Something Old, Something New, Specimens Borrowed and Published Too

Integrating new specimens and old collections into research

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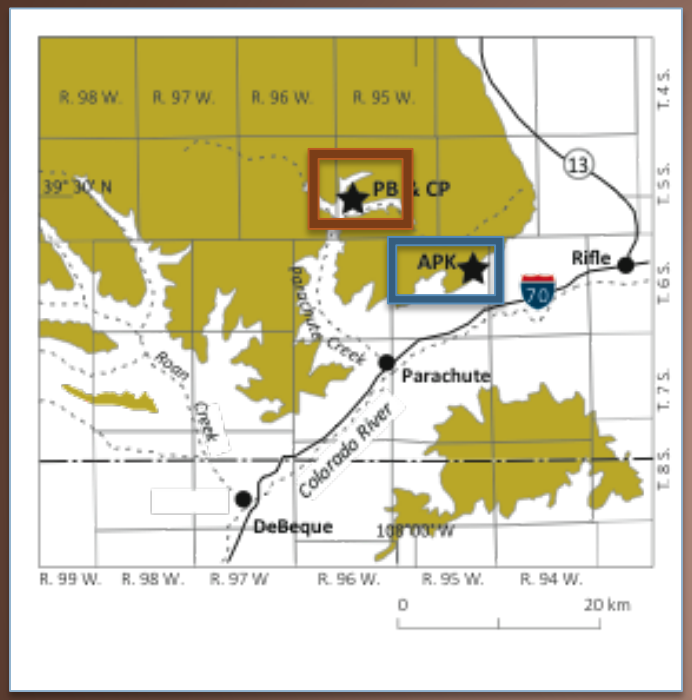
A collections opportunity

- 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...

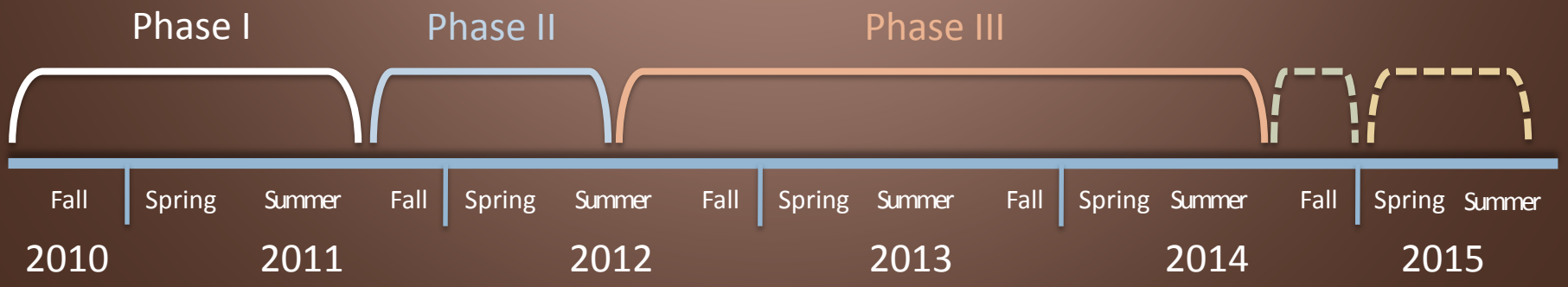
The insects of the Green River Formation



- At one site, the Paleoburn, insects are preserved in ruddy rocks as iron oxides.

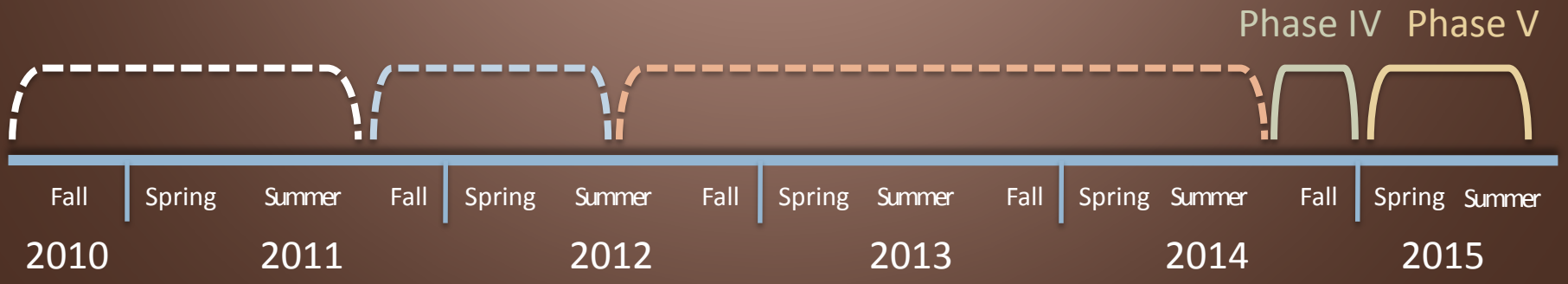
The Quantibug Project: Analyzing the Insects of the Green River Formation

- 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



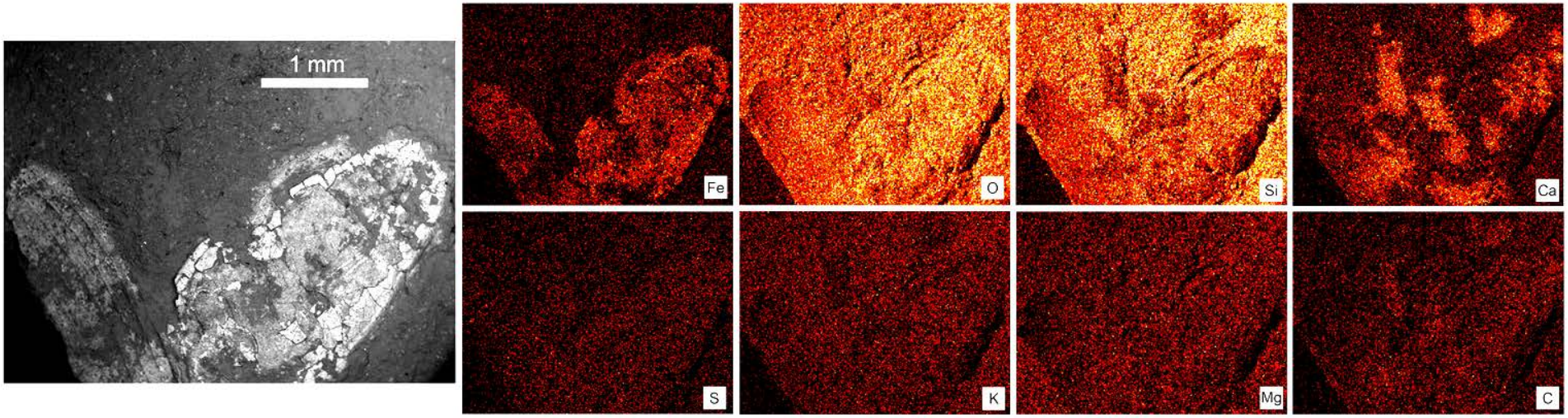
Phase I: Getting to know the insects

- 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

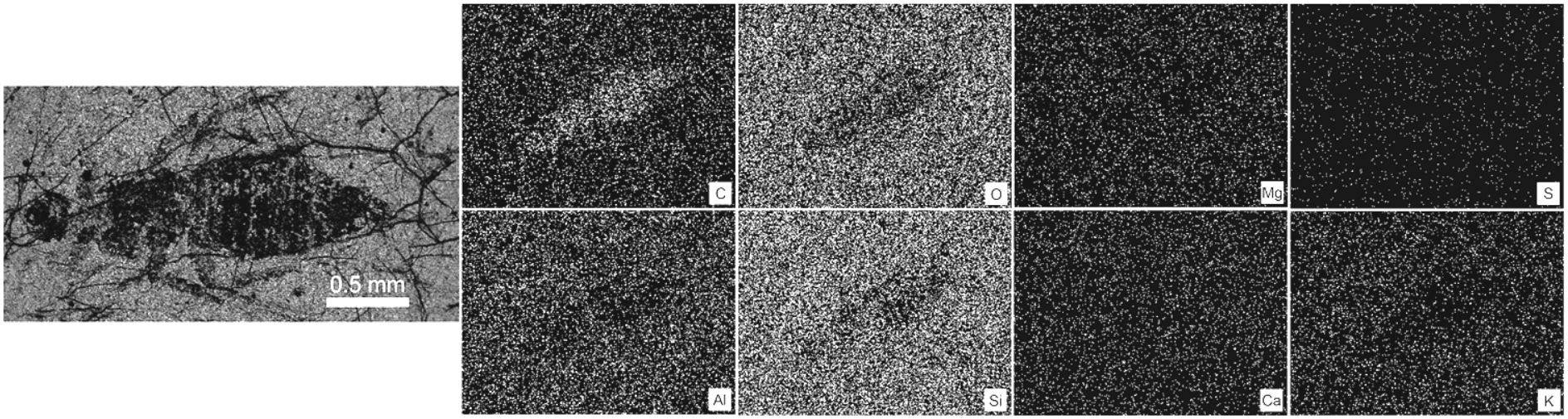
Phase II: Initial Analysis

- 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

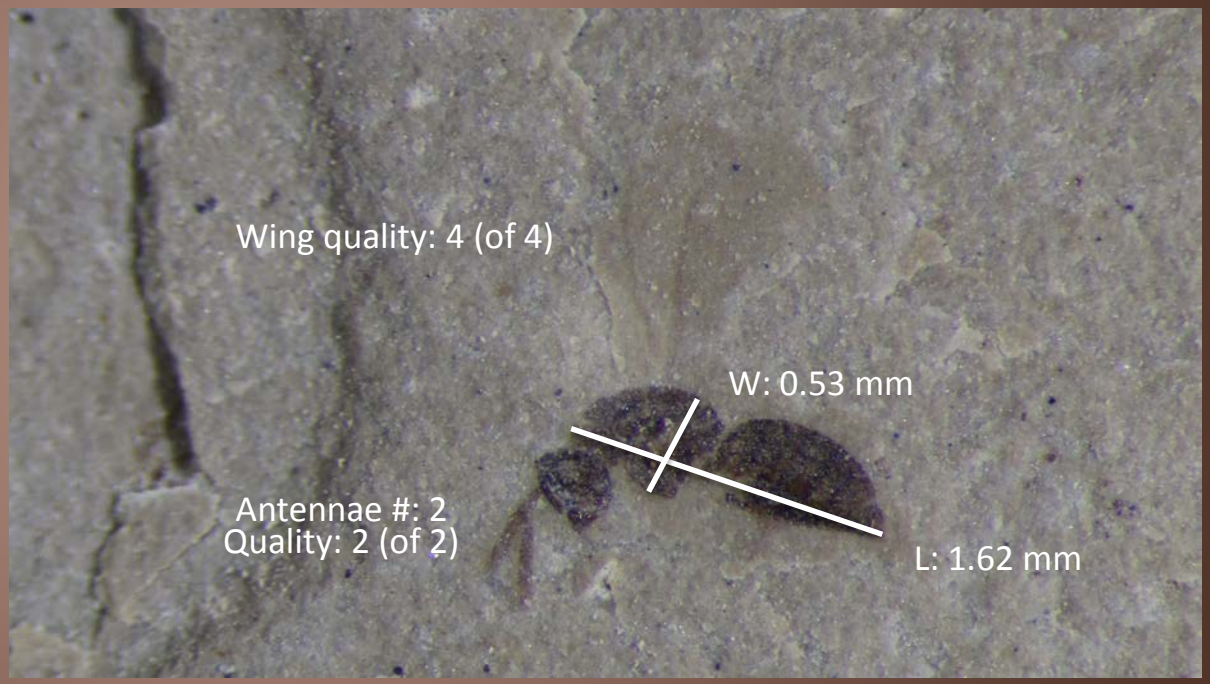
- Although they may have three-dimensional aspects, iron oxide paleoburn insects generally are less well-preserved than carbonaceous compression insects
- Pyritized soft-bodied fossils from other exceptional deposits thought to be of lower quality due to greater microbial activity
  - Sulfide for pyrite 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

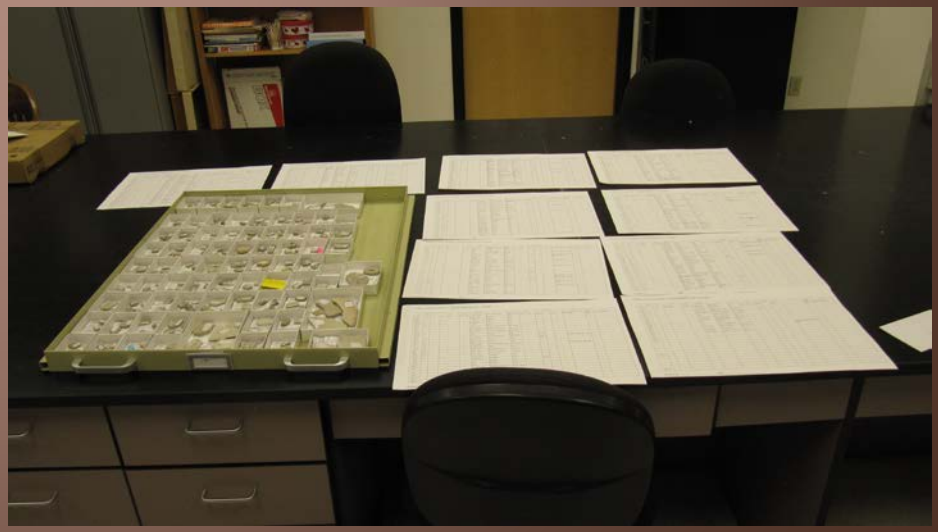
Newly Collected

- *225 new specimens*

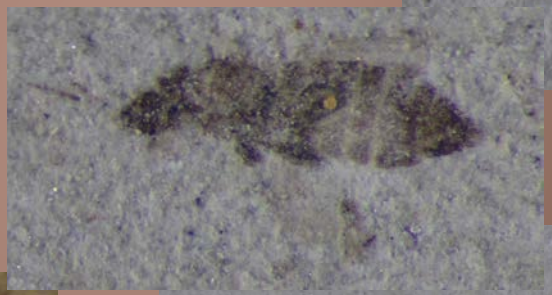
Anvil Points Insects

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)

Acknowledgements

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- The Dena Smith Lab for help and support, particularly Lindsay Walker for taking high-resolution photos of some of the specimens
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- Encana for land access to the Green River Formation
- Groups who have provided funding to me for:
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  - Lab analysis (Western Interior Paleontological Society; Colorado Scientific Society; Sigma Xi; University of Colorado Museum of Natural History; Shell via the Geological Science Department at the University of Colorado Boulder)
  - Research Assistanceships (NSF)

Thank you for Listening!