

discovery, of significant Lagerstätten.

In each instance the relationship between us and the professional paleontologist was quite different in terms of the fossils collected and the resulting possible scientific studies that followed

Two Silurian Lagerstätten, the Brandon Bridge and the Scotch Grove formations suffered the same fate. In each case we were able to collect and prep substantial collections of an extraordinary soft-bodied fauna. However, eventually our continued collecting was prevented by the professional paleontologists involved. In addition, either because of lack of ability or interest by these paleontologists few if no scientific papers resulted.

Our collecting of the famous ruin wash lower Cambrian Lagerstätten resulted in the discovery of many soft-bodied specimens with many species predating the Burgess Shale. The result was scientific papers largely in collaboration with Dr. Bruce Lieberman of the University of Kansas.

Our discovery of an extraordinary site in the Eocene green river of Colorado resulted in the finest collection of insects, arachnids and plants found so far in this formation. Many of the specimens ended up, through good graces of Dr. Kirk Johnson, in the collections and on displays at Denver Museum of nature and science. Eventually the site fell into the hands of fossil dealers.

Our most recent discovery of the big Hill upper Ordovician Lagerstätten has produced our best experience with regard to collaboration with professional paleontologists. We have been able to control the collecting of the site. In addition the collaboration between the professional paleontologist, Dr. Derek Briggs, Dr. James Lamsdell and Dr. Steve LoDuca has resulted in three major papers and more on the way.

Much can be learned from the success of the collaboration between us and the professionals from the big Hill experience.

GUIDED DISSECTION OF PRIMARY PALEONTOLOGY RESEARCH AS A TOOL TO BUILD SCIENCE LITERACY IN HIGH SCHOOL STUDENTS

MICHEL, Amber, Fort Hays State University Sternberg Museum of Natural History, Hays, KS; CONE, Marjean, University of Illinois Urbana-Champaign, Urbana, IL; LEVERING, David, Fort Hays State University Sternberg Museum of Natural History, Hays, KS; a_michels@mail.fhsu.edu

Comprehending primary research literature is an essential skill needed for students wanting to conduct

their own research projects. However, teaching novice students how to breakdown complex science topics in a way that is engaging and effective can be challenging. The purpose of this exercise was to engage high school students, all interested in paleontology, with primary scientific literature to develop their research comprehension skills. The Sternberg Museum of Natural History Field Paleontology: Kansas Camp offered a unique opportunity to provide students from diverse socioeconomic backgrounds with an outlet to express their interests and concerns regarding research. Students attending the field camp were given a paleontology-focused peer reviewed journal article and a detailed article synopsis that included an in-depth dissection of the article's sections and figures. Students were given access to these documents months before they arrived at camp. During the lab portion of the program, students were divided into two groups based on their age. Discussions about the article, the synopsis, and finding reliable research online were led by the authors. The campers were encouraged to discuss their interpretations, ask questions, and think critically about the provided article's content, and the purpose of its respective components. After the camps, the students were provided an opportunity to give feedback on the exercise and to offer suggestions for future uses of this lesson. Students expressed willingness to do the activity again at future camps and have stated that they have gained useful skills and knowledge that they have since applied to their schoolwork. High school students with limited access to educational resources may further benefit from the implementation of research literature dissection activities by gaining an understanding of science methods and paleontology that they may not have previously considered.

ALLOMETRIC VARIATION IN THE GENUS STEINMANELLA (TRIGONIOIDA, BIVALVIA) FROM THE LOWER CRETACEOUS OF THE NEUQUÉN BASIN (WEST-CENTRAL ARGENTINA)

MILLA Carmona, Pablo, Instituto de Estudios Andinos (IDEAN), National Research Council of Argentina (CONICET), Universidad de Buenos Aires (UBA), Buenos Aires, Argentina; LAZO, Dario, Instituto de Estudios Andinos (IDEAN), National Research Council of Argentina (CONICET), Universidad de Buenos Aires (UBA), Buenos Aires, Argentina; SOTO, Ignacio, Instituto de Ecología, Genética y Evolución de Buenos Aires (IEGEGA), National Research Council of Argentina (CONICET), Universidad de Buenos Aires (UBA),

Buenos Aires, Argentina; pablomillac@gmail.com

Because of the outstanding diversity and disparity they reached during the Mesozoic, the paleobiology of trigoniid bivalves has attracted considerable interest. In this work, we assessed the patterns of allometric variation within the genus *Steinmanella* Crickmay (Myophorellinae, Trigonioida) as it occurs in the lower Valanginian – upper Hauterivian (Lower Cretaceous) of the Neuquén Basin (west-central Argentina). The shells of 236 specimens belonging to 7 species of *Steinmanella* (namely, *S. quintucoensis*, *S. subquadrata*, *S. curacoensis*, *S. caicayensis*, *S. pehuenmapuensis*, *S. transitoria* and *S. vacaensis*) were digitized in three dimensions, and variation in two prominent external morphological characters, general valve geometry and sculpture, was subsequently analyzed. Shell surface shape and size were measured by means of geometric morphometrics, whereas sculpture was quantified using counts of ribs and nodes. The trajectories of the studied species through different size categories (intended to represent meaningful ontogenetic stages) were compared using phenotypic trajectory analysis. Our results show that early and late growth changes differ in nature between species. The former seems to be far more plastic, being characterized by changes in the direction and magnitude of the allometric trajectory through the shell surface and sculpture morphospaces respectively. On the other hand, late growth seems to be more conserved and channeled, showing more infrequent changes which mainly involve the magnitude of the trajectory across the shell surface morphospace. Therefore, the distinctive features of each species would have been acquired early in life, with later changes involving a general trend towards shell elongation, thus challenging the view that early development is more conserved in evolution. These findings can have important implications for the evolution of *Steinmanella*, as heterochronic processes acting upon ontogenetic variation is thought to be a major driver of bivalve evolution.

ANTLERS OF THE ARCTIC NATIONAL WILDLIFE REFUGE: BASELINES OF BIOLOGICAL VARIABILITY FROM BONES ON THE TUNDRA

MILLER, Joshua, University of Cincinnati, Cincinnati, OH; WALD, Eric, National Park Service, Fairbanks, AK; josh.miller@uc.edu

Quantifying natural variability in geographic range (including seasonal landscape use and migration) is a primary concern for evaluating animal populations

and establishing management and conservation goals. Unfortunately, this variability is often modeled using datasets with limited temporal perspectives. This predicament is exacerbated in arctic settings, where logistical complexities frequently interfere with biological surveys; including on economically and culturally keystone species, such as caribou (*Rangifer tarandus*). Unique aspects of caribou biology and ecology enable surface bone accumulations to significantly extend the observational window with which we study seasonal landscape use, particularly calving ground geographies (birthing grounds). Caribou females, like males, annually grow and shed antlers. While male caribou (and non-pregnant females) shed their antlers after the breeding season, pregnant females maintain their antlers until casting them within days of calving. Thus, the geographic distributions of male and female antlers offer data on historical migration and calving grounds. Because antlers can survive on arctic surfaces for centuries or longer, antler surveys not only offer insight into recent calving activity that is complimentary to traditional monitoring data, but they provide a unique source of historical baseline data on calving ground geography across timescales not available from ecological datasets. Here, we take advantage of naturally occurring accumulations of shed female caribou antlers to acquire data on calving ground landscape use and migratory fidelity across 10² to 10³ years. Further, we pair these data with hemispheric climate records (Arctic Oscillation) and other environmental and geographic parameters to test the drivers of calving ground geography and evaluate the impacts of current climate trajectories and recent changes in federal management policies. Antler surveys were conducted on foot across the Coastal Plain of the Arctic National Wildlife Refuge (ANWR), Alaska. Surveys focused on *Dryas* Terrace habitats, which are dry, have low vegetation cover, and appear to be a focal habitat during the calving period. On the ANWR calving grounds, accumulations of shed female caribou antlers can be large (> 1,000 antlers/km²). Relative to expectations from aerial surveys, many surveyed regions have higher-than-expected antler concentrations. Additionally, the rank-order correlation between modern and pre-1980 antler records is low, indicating a lack of congruence between modern and historical calving geography. Changes in the geographic distribution of antlers through time also indicate links between calving geography and climate (Arctic Oscillation) on decadal time-scales. Surficial bone records