01-20-2016
GEOSCIENCE 541
PALEOBIOLOGY

COURSE SYLLABUS

LEAD INSTRUCTOR:	ANDREW ZAFFOS
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CLASS HOURS:	1:20-2:10 M, W
LAB HOURS:	3:30-5:30 WED.
OFFICE HOURS:	12:00-2:00 W, F OR BY APPOINTMENT
COURSE WEBSITE:	HTTPS://GITHUB.COM/AAZAFF/TEACHPALEOBIOLOGY

COURSE PHILOSOPHY

This course is organized around the idea of *ontogeny*. Ontogenesis is a concept in biology that describes the anatomical and behavioral development of an organism from its birth to its death. In other words, it means progression through the successive stages of life as you age – e.g., birth, childhood, adolescence, adulthood, and death.

Paleobiology can be thought of as an extension of this idea, ontogeny, from individual organisms to species. Species are born into this world via abiogenesis or evolution from parent species; they grow in population size and geographic extent; and they eventually become extinct. If you understand the general processes governing the ontogenetic development of species and fossils, then you are equipped to hypothesize about the origins of any pattern you observe in the fossil record, whether or not you are familiar with the particulars of the place or time in question.

The course is split into two phases. In the first phase, we discuss the ontogeny of species and fossils in general terms. In the second phase, we proceed through successive periods in the history of complex animal life, and analyze the specific ontogenetic development of different *evolutionary faunas*. Evolutionary faunas are groups of species that evolved, dominated the globe, and became extinct around the same time. In other words, evolutionary faunas are the concept of ontogeny applied to groups of species.

COURSE SKILLS

In addition to the theoretical framework discussed above, this course places a strong emphasis on practical skills, especially data analytics. This includes downloading data sets, entering and editing data, and statistical analysis of those data. Ideally, at the end of this course, you will be able to construct and test your own paleobiological hypotheses using available online databases.

In particular, we will use the R statistical software, the Paleobiology Database, and the Macrostrat Database. All of these services are free, available online, and work with Mac, Windows, or Linux systems. R is an especially powerful tool that is highly sought

after in the job market. Companies like Google, Microsoft, and Amazon, as well as most major Universities and graduate programs are looking for R proficiency.

COURSEWORK ORGANIZATION

There are no midterms or final exams in this course. Instead, oursework is broken down into the following types of weekly assignment: short tests, reading and writing assignments, and lab-assignments. Each week will include one of each type of assignment. If you would like to learn more about this grading philosophy, and other study tips, I recommend the following book: Make it Stick: The Science of Successful Learning.

A. **TESTING (10 POINTS EACH)**

Short weekly tests will be given online over the weekend. Tests will generally consist of 10 short answer or multiple-choice questions related to the material covered that week.

B. **READING AND WRITING (10 POINTS EACH)**

Reading assignments will be given each week throughout the semester. These assignments may be formal scientific articles or popular science essays. You must read these papers and be prepared to discuss them in the following class.

In addition, you will write a two-page summary of the article describing the overarching question it addresses, the hypothesis tested, data, methods, results, and conclusions. An example write-up, with more detailed directions, is available online. Write-ups are due at the beginning of the next class.

C. **LAB ASSIGNMENTS (20 POINTS EACH)**

You will have open access to the lab area and can complete unfinished lab assignments at your convenience. Many labs will be lengthy and require you to continue working on them, as homework, after the official lab period has ended. **Many labs will require the use of a computer**, so please bring your laptop if you have one.

Lab assignments will generally be due at the start of the next lab period, unless otherwise specified.

D. **MAKE-UPS**

There are **no make-ups** for missed assignments. Instead, your lowest assignment grade is dropped at the end of the semester – i.e., you get **one** "freebie" to use for emergencies or even if you just want to take a day off. It will automatically be dropped when calculating your final grade, and you do not need to notify me in order for the grade to be dropped.

In the event of a truly significant medical (or other) emergency that spans for more than two weeks (significance determined entirely at my discretion), you can petition me directly to substitute one two-page essay for each missed **lab assignment**. These essays will require you to write an opinion piece that takes a stance on a controversial topic in paleontology, where your arguments are buttressed by peer-reviewed literature. You can see an example make-up essay on the course website.

RESEARCH PROPOSAL (60 POINTS TOTAL)

Towards the latter half of the course (starting March 16th), you will design a (hypothetical) research project utilizing the Paleobiology Database to test a hypothesis related to one of the biodiversification, dispersal, or extinction events covered in the class. Students can also cover topics not covered in the class with my approval.

You will write up the proposal following the Geological Society of America graduate research grant guidelines. You can examine examples of successful research grants on the course website. You will not have to actually carry out the proposed research project, but your proposal will be evaluated based on its scientific accuracy, clarity, and feasibility. The grading rubric and further details will be disseminated once we begin the grant-writing process.

FINAL GRADE

Final grades are the sum total of all points you earned throughout the semester divided by the total number of possible points. Each test is worth 10 points, each reading and writing assignment is worth 10 points, each lab assignment is worth 20 points, and the research proposal is worth 60 points (30 points for the first draft, and 30 points for the final draft).

TEXTBOOK

Several textbooks have been put on reserve in the geology library. Although the course listing recommends Principles of Paleontology by Foote and Miller, it is an optional purchase.

LAB ATTENDANCE

You are not graded on attendance, but it is highly recommended that you make an effort to attend all labs. The lecture will continue for a portion of the lab period in my cases.

COURSE SCHEDULE

What is Paleontology? WED: January 20	1. Course overview 2. Definition of paleontology 3. Definition of fossil 4. Definition of species 5. Linnean hierarchy *Reading Assignment:* How many species concepts are there? Wilkins (2010) *Lab:* Introduction to R and the Paleobiology Database

Origination I *(Living)* MON: January 25	1. Review Wilkins (2010) 2. Morphology and Morphometrics
Origination II *(Living)* WED: January 27	1. Ontogeny 2. Heterochrony 3. Phylogeny and Cladistics *Reading Assignment:* Hydrothermal vents and the origin of life. Martin et al. (2008) *Lab:* Phylogeny and Morphometrics
Origination III *(Living)* MON *February 1*	1. Review Martin et al. (2008). 2. Abiogenesis 3. Genetic drift and neutral theory 4. Molecular clocks
Origination IV *(Living)* *Distribution* I *(Living)* WED *February 3*	1. Sexual Selection 2. Geographic models of speciation *Reading:* Grinellian and Eltonian niches and geographic distributions of species. Soberón (2007) *Lab:* Characterizing species distributions
Distribution II *(Living)* MON: February 8	1. Review Soberón (2007). 2. Ecological niche 3. Ecological competition and facilitation 4. Ecological gradients
Distribution III *(Living)* WED: February 10	1. Anatomical and behavioral mechanisms of dispersal 3. Commonly observed patterns of species distribution *Reading:* Extinction vulnerability and selectivity. McKinney (1997) *Lab:* Modeling niches and biological invasion
Extinction I *(Living)* MON: February 15	1. Review McKinney (1997) 2. Determinants of extinction 3. Pseudoextinction

Extinction II *(Living)* WED: February 17	1. Extinction (cont…) 1. Measuring biodiversity 2. Measuring extinction 3. Measuring origination 4. Measuring evenness *Reading:* Global biodiversity scenarios for the year 2100. Sala et al. (2000) *Lab:* Ecoinformatics
Review I *(Living)* MON: February 22	1. Review Sala et al. (2000). 2. Review concepts covered in Origination (Living), Distribution (Living) and Extinction (Living) sections.
Origination I *(Fossils)* WED: February 24	1. Types of fossils (i.e., biosignatures, ichnofossils, and body fossils). 2. Ideal conditions for fossilization (lagerstätten) 3. Fossilization processes. 4. Diagenesis *Reading:* How good was the fossil record? Clues from the California Pleistocene. Valentine (1989) *Lab:* Mapping and "predicting" lagerstätten
Distribution I *(Fossils)* MON: February 29	1. Review Valentine (1989) 2. Fossil transport 3. Time-averaging 4. Taphonomically active zone 5. Condensed sections
Distribution II *(Fossils)* WED: March 2	1. Lazarus, Elvis, and Zombie taxa 2. Signore-Lipps effect 3. Holland effect 4. Common-cause hypothesis *Reading:* The influence of Lithification on Cenozoic marine biodiversity trends. Hendy (2009) *Lab:* Calculating stratigraphic ranges
Distribution III *(Fossils)* MON: March 7	1. Review Hendy (2009) 2. Unlithified vs. lithified sediments 3. Increased bioturbation 4. Pull-of-the Recent

Distribution IV *(Fossils)* WED: March 9	1. Siliciclastic vs. carbonate environments 2. High vs. low latitude paleocontinents 3. Epicontinental vs. open ocean 4. Ice House vs. green House *Reading:* Determinants of extinction in the fossil record. Peters and Foote (2002) *Lab:* Identifying "missing" biodiversity
"Cambrian" Fauna I MON: March 14	1. Review Peters and Foote (2002) 2. Ediacran biota 3. Cambrian Explosion 4. Ordovician Radiation
"Paleozoic" Fauna I WED: March 16	1. Late Ordovician Mass Extinction *Reading:* Decoupling taxonomic and ecologic severity of mass extinctions. Droser et al. (2000) *Lab:* Review grant proposal instructions and grading rubric. Brainstorm hypotheses in groups. Submit preliminary hypotheses.
	HAVE FUN OVER SPRING BREAK
"Paleozoic" Fauna II MON: March 28	1. Review Droser et al. (2000) 2. Early Silurian biodiversification *Grant Proposal*: Finalize your topic and hypothesis.
"Paleozoic" Fauna III WED: March 30	1. Terrestrial transition 2. Late Devonian Mass Extinction *Reading:* Origination, extinction, and mass depletions of marine diversity. Bambach et al. (2004) *Lab:* Diversity partitioning at the Ordovician/Silurian, Givetian/Frasnian, and Frasnian/Fammenian extinctions
"Paleozoic" Fauna IV MON: April 4	1. Review Bambach et al. (2004) 2. Mid-Carboniferous Rainforest Collapse

"Paleozoic" Fauna V WED: April 6	1. Late Permian Mass Extinction. *Reading:* The effect of geographic range on extinction risk. Payne and Finnegan (2007) *Lab:* Peer-review grant proposal rough drafts.
"Modern" Fauna I MON: April 11	1. Review Payne and Finnegan (2007) 2. Early Triassic fossil gap. 3. Late Triassic Extinction. *Grant Proposal*: **ROUGH DRAFTS DUE**
"Modern" Fauna II WED: April 13	1. Mesozoic plant revolution 2. Mesozoic vertebrates 3. Mesozoic microfossil revolution *Reading Assignment:* **TBD** *Lab:* Triassic and Jurassic Macrostrat
"Modern" Fauna III MON: April 25	1. Review **TBD** 2. End Cretaceous Mass Extinction
"Modern" Fauna IV WED: April 27	1. Cenozoic biogeography. 2. Cenozoic Climate Change 3. Cenozoic mass extinctions *Reading:* Has the Earth's sixth mass extinction already arrived? Barnosky et al. (2011) *Lab:* Inferring paleocontinent positions
"Modern" Fauna V MON: May 2	1. Review Barnosky et al. (2011) 2. The "sixth" mass extinction.
"Modern" Fauna VI WED: May 4	1. Review Class Material. 2. Class Evaluation *Lab*: PaleoDeepDive *Grant Proposal*: **FINAL DRAFTS DUE**