness due to size (2 m and more) and color (glossy black), however, is irrelevant as most observations concerned juveniles, which are less conspicuous (see above). Two of the cases occurred when predator and prey were artificially confined together (bag and terrarium). While the enhancement of cannibalism in captivity has been ascribed to stress (Polis and Myers, 1985; Mienis, 1986), first of all such confinement brings potential predator and prey together.

In all *D. jugularis* cases reported here the prey was smaller than the predator. Nevertheless, the size difference was amazingly small in three: in observation #3, the prey measured 82% of the predator in length, in Mienis' (1986) observation, 92.5% and in observation #4, 92.9%. Indeed, Mienis' (1986) description of the full-bellied predator resembles our observation #3 (Fig. 1), and it remains unknown whether the predator would have survived without the regurgitation seemingly stimulated by the interference. A yet more extreme case was reported among captive juvenile *Python regius*, where one 42 cm in total length ate another of 46.5 cm (111% of the predator) but died the next day (Greer, 1995). With two observations of nearly equally-sized juvenile *D. jugularis* behaving cannibalistically in the wild [Mienis' (1986) and our #4], we suggest that perhaps as the young hatch and start to forage, they have a high probability of encountering a sibling that they then regard as prey.

Of the six *D. jugularis* reports, only our observation #2 involved fully adult snakes but this shows that the cannibalism of *D. jugularis* is not restricted to the immature. Theoretically,

cannibalistic behaviour could serve to reduce intraspecific competition. However, in view of the varied diet of the species (Esterbauer, 1992; Disi et al., 2001), *D. jugularis* is a potentially cannibalistic species, and conditions in nature, such as starvation and stress (Polis and Myers, 1985; Mienis, 1986), could stimulate cannibalistic behavior. For example, Amr and Disi (1998) surveying the diet of snakes in Jordan, found that out of 30 *D. j. asianus* only one had stomach contents (*Gallus gallus*), compared with 6/33 *Malpolon monspessulanus* that contained prey (including a *D. jugularis*). Conceivably decreasing water sources and other preferable prey species, especially mice, in the semi-arid and warm summer of Cyprus, could increase cannibalism. Alternatively this species' cannibalism may be merely random, opportunistic. Yet it may be sufficiently frequent to be considered a significant feature in the ecology of *Dolichophis jugularis*. The situation may be similar in the American *Coluber constrictor*, from which cannibalism has been reported several times (Mitchell, 1986). Mitchell (1986) has suggested that cannibalistic individuals may suffer from a defect in their mechanism for recognizing conspecifics. If such a phenomenon exists, it may of course be more frequent in some species than in others.

In future it would be interesting to experimentally study the factors and mechanisms underlying reptilian cannibalism (as tried in amphibians—Heinen and Abdella, 2005). In a pioneering experiment, many individuals of *Podarcis hispanica atrata* preferred a conspecific juvenile over a mealworm (Castilla and Van Damme, 1996) but it is unknown how they would regard heterospecific small lizards. In a study of *Chamaeleo chamaeleon* the juveniles avoided the habitat and vicinity of the adults (Keren-Rotem et al., 2006). Upon experimental encounter, the adults, even when not large, shot their tongue at the juveniles, which were protected by a glass partition. However, it remains unsure what happens in natural encounters. First, the analysis of food (many feces and ten stomachs) found no vertebrate remains.

Second, captive *C. chamaeleon* sometimes shoot the tongue at large insects and small lizards that are too strong, leading to fatal over-extension of the tongue (Werner, 1949). Moreover, it is unclear whether the juveniles specifically avoid the conspecific adults, or merely avoid all larger lizards irrespective of their specific allocations. To reveal the nature of reptilian cannibalism, a wider experimental exploration would perhaps be practical, in terms of availability of material, with iguanid lizards, such as *Sceloporus* (Smith and Fritts, 1969; Groves, 1971).

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