Something Old, Something New, Specimens Borrowed and Published Too

Integrating new specimens and old collections into research

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A collections opportunity

- Academic departments working closely with museums have a large number of specimen collections to work with.
- Field experience and specimen collecting key to the education of biology and geology students.
- New specimens need to be curated and storage space made for them.
- Old collections sit unused and un-updated.
- A happy medium? Do both!
The Insects of the Green River Formation

• An inter-montane lake system deposited about 45 million years ago in the Eocene
• Lake shales contain many fossils, including insects
• In the Colorado depocenter, the Piceance Creek Basin, most insects are carbonaceous compressions, but...
At one site, the Paleoburn, insects are preserved in ruddy rocks as iron oxides.
The Quantibug Project: Analyzing the Insects of the Green River Formation

• Phase I: Curation and study of existing Green River Formation insect collections
• Phase II: Collection of new specimens from the Paleoburn site of the Green River Formation, and the formulation of a project from initial fossil analyses
• Phase III: Preservation Quality comparison between iron oxide insects and carbonaceous compression insects
The Quantibug Project

- Phase IV: Specimens from the carbonaceous compression site compared to those from other lacustrine formations. A return to the Green River Formation for sedimentological insights.

- Phase V: Statistical Analyses on collected data. Manuscript detailing results written.
Phase I: Getting to know the insects

• Took a course in modern entomology
• Applied for grants for field work and to subsequently analyze new samples
• Over the summer, grew more familiar with insect systematics and curated Green River Formation samples of the David Kohls Collection
Phase II: Initial Analysis

• Field Research at the Paleoburn site:
  • *Samples Collected:* 79
  • *Specimens Identified:* 266
  • Preservation quality seemed rather poor
  • Lots of beetles and unidentified insects
Phase II: SEM Comparisons

- Paleoburn preservation: Iron and oxygen-rich, likely oxidized pyrite
- Anvil Points “typical” preservation: Pure Carbonaceous Compressions
Phase II: Different Mineralogies, Different Qualities

- Although they may have three-dimensional aspects, iron oxide paleoburn insects generally are less well-preserved than carbonaceous compression insects.
- Pyritized soft-bodied fossils from other exceptional deposits thought to be of lower quality due to greater microbial activity.
  - Sulfide for pyrite must be generated by degradational bacteria.
Phase III: A fortuitous opportunity

• Different preservational pathways (oxidized pyritization vs. carbonaceous compressions) impart different preservation biases.
• Both pathways are present in the same formation:
  – Sites stratigraphically and physically near each other will share similar insect source populations and environments.
  – Differences in preserved populations will be primarily due to taphonomy.
• The quality of insects from the iron oxide site (Paleoburn, new collections) and a carbonaceous compression site (Anvil Points, existing collections) were compared.
Phase III: Quality Measurement Protocol

- Scores were assigned to the preservation quality of individual body parts
- Articulation and Orientation were recorded
- Specimens were Photographed
- Lengths and Widths measured based on photos
- Measurements done in ImageJ
  - Scales derived using photos of microrulers and the “Set Scale” option
Phase III: Quality Comparison by the Numbers

Paleoburn Insects
Newly Collected
• 225 new specimens

Anvil Points Insects
Already Collected
• 477 specimens identified
• 453 specimens curated
Phase III: Insect Gallery
Phase III: Identification Improvements

- In Fall 2014, began work on an NSF-funded grant to ID Green River Formation flies to family
- Greatly improved ID quality of curated Anvil Points Flies

--Mycetophilidae?
Cecidomyiidae
Phase IV: A potential complication

• Initial analyses showed Anvil Points carbonaceous compressions insects preserved with greater quality than Paleoburn iron oxide insects
• *But* how do we know Anvil Points carbonaceous compressions aren’t exceptionally good?
• Went back to our collections to search for specimens from different lacustrine sites
• Compared beetles from other carbonaceous compression localities (Most abundant taxon at Paleoburn)
Phase IV: New Sites

- New sites:
  - Kishenehn (Eocene of Montana)
  - Claudia’s Place (another Green River Formation site, higher in the section)
  - Stewart Valley (Miocene of Nevada)
  - Florissant (Eocene of Colorado)
Phase IV: New sites by the Numbers

Kishenehn Beetles
Already collected (now at NMNH)
• 30 specimens identified

Claudia’s Place
Already collected
• 30 specimens identified from 3 field localities
Phase IV: New sites by the Numbers

Stewart Valley Beetles
A few already curated
Most already identified
• 22 reviewed

Florissant Beetles
Already curated
• 30 reviewed
Phase IV: Back to the Paleoburn

• Return to the Green River Formation in September of 2014
• Emphasis not on collecting new specimens, but on sedimentological context
• Location of Paleoburn and Claudia’s Place in terms of lake evolution
• Explanation for insect diversity and disparity
Phase V: Statistical Analysis and Manuscript Writing

• Comparison of preservation quality scores, articulation, orientation, and length and width of:
  – All insects (Paleoburn vs. Anvil Points)
  – Beetles (Paleoburn vs. Anvil Points)
  – Beetles (Anvil Points and the Other Carbonaceous Compression sites)

• Predictions largely confirmed, but more to the story than initially thought
Phase V: Results (the short version)

- Preservation Quality between Paleoburn (iron oxide) and Anvil Points (carbonaceous compressions):
  - Articulation States very different
  - Quality of Characters Present less so
  - Lengths and widths generally similar

- Preservation Quality between carbonaceous compression sites
  - Articulation States and Quality of Characters Similar
  - Lengths and widths often different between sites

A long way from death to preservation for Paleoburn insects
Results for the Museum

- 225 new specimens from new collections
- 507 new IDs from existing collections
- 30 reviewed IDs from Florissant
- RA work has produced (thus far) 9,312 new, updated, or reviewed insect IDs
- More accurate family level IDs (particularly for flies)
- 1002 photos (17 additional composites) that will be associated with their specimens in the collection
- Greater understanding of the stratigraphic, sedimentological, and environmental context of existing collections (incorporated into museum’s locality data)
Conclusions

• An integrated approach optimizes collections use
  – Existing collections provide context, expand breadth and depth of research
  – New collections provide fresh specimens and interpretations

• Digitized specimen data facilitates information analysis and later retrieval

• Research and Curatorial work hand-in-hand can update museum collections and teach students how museums work
  – Facilitates appreciation for museums and collections (whether or not they are museum studies students)
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Thank you for Listening!