

# Skeletochronology and isotopic analysis of a captive individual of *Alligator mississippiensis* Daudin, 1802

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## Abstract

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In the present study, bone histology and isotope composition (C, N, O) of a femur and three postcranial osteoderms from an approximately 23–25 year-old captive female *Alligator mississippiensis* Daudin, 1802 were analyzed to infer the recorded life history. The number of visible annual growth marks in the femur cross-section is less than the known age for the individual concerned, this information clearly shows that skeletochronology has certain limits. However, bone histology reflects very well the traceable life history of this individual and its slow growth in early ontogeny. Bone histology on the basis of the osteoderms shows massive remodeling and an only incompletely preserved growth record, reflecting the egg-laying status of this individual. Interestingly, the carbon and especially the nitrogen isotope compositions of the osteoderms differ from those of the femur. This presumably reflects dietary changes and/or differences in resorption and remodeling processes during tissue formation of these bones. The N, C, and O isotope composition of the femur is consistent with the food and water the alligator had ingested during the last years of its life. Thus, contrary to the osteoderms, the femur yields reliable data for the reconstruction of an individual's dietary and environmental history.

## Introduction

Skeletochronology, the estimation of individual age based on bone histological data, has been well established to determine the ontogenetic age of Recent and fossil vertebrates (e.g., Ricqlès 1968, 1976a, 1976b; Zug et al. 1986; Castanet et al. 1988, 1993; Castanet & Smirina 1990; Castanet 1994; Horner et al. 1999, 2000; Steyer et al. 2004; Chinsamy 1990, 1993; Chinsamy-Turan 2005; Erickson & Tumanova 2000; Erickson et al. 2004; Erickson 2005; Klein & Sander 2007; Sanchez et al. 2008). However, these techniques are sometimes difficult to use because of the influence of bone remodeling and bone plasticity, and the sometimes irregular appearance of growth marks (Klein & Sander 2008). Additionally, the trigger for the deposition of lines of arrested growth (LAGs) is not entirely understood yet (see discussion in e.g., Starck & Chinsamy 2002; Chinsamy & Hillenius 2004; Padian & Horner 2004; Bybee et al. 2006; Lee & Werning 2008). Simi-

larly, the strictly yearly periodicity of LAGs is questionable, because at least juveniles of tropical turtles and crocodylians seem to miss sometimes deposition of annual LAGs in their early life stage (e.g., Björndal et al. 1998; Padian et al. 2004). Other causes, such as disease, can lead to the deposition of two or even more LAGs per year (Buffrénil & Castanet 2000).

Life conditions and effects on growth are clearly different in captive individuals and the use of skeletochronology is problematic here (Buffrénil 1980a; Chinsamy & Hillenius 2004; Padian & Horner 2004). However, these animals can show the variability but also the constraints of growth rates and bone tissue types in a group. Thus, they yield important information for the understanding of growth and the origin and formation of bone tissues. Because of the availability of more and regular food, combined with less activity and a more constant (warm) climate, crocodylians kept in captivity usually grow much faster than those in the wild (Buffrénil 1980b). A histological sample of a captive crocodylian,

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