3D Phenotypes for All

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Florida Museum of Natural History
University of Florida

Digital Data in Biodiversity Research
University of California, Berkeley
June 4, 2018
Marsupial Frogs of South America
Marsupial Frogs of South America
By creating new, freely accessible, digital media, we improve access to and add value to scientific specimens.

This access facilitates discoveries across disciplines and from a growing on-line community of scientists, students, and the public.
A few CT basics...

X-ray tube

Stage

detector

Filament

Anode

Magnetic lens

Target

Specimen
A few CT basics...
series of gray-scale digital images representing a map of density in a volume from which 3D digital models can be created
What can you do with these data? create models

Hemisus
family Hemisotdae

Ed in real time
What can you do with these data? digital dissection

Chaperina
family Microhylidae
Rare taxa

*Cryptotora thamicola*

Total specimens in iDigBio: 110,711,328

*Cryptotora* specimens in iDigBio: 0
Natural History By-catch

Phrynobatrachus

Barbourula

Paedophryne

Brachycephalus
Natural History By-catch

Colostethus
family Dendrobatidae
openVertebrate Thematic Collections Network

$2.5M from NSF’s Advancing Digitization of Biodiversity Collections program

2017–2021

CT-scan >20,000 fluid-preserved vertebrate specimens
Scan >80% extant genera; “soft tissue” scan >60% extant families
Make both raw and processed data freely available on-line
18 funded institutions, including 16 museums and 6 imaging centers.
Extant vertebrates
~10,500 genera
~1,100 families

Via oVert Team so far:
>2,100 genera in ~500 families
(resolution of most scans: ~20–80 μm)
Builds on previous collections digitization efforts

In US, most scientific collections of vertebrates are digitized.

Digital inventory allows oVert to (1) discover specimens and (2) prioritize particular specimens.
How do we choose specimens to scan?

<table>
<thead>
<tr>
<th>currentTypeSpecies</th>
<th>oVert collaborating institutions</th>
<th>non-funded US institutions</th>
<th>hasTissueOrImage</th>
<th>hasOtherNameInData</th>
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<tbody>
<tr>
<td>aiptichthys websteri</td>
<td>CAS</td>
<td></td>
<td></td>
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<tr>
<td>aiptostegus grypus</td>
<td>UMMZ,CAS</td>
<td>USNM</td>
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<tr>
<td>abactochromis labrosus</td>
<td>YPM</td>
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<td>abbottia rivularis</td>
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<td>USNM</td>
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<td>CAS,FMNH,SIO</td>
<td>BPBM,USNM</td>
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<tr>
<td>ablenes hians</td>
<td>CAS,UF,SIQ,MCZ,FMNH,ANSP,UMMZ,TCWC,TNH</td>
<td>NCSM,USNM,LACM,TU,BPBM,UAIC,AUM,AUM,OS</td>
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</table>
How can we best share these data?

Doug Boyer, Duke University
lead PI for MorphoSource; oVert coPI
Supports various forms of data
User-contributed datasets
Working with oVert to improve workflows
All data traceable back to specimens

Learn more tomorrow (Tuesday): Sibley Auditorium
1:45–2:00 PM Julie Winchester (MorphoSource)
2:15–3:00 PM, Q&A with oVert & MorphoSource
Builds on previous collections digitization efforts

MorphoSource sends request

UF-Herp-12345

iDigBio
Application
Program Interface
(API)

Darwin Core
structured metadata
reference ID
occurrence ID
locality
collection date
etc.

iDigBio sends metadata
Getting information on media files back to collections

MorphoSource RSS Feed (via referenceID) containing
1) Audobon Core metadata
2) usage statistics

for each collection (i.e., UF Herpetology)

UF-Herp-12345

MORPHO SOURCE

Darwin Core structured metadata
referenceID
occurrenceID
locality
collectionDate
etc.

add Audobon Core to IPT

FLORIDA MUSEUM

VertNet

GBIF

iDigBio

Integrated Digitized Biocollections
Getting information on media files back to collections

Data reporting for MorphoSource media

MorphoSource provides summary reports of media, download usage, and download requests for media that represent specimens that have been reported to iDigBio. The media report is formatted according to the Audubon Core metadata standard, and so can be incorporated into publisher reporting software, such as an IPT. All report files are linked and described in a single RSS feed, which can be used to receive regular report updates via automated download. Additionally, all report files are individually listed below, sorted by iDigBio publisher and recordset. For each report, there is a link to: 1) a Comma Separated Values (CSV) spreadsheet with the primary media, download usage, or download request metadata; and 2) an XML file encoded in Ecological Markup Language (EML) providing metadata about the CSV spreadsheet. These reports are updated as necessary on a daily basis.

RSS Feed: https://www.morphosource.org/rss/ms_rss.xml

Berkeley Natural History Museums IPT (552a0e1a-4152-43ae-bad6-9314b4234536)

<table>
<thead>
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<th>Download Requests</th>
<th>Pub Date</th>
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Data deposited in MorphoSource
- 3D mesh files (.stl)
- image stacks (.zip of .TIFF)

Download or view in browser
In ~2 years, 177 UF Herpetology specimens on MorphoSource >23,000 media views, and ~2,822 downloads

example: *Shinisaurus crocodilurus*
>1,000 views on MorphoSource, 30+ downloads in Australia, UK, and US

Stats on *Shinisaurus* Specimens
202 records in iDigBio
176 specimens in US
47 skeletons in 4 US institutions
In ~2 years, 177 UF Herpetology specimens on MorphoSource >23,000 media views, and ~2,822 downloads

M8691, 8/31/2017
maher, alice (A.E.Maher@liverpool.ac.uk)
For research project on body elongation

M15879, 8/31/2017
Schwippert, Sophie (sophie_schwippert@web.de)
I want to use the data for my Bachelor Thesis, which I am currently working on at the University of Hamburg. My Thesis focuses on malformations of the sacrum of anurans. Thank you!

M8902, 4/7/2017
Currier, Aaron (acurrier@central.k12.or.us)
8th grade classroom instruction

M10212, 9/1/2017
Lee, Aaron (aaronlee70@gmail.com)
3D print of model for personal use. File will be stored. Will not be uploaded or shared. No commercial element.

M9784, 4/7/2017
lewis, chris (clois@gmail.com)
3d print for surgery planning

M9207, 3/18/2017
Thomas, Lauren (lauren@thomasthomas.ca)
Import into Houdini, do cool stuff, post on my Instagram.
>50% download requests are for ‘non-research’
most state an intention to 3D print

K12 classrooms  Undergrad Teaching  Art: “Creature Design” class

Academy of Holy Names  Chris Sheil  Lars Grant-West
Tampa, Florida    John Carroll University   Rhode Island School of Design

oVert is working to:
engage high school teachers in lesson plan development
develop on-line tutorials for using 3D data in research and education
Next step: distributed trait annotation

Crowdsourced geometric morphometrics enable rapid large-scale collection and analysis of phenotypic data

Jonathan Chang¹* and Michael E. Alfaro¹

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