SHORT NOTES

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SCOLECOPHIDIAN SNAKES IN THE DIETS OF SOUTH ASIAN CAECILIAN AMPHIBIANS

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A recent review concluded that "Little is known about the diet of caecilians relative to other tetrapods" (O'Reilly, 2000: 148), a deficiency that is symptomatic of many aspects of the biology of the Order Gymnophiona. It is known that caecilians in nature take a variety of invertebrate prey (e.g. Daudin, 1802-3; Wall, 1922; Gliesch, 1929; Taylor, 1968; Largen *et al.*, 1972; Wake, 1980; Gudynas & Williams, 1986; Hebrard *et al.*, 1992; Nussbaum, 1998; Verdade *et al.*, 2000) and that earthworms and termites (soil ecosystem engineers, Lavelle *et al.*, 1998) make up a substantial proportion of the diet of some terrestrial species.

There are fewer reports in the literature of caecilians taking vertebrate prey. Small fish are known to be eaten in the wild by aquatic species such as *Typhlonectes natans* (Fischer) (Lancini, 1969), *T. compressicauda* (Duméril & Bibron) (Moodie, 1978) and *Potomotyphlus kaupii* (Berthold) (Fuhrmann, 1914). Anuran tadpoles have been reported in the diet of *T. compressicauda* (Verdade *et al.*, 2000) and there is a single report of the remains of an adult anuran in the gut of the semi-aquatic *Chthonerpeton indistinctum* (Reinhardt and Lutken) (Prigioni & Langone, 1983). Moll & Smith (1967) reported discovering two lizards (the teiid *Ameiva undulata parva* Barbour & Noble and the polychrotid *Anolis dollfusianus* Bocourt) in the gut of an adult *Dermophis mexicanus* (Dumèril & Bibron).

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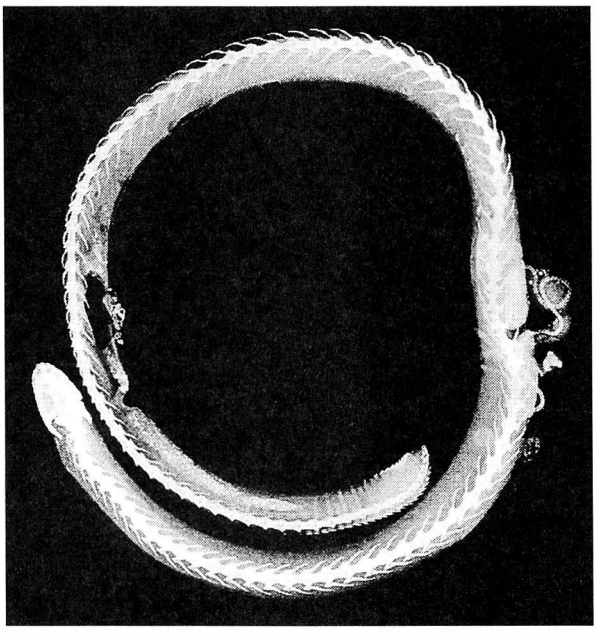

FIG. 1. X-ray from ventral surface of specimen of *Gegeneophis ramaswamii* Taylor showing a scolecophidian snake, *Ramphotyphlops brahminus* (Daudin), inside it. The outline of the snake lies beyond the body of the caecilian because a ventral incision in the body wall resulted in the protrusion of viscera. Total length of the caecilian is 290 mm.

Sarasin & Sarasin (1887-1890) reported that species of *Ichthyophis* eat small burrowing scolecophidian snakes, and Greeff (1884: 18) reported discovering a small scolecophidian in the gut of a *Schistometopum thomense* Barboza du Bocage from the island of Sao Tomé. Here we report and discuss two instances of burrowing scolecophidian snakes in the diets of two south Asian caecilians.

Gegeneophis ramaswamii Taylor is a caeciliid caecilian from the Western Ghats region of southern Kerala, India, where it is common in a wide range of habitats (Oommen *et al.*, 2000). As with many caeciliids, *G. ramaswamii* has a solidly-boned and com-

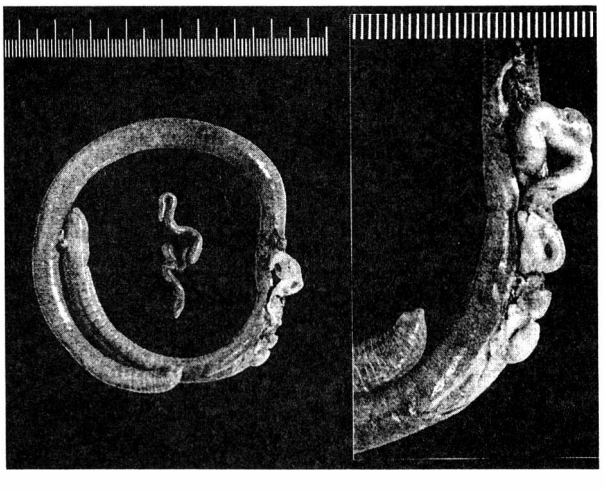

FIG. 2. Photograph of ventral surface of specimen of *Gegeneophis ramaswamii* Taylor and a *Ramphotyphlops brahminus* (Daudin) removed from its gut. Inset shows the snake in the gut prior to dissection. Scale bar in millimetres.

pact skull that lacks an orbit (Ramaswami, 1942) and it is a proficient burrower in soil (pers. obs.). In the course of ongoing studies of this species, a snake was discovered inside one specimen (Department of Zoology, University of Kerala, field tag MW 1292) by X-ray (Fig. 1), and its position within the gut of the caecilian confirmed by dissection (Fig. 2). The *G. ramaswamii* specimen is a relatively large male (total length, TL = 290 mm) collected on 7 July 2000 from near Shonlode, Kanyakumari District, Tamil Nadu (08° 20' N: 77° 23' E, 60 m asl). This is a new locality not reported by Oommen *et al.* (2000), and the second reported presence of *G. ramaswamii* in the state of Tamil Nadu. The specimen was collected from a smallholding (home garden) where it was dug from moist, loose, organically rich soil between a cow shed and a stream. The snake (University of Kerala, MW 2094) is an example of the typhlopid *Ramphotyphlops brahminus* (Daudin), with a TL of about 85 mm. It had been ingested tail-first and was between one third and one half along the alimentary canal of the caecilian. It was not stretched out, but instead sharply folded along its long axis in several places (Fig. 2). There is very little sign of damage caused by digestion. Other than a small patch near the vent end, the scales are in position and undamaged. Despite being protruded, the tongue is also undamaged. The X-ray reveals no indication of bone damage, though the vertebral column appears to have become partially dislocated toward the middle of the body, where the strongest flexion has occurred.

Ichthyophiid caecilians have a less consolidated arrangement of skull bones than *G. ramaswamii*, and a small, but externally visible eye (e.g. Taylor, 1968). Because *Ichthyophis* species are sometimes encountered in leaf litter and loose soil (e.g. Nussbaum & Gans, 1980), they have been considered surface-cryptic (e.g. Ramaswami, 1941), but they can also be found in firm soil (e.g. Nussbaum & Gans, 1980; pers. obs.). The caecilian fauna of Sri Lanka is currently considered to comprise three endemic species of *Ichthyophis* (Nussbaum & Gans, 1980), with *I. glutinosus* (Linnaeus) being the most widespread on the island. On 18 November 2000, a collection of subterranean vertebrates was made by digging compost and moist soil in a garden adjacent to secondary forest in Tiniyawala near Palawatta, Kalutara District, Western Province, Sri Lanka (N 06° 25' E 80° 19', 175 m asl). Taxa collected included examples of the typhlopid scolecophidian snake *Ramphotyphlops brahminus* and the caecilian *I. glutinosus*. One living *R. brahminus* specimen (National Museum, Colombo, field tag MW 1768; TL = 122 mm) was temporarily stored in soil in a small plastic bag within a larger bag containing soil and one living *I. glutinosus* from the same locality (National Museum, Colombo, field tag MW 1769; Mass = 30.9 g, TL = 350 mm). In observing these specimens some six hours later, it was found that the snake had escaped from a small hole in the corner of its small bag. It was found within the larger bag, approximately half-protruding, head-first from the vent of the *I. glutinosus*. The snake was dead, but no significant external damage was apparent. We believe that the most likely explanation for this is that the snake was ingested and egested by the caecilian during the six hours between capture and processing, without being notably digested. An X-ray of the *I. glutinosus* specimen revealed the absence of any other vertebrate prey within the digestive tract.

The single *Ramphotyphlops brahminus* (MW 2049) is the only vertebrate prey found by us in the X-ray examination of approximately four hundred specimens (various institutions) of *Gegeneophis ramaswamii* from many localities in southern Kerala. Similarly, X-rays and dissections (by BP, DJG & MW) of hundreds of ichthyophiids from India, Sri Lanka, and south-east Asia have not previously revealed the presence of vertebrate prey. This suggests that scolecophidian snakes are only a minor part of the diets of these caecilian species. Scolecophidian snakes occur at much lower densities than *G. ramaswamii* and *I. glutinosus* in those habitats in which we have encountered these caecilians (unpublished quantitative data). This is consistent with the hypothesis that these caecilians encounter scolecophidians rarely and feed on them opportunistically.

The generally undigested appearance of the scolecophidian found in the *G. ramaswamii* specimen might be at least partly explained by its relatively anterior position along the alimentary canal. The swift passage of the Sri Lankan scolecophidian through the digestive system of the *I. glutinosus* specimen, and its undamaged appearance, raises the speculative possibility that scolecophidians represent a relatively indigestible class of caecilian prey, from which only limited nutrition can be extracted. It is also possible, perhaps, that the scolecophidian was alive when ingested, and that this, in part, accelerated its rapid passage through the *I. glutinosus* gut. However, there are no background data on the passage time of items through the gut of caecilians.

We recognise that understanding the diets of organisms requires systematic quantitative investigations rather than isolated *ad hoc* reports. However, given the relative lack of data on caecilian diets (O'Reilly, 2000), even isolated reports are worthwhile. Our observations also have additional implications. Gans (1993: 191) suggested that at least Sri Lankan caecilians are generally confined to moist zones: "Consideration of the places where *Ichthyophis* were taken suggests that they always move parallel to streams and do not seem to cross the dry zones between these." Gans contrasted this with the distribution of Sri Lankan scolecophidian snakes (p. 192): "The snakes of the genera *Typhlops* and *Ramphotyphlops* are found on dry surfaces, within dry decaying pieces of wood and beneath rocks." In discussing the significance of fewer probable species of typhlopid scolecophidian snakes in southern India than in (the much smaller area of) Sri Lanka, Gans (1998: 103) stated that "the relative number of species is clearly the

reverse of that in caecilians. This suggests that the two groups occupy truly distinct subsets of the environment and that its subdivision is highly different." The findings presented here demonstrate that caecilians and scolecophidians (at least the widespread *Ramphotyphlops brahminus*) do interact in nature at least occasionally and that their niches are not absolutely disjunct.

Soil biodiversity is a crucial factor in regulating the functioning of terrestrial ecosystems, but the ecology of soil organisms is relatively little studied and understood (e.g. Copley, 2000). Most studies of soil ecology have focused on non-vertebrate organisms, with the potential importance of the natural vertebrate predators of invertebrate soil ecosystem engineers being largely overlooked. Several groups of reptiles and amphibians are soil-dwelling predators and, in general, we believe their ecology is less well understood than that of their relatives that are found in more conspicuous habitats. Tropical soil communities may include a diversity of vertebrates. For example, at the Tiniyawala locality in Sri Lanka, and on the same day as the *I. glutinosus* and *R. brahminus* were collected, single specimens of the fossorial cylindrophiid snake *Cylindrophis maculatus* Linnaeus and of a fossorial scincid lizard *Nessia* sp. Gray were also unearthed. At other Sri Lankan and Indian localities, we have found caecilians in the same habitat as fossorial uropeltid and colubrid snakes. The ecological relations of these co-occurring vertebrates might be expected to be of importance in gaining a fuller understanding of these communities and their impact on soils.

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