A55 Inferring Species Origin Through Virtual Histology: A Comparison of Third Metapodials From *Homo Sapiens* and *Ursus Americanus* Using Micro-Computed Tomography

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Learning Overview: The goals of this presentation are to: (1) describe the microstructural differences among human and black bear metacarpals and metatarsals using a non-destructive and volumetric 3D approach, and (2) provide microarchitectural data that will aid species identification efforts when bone fragments are discovered in a forensic context.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by introducing 3D parameters to the study of bear bone microstructure, providing additional information that will aid in the identification of morphologically similar human and non-human remains.

The gross similarities between human hand and foot bones and bear paws have been well documented. Macroscopic skeletal analyses provide insight into species origin when whole bones are recovered but are frequently rendered inapplicable when bones are fragmented. In these scenarios, histological techniques are often applied. However, specific research focusing on the quantification of bear bone microstructure remains scarce in the literature.

It is hypothesized that 3D analysis of bear cortical bone microstructure provides a more representative and accurate means to infer species origin from fragmented metapodials.

Methods included visualizing and quantifying bone microstructural parameters using micro-Computed Tomography (micro-CT). Black bear (*Ursus americanus*) metapodials were loaned from the Vertebrate Zoology Department at the Cleveland Museum of Natural History. Human bone specimens were obtained from the University of Akron's skeletal teaching collection housed in the Department of Biology. The third metacarpals and metatarsals from mature black bears (n=5) and mature humans (n=5) were assessed using 3D analyses. All selected bear and human specimens did not display visible signs of pathology and were from the left side of the body.

Micro-CT experiments were conducted using a SkyScan 1172 laboratory X-ray system at the Surface and Optical Analysis Facility at the University of Akron's Polymer Innovation Center. A source spot size of 5.5µm and 8.83 camera pixel size were used. A rotation step of 0.20 degrees, X-ray settings of 100 kV and 100 µ, 0.50 frame averaging, and a combined aluminum and copper filter were applied to obtain 1,224 projections spanning 180 degrees of rotation. Prior to all scans, flat and dark-field projections were collected to correct for noise in the detector and X-ray beam.

Micro-CT projections were reconstructed using NRecon 1.6.10.2. Cylindrical Volumes of Interest (VOIs) were identified within each bone sample. Image stacks were cropped and analyzed using CTAnalyser 1.15.4.0. The variables measured included: Total VOI Volume (TV), total Canal volume within VOI (Ca.V), Canal Number (Ca.N), average Canal Diameter (Ca.Dm), and Cortical porosity (Ca.V/TV). Statistical analyses were accomplished using SPSS 23.0 statistical software. To assess whether species and element have a significant effect on Ca.V/TV, Ca.N, and Ca.Dm, independent *t*-tests (comparisons between species) and paired *t*-tests (comparisons within species) were performed at a significance of $p \leq 0.05$. r^2 values were calculated to assess the fraction of variance present between the variables compared. The following qualitative features were further described: bone composition (e.g., woven, fibrolamellar, Haversian), osteon banding, and resorptive spaces.

Between-species *t*-tests revealed that Ca.N significantly differed between human and bear metacarpals ($t_{0.05(2),5}$=4.862; p=<0.05) and metatarsals ($t_{0.05(2),5}$=8.416; p=<0.05), as did Ca.Dm between human and bear metacarpals ($t_{0.05(2),5}$=-2.130; p=<0.03) and metatarsals ($t_{0.05(2),5}$=-2.568; p=<0.03). No significant results were found for Ca.V/TV, though the r^2 values for the metacarpal measures between human and bear indicated a moderate effect size (r^2=69.1; p=<0.05). Within-species *t*-tests revealed no significance difference between the paired cortical parameters for either the human or bear specimens. However, measures of the metacarpals between human and bear specimens indicated a medium effect size (r^2=27.0; p=<0.211). Ca.N and Ca.V/TV differed among human metacarpals and metatarsals, with the parameters being greater in the metatarsals. Qualitative features including osteon banding and resorption spaces were more prevalent in the bear metacarpals and metatarsals. Plexiform bone was observed in the bear metapodials only.

The 3D data for this study were obtained non-destructively and reveal the usefulness of laboratory micro-CT as a diverse and novel tool for the anthropologist. The volumetric nature of this approach demonstrates that it is possible to differentiate fragmented bear and human metapodials, both quantitatively and qualitatively.

Black Bear, Micro-Computed Tomography, Metapodials