EXCEPTIONAL PRESERVATION AND DIVERSITY OF INSECTS FROM THE PALEOBURN LOCALITY OF THE EOCENE GREEN RIVER FORMATION OF COLORADO

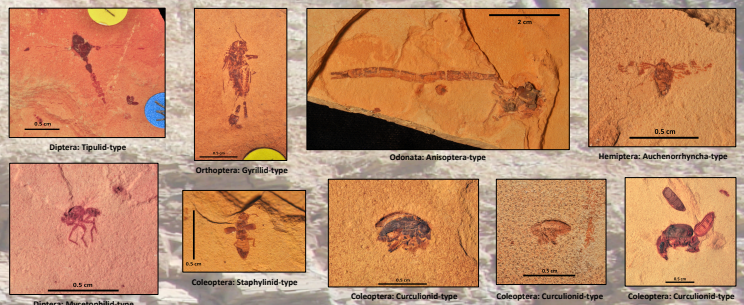
WALKER, Lindsay J.[1], DAHLBERG, Elisa[1], ANDERSON, Evan P.[2], LECKEY, Erin H.[2], and SMITH, Dena M.[1,2]
1. Museum and Field Studies, University of Colorado, 265 UCB, CU Museum of Natural History, Boulder, CO 80309
2. Department of Geological Sciences, University of Colorado, Boulder, CO 80309

ABSTRACT

The Paleoburn locality of the Parachute Creek Member of the Green River Formation, located in the Piceance Creek Basin near Parachute, Colorado, is known for its characteristic red coloration and insect fossils that can exhibit varying degrees of three dimensional preservation. The main fossiliferous unit grades from sediments that are bright red and orange to those that are tan and gray in color. Fossil specimens were sampled from two end-member sites along the gradient to study whether lithology is correlated with the diversity and quality of insects preserved. In the field, samples were standardized by collecting time. Specimens were identified to family and taphonomic data (specimen size, disarticulation, relief) were recorded. Sedimentological data (matrix color, texture) were also collected for each site.

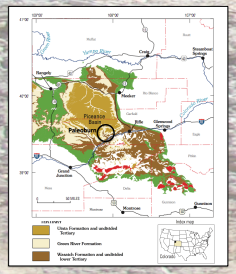
A total of 2,700 specimens were collected and a subset of 200 specimens (100 per site) was examined. An estimated family level richness of 31 was found for both sites combined. The number of families sampled was not significantly different between the two sites, but there was a significant difference (P<0.001) in the relative abundance of insects preserved. While both sites included a majority of Coleoptera and a relatively high abundance of Curculionidae (49% at the gray site, 26% at the red site), the red site also included more non-Coleopteran morphofamilies. The average specimen size was ~5 mm, and most specimens showed some level of disarticulation as only 10% were found to be complete. Although three-dimensional preservation has been well documented for the Paleoburn site, the majority of specimens (74%) were preserved in two dimensions. Lithological characteristics were not found to be correlated with insect size, disarticulation levels, or overall specimen relief. In general, these results support the finding of other studies, which have shown that lithology does not strongly affect the diversity and quality of insects preserved in lake settings. Additionally, color differences likely reflect chemical alterations from secondary fluid flow, and this appears to influence neither the diversity, nor the preservation quality of insect specimens. Thus differences in relative abundance of insect families may reflect real differences in the distribution of the living assemblage as opposed to taphonomic filtering.

LITHOLOGY



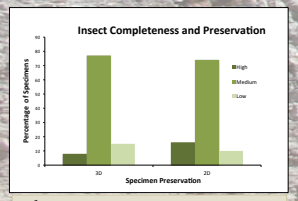
Fossil insects from the Paleoburn demonstrate unusual three-dimensional preservation. Specimens illustrated here represent typical variation in insect preservation quality, taxonomic diversity, and matrix coloration found at this locality.

LOCATION

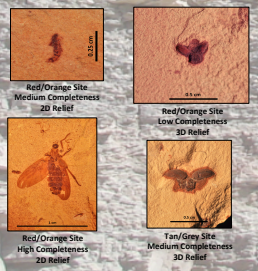


The "Paleoburn" is within the Parachute Creek Member of the Green River Formation, Piceance Creek Basin, near Parachute, Colorado. Map modified from Self et al. (2010).

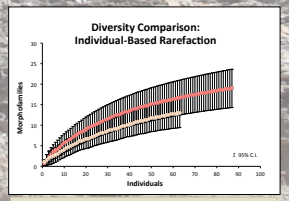
Does specimen completeness and preservation relief differ between sites?



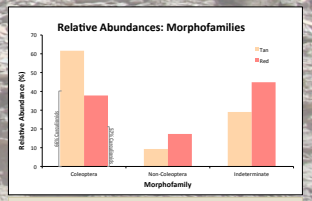
- x^2 = 2.222, P = 0.329
- No significant difference in levels of completeness between 3D and 2D specimens.



Does insect relative abundance and diversity differ between sites?



- Overlapping confidence intervals suggest no significant difference in morphofamily diversity between sites
- Jaccard's Similarity Index = 95% overlap
- Chao2 estimated diversity: tan ≈ 21, red ≈ 28



- Morphofamilies identified: tan = 10 (61 IDed individuals), red = 18 (86 IDed individuals), 20 total
- Significant difference between relative abundances of families identified from each matrix color (P<0.001)

CONCLUSIONS

- More specimens from the tan site are preserved in 3D relief than specimens from the red site.
- Rarefaction analyses and diversity estimators suggest the family-level diversity does not differ between sites, and that the total family-level diversity has been under-sampled.
- The taxonomic compositions of the red and tan assemblages differ significantly at the family level. We speculate this difference may be due to a spatial gradient within the ancient lacustrine environment.
- Lithology, as differentiated by matrix color, does not seem to affect the completeness of specimens preserved or family-level diversity of fossil insect assemblages at the Paleoburn locality.

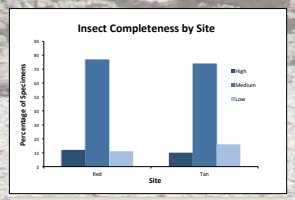
METHODS

Field

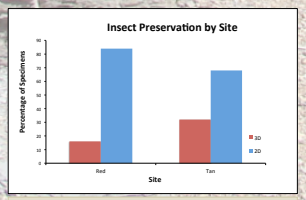
- Standardized collecting: 13 collectors, 2 days, 1.5 hours per site
- Goal: collect unbiased samples

Lab

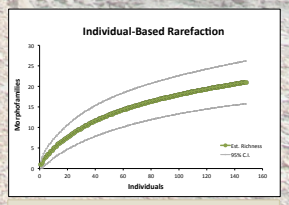
- Collection subsampled using transected boxes (10 boxes total)
- Samples categorized by matrix color, specimen completeness and relief
- Specimens identified as morphofamilies
- Rarefaction curves and diversity estimates calculated with *EstimateS*



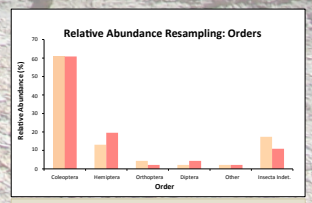
- x^2 = 1.236, P = 0.539
- No significant difference in level of completeness between sites.



- x^2 = 7.018, P = 0.0081
- The proportion of 3D specimens is significantly higher in the tan site than in red



- Curve has not reached asymptote: diversity under-sampled
- Chao2 estimate: 31 morphofamilies



- Orders identified: 5 per site (n = 46 for both colors)
- Distribution similar to results from initial sampling (above), but relative abundances of orders not different (P = 0.5)

FUTURE WORK

- Investigate matrix coloration, mineralogy, and secondary diagenetic alteration; future research will document the mineralogical basis of color differences, and investigate scenarios for their generation.
- Determine the influence of primary taphonomic biases and secondary diagenetic alteration on the taxonomic composition and preservation quality of Paleoburn insects.
- Make comparisons between the insects of the Paleoburn site and elsewhere in the Green River Formation, where they are preserved as carbonaceous compressions.

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