Assembling Continental Biotas from the Cretaceous of Gondwana

iDigBio Workshop — November 16-18th, 2022

We would like to invite you to participate in an iDigBio workshop focused on developing 21st Century perspectives, skills, and partnerships for assembling deep-time data (e.g., fossils, environments, climates) from historic and contemporary natural history collections. This workshop is designed to develop strong collaborative networks across specialties and institutions to facilitate accessibility and sustainability of current collections and the robust establishment of future collections. This effort is being sponsored by iDigBio, which is funded by the U.S. National Science Foundation.

The workshop will be held at the Denver Museum of Nature & Science (DMNS) in mid-November 2022. It will offer both in-person and remote options, to promote access for those who are unable to travel or attend for the entirety of the sessions. The topic, *Assembling Continental Biotas from the Cretaceous of Gondwana*, will bring together scientists, students, museum collections and records staff, preparators, data managers, and curators from several institutions and countries in the context of the Gondwanan vertebrate fossil record. However, the issues addressed by this working group could easily be applied to any type of natural history collection from anywhere on the planet.

Background Information: Relatively little is known about the diversity of continental biotas from vast regions of the southern supercontinent Gondwana during the later stages of the Mesozoic Era and early stages of the Cenozoic Era, particularly by comparison with Laurasian biotas during this interval. Such sampling disparity limits our ability to evaluate global phenomena impacting ecosystems leading up to and immediately after the Cretaceous/Paleogene (K/Pg) boundary, not to mention preventing a clearer understanding of clade-level dynamics (e.g., phylogenetic relationships, biogeographic distributions, diversification, extinction, recovery, etc.) in major groups of animals and plants at global levels.

Intensified field efforts over the past three decades in southern continental regions are beginning to address these sampling biases and allow for basic assessments of those clades present in different areas, while simultaneously highlighting a range of anatomical specializations not even predicted based on what was previously known from the fossil record. As many of the fossil specimens collected from these regions are ultimately reposited in collections in regional institutions, access to these data may be necessarily limited for researchers and educators around the planet. Further restricting access is the fact that many early collections, the result of colonial-era expeditions, are scattered in various European museums. It is notable that, more recently, the U.S. National Science Foundation has supported field and laboratory activities related to several Gondwanan-based paleontological projects, resulting in the discovery and initial description of many new taxa. However, NSF does not currently support the development and/or maintenance of specimens, their records, or associated digital datasets (e.g., digital specimen photographs, 3D volumes/stacks, etc.) outside of U.S.-based institutions.

Moreover, getting those important continental vertebrate, invertebrate, and plant fossil records that are currently known into a contemporary, consistent, and accessible format for data-sharing remains a challenge based on differing levels of interest and commitment (e.g., research group-specific, repository-specific, country-specific), as is garnering financial support for larger-scale dissemination efforts beyond the primary research output of conference proceedings and publications.

The workshop proposed herein will bring together content experts who span field-collection and fossil preparation, specimen curation, and digital characterization/modeling as part of their research efforts on Late Cretaceous/Paleogene continental biotas from Gondwanan landmasses. Importantly, a number of other experts versed in specimen record development, integration of museum databases with aggregators (e.g., Symbiota, GBIF), and data-hosting through web-based platforms have also been invited. Individuals from several institutions and countries have been invited to provide critical perspectives necessary for developing robust and realistic goals on how best to support specimen-based research, data dissemination, and specimen access in a manner usable by as many people as possible.

Specifically, we propose to:

- Identify, refine, develop, and promote best practices for organizing, recording, and sharing taxonomic, geographic, and temporal data associated with new (and old) specimens in a consistent/comparable manner, with the goal of digitally (re)assembling faunas and floras now housed in geographically disparate institutions for the benefit of research, outreach, and educational opportunities using FAIR data principles (Wilkinson et al. 2016) as a working construct.
- Promote the adoption/implementation of contemporary data management standards/principles (e.g., persistent identifiers [PIDs]) for specimens such that multiple data/metadata for a given specimen are consistent/comparable and linked throughout different repositories (e.g., museum collection, database for locality information, histology, CT/µCT and other digital data for morphological information) and aggregators (e.g., iDigBio, GBIF).
- Explore next steps for large-scale hosting/sharing of large 3D datasets (e.g., locality, CT/uCT stacks, mesh files, etc.) among digital repositories (e.g., museums, www.morphosource.org).
- Increase awareness for the need to continue decolonizing our discipline (paleontology) in a postcolonial world and highlight ways to achieve mutually beneficial objectives (research; infrastructure; collections accessibility, both physical and digital; student and technical training efforts; etc.) for all stakeholders going forward. The application of FAIR data principles in the context of museum collections, specimen records, and shared online resources (e.g., internet-based repositories) is but one potential way of addressing these issues.

Origin and Location of Exemplar Collections: Physical specimens (i.e., fossils) from Egypt, Madagascar, Tanzania, and Antarctica are currently housed in several US institutions (DMNS, CM, AMNH, FMNH, OHIO, USNM) in addition to companion collections dispersed throughout Europe (France, Italy, United Kingdom), Asia (Japan), South America (Argentina, Brazil), Africa (Egypt, Tanzania), and Madagascar. These countries/continents provide exemplars of a range of current laws/guidelines that govern exporting and repositing of fossil specimens (Egypt – no exportation; Tanzania – full exportation/full return; Madagascar – full exportation/half return + holotypes; Antarctica – full exportation/no return). Also, it is worth noting that many projects have in their basic workflow the development of exact replicas (casts, 3D prints) of important specimens and utilize Morphosource, MorphoBank, etc., for hosting/sharing specimen-affiliated data. Thus, there is an increasing need to considering both the physical specimens and their expanding digital footprint across the vastness of the internet.

WORKSHOP TOPIC: Herein we propose to hold a workshop on best practices for digital archiving of paleobiological resources, including standards of digital photography, geo-referencing, and linking different types of data (e.g., original specimen, locality and stratigraphic [provenance] information, 3D morphological data, research casts/3D prints, digital 2D images, etc.) concerning individual specimens across multiple platforms and institutions (see Mabry et al. [2022] on the rationale and implementation of PIDs). One of the broader goals would be to digitally reassemble biotas (i.e., specimen records and all associated data, 2D/3D morphological, etc.) from disparate collections of Late Cretaceous vertebrates of Madagascar, various African countries, and Antarctica based on recent, large-scale expeditions from U.S. institutions but also to integrate several smaller, poorly documented collections made by European institutions during colonial-era expeditions. The project proposed herein will allow our teams to refine standardized workflows and to provide proof-of-concept related to logistical, technical, and administrative issues before attempting the larger-scale reassembly of 'deep time' datasets from collections across the planet.

Provisional Topic Breakdown by day:

Wednesday 11/16/2022	Thursday 11/17/2022	Friday 11/18/2022*
AM: Introduction to workshop — identify issues to be addressed (*in paleontology generally and in workshop specifically*) A. Project overview talks (10–15 minutes) B. Tour of DMNS facilities related to storage, mechanical preparation, molding/casting, collections, digital preparation	AM: HOW TO SESSION I A. From field collections to museum collections B. Developing and maintaining standardized workflows C. Digital data standards (e.g., digital photography, preparation lab, and collections management)	AM: CURRENT/FUTURE TRAINING EFFORTS A. Beyond traditional specimen records (e.g., 4D data) B. Training across the internet. Barriers and opportunities (shared computer resources and specimen record platforms)
PM: Working Groups A. Fossils from the ground into the collection B. Working across boundaries (national, cultural, economic) C. Perspectives from international colleagues and funding agencies *Summary of working group perspectives.*	PM: HOW TO SESSION II A. From museum to aggregator B. Data management software options for international collections C. Persistent Identifiers in 21st Century natural history collections	PM: Wrap-up session, prospectus & next steps A. Collections management in a global context B. Shared responsibilities among research teams, institutions, and governments *Summary of workshop and overview of next steps (near-term vs. long term).*

*The workshop is scheduled to be finished by 2PM on Friday 11/18/2022 to allow participants to have the rest of the day to visit museum/return home, etc.