SKELETAL MICROSTRUCTURE GROWTH DYNAMICS IN ANCIENT HUMANS AND FOSSIL RATS FROM INDONESIAN ISLANDS

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INTRODUCTION

- Substantial evidence exists for insularity manifesting in modern animals through gigantism or dwarfism (MacArthur & Wilson, 2016).
- Previous studies have also described bone histology tissue types in isolated cases of dwarfed and giant vertebrate fossils (Kolb et al., 2015; Köhler & Moyà-Solà, 2009). However, quantitative records in relation to island ecology are currently non-existent for fossil rats and ancient humans.
- This study reconstructed links between skeletal microstructure growth dynamics and skeletal size (Bromage et al., 2009; 2016) in rat and human samples from Timor and Maluku Islands in Southeast Asia (SEA).

MATERIALS & METHODS

- We studied human midshaft femur, occipital bone, and permanent molar histology samples in three adult males of 152.90 – 164.00 cm stature. These individuals were recovered from the Maluku Islands (BCE/CE junction Morotai, 2314–1415 cal. BP Gebe) (**Fig. 1**, Bellwood, In Press). The rat specimens represented ten adult small and giant murids (Murinae spp.) recovered from late Quaternary ca. 5-18 ka deposits on Timor island (**Fig. 1,** Louys et al., 2017).
- Osteocyte lacunae density (Ot.Dn) and secondary osteon parameters were recorded in bone, whereas lateral enamel daily secretion (DSR) and root extension rates were calculated from upper first and second human molars (Miszkiewicz & Mahoney, 2017). Histology data were evaluated against human stature and rat femur size.

FIGURE 1: A - site locations for Timor rats and Maluku human samples (Map data © 2019 Google); **B -** ten fossil rat (n = 9 right, *n = 1 left) femora illustrating size variation from giant to small in the sample (all caudal view); **C -** Schematic illustration of the sampling and Ot.Dn scoring procedure; **D -** fragmented human femur studied from Maluku Islands.

RESULTS

- Results reveal significant (p<0.001) and negative relationships between Ot.Dn and rat femur size, with giant specimens showing low Ot.Dn (Rho min. = -0.891, max. = -0.976) (**Fig. 2**).
- The DSR of 3.9µm (mid-enamel) to 4.6µm (outer enamel) for the human crowns is similar to modern day molars, but the daily extension rate of 7.61µm over the first 2 mm of root growth is faster than the rate roots form over this distance in modern clinical samples.
- The range of remodelling data indicate increased bone deposition (21.18–27.86 #/mm^2) despite the short human adult stature.

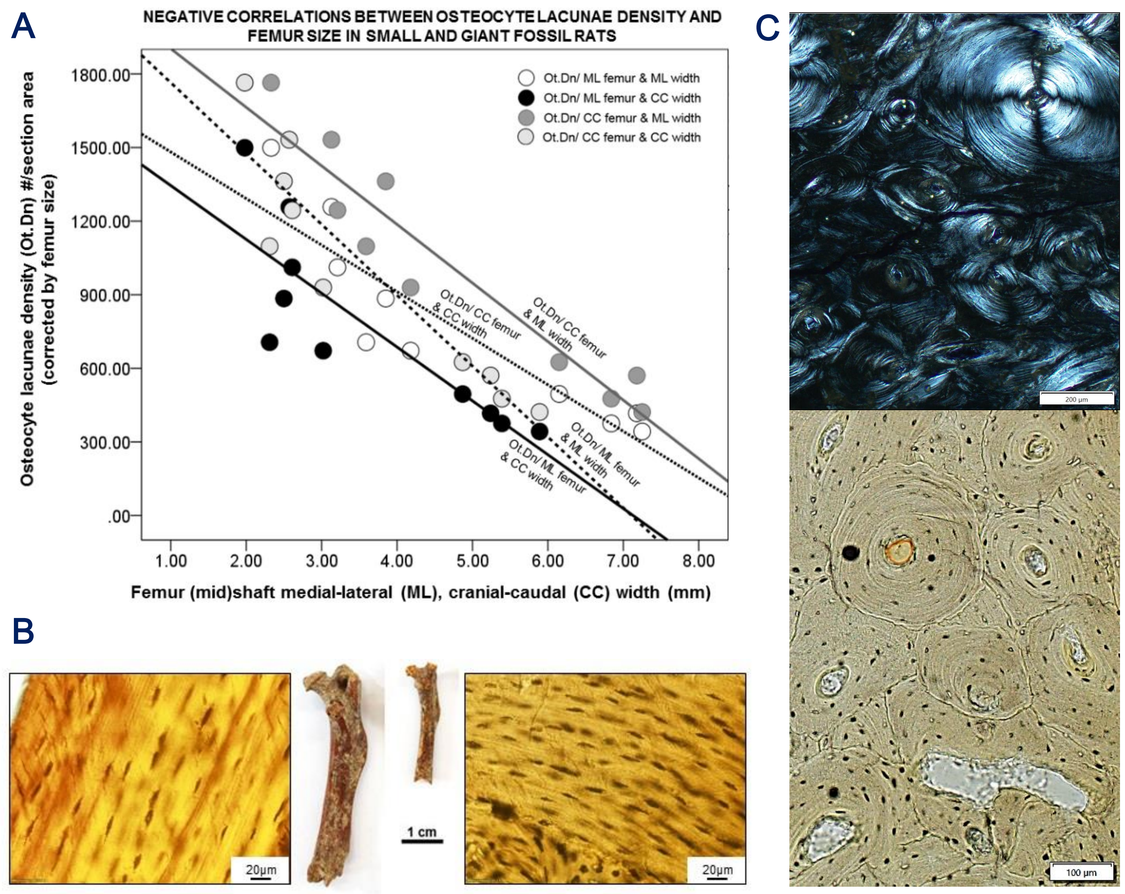

FIGURE 2: A - negative relationships between femur size adjusted osteocyte lacunae density data and femur size; **B -** images of femoral bone histology showing widely and less dispersed osteocyte lacunae in the giant and smaller rat femur (left and right respectively); **C -** images showing well preserved and remodelled secondary osteons in the human occipital (top) and femur (bottom) cortical bone.

DISCUSSION & CONCLUSION

- Findings from our ancient human and rat model experiment suggest that island living may affect internal dynamics of skeletal growth.
- Rat gigantism was associated with a slowing down of metabolism as inferred from low osteocyte lacunae densities that may have occurred in response to favourable Timor island environments (O'Connor et al., 2012).
- Smaller rats in our sample exhibit increased osteocyte lacunae densities, indicating accelerated bone metabolism at a sub-family level. Respectively, we present a gradient from slow to fast in skeletal tissue growth in this sample.
- Such relationships have previously been restricted to mainly higher order comparisons, including a pygmy (*Phanourios*) and normal hippo (*Hippopotamus amphibious*), as well as lesser (*Galago moholi*) and greater (*Cheirogales major*) galago (Bromage et al., 2009).
- It is possible that the three short human individuals increased their growth rates to facilitate a physiological adaptation to island environments.
- We recommend that future research using insular human remains considers internal indicators of their skeletal growth.

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