Ecological data on the Goldie’s tree cobra, *Pseudohaje goldii* (Elapidae) in southern Nigeria

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Over the last few years, a series of field studies have been published by scientific journals worldwide on the ecology and natural history of highly venomous African elapids (e.g., for studies on *Dendroaspis* see Angilletta, 1994; Branch et al., 1995; Luiselli et al., 2000; Phelps, 2002; for studies on *Naja* see Luiselli and Angelici, 2000; Luiselli, 2001, 2002; Luiselli et al., 2002), thus indicating a renewed interest in the behavioural ecology of these impressive animals after many years in which most studies related to their venoms and clinical outcomes of their bites or taxonomy. However, the tree cobras (genus *Pseudohaje*), despite being highly venomous and impressive in size, have just been subjected to a few brief notes during recent years (e.g., see Pauwels and Ohler, 1999; Pauwels et al., 1999). The relative scarcity of tree cobra studies is likely due to the highly elusive habits of these arboreal elapids compared to mambas and cobras, as well as on their apparent rarity in portions of their ranges in west and central Africa (e.g., see the field notes reported in Cansdale, 1961, and in later literature).

During the long-term field works we have been devoting to study the ecology of forest snakes in Nigeria (1994 up to now, with at least 100 days in the field on each year), we have encountered Goldie’s tree cobras (*Pseudohaje goldii*) on several occasions, and obtained data on their field biology. Although we were unable to get data as detailed and informative as those we collected from other species including e.g. cobras and green mambas (Luiselli et al., 2000, 2002; Luiselli, 2001, 2002), nonetheless we feel that our data are still important to improve the knowledge of the tree cobras biology, given that nearly to nothing is known of the field ecology of these elapids. Therefore, in this paper we collate all our field data on the tree cobras in southern Nigeria, although we realize that the data presented in this paper may have some limitations due to a relatively small sample size.

Distribution data for Goldie’s tree cobra reported here are based on our original records (years 1994-2004) and recent bibliographic information (i.e. Butler and Reid, 1986, 1990). Our aim is not to review all the historical Nigerian records for this species (i.e. those before 1980), because the habitat changes in Nigeria have been so impressive in the last decades (mainly due to huge industry expansion, tremendous urbanization, forest habitat loss, and pollution) that we are almost sure that several (most?) old distribution records are no longer valid. Additional zoogeographic data on *Pseudohaje* species is reported in Hughes (1976, 1983), and general distribution maps in Spawls and Branch (1997) and Chippaux (1999).

Our field study was carried out from September 1996 to March 2004 (with additional data recorded in 1994 and 1995), in several localities of south-eastern Nigeria (for the territories surveyed cf. Luiselli and Angelici, 2000), situated in the central and eastern axis of the Niger Delta (Edo, Delta, Bayelsa, and Rivers States), in Anambra, Enugu, Akwa-Ibom, Abia, and Cross River States. The study region is tropical, with a wet season from May to October, and a dry season from November to April. The wettest period of the year is June-July, and the driest period between late December and February. Climatic data for a typical locality inhabited by tree cobras in southern Nigeria are given in fig. 1.

Methods used to survey the study area, capture snakes, and analyse their food items, are detailed elsewhere (e.g., Luiselli et al., 1998, 2002). Fieldwork was conducted under all climatic conditions, but with a bias toward diurnal hours.

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Figure 1. Frequency of rainy days per month (bars) and mean monthly relative humidity (line) at a locality of southern Nigeria, where tree cobras were captured (Calabar; data from the Department of Geography, University of Calabar, Nigeria).

(from 8 a.m. to 6 p.m.) due to security constraints related to the prevailing unstable political situation. Field effort was almost identical in the wet (526 field days) and dry (537 field days) seasons.

We searched for snakes along standardized routes in the various micro-habitats frequented by snakes at the study areas. We captured snakes by hand or, more frequently, with the help of sticks, but additional free-ranging specimens were captured by traps used by locals to capture terrestrial animals. We always recorded the site of capture and the habitat at each capture site. Occasionally, tree cobras were also captured in traps placed to sample arboreal rodents (Angelici and Luiselli, 2005).

The habitats of capture were defined as follows:
(a) Primary (mature) rainforest, i.e. a forest resembling the typical ‘biafreen’ forest of Letouzey (1968), with a high density of big trees (over 240 stems greater than 30 cm diameter at breast height (dbh) per hectare, and about 40-60 stems of 1 m and above dbh per hectare);
(b) Secondary rainforest, i.e. re-growing dry forest with *Terminalia superba*, *Dacryodes* sp., *Elaeis guineensis*, *Mitragyna* sp., etc; rather low density of big trees (less than 100 stems greater than 30 cm diameter at breast height (dbh) per hectare, and no more than 6-10 stems of 1 m and above dbh per hectare);
(c) Plantations (>2 ha), i.e. small patches of cassava, palm oil, yam, and pineapple plantations on edges of secondary forest, used for subsistence by local family groups of people;
(d) Permanently flooded swamp forest, with the most abundant plant species being *Pterocarpus* sp., *Raphia* sp., *Triumphetta eriophlebia*, *Mitragyna stipulosa*, *Triplichiton scleroxylon*, *Khaya* sp., *Terminalia superba*, *Mitragyna ciliata*, and others;
(e) Altered bush, i.e. overgrown banana farms, with *Raphia vinforesa* and *Pandanus* sp. growing along small seasonal water bodies, with rubber trees and *Gmelina* also present;
(f) Suburbia, i.e. strongly altered habitat found near roads, with mature mango trees, plantains, ornamental shrubs, cassava fields, and grassy fields with *Telpharix* and *Tiltnium*, and bare sand; the density of houses was 0.8-1.5 per ha;
(g) arboreal mangroves (*Rhizophora racemosa* and *Avicennia marina*) growing on the banks of brackish-water river tracts.

Each snake was measured for snout-vent length (SVL, to the nearest ± 1 cm), and individually marked by ventral scale clipping for future identification. Then, the snakes were palpated in the abdomen until regurgitation of ingested food or defecation occurred. In addition, specimens found already dead during our surveys (e.g., snakes killed by farmers, or by cars, etc) were dissected to determine if prey were present. We identified prey items to the lowest taxonomic level possible. Although in this article we used data collected from both stomachs (most of the items) and faeces, no specimen for which stomach contents were used was also used for faecal pellets, to avoid multiple counts of the same food items. The food contents from both faeces and stomachs of a same snake specimen were considered in the cases in which, for instance, faecal samples contained mammal hair and the stomach a frog.

All statistical tests were two-tailed, with alpha set at 0.05. Means are followed by ± 1 SD.

Local distribution. Two species of tree cobras are reported for Nigeria, i.e. *Pseudohaje nigra* and *Pseudohaje goldii* (Hughes, 1976, 1983; Spawls and Branch, 1997; Chippaux, 1999). *Pseudohaje nigra* is a typical inhabitant of west African forests, from Sierra Leone east...
to Ghana, but with a single record from southern Nigeria (Enugu, Enugu State) (Hughes, 1976; Spawls and Branch, 1997). We were unable to find any specimen of *P. nigra* during our long-term researches in the Nigerian forests, although we had also made attempts to explore sites around Enugu presumably inhabited by this species. We also visited several high schools in the Enugu area to check whether any such snakes was present in their ‘collections’ for exhibition to students, but with no success. Actually, the hilly areas around Enugu are characterized mainly by a patchy mosaic of derived savannas and plantations, with few remnant secondary forests, generally of very limited surface. Thus, if *P. nigra* is at all still occurring around Enugu, it must be very rare and presumably confined to a few scattered spots. Indeed, we observed several large arboreal snakes from this area (mainly *Thrasops* spp. and *Dendroaspis jamesoni*), but with no proof of the current existence of any remnant population of *P. nigra*. Unless further studies confirm the presence of *P. nigra* around Enugu, we think that it would be cautionary to delete this elapid species from the current snake-fauna of Nigeria.

*Pseudohaje goldii* is widely distributed in central Africa from Kenya westwards to Nigeria, with two specimens also known from Ghana (Hughes, 1976; Spawls and Branch, 1997). Its type locality is in Nigeria (Asaba in western Niger Delta, see Chippaux, 1999). Recent records for this species include:

1. the area of Calabar (Cross River State), where a single specimen was captured in October 1983 by J. Reid in forest habitat (Butler and Reid, 1986; according to J. Butler (personal communication, September 2002) it was found squashed along the road), and where it was repeatedly captured by us in 1996-2002;
2. the Oban Hills, also in Cross River State (extreme south-east of Nigeria, close to the borders with Cameroon), where the species was captured by Reid (1989) and Schmitt (1996), and where it was repeatedly captured also by us in 1996-2002;
3. the neighbouring of Port Harcourt, in Rivers State (Ahoada village, eastern axis of the Niger Delta), where a scientific expedition of the Agip oil company collected 8 different specimens between 1983 and 1984 (see Politano, 1985), and where it was repeatedly captured by us in 1994-2004;
4. the mangroves of the Rivers Nun and Brass, south-west of Port Harcourt (Rivers State), where 10 specimens were captured between 1996 and 2000 by Luiselli and Akani (2002).

**Habitat and body size characteristics.** Sixty-two Goldie’s tree cobra specimens were captured during our surveys: six were juveniles (SVL ranging from 62.3 to 89.6 cm SVL), 33 were adult males and 23 were adult females. Adult sex-ratio was not significantly different from 1:1 (*P* > 0.1). Adult SVL was significantly larger in males (\(\bar{x} = 156.2 \pm 23.9\) cm, \(n = 33\)) than in females (\(\bar{x} = 146.0 \pm 16.8\) cm, \(n = 23\)) (inter-sample comparison: one-way ANOVA – \(F_{1,54} = 5.202, P = 0.026\)). Maximum size was also attained by males (203 cm SVL for the largest specimen, with three specimens over 200 cm, and 24.2% of the specimens over 170 cm SVL), whereas the maximum size of a female was 181 cm SVL, with just three specimens (= 13% of the total) over 170 cm SVL.

Habitat was recorded for 62 specimens: 29% were captured in primary forest, 14.5% in secondary forest, 4.8% in plantations, 24.2% in swamp-forests, 4.8% in altered bush, 6.4% in suburbs, and 16.1% in mangroves.

70.9% of the specimens were captured less than 25 m (linear distance) from a water body, either a river, a pond, or a marsh, independent on the habitat types where they were captured.

**Diet.** We examined for food contents 62 specimens: 6 were juveniles, 33 were adult males and 23 were adult females. Forty-one specimens...
had the stomach empty. The proportion of specimens that had eaten was, respectively, 16.7% of juveniles, 33.3% of the males, and 39.1% of the females. The single fed juvenile, captured in primary forest, had a frog (*Astylosternus diadematus*) in the stomach. The males had six anurans (*Chiromantis rufescens* in two specimens, *Astylosternus diadematus* in one specimen, *Trycobatrachus robustus* in one specimen, *Bufo maculatus* in one specimen, *Hyperolius guttulatus* in one specimen; all anurans were found in snakes captured in the mangroves area), one juvenile hinge-back tortoise *Kinixys homeana* (this record was already presented in Akani et al., 2003), and two mammals (*Rattus rattus*; both were eaten by snakes captured in suburbs). The females were found to prey on frogs (*Chiromantis rufescens* in three specimens, *Leptopelis* sp. in two specimens, *Bufo maculatus* in one specimen, and *Ptychadena aequiplicata* in one specimen) and on fishes (*Clarias* sp. in two specimens).

Although our sample size is relatively modest, the present study certainly collates the most comprehensive ecological dataset on free-ranging Goldie’s tree cobras from a well defined geographic zone (southern Nigeria), whereas previous data were very scanty and relative to scattered specimens observed across an enormous geographic region (West and Central Africa). Thus, it seems that the present data are valuable to provide a reliable synthesis on the natural history of this little known African elapid in a specific area of its range.

Our data confirm that Goldie’s tree cobras are essentially forest organisms (Spawls and Branch, 1997), although in a very broad sense, as they were found in primary as well as altered forests, mangroves, and swamp-forests. In these varied habitats, however, they rarely appear abundant, and always represent a small percentage of the total number of snakes captured at each site (Luiselli et al., 2005). They seem particularly linked to water bodies (see also Spawls and Branch, 1997), probably because the great majority of their preys were more or less aquatic (amphibians and fishes). Our study also documented that these snakes can survive in suburbs and deforested areas, although we have a comparatively low number of records from these altered areas. The same was also observed in Gabon (Pauwels and Toham, 2002). Certainly, the presence of tree cobras in Nigerian suburbs is much more occasional than that of other elapids, including the spitting cobra *Naja nigricollis* (Butler and Reid, 1986; Luiselli and Angelici, 2000; Luiselli, 2001, 2002) and the Jameson’s green mamba *Dendroaspis jamesoni* (Luiselli et al., 2000).

Adult sex-ratio was not different from equality, as is usual in large elapids from Nigeria (Luiselli and Angelici, 2000; Luiselli et al., 2000), as well as in other arboreal snakes from elsewhere (Phelps, 1989; Shine et al., 1996). The very low number of small sized specimens observed during our surveys (12.9% of the total) suggests that tree cobras grow rapidly through the range of small body sizes (60 to 120 cm SVL), the same being true for other large-sized elapids from Nigeria (Luiselli et al., 2000) as well as from elsewhere (Shine and Covacevich, 1983).

Males in Nigerian populations were clearly bigger than females, possibly as a consequence of the presence of male-male combats for access to females (cf. Shine, 1994). Indeed, we captured two males while fighting in two different occasions during our surveys (both cases in January, thus suggesting the existence of a mating period during the dry season in Nigeria).

Our data clearly showed that the bulk of the diet of Nigerian tree cobras is constituted by anuran amphibians, followed by fishes and, occasionally, by rodents. The males appeared to have a wider dietary spectrum than females, possibly in consequence of their average larger size. Up to recent times, it was supposed that Goldie’s tree cobras were exclusively batrachophagous (Spawls and Branch, 1997), but recent data witnessed that this snake is indeed very generalist in feeding habits, with fishes be-
ing a component of the diet of these elapids (Pauwels et al., 1999). Although our study also documented the usual predation of this elapid upon fishes, nonetheless it is also consistent with Spawls and Branch’s (1997) claiming that it is a batrachophagous species, given that most of our diet records were indeed anurans. In particular, if compared with other sympatric large-sized elapids (Dendroaspis jamesoni and, especially, Naja nigricollis and Naja melanoleuca), Goldie’s tree cobras were much less generalists in terms of dietary spectrum (compare the present data with those given in Luiselli and Angelici, 2000; Luiselli et al., 2000, 2002).

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References


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