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Preface

Fossil bones and teeth: Preservation or alteration of biogenic compositions?

1. Bones and teeth — archives for palaeobiology and palaeoenvironment

Hard tissues such as bones and teeth are often the only direct fossil remains of animals and humans and hence represent valuable archives for palaeoecology and palaeoenvironment. The bone and tooth microstructure is often well-preserved down to the μm-scale in fossil specimens recording growth marks and other histological features that are often used for life history reconstructions of extinct animals or humans (e.g., Chinsamy-Turan, 2005; Erickson, 2005; Smith, 2008). In contrast, biomolecules such as proteins or DNA are usually only preserved in Holocene or Late Pleistocene skeletal remains (e.g., Hagelberg et al., 1994; Greenwood et al., 1999; Jones et al., 2001; Collins et al., 2002; Adler et al., 2011; Bocherens et al., 2011) and only rarely reported for pre-Quaternary specimens (e.g., Asara et al., 2007; Schweitzer et al., 2009). The latter finds are, however, controversial. Ancient DNA enables us to infer phylogenetic relations, geographic origin and spatial distribution of species yielding new insight into their evolution (e.g., Pääbo et al., 2004). The chemical compositions of both the mineral phase bioapatite and the protein phase, predominantly collagen, yield important information about the palaeobiology and palaeoecology of fossil vertebrates (Overviews in: Kohn and Cerling, 2002; Hedges et al., 2006; Koch, 2007; Lee-Thorp, 2008; Tütken, 2010) as well as the life history of the individual animal or human (e.g., Hoppe et al., 2011-this issue; Müller et al., 2003; Schweissing and Grupe, 2003; Tütken et al., 2008a). The isotopic compositions of fossil bones and teeth record information about the diet (e.g., Tieszen and Fagre, 1993; Richards et al., 2003; Kohn et al., 2005; Passey et al., 2005; Zazzo et al., 2010; Tütken, 2011), thermophysiology (e.g., Barrick and Showers, 1994 (but see Kohn, 1996); Kolodny et al., 1996; Fricke and Rogers, 2000; Amiot et al., 2006; Bernard et al., 2010; Eagle et al., 2010, 2011), mobility and habitat use (e.g., Vogel et al., 1990; Sillen et al., 1998; Hoppe et al., 1999; Bentley, 2006; Feranec et al., 2007; Kocsis et al., 2007; Hobson and Wassenaar, 2008; Arppe et al., 2009; Tütken and Vennemann, 2009; Chenery et al., 2010; Radloff et al., 2010; Copeland et al., 2011; Tütken et al., in press) of the animals, as well as the geological age of the specimens (e.g., Romer, 2001; Pike et al., 2002; Grün et al., 2010; Fassett et al., 2011) and the contemporaneous climate (e.g., Longinelli, 1984; Fricke and O'Neil, 1996; Sharp and Cerling, 1998; Levin et al., 2006; Tütken et al., 2006, 2007). These are summarised in Fig. 1. Tooth enamel especially is least affected by diagenetic alteration and able to preserve original elemental and isotopic compositions over geological time scales of millions of years (e.g., Lee-Thorp and Sponheimer, 2003; Sponheimer and Lee-Thorp, 2006; Fricke et al., 2008; Heuser et al., 2011).

However, chemical in vivo signals of bones and teeth are often altered during the fossilisation process. These chemical, mineralogical and histological changes during diagenesis are themselves a valuable source of information in their own right. They enable us to characterise the post-mortem history, diagenetic milieu, taphonomic processes and the timing of fossilisation (Turner-Walker, 1999; Reiche et al., 2003; Tütken, 2003; Berna et al., 2004; Pfetzschner, 2004; Wings, 2004; Trueman et al., 2006; Kohn, 2008; Turner-Walker and Jans, 2008;

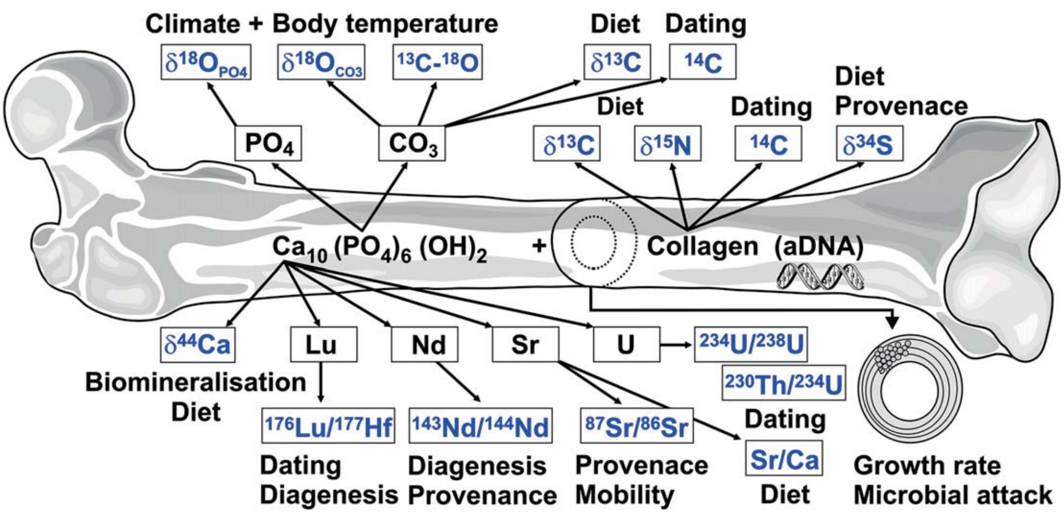

Fig. 1. Elements and isotopes in bones (the same applies for teeth) and their applications for palaeoenvironmental and palaeobiological reconstructions. The use of the bone microstructure to infer life history and growth rate of vertebrates using growth marks is also schematically displayed as well as traces of microbial alteration.

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