Beyond Imaging: Using 3D-Datasets in Comparative Morphology

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Imaging modalities such as computer tomography and magnetic resonance have long provided the opportunity to noninvasively peer inside organisms. However, recent technological developments have permitted morphologists to move beyond a series of 2D slices to a 3D digital representation of vertebrate anatomy that may be queried for different kinds of analyses. First, for example, specific tissue elements (e.g., neural structures, inner ear canals, pneumatic sinuses, neurovascular canals, vessels, muscles) can be extracted, or "segmented," from the 3D dataset, rendered in 3D in isolation or with other elements, and manipulated in real time, facilitating the morphological visualization of each element, as well as their interrelationships. Moreover, a wealth of metric data (e.g., volumes, areas, distances, angles) can be calculated for each segmented tissue or cavity with unparalleled precision. Second, datasets from different modalities, such as CT and MR, can be registered and integrated into composite 3D models combining the best attributes of each modality. Third, for fossils, enclosing rock can be digitally removed from the 3D dataset, but, more significantly, the 3D dataset can be modified, allowing "virtual restoration" of not only missing or damaged bony structures but also addition of hypothesized soft-tissue elements. Finally, these 3D datasets can be exported to finite element analysis software for engineering studies, and physical models can be produced through stereolithography for presentations or education.