

Essay Assignments for Paleontology

These are four essay assignments I use in Paleontology. These assignments work to help students meet several goals of the course, including using reading/writing as critical thinking, synthesizing information from different sources, and formulating new research questions.

In particular, the last two of the four assignments are designed as part of a multi-step process. Each student is assigned a particular reading for which he or she will be the primary discussant in a class discussion. Two things make this discussion and the (hoped for) “aha” moments for the students are required.

- 1) Students must take the time to read and understand the paper they’ve received. It’s useful, particularly if students are just starting out reading primary literature, to discuss *how* to approach reading a journal article. Maybe most important inculcating the idea that most people don’t read straight through a paper, that multiple readings are important, and that it’s not like reading a novel – it takes time to absorb.
- 2) On discussion day, have students talk about the papers *in chronological sequence*. There should be back and forth discussion, of course, but when this process works right, (which is most of the time, in my experience), the stepwise introduction and discussion of the papers allows students to see how the problem was originally framed, how it developed, and how new information changes interpretations (and that there may not be a clear resolution).

After the discussion, hand out essay assignments tailored to the skills and knowledge you want them to acquire.

GEO 290 Paleontology
Testing Taphonomic Hypotheses

In lecture we discussed the process by which fossils are formed and the journey that a living organism takes from its death or separation until it is available for study (taphonomy). In this essay you will investigate an issue of taphonomy in more depth, as well as start your thinking about methodological differences between historical and experimental science.

You've learned how preservation potential varies depending on material. In other words, hard parts, like mineralized bone and shell or wood, are more often preserved than soft parts – tissues like skin, muscle, and cartilage. Under the right conditions, however, soft parts can be preserved.

In this essay, you will explore the following question: What is the role of clay in the preservation of organism "soft parts"? The goal here isn't to answer the question, but rather think about ways to find out the answer. Here is what to do:

1. Formulate this question as a single hypothesis that can be tested scientifically. Don't expect to be comprehensive. Just pick some aspect to focus on.
2. Describe an experimental test for the hypothesis.
3. Describe an historical test for the hypothesis.

Remember that both experimental and historical sciences test hypotheses. They also use evidence and collect data. Your task in this essay is to clearly understand how the process works differently in each of these perspectives.

Your essay should include an introductory paragraph that presents the hypothesis you will test along with any background information you need to present so that the reader can understand where the hypothesis comes from. Please do not cite lecture. If you need more background on clay and its role in fossil preservation, do some research. Your introductory paragraph should be followed by a paragraph (or two) describing your experiment, and a paragraph (or two) describing the historical test for your hypothesis. Use headings to distinguish the experimental test from the historical test. The essay should probably be in the neighborhood of 600-700 words.

You will be graded on whether the tests you propose will really address the hypothesis you present. I will also consider the quality and practicality of your tests, clarity of presentation, and bonus points for quality (e.g., primary literature) additional research. If you do cite primary literature, make sure you cite your sources in the style presented in the Citing and Referencing document provided.

GEO 290 – Paleontology
Natural(?) Selection

Most people's understanding of how evolution works is strongly shaped by the popular media, ranging from documentaries on the Discovery channel to articles in Time or Newsweek. For example, in "It's survival of the weak and scrawny", Huang (2009) examines the effects that poaching and hunting are having on large mammal populations and links those effects to changing fitness of those species. Evolution has become a kind of lightning rod for cultural conflict. How well do you think the popular media portrays the way evolution works? Acknowledging that any popularization of a scientific idea is not going to get it 100% right, do you think that articles like this contribute to the growth of understanding and intellectualism or do they perpetuate myths destructive to the common discourse?

Your essay should be 800 to 1000 words. I'll be looking for a coherent explanation of your stand, as well as the usual things – clean, concise, and precise prose. I am NOT looking for any answer in particular and I'm not looking for a detailed explanation of what was "right" or "wrong" about the article. You could certainly cite elements of the article as examples, however.

Huang, L. 2009. It's Survival of the Weak and Scrawny. *Newsweek* (12 January 2009).

Geo 290 Paleontology
Tales of the Whale

We've delved a little bit into the healthy debate around reconstructing the origins of whales and their evolutionary relationships. New data from fossils and the explosion of molecular techniques have helped resolve a lot of murky understanding. Interesting, then isn't it, that as researchers apply morphological and molecular techniques to the same problem, then can arrive at different answers? Indeed, phylogenies based on molecular data (nucleotide sequences in key genes) commonly conflict with those based on morphological characters.

In this essay (not to exceed 1500 words), address the following questions:

- What are the main areas of conflict between molecular and morphological phylogenies in the origin of whales?
- Why might these two data sets give such different results?
- How can the controversy be resolved? Add data? Remove data? If so, what? Something else?

Use the articles we discussed, but check their reference lists for anything that might provide additional insight. You could also check to see if there's anything more recent on this subject. Finally, you might also look to other examples of conflict between molecular and morphological or fossil data for other opinions.

Your essay will be evaluated on two criteria: (1) the content and reasoning of your arguments addressing the questions above; and (2) your correct and complete use of citations and references.

Reading List:

Gatesy, J., and M. A. O'Leary. 2001. Deciphering whale origins with molecules and fossils. *Trends in Ecology and Evolution* 16(10):562-570.

Geisler, J., and M. D. Uhen. 2003. Morphological support for a close relationship between hippos and whales. *Journal of Vertebrate Paleontology* 23(4):991-996.

Gingerich, P. D., B. H. Smith, and E. L. Simons. 1990. Hind Limbs of Eocene *Basilosaurus*: Evidence of Feet in Whales. *Science* 249(4965):154-157.

Luo, Z., and P. D. Gingerich. 1999. Terrestrial Mesonychia to aquatic Cetacea: transformation of the basicranium and evolution of hearing in whales. *University of Michigan Papers on Paleontology* 31:1-98

- Nikaido, M., A. P. Rooney, and N. Okada. 1999. Phylogenetic relationships among cetartiodactyls based on insertions of short and long interspersed elements: Hippopotamuses are the closest extant relatives of whales. *Proceedings of the National Academy of Sciences* 96:10261-10266.
- Thewissen, J. G. M., and S. I. Madar. 1999. Ankle morphology of the earliest Cetaceans and its implications for the phylogenetic relations among ungulates. *Systematic Biology* 48(1):21-30.
- Thewissen, J. G. M., E. M. Williams, L. J. Roe, and S. T. Hussain. 2001. Skeletons of terrestrial cetaceans and the relationship of whales to artiodactyls. *Nature* 413:277-281.

Geo 290 Paleontology
Bug Creek Essay

You've read and discussed a sequence of papers about the richly fossiliferous, stratigraphically complex Bug Creek site. You saw how the ideas about the site changed over time, as well as how the implications (like whether dinosaurs survived into the Paleocene) changed with detailed study. The issue of what time these deposits represent has been resolved (and hurray for that), but there are many other unanswered questions that could be developed. (The nature of good science is that closing the door on one issue will open the door for some other area of inquest.)

Develop a new research question to address in the Bug Creek area. I'm not asking you to answer the question (though by all means, go for it, if you get inspiration), but rather formulate a research idea. Remember, the question can be very simple and straightforward.

Create an essay in the form of a research proposal. This proposal will consist of several parts.

1. An introduction that provides background on the region, specific location, time interval, and previous work. This background should support and inform the question you're leading up to and make its significance obvious
2. A section explaining the question to be addressed, its importance and relevance.
3. A short section outlining the research plan itself

You'll be citing the relevant literature for this exercise. That'll include at least some of the stuff in the reference list below, but would also draw in other things relevant to your question as well. There's no exact word count, but shorter than 1000 words means you haven't developed the idea and the background enough.

Your essay will be evaluated on two criteria: (1) your command of the background, (2) the development of your question; and (3) your correct and complete use of citations and references.

Bug Creek In-Class References

Archibald, J. D. and W. A. Clemens. 1984. Mammal evolution near the Cretaceous-Tertiary boundary. In: W. A. Berggren and J. A. Van Couvering, (eds.) *Catastrophes and Earth History; the new uniformitarianism*. Princeton University Press, Princeton, N.J., p. 339-371.

Archibald, J. D., D. E. Fastovsky, and R. H. Dott. 1986. Comment and Reply on

"Sedimentology, stratigraphy, and extinctions during the Cretaceous-Paleogene transition at Bug Creek, Montana. *Geology* 14(10):892-894.

Fastovsky, D. E., and R. H. Dott. 1986. Sedimentology, stratigraphy, and extinctions during the Cretaceous-Paleogene transition at Bug Creek, Montana. *Geology* 14:279-282.

Lofgren, D. L., C. L. Hotton, and A. C. Runkel. 1990. Reworking of Cretaceous dinosaurs into Paleocene channel deposits, upper Hell Creek Formation, Montana. *Geology* 18: 874-877.

This Lofgren article was not assigned but is part of the solution in the end. Worth a look.

Lofgren, D. L. 1995. The Bug Creek Problem and the Cretaceous-Tertiary Transition at McGuire Creek, Montana. *University of California Publications in Geological Sciences* 140. 185 pp.

This is Lofgren's treatise on the subject and pretty much the last bit needed to resolve the issue of what the age of the Bug Creek stuff is. Does not resolve whether extinction dino extinction is gradual or instantaneous, but does resolve the ages of the deposits and whether dinos persisted into the Paleocene (recounting some of above paper).

Sloan, R. E., J. K. Rigby, L. M. V. Valen, and D. Gabriel. 1986. Gradual dinosaur extinction and simultaneous radiation in the Hell Creek Formation. *Science* 232(4750):629-633.

Sloan, R. E., and L. V. Valen. 1965. Cretaceous Mammals from Montana. *Science* 148(3667):220-227.

Smit, J., and S. Van Der Kaars. 1984. Terminal Cretaceous extinctions in the Hell Creek Area, Montana: Compatible with Catastrophic Extinction. *Science* 223(4641):1177-1179.