

Trilobite evolution and biogeography paper

DUE DECEMBER 8

You collected a set of trilobites from a Lower Cambrian unit in eastern California. The specimens belong to the suborder Olenellina and your goal is to classify them (to genus level) and use the specimens, along with specimens you examined from previously-published papers, to discuss ontogeny, evolution, and heterochrony in the Olenellina. You will also study biostratigraphy and biogeography, but we will work on that in class on November 21.

Part 1: Ontogeny, evolution, and heterochrony

Here are some of the tasks you will need to do.

1. Use ordination (Principal Components Analysis – see triloPCA.R at eCommons) to perform a phenetic classification of the trilobite specimens based on the landmark data. Use the ordination plot to divide the “unknown” specimens and assign them to known genera, based on comparison with known specimens on the plot (hint: all of the U11 specimens are one genus and the 85 specimens belong to two different genera).
2. Use the ordination plot to assess how cephalon shape changes during ontogeny. There are nine separate landmarks, but remember that the longer arrows are more important sources of variation. Try to generalize in terms of the cephalon shape (length/width, position of eye, etc.) rather than just listing how each landmark shifts.
3. Complete the cladistics data matrix for the trilobite genera, using the pictures provided on the website and the instructions on the data matrix handout.
4. Construct a cladogram from the character matrix using RStudio (triloPhylo.R file at eCommons). Use the hypothesized evolutionary relationships suggested by the cladogram and your analysis of adult morphology and ontogenetic shape change (from steps 1 and 2) to discuss how heterochrony may have influenced evolution in these trilobites.

You can start writing your results and discussion now, but you should wait until finishing the second part (biostratigraphy/biogeography) before writing the abstract and conclusions. You should carefully consider how to organize the data in the results and discussion sections. You will cover cephalon shape and classification, ontogenetic shape change, evolutionary relationships (from cladistics), and heterochrony – think about how to organize that logically in both sections.

Part 2: Biostratigraphy and biogeography

This part of the paper will add information about biogeography and biostratigraphy to your existing data. The material will be covered in class on November 14, 17, and 19 and you will have time to work on the analyses on November 21. There are two new pieces of information you will use:

1. Use the trilobite range chart (Trilobite strat ranges at eCommons) to assign each location (your samples come from two locations – 11 and 85 – but you don’t have any other information) to a trilobite zone. The range chart shows the stratigraphic ranges

of selected trilobite genera, divided into three zones (all are in the Early Cambrian). Use your genus identifications from the previous paper to assign each location to a particular trilobite zone. You should describe your findings in the results section of your paper, but you don't need to interpret their meaning because the main goal of biostratigraphy is to lay the groundwork for the biogeography analysis.

2. Analyze the biogeographic distribution of the trilobites using RStudio (see `triloBiogeog.R` at eCommons). You will make cluster dendrograms for each region to determine which regions are more similar to one another. You can then use this information, in conjunction with your previous cladogram and the paleogeographic maps (also at eCommons), to discuss how changes in sea level affected trilobite biogeography and explain how vicariance and/or dispersal influenced evolution of Early Cambrian olenellid trilobites.

Your paper will need to have the same organization as the environmental reconstruction report. You should have an informative title, abstract (maximum 250 words, containing detailed results and conclusions), introduction, methods, results, discussion, conclusion, references cited, and figures/tables. You may want to use a second level of subheadings within the results and discussion to divide different topics.

Be specific and clearly distinguish your results from interpretation of those results. As a rule of thumb, results contain presentation of data and straightforward deductions from that data (which can include observations you make from graphs), whereas the discussion contains your interpretations of the meaning or implications of those results (especially syntheses that require combination of several lines of evidence). For example, species identifications based on the ordination plot or descriptions of ontogenetic shape change are best placed in results because they are simple observations from the analyses. Likewise, the issue of heterochrony is a matter for the discussion because it requires synthesis and interpretation of multiple lines of evidence.