3D Imaging Symposium, Friday 11:00

3D APPROACHES IN PALEOANTHROPOLOGY USING GEOMETRIC MORPHOMETRICS AND LASER SCANNING

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The emergence of 3D GM (geometric morphometric) techniques as a way of quantifying

morphology has significant implications for 21st century paleontology. Not only is it possible to easily collect data in a true 3D sense, such as sets of homologous landmarks or complete surfaces, but it is now also possible to analyze such data in increasingly complex and elegant ways that were computationally impossible even a few years ago. We present an exciting new study that integrates techniques of 3D data collection with computer graphics and computationally complex multivariate analyses to place biological shape change within an evolutionary context. The basic aim of this project is to infer ("reconstruct") the 3D cranial shape of hypothetical intermediate ("ancestral") taxa along an a priori evolutionary tree. We focus on the papionin cercopithecids (Old World monkeys), a taxon well-represented in the modern biota which underwent a major Pliocene-Pleistocene radiation in Africa. Our baseline cladogram and its divergence dates are estimated using molecular data from living papionins. The mean cranial shape of each taxon (separately by sex) is calculated from large datasets of homologous 3D landmarks collected with a Microscribe digitizer. Highly accurate surface models of exemplar crania for each taxon are also produced using a high-resolution Minolta laser surface scanner. These scans are then warped to "fit" the shape of each taxon-sex mean as determined by the landmark dataset, thus giving greater statistical power to all subsequent analyses. These data in turn can be warped "along" the branches of the existing tree using an algorithm that assumes a Brownian motion model of evolutionary change. These last two steps are conducted using our specifically designed software, Landmark. We produce statistically inferred (interpolated) 3D virtual papionin crania at any point on the tree (including nodes) which can be fully visualized and explored in all orientations. Using extant taxa, the technique produces 3D models of crania that are biologically meaningful, visually appealing, and analyzable using GM. The next step is to statistically compare the virtual crania with fossils branching from a similar point on the tree and to incorporate fossil data directly into the tree and subsequent shape analyses, to compare observed and estimated evolutionary change. Our first-stage model of evolution is oversimplified, but will be modified to account for mosaicism and functional integration, and retrodeformation of distorted fossils is under development.