Deciphering the life history traits of fossil giraffes from Langebaanweg, South Africa

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Our aim is to deduce the life history traits of two extinct girrafids from Langebaanweg: *Sivatherium hendeyi* and *Giraffa jumae* through an analysis of the histology of their bones and teeth.According to Stearns (1992), the life history traits of an animal underlies its survival and reproduction. For example, age at first reproduction and age at death along with other biological characteristics that co-vary with them (e.g. growth rate, adult body size, size at birth), are considered life history traits. It is well recognised that life history traits are modulated by environmental conditions to maximize the reproductive success of the individual (Stearns 1992). More specifically, predation and resource availability are the main selection pressures that shape an individuals’ life history (Stearns 1992). Thus, the study of life histories, of extinct and extant animals provide valuable insights into many aspects of a species’ biology and ecology, including the ecological conditions of its ecosystem (Stearns 1992).

Since mineralised tissue, such as bones and teeth, grow incrementally, they provide a track-record of the growth and development of the individual (e.g. Klevezal 1996). Thus studying the histology of the bones and teeth (e.g. matrix typology, vascularization, etc.), enables inferences concerning the life history traits of extinct taxa (Castanet et al. 1993, Chinsamy-Turan 2005). Bone histology studies therefore provide information about the age at death, the age at maturity and the overall growth rate. Inferences concerning the rate of growth are mostly based on the qualitative and quantitative analysis of particular characteristics of the bone tissue, such as the number and density of bone cells, the quantity and orientation of the vascular canals and the distribution and organisation of the collagen fibres within the bone matrix (Chinsamy-Turan 2005). Estimations about the age at death and the age at maturity, rely on an assessment of the number of growth rings through skeletochronology (Castanet et al. 1993). Additionally, since in mammals, dental development and key life history events are strongly correlated, studying the incremental marks in enamel and dentinal tissues permit an assessment of the timing and rates of tooth formation (Smith 2008). For example, the eruption of the first permanent molar, correlates with the age at weaning, while the eruption of the third molar correlates with the age at maturity (Dean 2006). Thus, estimations of tooth formation time in the extinct giraffes will provide valuable insights into these aspects their life history, whereas a count of the incremental markings in dental cementum will provide information about the age and/or the season of death (Klevezal 1996). It is therefore evident that the histology of teeth and bones permit valuable insights into various life history traits of extinct animals.

Until quite recently, studies of bone histology aimed at reconstructing the biology and life history of fossil species have essentially focused on birds, reptiles and dinosaurs (see Chinsamy-Turan 2005), while those on dental histology have traditionally focused on primates and hominins (Smith 2008). Many mammalian groups have largely remained relatively unexplored. Fortunately, recent studies on the bones and teeth of equids (e.g. Nacarino-Meneses et al. 2017, Nacarino-Meneses & Köhler 2018), and a comprehensive study of modern giraffe bone histology is nearing completion (Smith et al 2019).These latter studies will provide an important framework for the proposed investigation of the fossil giraffids from Langebaanweg.

Although there are 3 giraffes known from Langebaanweg, here we intend to focus on the Pliocene short-necked giraffe, *Sivatherium hendeyi* and the Plio-Pleistocene *Giraffa jumae (*since they are better represented in the fossil record than the okapi-like giraffid).Thus, the current study proposes to investigate the mineralised tissues (bones and teeth) of *S. hendeyi* and *G. jumae* to obtain life history information that is completely lacking for these animals.

*Sivatherium hendeyi* is a giraffid from the early Pliocene (ca 5Ma) river channel deposit (e.g. Harris 1976; Franz-Odendaal et al. 2004a,b) of Langebaanweg. It is the best represented of the three giraffids and is known by over 500 cranial (skull and teeth) and postcranial elements (Harris 1976). This Plio-Pleistocene *Sivathere* species from Langebaanweg is the youngest member of the Sivathere clade with other members being *S. olduvaiense/maurusium* from Kenya, and *S. giganteum* from Siwalik Hills from India and Pakistan (Rios et al. 2017). Furthermore, of the three giraffids known from Langeabaanweg, only *Sivatherium* has been relatively well studied (e.g. Franz-Odendaal et al. 2004), although no histology studies have been made on this taxon. Here, we propose to analyse the histology of metapodials and molars (1st and 3rd molars ) assigned to *Sivatherium hendeyi* to deduce life history data for this taxon.

Leakey (1965) and Harris (1976) describe *G. jumae* as a large giraffid species, similar in size to *G. camelopardalis* (Harris et al. 2003). It is known from the Plio-Pleistocene localities of East Africa and Langebaanweg. No studies of their mineralized tissues have been done previously. Thus, here we also intend to examine the histology of metapodials and molar specimensof *Giraffa jumae* from the Varswater formation of Langebaanweg.

This study of the mineralised tissue histology of two giraffids from Langebaanweg will provide important life history and palaeocological information, as well as pertinent insight into the evolution of giraffes in South Africa.

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