

# CAECILIANS: MYSTERIOUS AMPHIBIANS OF THE EASTERN ARC MOUNTAINS

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The Eastern Arc (EA) Mountains are home to many fascinating animals, a proportion of which are restricted to small patches of forest in single mountain blocks. Many of these spatially restricted species are rarely seen or collected. Consequently, little is known of their biology. Nevertheless, it is unusual to misidentify the major group to which any given animal encountered in the field belongs. This is especially true for vertebrates, so that a frog is clearly identifiable as a frog, a bird is a bird etc. However, members of one major group of amphibians are often mistaken as belonging to other vertebrate or even invertebrate groups. These are the caecilian amphibians (Order Gymnophiona). So scant is the knowledge of these creatures that they must be the most poorly known group of tetrapods (the group comprising all amphibians, reptiles, birds and mammals). This is true for all aspects of their biology, including their systematics, i.e. their classification and evolutionary relationships.

Caecilians are poorly understood for a number of reasons, but the main factors are probably their cryptic habits, tropical distribution, and lack of dedicated study. Although one of the six recognised families (the South American Typhlonectidae) includes aquatic species, most caecilians are denizens of the soil, spending time in their subterranean burrows, and probably only coming to the surface during heavy rains and/or possibly at night. As a result, caecilians are very rarely seen in the wild. Caecilian morphology is well adapted to life underground. They



Photo 1. The caecilian, *Scolecomorphus vittatus*

have a robust skull that they push through the soil, and many have their eyes greatly reduced, sometimes to just a small group of cells concealed beneath bone and skin. In such forms, the eyes probably have a limited visual function, perhaps only detecting light and dark. The main sensory apparatus used by caecilians instead appears to be a pair of retractable, probably chemosensory tentacles on the snout that are unique to the group. Unlike other amphibians, caecilians are entirely limbless with elongate snake or worm like bodies. Their resemblance to worms is further enhanced by their moist, externally scaleless amphibian skin and its subdivision into conspicuous rings or annuli.

Bright colours are of no use underground or in communicating with poorly sighted kin. However, some caecilian species are surprisingly brightly coloured, a striking example being *Scolecomorphus vittatus* (Photo 1) from the East Usambara Mountains. This species has a dark dorsum combined with a vivid pink belly. Such contrasting colours are typically used as warnings to predators. The skin secretions of caecilians are almost certainly toxic as they are in other amphibians. Caecilians are carnivorous, with the terrestrial forms probably feeding mostly on earthworms, termites and other invertebrates that live within the soil. Dietary preferences and the impact of caecilians on soil ecosystems are particularly poorly understood and understudied.

*continued page 4*

Caecilians are often regarded as a small, conservative, and even 'primitive' group. However, despite there being only about 160 currently recognised species worldwide, these have diverse morphologies and natural histories. The smallest species reach little over 11cm (*Idiocranium russelli* from Cameroon and *Grandisonia brevis* from the Seychelles), but the largest species reach lengths of over 150cm (*Caecilia thompsoni* from South America). Numbers of vertebrae in the backbone vary from about 70 to over 300. Perhaps the most divergent caecilian discovered thus far is the South American *Atretochoana eiselti* which, at 80 cm, is by far the largest tetrapod to completely lack lungs, and rely entirely on cutaneous gas exchange.

Caecilians are also particularly diverse in their reproductive modes. Some have the typical amphibian life history of aquatic larvae that metamorphose into terrestrial adults, though the eggs are fertilised internally and are laid in terrestrial burrows rather than in water so that hatchling larvae must make their way to nearby water courses. Others develop directly within their terrestrial eggs and completely bypass the larval stage. Some species do not lay eggs but are instead viviparous.

Local names for caecilians often reflect the misconception that they are snakes or earthworms. For example, peoples of the Mahenge Mountains of Tanzania refer to the caecilian *Scolecormorphus kirkii* as 'namtakosa', which means a snake. Unlike earthworms, caecilians are vertebrates with an internal skeleton and toothed jaws. They differ from reptiles, including snakes, in having eggs that lack the complex of amniotic membranes. Another obvious difference is the skin, dry and scaly in reptiles and moist, externally scaleless and highly glandular in caecilians. This was clearly recognised by the pioneer of East African amphibian studies, Sir Arthur Loveridge. His 1944 book 'A Mountain Safari' makes clear that caecilians "may be distinguished from snakes at a glance by the absence of a scaly covering, though some have scales embedded in the skin". Another trait, contributing to the view that caecilians form a natural group with frogs and salamanders, comprising what are recognised today as the three extant amphibian orders, is the adult dentition in which tooth crowns are attached to and sit upon distinct pedicels.

Caecilians are distributed throughout much of the wet tropics, occurring in South America, Africa, the Seychelles, the Indian subcontinent and parts of SE Asia. They are absent (or at least unknown!) from Madagascar and Australasia. A centre of African caecilian diversity is the Eastern Arc (EA), which harbours six of the nineteen species, and representatives of both families (Caeciliidae and Scolecormorphidae) known from the continent. Our ongoing research on caecilians of the EA is focused primarily on their systematics. As a result of our work we anticipate a better understanding of the diversity of EA caecilians, their distribution and evolutionary relationships, along with better tools for reliable identification of caecilian species. We are also trying to understand the historical events that have produced the current geographical distributions of species. Some new species will be described, and we expect to have preliminary results on their ecology and natural history. Understanding the systematics of caecilians is a necessary prerequisite for the interpretation of all other aspects of caecilian biology, from physiology to ecology. Historically, caecilians have been neglected and understudied, but recent work has begun to uncover the fascinating biological diversity of these amazing creatures. We hope our work will continue to add to this growing knowledge.

Caecilians occur on all the mountains of the EA, where they can be



Photo 2. The caeciliid *Boulengerula boulengeri* from the East Usambara Mountains. Photograph kindly provided by James Vonesh.

found in moist soils both in forest and agricultural land. Most EA mountain blocks harbour species of both the genera found in the region, the caeciliid *Boulengerula* (Photo 2) and the scolecormorphid *Scolecormorphus* (Photo 1 & 3). These are very different animals.

*Boulengerula* are slender, with short globular tentacles and eyes very reduced and not visible externally. Species of *Scolecormorphus* are usually more robust with larger maximum sizes (up to 46 cm, in contrast to up to 36 cm in *Boulengerula*), and eyes that are visible when they protrude with closely associated, long tentacles. Species of *Boulengerula* lay eggs which develop directly, while *Scolecormorphus* are viviparous. The systematics of these genera have been recently reviewed, but there still remain several outstanding questions. Previous sampling of EA caecilians was very patchy. Recent work has partly remedied this, and we are optimistic that a combination of morphological and DNA sequence data for representatives of populations from each mountain block will allow us to further refine the taxonomy and provide robust hypotheses of the interrelationships of the species within each genus. This in turn will allow biogeographical hypotheses to be tested.

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Photo 3. A species of the scolecormorphid from the Pare Mountains, note the protruding tentacle near the front of the snout.