

Short Notes

Lines of arrested growth in the caecilian, *Typhlonectes natans* (Amphibia: Gymnophiona)

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Following Senning's (1940) study of the parasphenoid of the salamander *Necturus maculosus*, many workers have found that haematoxylinophilic lines of arrested growth (LAG) are laid down in bones of amphibians, including femurs (Smirina, 1972) and phalanges (Hemelaar, 1981). LAG in these bones have been reported for a wide range of anurans and urodeles (see Castanet et al., 1993, for references before 1992, and also: Bastien and Leclair, 1992; Flageole and Leclair, 1992; Tinsley and Tocque, 1995; Guarino et al., 1995; Esteban et al., 1996). LAG have also been found in the vertebrae and flat bones of a number of reptiles (see Castanet and Smirina, 1990). Despite the proliferation of this skeletochronological technique, there have been no investigations of LAG in the poorly known, mostly tropical caecilian amphibians. Although tropical amphibians do not undergo the profound seasonal changes in temperature associated with LAG formation in temperate species, LAG have been found in some species which experience less rigorous climatic conditions (Castanet and Gasc, 1986; Esteban, 1990).

Typhlonectes natans is a viviparous, aquatic caecilian from Colombia and Venezuela where it is found in rivers and lowland swamps (Fuhrmann, 1914; Lancini, 1969; Wilkinson, 1996). This species is frequently exported from Colombia and often available via the tropical fish trade (Wake, 1994). There are several descriptions of behavior and reproduction in captivity (e.g. Heinroth, 1915; Wilkinson, 1980) but little is known of its ecology and behavior in the wild. In this brief note we report the presence of LAG in the vertebrae of *T. natans*.

Trunk vertebrae were dissected from the midbody regions of five formalin fixed, ethanol preserved *Typhlonectes natans* which were obtained commercially and preserved

Table 1. Measurements of *Typhlonectes natans* specimens.

| Individuals | Length (mm) | LAG |
|-------------|-------------|-----|
| j | 154 | 0 |
| m1 | 298 | 2 |
| m2 | 332 | 2 |
| f1 | 421 | 4 |
| f2 | 496 | 7 |

within one month of importation (table 1). Vertebrae were decalcified in 2.5% nitric acid for 4 hours, dehydrated and embedded in wax in a vacuum oven at 60°C. Transverse serial sections of 12 to 20 μm were cut through each vertebra and mounted on gelatinized slides. All preparations were stained with Harris' haematoxylin, counter stained with Eosin, and mounted in DPX (BDH). Stained slides were examined and photographed with a Nikon Optiphot compound microscope.

Specimens varied in total length from 154 to 496 mm and included two mature males (m1, m2), two mature females (f1, f2) and a juvenile (j) of indeterminate sex (table 1). Sections through the vertebral centra of all but the smallest specimen showed a distinct series of concentric darkly stained narrow rings separated by wider bands with paler staining (fig. 1). This is the typical structure of LAG reported for anuran and urodele amphibians. The number of rings was found to be consistent in each of the vertebrae sectioned from each specimen.

The width of the pale bands in the largest specimen (496 mm, female) was found to decrease toward the exterior of the vertebrae (fig. 1b). Inner LAG often showed a change in shape consistent with ontogenetic development. For example, the shape of the inner LAG of specimen m2 (table 1) shown in figure 1a illustrates that, at an earlier stage of development, this region of bone contributed to the paired parasphenes that project anteriorly from the centra of caecilians (bracing against the posteriorly projecting zygosphenes of adjacent vertebrae).

The discovery that *Typhlonectes natans* have LAG shows that they experience periods of no or greatly reduced growth. Without more information on the age of the specimens we cannot infer how frequently *T. natans* undergoes periods of no growth or whether LAG formation is circannual. It is unlikely that periods of no growth are related to temperature because areas such as Maracaibo, where *T. natans* are commonly collected have fairly constant temperatures (of approximately 27°C). It is more likely that periods of no growth are correlated with the distinctly seasonal rainfall. For example, Maracaibo experiences a minimal (0 mm) average rainfall in February and a high peak (110 mm) in October (Walter et al., 1975). Major changes in rainfall are likely to impact upon the availability of food in the aquatic habitat of *T. natans*.

The presence of LAG in both male and female specimens indicates that the formation of LAG is not due to female reproduction, although additional samples are needed to determine whether the female specimens have more LAG solely because of their greater

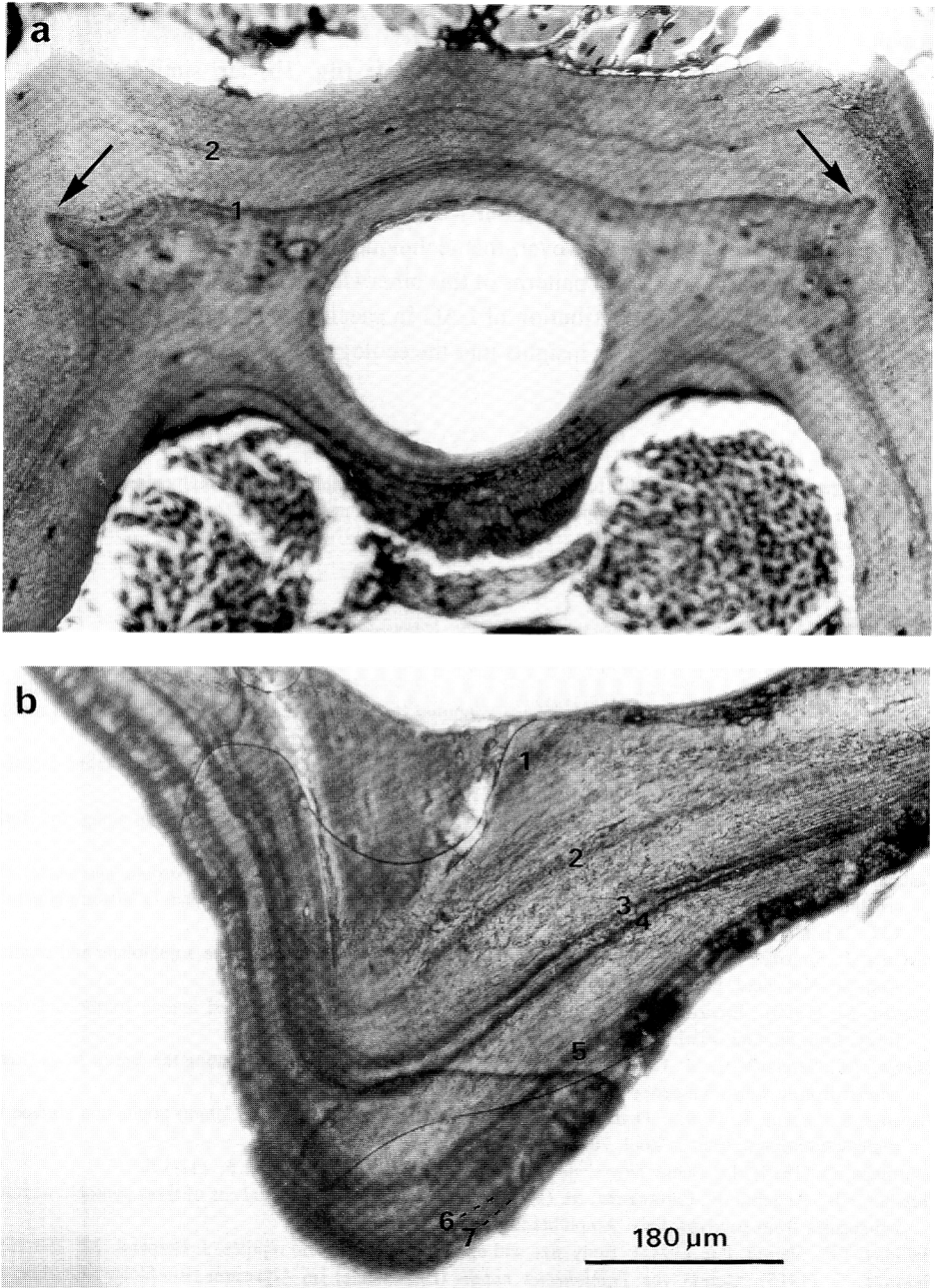


Figure 1. *Typhlonectes natans*, transverse sections of mid body vertebrae of (a) m2 and (b) f2 (table 1). Numbers indicate LAG. Arrows indicate regions inferred to have contributed to vertebral parasphenes at an earlier ontogenetic stage.

age or if, in addition, reproductive investment leads to additional periods of no or reduced growth.

The pattern of LAG found in the largest female (fig. 1b) are similar to those in older anurans and urodeles (see Guarino et al., 1995; Castanet et al., 1996) suggesting that, like other amphibians, the decreasing width of pale growth bands in *T. natans* can be associated with a von Bertalanffy indeterminate growth pattern. LAG cannot be presumed to be annual without validation from long-term studies in known locations (Halliday and Verrell, 1988). However, this technique opens the possibility of studying population structures and growth patterns of this otherwise ecologically unknown species. Further investigation of the distribution of LAG in caecilians, the majority of which are terrestrial, may provide valuable insights into the ecology of this most poorly understood amphibian group.

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