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Synchrotron tomography reveals life history and physiology of the earliest mammals

Palaeontological applications of synchrotron techniques such as tomography and spectroscopy have offered a new dimension to palaeobiological studies, revealing what extinct animals ate, the long believed unknowable colour of ancient animals from insects to dinosaurs, and the life histories of animals from the earliest tetrapods to the first humans. Despite recent discoveries and analyses revolutionising our knowledge of Mesozoic mammals (the early mammals living alongside dinosaurs for the first 2/3 of mammalian evolutionary history), little is known about their physiology or life history. Were they warm-blooded, how long did they live, and how active were they? To address this we used synchrotron tomography to measure the lifespan of fossil mammals using growth rings in tooth root cementum, analogous to tree growth rings. Maximum lifespan is highly correlated with many aspects of physiology such as maximum growth and basal metabolic rates.
Traditional cementum growth ring analysis requires destructive thin sectioning of teeth. Since large sample sizes are needed for population maximum lifespan estimates, this is not allowed in valuable fossil material. Tomography allows non-destructive imaging of whole root volumes instead of single slices, improving understanding of cementum ring formation and increasing percentages of successfully counted specimens. Sub-micron scale phase contrast synchrotron tomography is required for its high sensitivity and signal:noise ratios, due to the small size of growth rings and low density-differences between dark/light rings.

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