

Invertebrate Paleontology

GEO 217

INSTRUCTOR

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Preferred name: Drew

Pronouns: He/him

Office: Norton Geology Building Room 102

CLASS MEETING TIMES & LOCATION

We will meet from 9 to 11 am and 1 to 3 pm in Norton Geology 108 each day during the block, except for days dedicated to the field trip, practical (lab) exam, and final (open-book) exam.

Some days, we may work in Norton Geology 103 on lab exercises and the course project.

COURSE DESCRIPTION

Earth is a planetary system. It consists of many interconnected zones or “spheres,” including the atmosphere, hydrosphere, lithosphere, cryosphere, and biosphere. The focus of this course is the biosphere—the zone of life—and its ancient history. In this course, you will learn about the many diverse forms of life on Earth, both living and extinct, and their significance for the past, present, and future of our planet. Moreover, you will explore methods employed by paleontologists that study the fossil record, for example, methods for interpreting sedimentary rocks and reconstructing paleoenvironments based on fossils and using fossils as proxies for Earth surface processes in deep time. Finally, you will develop a number of transferable skills related to critical thinking, organization, collaboration, data analysis, and oral communication, in addition to learning disciplinary knowledge.

COURSE GOALS

1. Gain a basic familiarity with common fossil groups
2. Apply methods of paleobiological analysis / Develop the ability to study fossils
3. Learn to ask appropriate questions of the fossil record
4. Have an opportunity to do paleobiological research
(compiling data, preserving data in databases, accessing/analyzing those databases, and collaborating on scientific projects)
5. Be exposed to the big questions/themes in paleobiological research
(biases, diversification, extinction, evolutionary morphology, paleoecology, etc.)
6. Hone skills relating to researching, sketching, writing, and organizing information

*This course supports the Educational Priorities and Outcomes of Cornell College with emphases on **knowledge, inquiry, reasoning, ethical behavior, and communication.***

What I expect from you:

You should come to class on time and prepared to learn. Be engaged and actively participate in discussions and activities. Remember, you should be working a solid 8 hours/day, both for your own learning and to fulfill the requirements for this program to have accreditation.

Consequently, you will spend at least 150 hours/course. Most days, we will have ~4 hours in class, including lab time. When we are not engaged in class, you should plan on reviewing materials from class, working on the course project, and keeping up with your reading assignments. Of course, you may end up needing to do more (or perhaps less), depending on your own learning pace and style. I encourage you to read to understand, not to simply finish.

PREREQUISITES

GEO 130 (Historical Geology) or BIO 142 (Organismal Biology) BUT different introductory geology courses will be considered. Some knowledge of sedimentology, stratigraphy, and biology are recommended. If you do not have this additional background, please be prepared to spend out of class to ensure you are confident with all of the Paleontology material.

OFFICE HOURS

I am always happy to speak with you about class or other issues, and if there is anything you feel that I should know, I would prefer to meet as soon as possible. I will hold office hours by appointment before or after class. In general, I would probably prefer to meet between 3 and 5 pm. I do my best to promptly respond to emails BUT you may need to wait a day or so for an individual meeting.

TEXTBOOK

Our primary textbook will be *Introduction to Paleobiology and the Fossil Record* (Benton and Harper, 2009) Wiley-Blackwell, ISBN 9781405141574. Editions are available in the bookstore. You will read roughly one or two chapters per day. Some days, you may be asked to read additional papers. Other relevant readings will be posted on the course Moodle website. You are responsible for all assigned readings and content. I strongly recommend that you read Benton and Harper (2009) chapters BEFORE class, as it will improve your ability to participate AND allow you to complete your daily index card questions assignment (see below).

ADDITIONAL ITEMS

In addition to writing utensils, you must have a healthy supply of index cards AND a basic set of colored pencils for lab exercises (available in the bookstore). I also recommend that each student keeps a notebook for notetaking. In this course, you will use index cards for the majority of class activities and lab exercises. I STRONGLY recommend that you hold onto all the cards from the activities and exercises, as you can use them as flash cards as you prepare for your exams.

You must bring your laptop with you to class during days dedicated to data analysis with the programming language **R**. The activities in this course will not require any previous experience with **R**. Indeed, one of the goals of this course will be to introduce you to **R** and some statistical methods, which you may find useful in other walks of life. I will guide you through the installation of **R**, **RStudio** (a workspace manager that make **R** easy), and a variety of packages for analyzing and visualizing data. We will then troubleshoot any issues. All our data will come from the Paleobiology Database (PBDB), an open access and global database on fossil taxonomy and occurrences.

EVALUATION

Your grade for this course will be based on six factors: (1) an open-book final exam that will help develop your inquiry, reasoning, and critical thinking skills and test your understanding of major concepts in paleobiology; (2) a lab (specimen-based) exam that will assess your practical skills (i.e. your ability to identify fossils and recall basic information about them); (3) daily short quizzes based on previous days' materials; (4) regular participation in class discussion; (5) lab activities that will give you hands-on experience with fossils/data, enhance your inquiry/reasoning abilities, and prepare you for the lab practical; and (6) a course project that will give you an opportunity to collaborate as part of a team, organize information, compile data, and utilize open-access data resources (i.e. databases) used by paleontologists for research.

GRADING SCALE

95-100	A
90-94.9	A-
86-89.9	B+
83-85.9	B
80-82.9	B-
76-79.9	C+
73-75.9	C
70-72.9	C-
66-69.9	D+
60-65.9	D
0-59.9	F

GRADING POLICY

Final (open-book) exam	20%
Practical lab (specimen-based) exam	20%
Class/Field Trip Participation	10%
Class Activities and Lab Exercises	20%
Lab Quizzes	20%
Course Project	10%

FINAL (OPEN-BOOK) EXAM

This exam will consist of a number of open-ended questions that will engage you in critical thinking. You will receive several days to complete the exam, and you can use any resource(s) to answer the questions *except* for the Instructor or each other. You must work individually. We will embrace the honor system, so I expect you to engage in ethical behavior and follow the college's code of conduct. This test is an exercise in persuasive writing. Some questions may have a single correct answer; others may have several. You should present your understanding of the topic and your reasoning for each answer. Questions may require answers that range in length from several sentences to several pages in length. That said, concise answers will be rewarded and needlessly long answers will be penalized (particularly if those long answers are wrong). Use common sense.

PRACTICAL EXAM

The practical exam will require you to examine dozens of fossil specimens and answer questions related to their taxonomy, taphonomy, ecology, and evolution. This test will assess your comprehension and retention of disciplinary knowledge as well as your ability to apply it. You will take the test in Norton Geology 103, and you must work individually. No outside materials are allowed. Once you enter, you may take as much time as you need prior to 5 pm on the exam date to answer the questions BUT you will not be allowed to leave the vicinity of Norton 103. Under these guidelines, you may rotate and revisit the fossils as many times as you need. In all likelihood, you will only need 2 or 3 hours to complete the exam (maybe less).

The Final and Practical Exam dates do overlap. Consequently, you will have the option to review your open-book exam BEFORE your lab practical exam. I strongly encourage you to begin the final exam (and read all of its questions) prior to taking the lab practical exam. Then, you should complete the lab practical exam. Finally, you can return to the task of completing the final exam. If you follow this approach, you may benefit from seeing both exams.

CLASS ACTIVITIES AND LAB EXERCISES

You will be asked to complete a number of class activities and lab exercises. The format of these activities/exercises may change to a degree from day to day, but in all cases, they will be graded PASS/FAIL. Unless told otherwise, you should focus your attention on two types of assignments. (1) At the start of each morning class, you must submit an index card with **five or more** questions related to your reading assignment(s). The questions should be thoughtful, and I hope you will use the opportunity to ask about topics that interest or confuse you. Your questions will be graded and *immediately* returned to you so that you can add notes to the cards. (2) In each lab, you will work to identify and sketch a number of fossil specimens, and answer questions based on your observations of them. You will provide your drawings and answers for each specimen on an index card. Again, these index cards will be graded and *immediately* returned to you. Ultimately, you may find it useful to use the index cards as flash cards/study aids for preparing for your quizzes and lab practical exam. We will also dedicate class time to analyzing data from the Paleobiology Database (PBDB) in R. You will receive further instruction and direction on the exercises in class with live demonstrations and guided exercises.

CLASS PARTICIPATION

Participation is central to the success of any small class. Accordingly, you are expected to attend and actively contribute to all class meetings and field trips (you should contribute in a positive manner). Your participation will be assessed PASS/FAIL. You will receive a passing grade each day if you (1) attend both sessions of class and (b) contribute to class discussions by asking questions and sharing your opinions. The best way to participate will be to ask the questions on your index cards! Besides ensuring your presence, participation/discussion will provide you with an opportunity to develop skills of oral communication, as it relates to paleontology.

LAB QUIZES

Most days, you will complete a short ~10-20 min quiz at 1 pm based on the material presented in class the prior day. You will provide your answers on index cards, so please remember to bring them to class. In addition to review questions about the readings, lectures, and discussion, these quizzes will consist of questions similar to your lab exercises (i.e. you will be asked to identify fossil specimens and report observations of them). These quizzes will assess your retention of knowledge from the previous day, offer you an opportunity to apply that knowledge, and prepare you for the Lab Practical Exam. In essence, the Lab Practical will be similar to these quizzes but longer in format.

COURSE PROJECT

You will work as a team (including the Instructor), collaborating to inventory, catalog, digitize, label, and curate the fossils in the Norton Geology repository of geologic samples. This project will provide you with an opportunity to develop skills related to collaboration, organization, and teamwork as well as expose you to the development and management of data resources (i.e. databases). Most days, you will receive a drawer of specimens related to the topic of the Lab. Based on your emerging knowledge of the fossils, you will compile data on their origin, taxonomy, preservation, and ecology. This data will ultimately be saved as a digital spreadsheet. Additionally, you will photograph each specimen with scale bars, and fix a label to each specimen, per demonstrations by the Instructor in class. As this Project will benefit future generations of Cornell College students and immediately improve the state of the Norton Geology Building, its success will be measured by the accuracy of the data, the details of the photographs, and the quality of the labeling effort. With this in mind, each student will be assessed PASS/FAIL for each drawer, and quality work will be emphasized.

To assist you in compiling the data, you are strongly encouraged to utilize the Paleobiology Database (PBDB) and additional literature sources, which the Instructor will introduce to you via demonstrations in class. Because you will be working as a team, you will have the opportunity to assign responsibilities and specify a workflow that works for the entire team. That said, each member of the team should contribute their 'expertise' to the compilation of data. Indeed, you are encouraged to use the opportunity to develop your emerging skillset. You should not rely on classmates to complete the project.

COURSE PHILOSOPHY

The design of this course will reinforce the major concepts of Paleobiology, and over the block, help you to develop your practical skills and prepare you for the exams. The Lab exercises, quizzes, and Course Project will give you ample opportunity to build your knowledge, while class discussion will be aimed at developing your inquiry skills. The index cards that you prepare may be used as flash cards for studying for the Lab Exam and Quizzes as well as a resource for your open-book Final Exam. Most importantly, as your work as a team on the Class Project and as individuals on your data analysis activities, you will be applying some of the most common methods used by paleontologists for research (the Instructor regularly applies the same methods).

Add/Drop/Withdrawal

This course may be added or dropped within the first three days of the block with the permission of the instructor, per College policy. A withdrawal may be granted on the 15th day, provided that you have completed all assignments, participated fully in course activities, and attended all class sessions (1 *excused* absence permitted). NOTE: A 15-day drop will not be granted to students who, in my estimation, have not made a good faith effort to learn and/or complete the course material. A health withdrawal (WH) may be obtained if health issues are serious enough to interfere with course completion. To qualify, you must speak with a health professional either on or off campus and receive written documentation.

ACADEMIC HONESTY POLICY

Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgment of sources, whether intended or not, this may constitute a violation of the College's requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Catalogue, under the heading "Academic Honesty."

DISABILITIES AND ACCOMODATIONS POLICY

Cornell College makes reasonable accommodations for persons with disabilities. Students should notify the Office of Academic Support and Advising and their course instructor of any disability related accommodations within the first three days of the term for which the accommodations are required, due to the fast pace of the block format. For more information on the documentation required to establish the need for accommodations and the process of requesting the accommodations, see <http://www.cornellcollege.edu/academic-support-and-advising/disabilities/index.shtml>.

MENTAL HEALTH

Your mental health is important to your success at Cornell College and beyond. It should not be ignored, and instead, should be treated with the same care as the rest of your physical state. If you believe you may be suffering any mental health problems (e.g. symptoms of depression, suicidal thoughts, trouble focusing, memory problems, etc.), you are encouraged to discuss them privately with your Instructor and seek assistance from trained professionals (including those in the Cornell College Counseling Center: <https://www.cornellcollege.edu/counseling/>). Academic success should not come at the cost of mental health, and we will take steps to ensure both.

LATE WORK AND MAKE-UP POLICY

Due to the fast-paced nature of the class, policies are strict. Unless you inform me of absences in advance and your reasons are legitimate, I will **not** accept late assignments except under the most extreme circumstances. Lab exercises are the only exception to this rule.

TECHNOLOGY POLICY

Technology has become a major aspect of life and education. You are allowed **limited** use of cell phones, laptops, and tablets in this course. However, out of courtesy to your classmates and Instructor, please use your technology with care, and do not create distractions, for example, by using text messaging services, social media, web browsers, or games during class. If you do create distractions or use your technology for non-essential activities, you will receive a verbal warning on your first offense, and on the second offense, you will be asked to leave class. You are permitted to type notes. That said, you may ultimately find it more useful to write and sketch your notes, particularly if you embrace the index cards described above. For Lab Exercises, you must sketch the fossil specimens. You may additionally take photographs, if you believe they may also be useful to you. **BUT** sketching is an age-old tradition, which forces you to carefully observe and recognize the important characters of the fossils.

Geological Time Scale

EON	ERA	PERIOD	EPOCH	Ma	EVENTS	
Phanerozoic	Cenozoic	Quaternary	Holocene	-----0.01		
			Pleistocene	-----2.6	glaciation/extinction of large mammals	
		Neogene	Pliocene	-----5.3		
			Miocene	-----23		
			Paleogene	Oligocene	-----34	
		Eocene		-----56	cooler climate; first horses	
		Paleocene		-----66	first primates	
		Mesozoic		Cretaceous		-----145
			Jurassic		-----201	<i>Archaeopteryx</i>
			Triassic		-----252	dinosaurs; first mammals
	Paleozoic		Permian		-----299	
		Pennsylvanian] Carboniferous	-----318		
		Mississippian		-----359		
		Devonian		-----419	land plant radiation	
		Silurian		-----443	fish radiation	
		Ordovician		-----485	fishes first appear; land plants	
		Cambrian		-----541	Cambrian Explosion; Archaeocyatha	
		Proterozoic	Neoproterozoic	Ediacaran	-----635	
				Cryogenian	-----850	glaciations; early animals; Ediacaran
			Tonian		-----1000	
	Mesoproterozoic			-----1600		
	Paleoproterozoic			-----2500	cyanobacteria; eukaryotes	
	Archean		-----3800	origin of life; bacteria; earliest sed. record		
	Hadean		-----4600	severe bombardment origin of the Earth		

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
August 25	August 26 <ul style="list-style-type: none"> Review syllabus Introduction to repository/PBDB Intro to Paleo What are fossils? 	August 27 <ul style="list-style-type: none"> Subdisciplines (paleogeography, biostratigraphy, & taphonomy) Fossil preservation 	August 28 <ul style="list-style-type: none"> Macroevolution & the tree of life Fossil form & function Taxonomy, phylogenetics, & systematics 	August 29 <ul style="list-style-type: none"> Origin of life Microfossils 	August 30 <ul style="list-style-type: none"> Origin of animals Overview of animal phyla 	August 31
September 1	September 2 <ul style="list-style-type: none"> Paleoecology Paleoclimate Depositional environments Fossils & facies Trace fossils 	September 3 <ul style="list-style-type: none"> Mass extinctions & biodiversity Introduction to RStudio Accessing & analyzing PBDB data activities *computer required*	September 4 Sponges & Cnidarians	September 5 Lophophorates	September 6 Mollusks	September 7
September 8	September 9 Arthropods	September 10 Echinoderms	September 11 Hemichordates & Plants	September 12 Introduction to some common paleoecological methods *computer required*	September 13 <ul style="list-style-type: none"> Analyzing the Boag et al. (2017) data Analyzing PBDB data Course evaluations *computer required*	September 14
September 15	September 16 <ul style="list-style-type: none"> Field trip to the Devonian fossil gorge (hands-on review) Open-book final exam distributed 	September 17 Lab Practical Exam (door opens at 9 am and closes at 5 pm)	September 18 Open-book final exam DUE			

Calendar of Reading Assignments (You should **complete** the readings by the dates indicated in the calendar)

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
August 25	August 26 Benton & Harper (2009) Chapter 1	August 27 Benton & Harper (2009) Chapters 2 & 3	August 28 Benton & Harper (2009) Chapters 5 & 6	August 29 Benton & Harper (2009) Chapters 8 and 9	August 30 Benton & Harper (2009) Chapter 10; Droser & Gehling (2015)	August 31
September 1	September 2 Benton & Harper (2009) Chapter 4 & additional reading TBD	September 3 Benton & Harper (2009) Chapter 7; Sepkoski (1982); Barnosky et al. (2011)	September 4 Benton & Harper (2009) Chapter 11	September 5 Benton & Harper (2009) Chapter 12	September 6 Benton & Harper (2009) Chapter 13	September 7
September 8	September 9 Benton & Harper (2009) Chapter 14	September 10 Benton & Harper (2009) Chapter 15 (Echinoderms)	September 11 Benton & Harper (2009) Chapters 15 (Hemichordates) & 18	September 12 Waggoner (2003) & Boag et al. (2017)	September 13 Readings TBD	September 14
September 15	September 16	September 17	September 18			