

# Levels of Representation and Data Infrastructures in Entomo-3D

An applied research approach to addressing metadata curation issues to support preservation and access of 3D data

Wen Nie Ng, Digital Collections Librarian | [wenng@vt.edu](mailto:wenng@vt.edu)

Alex Kinnaman, Digital Preservation Coordinator | [alexk93@vt.edu](mailto:alexk93@vt.edu)

Nathan Hall, Director of Digital Libraries and Preservation | [nfhall@vt.edu](mailto:nfhall@vt.edu)

# Agenda

1. About Entomo-3D
2. Collection Details
3. Pipeline Overview
4. Data Infrastructures and Levels of Representation
5. Metadata Standards and Workflows
6. Digital Object Design
7. Challenges
8. Next Steps



*Emerald Euphoria Beetle*



# Virginia Tech Insect Collection (VTEC)

- Oldest and largest entomological collection in Virginia
- ~500,000 specimens
- Houses:
  - Fragile specimens for educational purposes
  - Extinct insects
  - Population histories and extensive metadata
- Only 3% of specimens currently digitized



American Burying Beetle

Image courtesy of the U.S. Fish & Wildlife Services



# Entomo-3D: Digitizing Virginia Tech's Insect Collection

- Grant supported by CLIR's Digitizing Hidden Collections
- Collaboration between Virginia Tech Digital Libraries (VTDL) and Virginia Tech Insect Collection (VTEC)
- Digitize 10,000 specimens in 2D with high-resolution photos
- Digitize 300 specimens in 3D through photogrammetry



# Project Goals

- **Determine the level of representation** as we generate new digital objects for multiple purposes from different data sources
- Determine how to address both **descriptive and technical metadata**
- Determine a **sustainable preservation plan** for 3D objects
- Provide **ongoing access to VTEC specimens**



# External Partners



Morphosource



Global Biodiversity  
Information Facility  
(GBIF)



Symbiota Collections  
of Arthropods Network  
(SCAN)

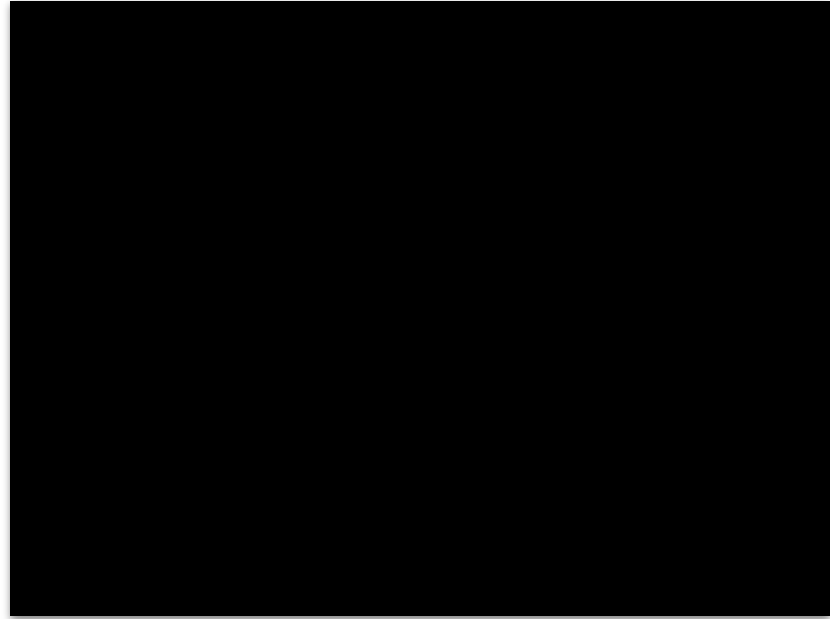


iDigBio

# Levels of Representation

# Pipeline Overview

1. Collection intake with specimen metadata
2. Photogrammetry → Photography
3. Photogrammetry → 3D model processing
4. Model deposited to different repositories

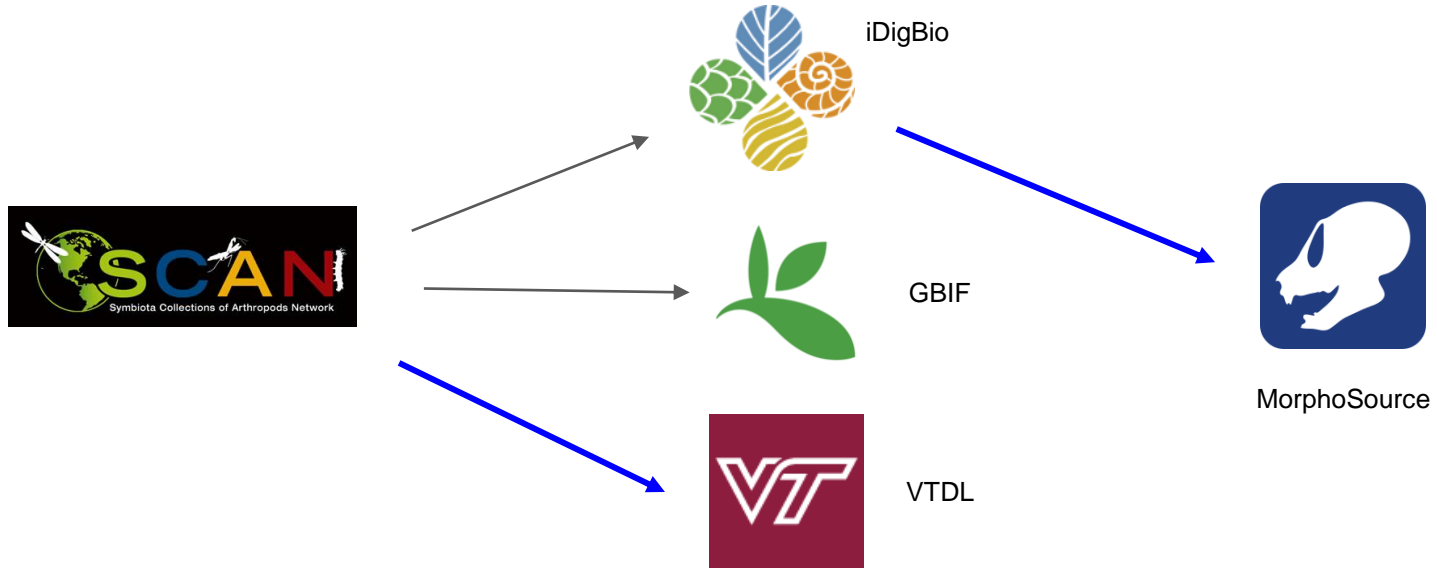


*Bee*



# Specimen Metadata

- Exported from SCAN (Symbiota Collections of Arthropods Network)
- Originally collected by Virginia Tech Entomology Department

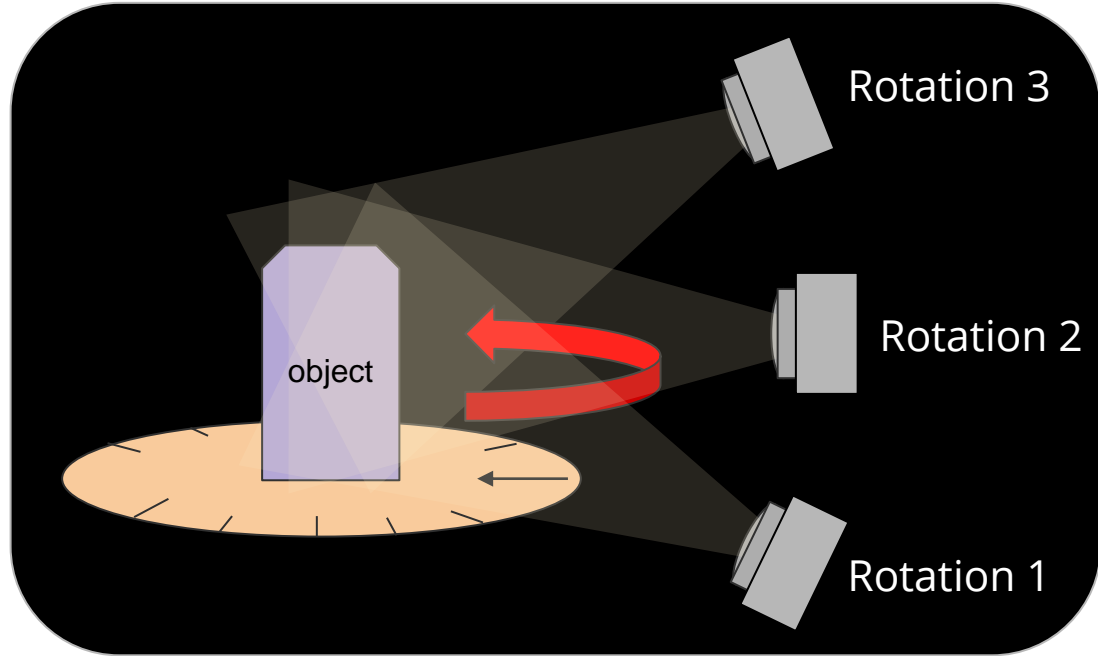


# 3D Photogrammetry Workflow

# Photogrammetry Workflow



3D Imaging Insect  
Photo by Erin Williams of VT Imagine Magazine



	Specimen intake from partner	Photogrammetry imaging	Cropping a series of images	3D model generation (sparse point cloud, dense point cloud, color texture, mesh)	Create lighter mesh	Generate high-res model with lesser vertices mesh
Software			Camera RAW	Agisoft Metashape		
File needed for process			RAW	Cropped tiff set		
Output file name		RAW	Cropped tif set	Agisoft model		
Output file type		tif image series	tif image series	mesh + texture		
Recorded metadata		Technical - Capture event metadata	Technical - Processing metadata	Technical - Processing metadata		



*Sparse cloud*

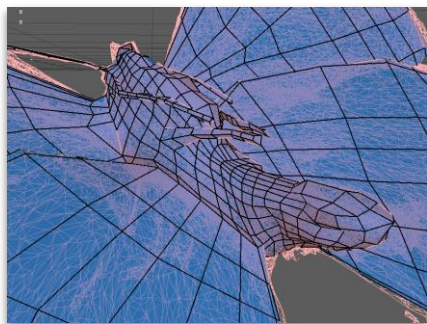


*Dense cloud*



*Heavy mesh*

	Specimen intake from partner	Photogrammetry imaging	Cropping a series of images	3D model generation (sparse point cloud, dense point cloud, color texture, mesh)	Create lighter mesh	Generate high-res model with lesser vertices mesh
<b>Software</b>					<b>Autodesk Maya</b>	
<b>File needed for process</b>					<b>Agisoft mesh</b>	
<b>Output file name</b>					<b>Retope model/mesh</b>	
<b>Output file type</b>					<b>mesh</b>	
<b>Recorded metadata</b>					<b>Technical - Processing metadata</b>	



*Maya light mesh*

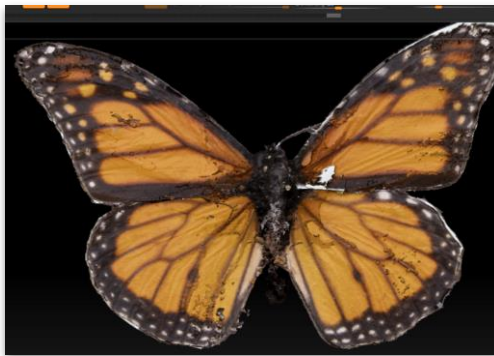


*Retopolization*

	Specimen intake from partner	Photogrammetry imaging	Cropping a series of images	3D model generation (sparse point cloud, dense point cloud, color texture, mesh)	Create lighter mesh	Generate high-res model with lesser vertices mesh
Software						Pixology Zbrush
File needed for process						Retope mesh + Agisoft mesh + Agisoft texture
Output file name						HighRes model
Output file type						mesh + texture
Recorded metadata						Technical - Processing metadata



*Retoped mesh*



*Detail clean-up*



*Final high-res product*

# Metadata Standards & Workflows

# Customized Metadata Schema

## **Specimen Metadata:** DarwinCore and DublinCore elements

- Only displaying select DwC elements essential for information retrieval and linkage with different databases
- Specimen data not displayed or crosswalked to the VTDL schema is saved in our VTDL repository, and accessible from SCAN, iDigBio, and GBIF
- 3D model metadata will be accessible from the Virginia Tech Data Repository and MorphoSource, a public 3D data web repository for the research community.

## **Technical Metadata:** [Smithsonian 3D Metadata Model](#), MorphoSource

- 67 select elements





# Access Metadata on Virginia Tech Digital Library (VTDL)

## Who:

- General users
- K2-12
- Community partners
- Specimen specific fields
  - Scientific name, Occurrence ID\*, Catalog ID, Basis of record, Collection locality, Collection date
- 3D specific metadata
  - Modality
  - Rights of models
  - References

*\*Primary ID*

View metadata schema: <https://doi.org/10.7294/21230690.v1>

# Access Metadata on MorphoSource

## Who:

- Research community
- Digital curators
- Specimen specific fields
  - Scientific Name, Occurrence ID\*, Catalog ID, basis of record, Collection locality, Collection date
- 3D model metadata
  - Modality
  - Equipment
    - Equipment owner
  - Processing
    - Processor, processing steps, processing software
  - File type, size, relationship of files
  - Rights of models

*\*Primary ID*

View metadata schema: <https://doi.org/10.7294/21230690.v1>

# Digital Object Design & Ingest

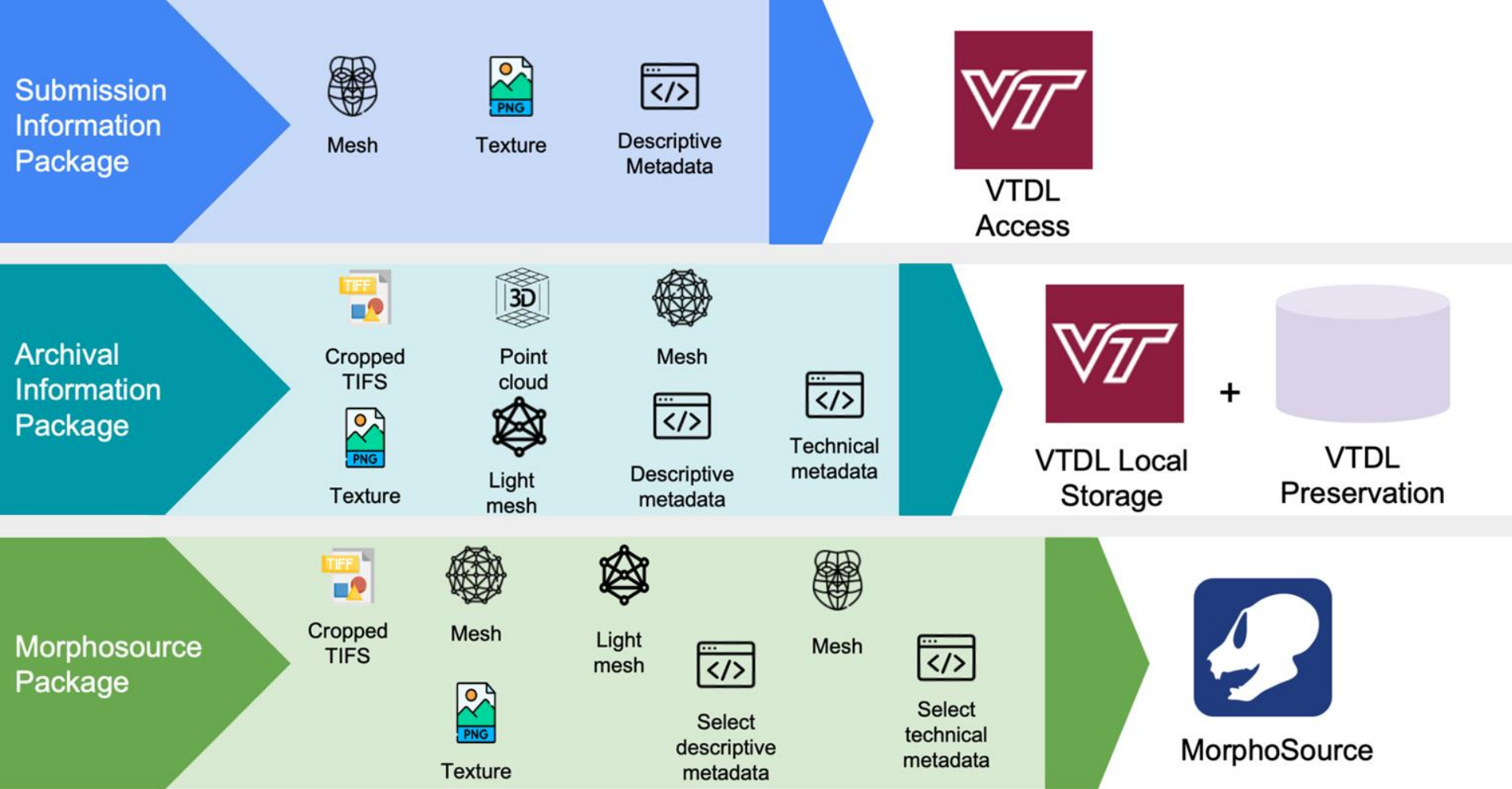


Figure 2: Digital object design for different repositories

# Digital Object Design & Ingest - VTDL Access

## Virginia Tech Digital Library

- Built on AWS and individual, serverless microservices
- Files are a light 200-300 MB X3D object
  - Mesh + Texture + Descriptive metadata

Submission  
Information  
Package



Mesh



Texture



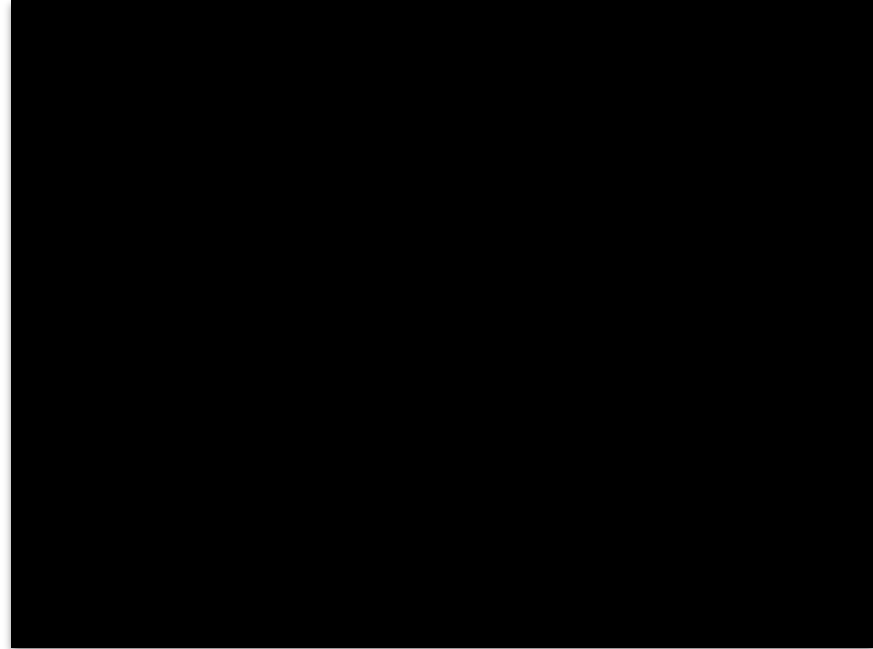
Descriptive  
Metadata



VTDL  
Access

# Digital Object Design & Ingest - VTDL Process

- ID Minting Service assigns persistent, non-semantic identifiers (NOID) with an Archival Resource Key (ARK)
- Scanned for viruses
- Fixity is verified via SHA-3 checksum hashes
- Metadata is stored in a NoSQL DynamoDB metadata server

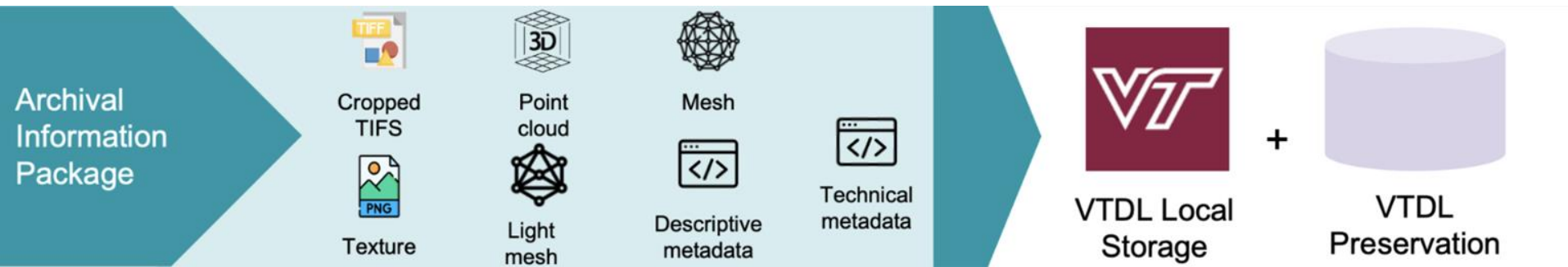


*Blister Beetle*



# Digital Object Design & Ingest - VTDL Storage

- Storage
  - AWS Primary Local Storage (Cloud) in VA, synced to AWS Secondary Storage (Cloud) in OR
  - Preservation storage (APTrust or MetaArchive)
- Contains Cropped TIFs + point cloud + mesh + texture + light mesh + all metadata
- Each record indexed in DPLA and MorphoSource, and linked from corresponding records in iDigBio and SCAN
- Source files for 3D models available through the Virginia Tech Data Repository and MorphoSource



# Digital Object Design & Ingest - Preservation

Preservation metadata based on the [PREMIS Data Dictionary](#)

Preservation storage through [APTrust](#) or [MetaArchive](#)

- Academic Preservation Trust, also based on AWS but is administratively separate from our VT account
- The MetaArchive Cooperative, which is based on the diverse and distributed LOCKSS system caches across the country

Preservation Strategy: Reconstruction

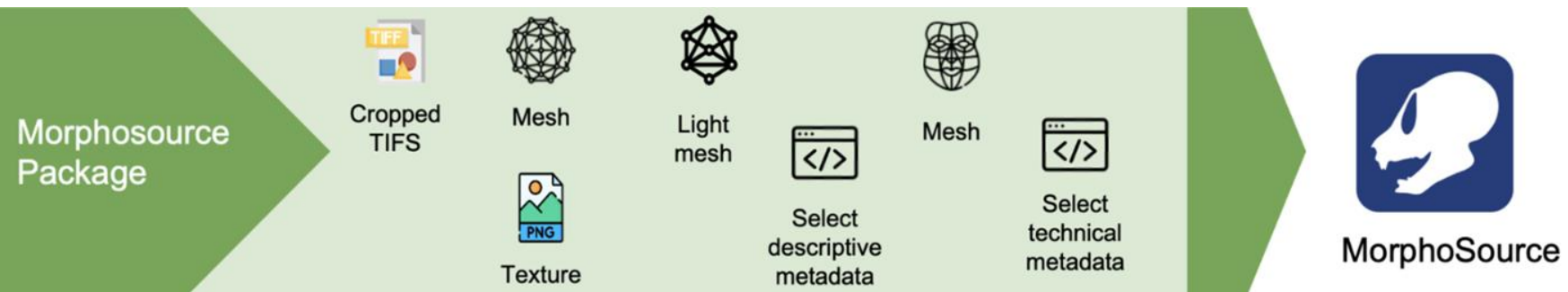
- All elements preserved are to prepare for reconstruction, rather than emulation





# Digital Object Design & Ingest - Morphosource Access

- URLs for 3D models queried and reconciled with the SCAN datasets
- Updated records in SCAN will be harvested and updated automatically in iDigBio and GBIF.
- Specimen data exported from SCAN, query 3D model metadata through RESTful API from MorphoSource, reconcile and crosswalk metadata to the VTDL schema

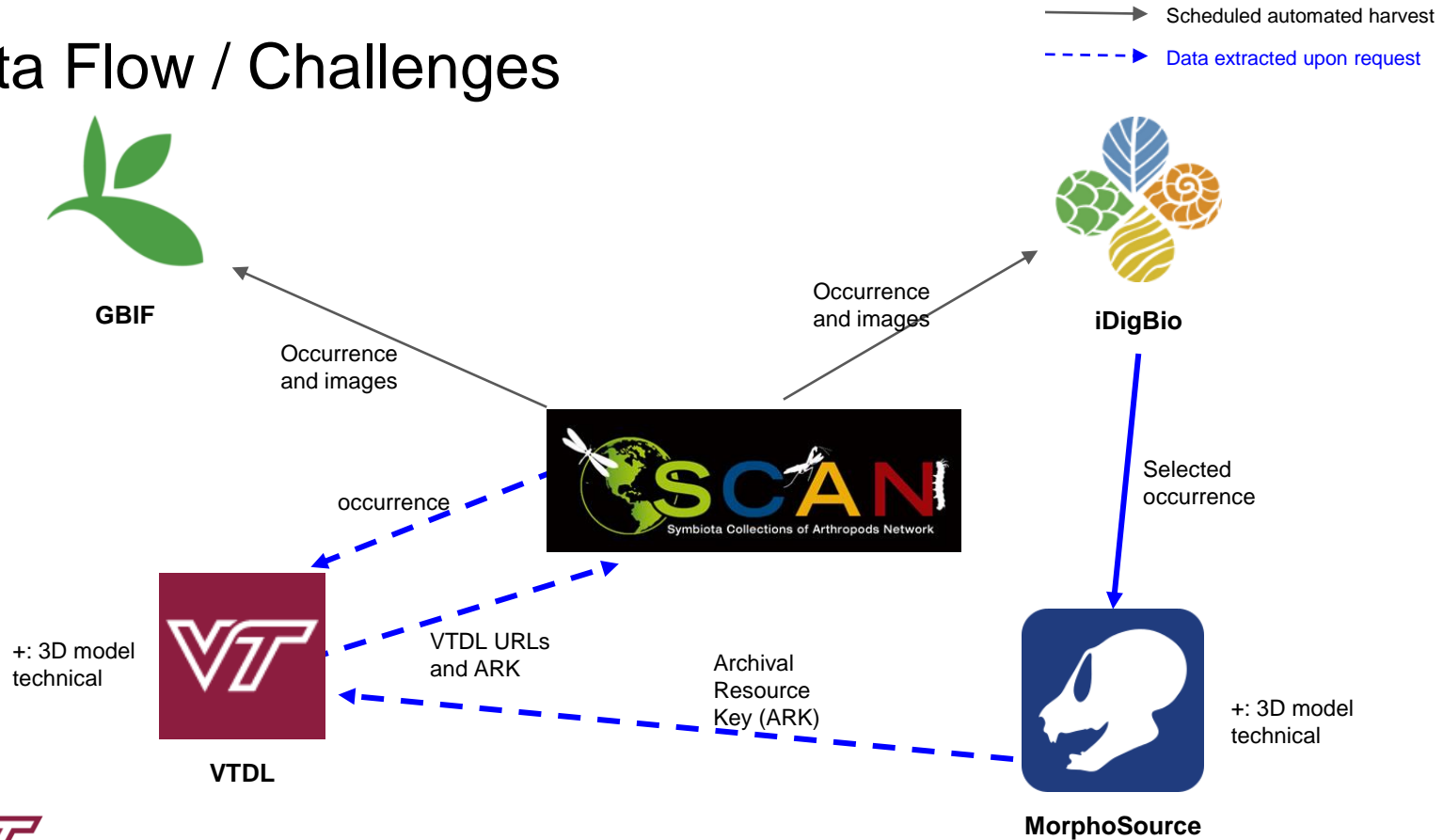


# Digital Object Design & Ingest - Morphosource Access

- Each of the 10,000 2D images and 300 3D insect models with associated metadata that include geographical coordinates, species identification, date, and other metadata associated with the historical collecting events in DwC biodiversity standards
- Each of these metadata values will be searchable through the SCAN and iDigBio web portals
- Scientists and the public should be able to search for a certain insect group (e.g. butterflies, bees) that have been collected with a past time period to compare against a modern time period to understand insect declines, and other trends.



# Data Flow / Challenges



# Next Steps

- Updating with the evolving metadata standard as appropriate
  - Potentially expanding our use of the Smithsonian 3D Metadata Model
- Exploring possibility of automated mechanism for data synchronization and minimizing manual work
- Staying up to date on new advances in FADGI requirements for 3D production
- Continuing to report back to the 3D community for feedback



# Grant Acknowledgement

This project is supported by Digitizing Hidden Collections Grant 697 from the Council on Library and Information Resources. The grant program is made possible by funding from The Andrew Mellon Foundation.



# Project Acknowledgements

**Dr. Doug Boyer**, Associate Professor of Evolutionary Anthropology and the Director of MorphoSource 3D Digital Repository

**Dr. Nicholas Polys**, Director of Visual Computing at Virginia Tech

**Dr. Paul Marek**, Associate Professor in the Department of Entomology

**Maureen Saverot**, former 3D Technical Artist for Virginia Tech University Libraries

**Students:** Younhee Erin Chun, Eva Deisa, Maria Katrina Enriquez, Jillian Sy, Tianyu Ge

**LIB3DVR Grant** (<https://www.ims.gov/grants/awarded/lg-73-17-0141-17>)



# Resources to Share!

Full metadata schema: <https://doi.org/10.7294/21230690.v1>

SketchFab Insect Collections: <https://sketchfab.com/VirginiaTechUnivLibraries>

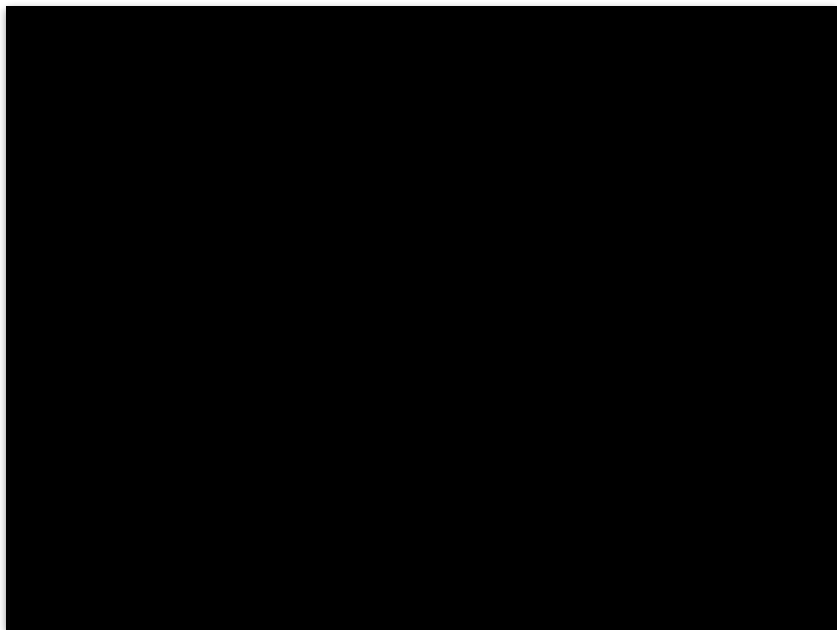
MorphoSource: <https://www.morphosource.org/projects/000449201?locale=en>

Related presentations:

- [Entomo-3D and the Student Experience in Developing Organizational Capacity](#)
- [3D Preservation Models and Modalities: Advancing Research Reproducibility and Capacity at Virginia Tech](#)



# Thank you!



Wen Nie Ng | [wenng@vt.edu](mailto:wenng@vt.edu)

Alex Kinnaman | [alexk93@vt.edu](mailto:alexk93@vt.edu)

Nathan Hall | [nfhall@vt.edu](mailto:nfhall@vt.edu)



UNIVERSITY LIBRARIES  
VIRGINIA TECH™

*Eastern Hercules Beetle*

