Keynote: Morphology 3D Data: Initiating Virtuous Cycles

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Abstract
Data repositories designed for genetic sequences have existed for decades (i.e. Genbank was founded in 1982). These repositories have revolutionized biological sciences and profoundly magnified the impact of biology on society. Rich data on genetically programmed anatomical structures are also critical for advancing biological science. The richest sources of information on anatomy are preserved animal cadavers and plant structures, as well as bones and fossils in museum collections. 3D digital data representing anatomy includes surface geometry/color/texture from photogrammetry, structured light scanners, or laser scanners; or internal volume data from CT/MRI devices. There were no open repositories specialized for 3D data representing anatomical aspects of phenome until Duke University founded MorphoSource.org in 2013 to fill this gap. While data repositories are critical for enhancing reproducibility of published research, the hope is that these repositories can also be instrumental in fueling scientific research, accelerating its pace, and magnifying the value of data to society.

Over the last 9 years, MorphoSource has made a profound impact on fields like evolutionary/comparative biology, paleontology, and biological anthropology. Over 1,300 peer reviewed papers utilizing MorphoSource have been published, with increasing numbers of papers published every year. These papers span a huge taxonomic diversity. Increasing use of the resource is also reflected by data download rates. Various factors likely explain the increasing utilization. It can be explained in part by growth of holdings in the repository, which makes it more broadly useful for new research. Since 2016, the data holdings have grown from 15,000 data objects to 158,000. These datasets now represent anatomy from 3 kingdoms, 9 phyla, 29 classes, and 17,000 species of organisms (a 20-fold increase from 2016). Pandemic restrictions have spiked demand for MS datasets. Beyond pandemic related spikes in use, increases in download rates are also correlated with the launch of MS 2.0 with enhanced search/discovery functions. Finally, we think increasing use can be explained to an important degree by shifting attitudes in stakeholder communities for 3D data. These shifts have strengthened expectations and willingness for archiving 3D data.

While the success of MorphoSource would seem to be a simple reflection of intensifying needs for 3D data access and archiving, this view obscures the challenges such a resource has to overcome. Access to high fidelity 3D data and digital models representing museum objects is typically impeded by a complex web of conflicting stakeholder interests. Orthogonally, deeply specialized data models required for preserving diverse 3D data according to FAIR principles can lead to user interfaces of intolerable complexity. MorphoSource has been able to provide a workable answer to the question of 3D data preservation and access primarily because of its focus on these issues during its development.

Going forward MorphoSource will continue to focus on improving its value and utility to museums for data dissemination and management; researchers for data deposition, access, and analysis; and the general public for education and inspiration.

Bio:

Doug is an associate professor in the Department of Evolutionary Anthropology at Duke University in Durham, North Carolina where he has been employed since 2012. His research focus is on evolutionary origins and diversification of primate mammals. These studies draw on evidence from comparative skeletal morphology of extant and fossil species. He has a long history working for museums and with museum collections. Before and while pursuing a BS in Geology at the University of Michigan (1997-2003), he worked as a fossil preparator and paleo artist in the University of Michigan Museum of Paleontology. He earned a PhD in Evolutionary Anatomy at Stony Brook University (2003-2009), learning key principles of specimen collection management by working with his advisor's extensive Crazy Mountain Basin Collection of Paleocene mammal fossils, while continuing to develop fossil preparation and documentation techniques. He also began to learn techniques for CT scanning and laser scanning at this time. As a bioinformatics postdoc under Jukka Jernvall of the University of Helsinki (2009-2010) he was charged with developing initial designs for what would ultimately become MorphoSource in 2013. Boyer connected with Dr. Ingrid Daubechies (Duke Dept of Mathematics) and Dr. Julie Winchester (lead developer and Technical Director of MorphoSource) through Jernvall. Upon arriving at Duke in 2012, he set up a multi-user microCT facility that is widely used today and founded MorphoSource. In 2016, Julie Winchester joined the team at Duke. Together, Boyer and Winchester develop and run MorphoSource and pursue research into methods for morphometric shape comparison with Daubechies.