Diet Records for Snakes from Guinea, West Africa

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Abstract

We present various predation records based on museum-preserved snakes from southeastern Republic of Guinea, West Africa: *Aparallactus niger* (Atractaspididae) on an earthworm (Oligochaeta); *Crotaphopeltis hotamboeia* (Colubridae) on *Sclerophrys* sp. (Anura; Bufonidae); *Grayia smithii* (Colubridae) and *Natriciteres variegata* (Natricidae) on *Arthroleptis* sp(p). (Anura; Arthroleptidae); *Grayia tholloni* on *Xenopus* cf. *tropicalis* (Anura; Pipidae); *Toxicodryas pulverulenta* (Colubridae) on *Agama* cf. *sankaranica* (Agamidae); *Elapsoidea semiannulata moebiusi* (Elapidae) on *Hemisus* cf. *guineensis* (Anura; Hemisotidae); *Naja savannula* (Elapidae), *Afronatrix anoscopus* (Natricidae) and *Causus maculatus* (Viperidae) on *Sclerophrys regularis*; *Psammophis phillipsii* (Psammophiidae) on *Trachylepis* cf. *affinis* (Scincidae); *Causus maculatus* on *Ptychadena* sp. (Anura; Ptychadenidae); *Limaformosa guirali* (Lamprophiidae) on *Atheris chlorechis* (Viperidae); and *Atheris chlorechis* on *Hyperolius* sp. (Anura; Hyperoliidae). Diagnostic morphological characters are provided for all snakes involved in these records, as well as clutch sizes for pregnant females (*Crotaphopeltis hotamboeia* and *Causus maculatus*). We provide identifications for some insects found in the stomachs of the ingested amphibians.

Keywords

Herpetofauna, Squamata, Anura, Insecta, ecology, predation, food chain, Guinea Conakry, Afrotropics

Introduction

In spite of several recent major contributions (among others, Böhme, 2000; Ineich, 2003; Böhme et al., 2011; Trape and Baldé, 2014), the snake fauna of the Republic of Guinea remains poorly studied. This is even more true for the snakes' ecology and their place in the local food chain. A general classification of Guinean snakes according to their food niches was provided by Böhme (2000), but few documented predation records for Guinean snakes are available to date. Amphibians are an important component in the diet of many snakes, as is also shown in our results below, and the ecology of most Guinean species is still poorly documented (Doumbia *in* Rödel et al., 2021).

In the course of a study on West African preserved snake material housed in the collections of the Royal Belgian Institute of Natural Sciences (RBINS), we came across several individuals from forested southeastern Guinea that had full stomachs, including some being pregnant. We dissected them and present here a compilation of their stomach contents and clutch sizes, as a contribution to the understanding of the importance of snakes and their prey items in the local food web, and to the knowledge of their reproductive biology.

Material and Methods

We dissected only snakes for which we had detected stomach contents or eggs by palpation. Snakes and other squamates were identified using the keys and morphological information provided by Wagner et al. (2009), Trape et al. (2012) (as corrected by Pauwels and Kok [2013]), Wüster et al. (2018), Chippaux and Jackson (2019) and Greenbaum et al. (2021). We identified amphibian prey items using Laurent (1972), Schiøtz (1999), Evans et al. (2015) and Channing and Rödel (2019). Among the insects found in the frogs ingested by the snakes, some were still in good condition, and were transferred within RBINS from the herpetological collections to the entomological collections; the transferred specimens are marked with an asterisk (*).

Morphological data of all snakes involved in the diet and clutch records are presented in Table 1. Snake ventral scales were counted according to the method of Dowling (1951). Snake dorsal scale rows were counted at one head length behind head, at midbody (above the ventral corresponding to half of the total number of ventrals), and at one head length before vent; subcaudal counts exclude the terminal pointed scale. Paired meristic characters are given left/right.

The specimens reported here originate from eight localities in southeastern Guinea: Bankoro Fassirou (9°12'59.0"N, 8°59'41.0"W; alt. 524 m above sea level), Préfecture de Kérouané; Balagbeni (= Baragbéni; 9°12'16.0"N, 8°53'7.0"W; alt. 682 m asl), Préfecture de Kérouané; Damaro (9°07'50"N, 8°54'7"W; alt. 720 m asl), Préfecture de Kérouané; Gpaolé (7°38'22.0"N, 9°13'45.0"W; alt. 411 m asl), Préfecture de Yomou; Guérédou (9°22'30.9"N, 8°54'45.4"W; alt. 732 m asl), Préfecture de Kérouané; Koundian (= Kounian; 9°23'42"N, 8°55'57"W; alt. 588 m asl), Préfecture de Kérouané; Ouetoua (= Oueta; 7°37'8.0"N, 9°16'19.0"W; alt. 417 m asl), Préfecture de Yomou; and Saniamoridou (9°05'35"N, 9°01'17"W; alt. 558 m asl), Préfecture de Kérouané.

Abbreviations: Institutions: RBINS = Royal Belgian Institute of Natural Sciences, Brussels, Belgium. Morphology: A = anal

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Table 1. Morphological data for Guinean snakes. FF = pregnant female. NA = not available/not assessed. For the other abbreviations see Material and Methods.

Species / Specimen	Sex	SVL (mm)	TaL (mm)	DSR	PV+VEN	A	SC	SL	IL	Lor	PreO	SubO	PoO	AT
Atractaspididae														
Aparallactus niger														
RBINS 20301	M	372	105	15-15-15, K	1+146, U	S	1D+62S, U	7(3-4)/7(3-4)	7(4)/7(4)	0/0	1/1	0/0	1/1	0/0
Colubridae														
Crotaphopeltis hotamboeia														
RBINS 20269	FF	470	68	17-19-15, K	2+159, U	S	35, D, U	8(3-5)/8(3-5)	10(5)/10(5)	1/1	1/1	0/0	2/2	1/1
Grayia smithii														
RBINS 20162	M	366	155	17-17-15, U	2+147, U	D	97, D, U	7(4)/7(4)	9(5)/10(5)	1/1	1/1	0/0	2/2	2/2
Grayia tholloni														
RBINS 20166	F	551	347	15-15-15, U	2+146, U	D	112, D, U	8(4-5)/8(4-5)	10(5)/10(5)	1/1	1/1	0/0	2/2	2/2
Toxicodryas pulverulenta														
RBINS 20288	NA	352	95	19-19-15, U	1+249, U	S	114, D, U	8(3-5)/8(3-5)	13(5)/12(4)	1/1	½	0/0	2/2	2/2
Elapidae														
Elapsoidea semiannulata moebiusi														
RBINS 20273	NA	356	26	15-13-13, U	2+152, U	S	17, D, U	7(3-4)/7(3-4)	7(3)/7(3)	0/0	1/1	0/0	2/2	1/1
Naja savannula														
RBINS 20266	F	450	89	23-19-13, U	1+227, U	S	65, D, U	7(3-4)/7(3-4)	8(4)/8(4)	0/0	1/1	0/0	3/3	1/1
Lamprophiidae														
Limaformosa guirali														
RBINS 20292	NA	NA	NA	NA	1+>5	NA	NA	7(3-4)/7(3-4)	8(4)/8(4)	1/1	1/1	0/0	1/1	1/1
Natricidae														
Afronatrix anoscopus														
RBINS 20325	F	490	>101	23-23-19, K	1+139, U	D	>39, D, U	9(0)/9(0)	10(5)/10(5)	1/1	1/1	¾	2/1	1/1
RBINS 20322	F	276	97	23-23-20, K	2+140, U	D	68, D, U	9(0)/8(0)	9(5)/9(5)	1/1	1/1	3/3	2/2	1/1
Natriciteres variegata														
RBINS 20324	NA	153	>27	15-15-15, U	3+131, U	D	>29, D, U	8(4-5)/8(4-5)	8(4)/8(4)	1/1	2/2	0/0	3/3	1/1
Psammophiidae														
Psammophis phillipsii														
RBINS 20286	F	330	>87	17-17-13, U	3+169, U	S	>61, D	8(4-5)/8(4-5)	9(4)/9(4)	1/1	1/1	0/0	2/2	2/2
Viperidae														
Atheris chlorechis														
RBINS 20279	F	394	70	29-31-20, K	1+158, U	S	1D+53S, U	12(0)/12(0)	13(2)/11(3)	NA	NA	2–3 rows	NA	NA
RBINS 20291	F	505	94	30-31-23, K	1+158, U	S	1D+52S, U	NA	NA	NA	NA	NA	NA	NA
Causus maculatus														
RBINS 20265	M	369	39	19-19-12, K	3+134, U	S	17D+4S, U	6(0)/6(0)	9(4)/9(4)	1/1	2/2	1/1	2/2	2/2
RBINS 20274	F	391	28	19-19-13, U	3+141, U	S	16D+1S, U	6(0)/6(0)	9(4)/10(4)	1/1	2/2	1/1	2/2	2/2
RBINS 20275	NA	242	20	19-19-13, U	3+139, U	S	15D+3S, U	6(0)/6(0)	9(4)/9(4)	1/1	2/2	2/1	2/2	2/2

plate; AT = anterior temporals; D = divided; DSR = number of dorsal scale rows; IL = number of infralabials, followed in brackets by the number of IL in contact with the first pair of sublinguals; K = keeled; Lor = number of loreal scales; PoO = number of postoculars; PreO = number of preoculars; PV = number of preventrals; S = single; SC = number of subcaudals; SL = number of supralabials, followed in brackets by the SL in contact with the orbit; SubO = number of suboculars; SVL = snout–vent length; TaL = tail length; U = unkeeled; VEN = number of ventral scales.

Results

Atractaspididae

Aparallactus niger Boulenger, 1897

The stomach of the adult male RBINS 20301 from Guérédou contains a partly digested, more than eight cm long, earthworm (Oligochaeta). As is typical for this snake species, it has seven infralabials, its prefrontals are fused, and its dorsals and supracaudals show discreet keels. Its ventral number (146) is lower than the range of 151–175 indicated by Chippaux and Jackson (2019). The difficulty to detect by palpation stomach contents as soft as a (partly digested) earthworm might explain the lack of diet records for this snake species.

Colubridae

Crotaphopeltis hotamboeia (Laurenti, 1768)

The stomach of the adult pregnant female RBINS 20269 from Balagbeni contains the remains of a *Sclerophrys* sp. ingested head first. The anterior part of the toad is mostly digested, and its own stomach contents are exposed, including remains of three workers and three small soldiers of *Pseudacanthotermes militaris* Hagen, 1858 (Isoptera: Termitidae, Macrotermitinae)*, elytra of a beetle (Coleoptera: Chrysomelidae), and eight differ-

ent ant species (Hymenoptera: Formicidae)*. The most abundant ant species were two *Pheidole* spp. of which more than 20 minor workers were counted for both species. Other ant species present were *Anochetus katonae* Forel, 1907 (three specimens), one major and three minor workers of *Camponotus* sp01, one minor worker of *Camponotus* (*Orthonotomyrmex*) sp01, two workers of *Tetramorium cristatum* Stitz, 1910 and one worker of a Ponerinae (probably *Mesoponera* sp.). The nine eggs of the *Crotaphopeltis* are aligned between ventrals 100 and 152. The first supralabial of this herald snake is in contact with the loreal on the right side, but separated from it on the left side (in the identification key provided by Chippaux and Jackson [2019], *Crotaphopeltis hotamboeia* is separated from *C. degeni* (Boulenger, 1906) and *C. hippocrepis* (Reinhardt, 1843) based on contact vs. no contact between the 1st supralabials and the loreal). Its dorsal scales are mostly smooth, except some posterior ones showing a very poorly marked keel.

An analysis of 283 diet samples of Nigerian *Crotaphopeltis hotamboeia* by Eniang et al. (2013) showed that *Sclerophrys* toads were the second most common prey after *Phrynobatrachus*.

Grayia smithii (Leach, 1818)
The stomach of the juvenile male RBINS 20162 from Koundian contained a male *Arthroleptis* sp. (Anura; Arthroleptidae: removed and registered as RBINS 18409) ingested legs first, as well as several large nematodes (the latter not originating from the frog). The squeaker frog measures 12 mm SVL, and shows a horizontal pupil, unwebbed toes and fingers, toe and finger tips only slightly expanded, a well-marked *canthus rostralis*, a distinctly elongated third finger, a single subgular vocal sac; dorsal surface of head light brown, dorsum light brown with a light vertebral stripe and two pairs of dark brown paravertebral patches; flanks are dark brown, with white patches on the lower flanks. The *Grayia*'s dorsal scale row reduction from 17 to 15 involves the fusion of rows 3 and 4 above ventrals 117 (left) and 136 (right).

The aquatic *Grayia smithii* seems to feed exclusively on fish and anurans, with a marked preference for clawed frogs (*Xenopus*, Pipidae) (Leston and Hughes, 1968; Pauwels et al., 2000; Akani and Luiselli, 2001; Luiselli, 2006). The frog genus *Arthroleptis* has not previously been listed as part of its prey spectrum.

Grayia tholloni Mocquard, 1897
The adult female RBINS 20166 from Bankoro Fassirou had ingested, legs first, an adult *Xenopus* cf. *tropicalis* (Gray, 1864) (Pipidae) (Figure 1). The stomach also contained a specimen of a dealate termite (Insecta: Isoptera, Termitidae), probably from the frog's stomach whose contents are partly exposed, and a long grass-like leaf, the latter probably accidentally ingested while the snake was catching the amphibian. The clawed frog measures about 55 mm SVL, and shows a smooth dorsum, a short subocular tentacle, and three clawed toes plus a claw on the prehallux (one leg is mostly digested, the other is extended anteriorly along the body and mostly preserved). The frog's cloacal area is digested, including the cloacal lobes.

Toxicodryas pulverulenta (Fischer, 1856)
The stomach of the juvenile RBINS 20288 from Gpaolé contains an *Agama* cf. *sankaranica* Chabanaud, 1918 (Agamidae: removed and numbered RBINS 20430) (Figure 2). The agama,

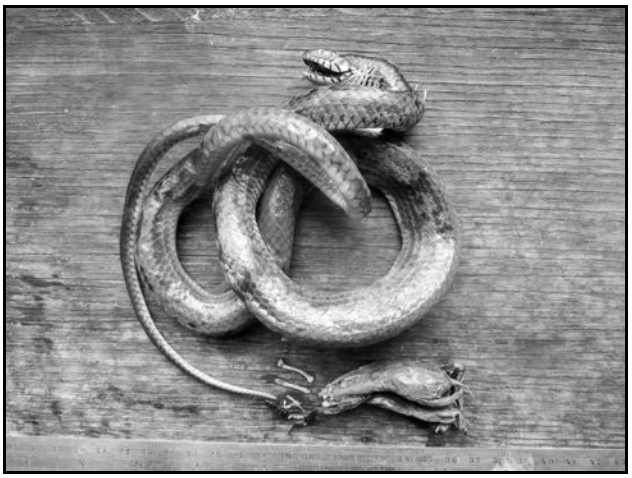

Figure 1. Preserved adult *Grayia tholloni* from Bankoro Fassirou, southeastern Guinea, and its prey, and adult *Xenopus* cf. *tropicalis*. Photograph by O. S. G. Pauwels.

of which the skin of the head is partly digested, measures 41 mm SVL, with a tail length >39 mm (tip missing). It has homogeneous dorsal scalation, 66 scale rows around midbody, and 34 vertebral scales between the level of the posterior insertion point of the anterior members and the anterior insertion point of the posterior members. Four black dorsal bars join each a pair of white irregular, elongated spots on the flanks. It shows no dorsal or caudal crest, no light vertebral line, and no black spot on each side of the neck.

Böhme et al. (2011) reported cases of predation on an agamid of the *Agama agama* complex and on mice by *Toxicodryas pulverulenta* from southeastern Guinea. Following a recent revision of the genus (Greenbaum et al., 2021), *Toxicodryas pulverulenta* has been restricted to West Africa and is confirmed to feed on a wide variety of vertebrate prey, including lizards, birds, shrews and rodents.

Elapidae
Elapsoidea semiannulata moebiusi (Werner, 1897)
The subadult individual RBINS 20273 from Bankoro Fassirou has ingested, head first, an adult female *Hemisus* cf. *guineensis*

Figure 2. Preserved juvenile *Toxicodryas pulverulenta* and its prey, an *Agama* cf. *sankaranica*, from Gpaolé, southeastern Guinea. Photograph by O. S. G. Pauwels.

Figure 3. Preserved subadult *Elapsoidea semiannulata moebiusi* from Bankoro Fassirou, southeastern Guinea, and the adult female *Hemisus* cf. *guineensis* removed from its stomach. Photograph by O. S. G. Pauwels.

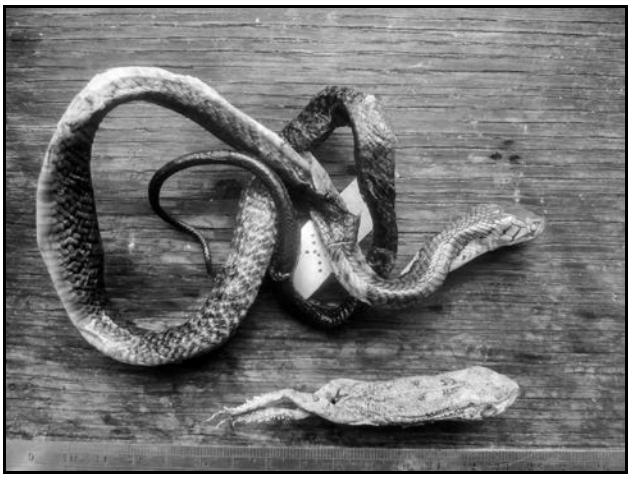

Figure 4. Preserved juvenile *Naja savannula* and its prey, a subadult *Sclerophrys regularis*, from Balagbeni, southeastern Guinea. Photograph by O. S. G. Pauwels.

Cope, 1865 (Anura; Hemisotidae: removed and numbered RBINS 18417) with SVL about 55 mm. While the skin of the head of the piglet frog has been digested, the body is still in good condition, and shows a black dorsum dotted with small, irregular yellow spots (Figure 3).

Mané and Trape (2017) noted that amphibians represented more than a third of the prey items recovered from 13 Senegalese *Elapsoidea semiannulata trapei*. It seems that the fossorial frog genus *Hemisus* had not yet been recorded in this snake's diet.

Naja savannula Broadley, Trape, Chirio & Wüster *in* Wüster et al., 2018
The stomach of a juvenile individual (RBINS 20266) from Balagbeni contains a well preserved subadult *Sclerophrys regularis* (Reuss, 1833) (Anura; Bufonidae: removed and numbered RBINS 18408) with SVL of 44 mm, ingested head first (Figure 4).

No natural history data for this recently described cobra, long confused with *Naja melanoleuca* Hallowell, 1857, were included in its original description (Wüster et al., 2018).

Lamprophiidae
Limaformosa guirali (Mocquard, 1887)
Villagers of Balagbeni encountered an adult individual (RBINS 20292) while it was beginning to swallow an adult female *Atheris chlorechis* (RBINS 20291), head first. The predator snake was killed with a machete and only its head was preserved, while its prey, with its head still within the mouth of the *Atheris*, was entirely preserved (Figure 5). The head scalation of the *Atheris* is hence not accessible, but it was identified based on the other diagnostic characters given in Table 1.

Böhme et al. (2011) recovered a *Boaedon virgatus* (Hallowell, 1854) (Lamprophiidae) from the stomach of a Guinean *Limaformosa guirali*.

Natricidae
Afronatrix anoscopus (Cope, 1861)
The stomach of the adult female RBINS 20325 from Saniamoridou contains the remains of a toad ingested head first, and several nematode worms. The head and forebody of the toad are mostly digested, but the posterior part of the body, a hand and the legs are still in good condition, and show the same morphological characters and coloration presented by an intact, slightly smaller *Sclerophrys regularis* (RBINS 18408, see account for *Naja savannula*) from Balagbeni, and we regard them as conspecific. The toad's stomach contents are exposed and include a femur of a small Orthoptera and an elytra of a small beetle (Coleoptera). The stomach of the subadult female RBINS 20322 from Damaro contains disassembled remains of a fish skeleton.

Böhme et al. (2011) recovered three fish species and unidentifiable frog remains from the stomachs of *Afronatrix* specimens from southeastern Guinea. Trape et al. (2008) found five fish species and one anuran species in the digestive tracts of southeastern Guinean *Afronatrix*. These data agree with observations made by Luiselli et al. (2003) and Luiselli (2006) who recorded only fish and anurans in the diet of *Afronatrix* in southern Nigeria. Within these two vertebrate groups *Afronatrix* however shows a wide eclecticism in its diet and seems to be very opportunistic.

Natriciteres variegata (Peters, 1861)
The juvenile RBINS 20324 from Damaro had ingested two frogs

Figure 5. Preserved adult *Atheris chlorechis* being predated by a *Limaformosa guirali*, from Balagbeni, southeastern Guinea. Photograph by O. S. G. Pauwels.

Figure 6. Preserved adult *Atheris chlorechis* from Ouetoua and its prey, a *Hyperolius* sp. Photograph by O. S. G. Pauwels.

Figure 7. Preserved juvenile *Causus maculatus* from Saniamoridou, southeastern Guinea, along with its prey, a *Ptychadena* sp. Photograph by O. S. G. Pauwels.

head first: one partly digested *Arthroleptis* sp. (Arthroleptidae) with a SVL of ca. 11 mm, and another larger frog, ingested earlier, of which only the legs are still undigested, and which cannot be properly identified.

Extensive studies by Akani and Luiselli (2000) and Luiselli (2003) in southern Nigeria showed that *Natriciteres variegata* consumes a variety of invertebrates and anurans, with a strong preference for the latter, and occasionally fish. Oligochaetes and other soft invertebrate prey items are probably often overlooked, due to their elongate shape and the difficulty to detect them by palpation of the snakes.

Psammophiidae

Psammophis phillipsii (Hallowell, 1844)

The juvenile female RBINS 20286 from Gpaolé had ingested a subadult *Trachylepis* cf. *affinis* (Gray, 1838) (Scincidae). The sand snake's supraocular is in contact with the prefrontal. The skink is in poor condition, with its head and shoulders mostly digested. The skink's intact trunk allows to examine the 28 scale rows around midbody and the tricarinate dorsal scales, and shows a pattern consisting of a brown dorsum with black, irregular paravertebral spots, and on each flank a dark brown stripe separated from the background color by an upper and a lower parallel, discontinuous beige stripes, the lower being more marked. The skink's belly is uniformly beige.

Viperidae

Atheris chlorechis (Pel, 1852)

The female RBINS 20279 from Ouetoua had ingested an adult *Hyperolius* sp. (Anura; Hyperoliidae: removed and numbered RBINS 18410) (Figure 6). The reed frog, ingested legs first, is nearly intact, and shows a SVL of 32 mm, a horizontal pupil, a snout longer than the eye, a uniformly brown dorsum, a dark brown, irregular stripe on the flanks, extending from the snout to the groin; yellow irregular spots on the lower flanks under the dark brown stripe; and belly and lower surfaces of head and limbs uniformly beige. The viper shows 20/18 circumoculars, and a paraventral row much broader than the other dorsal rows (this latter character in contradiction with the identification key and account provided by Chippaux and Jackson [2019]).

Captive *Atheris chlorechis* fed on *Sclerophrys regularis*, *Hemidactylus* "*brookii*" Gray, 1845, and *Trachylepis affinis* (Leston and Hughes, 1968). This viper is an opportunistic predator. See also account for *Limaformosa guirali*.

Causus maculatus (Hallowell, 1842)

The stomach of an adult male (RBINS 20265) from Balagbeni contains the remains of an adult *Sclerophrys regularis* ingested head first. Only the toad's feet are still intact, and the rest of its body is mostly digested, except for its stomach contents, which are still in relatively good condition. They include three workers of the African Stink Ant *Paltothyreus tarsatus* (Fabricius, 1798) (Formicidae Ponerinae)*, one weevil of the genus *Brachycerus* (Curculionidae Brachycerinae)*, and the remains of small Orthoptera. We identified the toad species based on a morphological comparison with an intact conspecific individual from the same locality (see account for *Naja savannula*). This adult *Causus* shows poorly marked keels on its posterior dorsal scales; the anterior dorsals are unkeeled. The pregnant female RBINS 20274 from Saniamoridou contained a partly digested juvenile *Sclerophrys* sp., the feet and some leg bones of an adult *Sclerophrys* sp., and nematodes of various sizes. The clutch includes five eggs, aligned between ventrals 81 and 113. We recovered the posterior part of the body and the legs of a *Ptychadena* sp. (Ptychadenidae) from the juvenile RBINS 20275 from Saniamoridou (Figure 7). The head and forebody of the frog, ingested head first, are digested, but its hands, detached from the body, are still intact.

Leston (1970) found *Sclerophrys regularis* to be the most common prey of *Causus maculatus* living in southern Ghana. Ineich et al. (2006) found *Sclerophrys* spp. to be by far the most common prey for *Causus maculatus* among the anurans they could identify until genus level. Mané and Trape (2019) analyzed the stomach contents of 105 Senegalese *Causus maculatus* and found only amphibians; they mentioned that most were bufonids, but they unfortunately did not provide identification for any of the prey items. Our new records confirm this viper to be a specialist feeder on anurans.

Discussion

Diet spectra attributed in the literature to a number of snake species are artificial, because they are in fact referable to several species before they were separated following taxonomic revisions. In West Africa, recently subject to many revisions and new species descriptions, this is especially true for the genera *Toxicodryas*, *Naja*, *Psammophis* and *Causus*, and other genera are being reviewed, with additional splitting expected. This is why it is important to properly document predation records, localize them geographically, and provide morphological data on the snakes involved, in order to be able to correctly refer the natural history data to the involved species after the taxonomic revisions take place.

Soft and elongate invertebrates, such as worms and many larvae, are probably an important component of the diet of some snakes, but might often be overlooked because they cannot easily be detected by palpation. The same is true for tadpoles. Revealing them requires systematic dissections, often not done if results are not guaranteed, because they damage the snake specimens. This could explain why the dietary spectra of some snakes, such as *Aparallactus niger*, are still so poorly known. That is why systematic dissections of large series of a single species in a given area such as was done by Luiselli's team in southern Nigeria or Trape et al. (2008) in Guinea are important. Such large-scale studies over the long term are rarely possible, and must be done only under controlled circumstances (Trape and Mané, 2019), but remain the best way to clearly understand the predator role of a species in its environment.

Acknowledgments

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