

An Anatomical Feature of Caecilian Amphibians: The Lengthening of the Body and Organs

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Editorial

Lengthening of body and organs is widely observed among the animal kingdom. Besides the lengthening of some invertebrates such as worms (Platyhelminthes or flatworms, Nematelminths still called nematodes or roundworms, Annelids), Arthropods (Myriapoda) [1], lengthening is also observed among the Vertebrates. It can be met in fishes more especially such as congers, moray eels, and eels, in reptiles such as the snakes which attempt the maximum of lengthening, but also lizards such as some Scincidae like *Chalcides* or *amphisbaena*, which are equipped with four legs, and also slow-worms which are totally devoid of limbs [2].

Lengthening is also observed in two Amphibians orders: Urodeles and Gymnophiona (Caecilians) [2]. Urodeles group a large number of species characterized by the presence of a tail, and four members linked to two belts. The amphiuma is a well elongated salamander which can measure more than 100cm; its legs are very small, almost vestigial. This animal lives in ponds of southern states of USA. Being aquatic, it possesses a lateral line characteristic of water living anamniotes. Among their characteristics, its metamorphosis is not complete and a pair of internal gills remains besides a pair of lung. The sirens are also long salamanders (25 to 90cm length) characterized with a single pair of anterior legs, and remaining gills the animal being neotenic, i.e. with an uncomplete metamorphosis. They live in the same biotope than amphiuma.

Caecilians (Gymnophionans) are characterized by the lengthening of their body which can measure from 25cm to more than 100cm. Their skeleton is composed with a variable number of vertebrae reaching more than one hundred. They are totally devoid of belt and legs. Nevertheless, it has been shown that the most primitive species belonging to this order (among more than 170 species [3,4]), presented vestigial traces of limbs on the end of vertebrae. In a single specimen of *Ichthyophis glutinosus* and another of *Ichthyophis elongates*, two Asiatic species among the most primitive, some traces of nodules were observed at the tip of 4th to 6th ribs, which can correspond to traces of vestigial anlagen of limbs [5]. The presence of limb buds was observed throughout the embryonic development of *Typhlonectes compressicauda*, an aquatic and viviparous South American species. Between stages 18 and 27, the presence of buds was observed between the 3rd to 6th somite, in the region at which the limbs develop in other amphibians [5]. Detection of RNA performed with a specific pyronin staining showed a more and more intense labeling of these buds, indicating a period of intense period of synthesis. From stage 28, the buds decreased, staining of RNA became weaker and weaker and finished to disappear [5]. Some fossils of Gymnophionans have been found [6-8]. Among them, *Eocilia micropodia* from Arizona presents a pair of girdles with small limbs suggesting that the legs disappeared during the subsequent evolution of the group [9,10].

All the organs of Caecilians are lengthened but some of them are also segmented, recalling the ancestral metamerism. Several reviews of these anatomical tracts have been published [11]. The liver is especially elongated, constituted with several lobes giving a segmented appearance. The adult kidney is a mesonephros looking like a slightly segmented organ with variations according to the species [12,13]. In the anterior part of each kidney, several cell masses of interrenal tissue are more or less segmented. The reproductive systems also are lengthened [14,15]. In males, the testes are segmented with a variable number of lobes according to the species. Each lobe is situated upon a duct, and all the lobes communicate. Each lobe is composed with locules (or lobules or ampullas) in which spermatogenesis occurs. These lobules empty into a pair of duct joining the corresponding kidneys at a glomerular level. Spermatozoa are evacuated by means of the Wolffian duct. Parallel to each testis a Müllerian gland synthesizes some glycoproteic substances which mix with spermatozoa in the cloaca before to be evacuated at breeding. Fertilization is internal and males are equipped with an intromittent organ, the anatomy of which being lightly different according to the species.

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In females also, the ovaries are elongated. Each ovary is constituted with a series germ nests disposed in a segmented pattern throughout the ovary. Follicles and oocytes develop around germ nests and finish to invade the ovary with variations according to the sexual cycle. Parallel to each ovary, a pair of elongated oviduct receives the oocytes in its anterior tubal part. Fertilization occurs in this anterior part and eggs are surrounded with tubal secretions in oviparous and direct-developing species. In viviparous ones, the embryos develop into the posterior part of oviduct, transformed in a uterus according to several modes species-specific.

All caecilians are burrowing, even if they returned secondarily to the aquatic medium. The lengthening of their body and organs could be linked to the burrowing habits of these animals. Exbrayat and Raquet (2009) proposed that when amphibian ancestors emerged out of water, several of them had the possibility to live on the ground, others to live under the ground [16]. Probably the ancestors of Gymnophionans chose this last solution and became burrowing. Evolution then selected more and more lengthened, this anatomical trait making them more performant for an underground life.

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