



Course title and number	Geol 650 – Paleoecology
Term	Fall 2020
Meeting times and location	Lecture: Monday, Wednesday, Friday 10:20-11:10 Halbouty 174

Course Description and Prerequisites

Description: Interrelationships of organisms and environment in the fossil record; methods and criteria available for interpreting ancient environments; critical review of classical studies and current research in paleoecology.

Learning Outcomes or Course Objectives

Upon successful completion of Geol 650 students will be able to:

- Apply fundamental ecological concepts to problems in the fossil record.
- Critique the experimental design of paleoecological studies.
- Interpret and evaluate paleoecological data presented in the primary literature.
- Connect the deep history of life on Earth to modern ecological processes.

Instructor Information

Name	Dr. Christina Belanger	Dr. Anne Raymond
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Office hours	TBD	TBD
Office location	Halbouty 265	Halbouty 169

Textbook and/or Resource Material

No textbooks are required. All readings will come from peer-reviewed sources available through the TAMU libraries or supplied by the instructors. Please see the course schedule for a tentative list of papers. Students will also have the opportunity to suggest readings for discussion and we may adjust readings with participant interests.

Grading Policies

The final course grade will be based upon:

Discussion Participation and Questions	10%
After-Discussion Summaries	10%
Discussion Leadership and Outline	15%
Oral Presentation of Project	15%
Final Paper	40%

Grading Scale

A=100-90%; B=89-80%; C=70-79%; D=60-69%; F<60%

Course Expectations

Students are expected to attend all classes with exceptions provided by the University's policy for excused absences. For more information, visit <http://student-rules.tamu.edu>. This course can make accommodations for distance learning via Zoom participation.

Class Discussion: It is essential to do the reading well in advance of the class so that you have time to think about it

before you come to class. One way to make sure we have discussion is **for each of us to come to class with three questions on the reading. Questions are due before class and should be turned into the designated discussion board on eCampus.** These could be 'point of information' questions (such as, 'What is the Redfield ratio?'). In addition, these questions could address the author's data or methods or study design; or they could be aimed at comparing/contrasting the ideas of two different authors. Finally, these questions could address the implications of an author's results for another area of (paleo)ecology or (paleo)biology. **After the discussion, each student should answer at least one question posted by a different student before the next class.** The instructions will also post to the board.

Discussion Leader Summaries: Each student will be responsible for at **least two summaries** as discussion leaders. Discussion leaders should start by reading the papers listed for the topic then add one other related paper of their interest they find through literature searches. Consult with the instructor at least one week before your discussion day for guidance. Written summaries should be bulleted outlines with key background information, data, observations, controversies, results and interpretations relevant to the topic. You may find it useful to start the discussion by summarizing the topic broadly then presenting case studies from the literature. Include key figures if they are integral to the discussion. These are **due at by midnight the day before the discussion** and will be posted to eCampus for others to download. Written summaries should be no more than 2-3 pages in length...we only have a 50 min class period.

After-Discussion Summaries: All students should write one summary after each class. These need only be ~1 paragraph and should reflect upon the things you learned. Ideally, you would do this immediately following class. They are due prior to the beginning of the following class meeting and should be turned into the eCampus drop box. Images of handwritten prose is acceptable or you may type your submission.

Individual Project (Final Paper + Presentation)

The final paper should be an investigation of some topic in Paleoecology, **either a paper reviewing the historical development of a paleoecological concept or a research paper/proposal focused on designing a study that uses paleoecological data in some way.** Papers incorporating original data are welcomed. Your work for this class should not, however, duplicate work you have already done for a different course. If you are working on a thesis/dissertation, you may want to develop the paleoecological aspects of your study into a paper for this course. If you are developing a thesis/dissertation proposal, you can submit a research proposal (using the guidelines developed by NSF or other relevant agency, with modifications where appropriate) to fulfill this course requirement. Either (paper or proposal) could incorporate preliminary research results. Finally, you may want to investigate the paleoecological implications of a data set that you gathered prior to this course in a paper or proposal format. The draft of this paper is due significantly before the end of the semester so that you have an opportunity to rewrite it based on instructor comments.

Project Presentation

This should be a short (12-15 minute) oral presentation of your project, approximately the same amount of time you would have to present a paper at GSA, AGU, ESA, etc. You should have slides and upload those slides to eCampus prior to your presentation.

Course Topics, Calendar of Activities, Major Assignment Dates

Tentative Schedule of Topics. Lecture-style classes in bold, discussion-style in italics.

Week	Day	Date	Topic	Reading (to be posted on eCampus)
1	M	Aug 24	Introduction	Background Lecture
1	W	Aug 26	<i>Ecological Questions in the Fossil Record</i>	Jackson & Erwin, 2006
1	F	Aug 28	<i>Modern Approaches to Paleoecology</i>	Lambsdell et al., 2017
2	M	Aug 31	Controls on the distribution of organisms	Background Lecture
2	W	Sept 2	<i>Historical Contingencies of Distributions</i>	Jablonski et al., 1995; Jackson, Steve 2000
2	F	Sept 4	<i>Environmental drivers distributions</i>	Kreft and Jets, 2007; Belanger et al., 2012
3	M	Sept 7	Sampling and Taphonomic considerations	Kidwell and Flessa 1995; Benton et al., 2011
3	W	Sept 9	<i>Quality of the Fossil Record</i>	
3	F	Sept 11	<i>Quantifying taphonomic loss</i>	Behrensmeyer 1978; Parsons-Hubbard 2005
4	M	Sept 14	Taxonomic Diversity – local/regional	Background Lecture
4	W	Sept 16	<i>Alpha diversity across the Phanerozoic</i>	Powell and Kowalewski, 2002; Close et al., 2019
4	F	Sept 18	<i>Beta Diversity</i>	Wilson and Shmida, 1984; Baselga 2010; Layou 2007
5	M	Sept 21	Taxonomic Diversity – global patterns	Background Lecture
5	W	Sept 23	<i>Major patterns in marine environments</i>	Sepkowski, 1981; Alroy et al. 2008
5	F	Sept 25	<i>Diversification of terrestrial systems</i>	Niklas 1988, Alroy, 2020
6	M	Sept 28	Primary Productivity	Background Lecture; ; Martin, 1996
6	W	Sept 30	<i>Seafood through time</i>	Bambach 1993; Bambach 1999; Allmon and Martin 2017
6	F	Oct 2	<i>Salads through time</i>	Bond 1989; Boyce et al., 2019
7	M	Oct 5	Herbivory and Predation Behaviors ***Paper outline and preliminary bibliography due***	Background Lecture
7	W	Oct 7	<i>Fossil Records of Herbivory</i>	Tiffney 1982; Currano et al., 2016
7	F	Oct 9	<i>Fossil Records of Predation</i>	Vermeij, 1977; Huntly and Kowalewski, 2007; Selly et al. 2016
8	M	Oct 12	Assembling communities	Background Lecture
8	W	Oct 14	<i>What is a community in the fossil record?</i>	Miller 1993; Jablonski and Sepkoski 1996
8	F	Oct 16	<i>Community Assembly</i>	Olszewski, 2012; Williams and Jackson 2007
9	M	Oct 19	Functional Ecology	Background Lecture; Bambach, Bottjer and Ausich 1986
9	W	Oct 21	<i>Guilds across time</i>	Bottjer and Ausich, 1986; Bush & Bambach, 2011; Laird and Belanger, 2019
9	F	Oct 23	<i>Trophic networks</i>	Roopnarine and Angielczyk, 2015; Dunne et al., 2014
10	M	Oct 26	Mass Extinctions and Ecological Upheaval	Background Lecture
10	W	Oct 28	<i>Finding extinctions despite megabiases</i>	Kowalewski and Flessa 1996; Smith et al., 2001; Benson 2010
10	F	Oct 30	<i>Taxonomic vs Ecologic change</i>	Droser et al. 2000 , Rees 2002; Muscente et al., 2018
11	M	Nov 2	Gradients in Ecology and Environment ***Draft of Term Paper Due***	Background Lecture
11	W	Nov 4	<i>Gradients in the marine realm</i>	Holland 2005; Scarponi and Kowalewski, 2004
11	F	Nov 6	<i>Terrestrial gradients</i>	Jackson and Overpeck 2000; Fraser 2017

12	M	Nov 9	Conservation Paleocology	Background Lecture; Dietl and Flessa, 2011; Dietl et al., 2015; Jackson et al.; 2001
12	W	Nov 11	<i>Putting the dead to work in conservation and management</i>	Rick and Lockwood, 2013; Smith et al. 2018
12	F	Nov 13	<i>Modern (sub)fossil comparisons</i>	Kidwell 2007; Terry, 2010
13	M	Nov 23	<i>Deep time lessons for the future</i>	Barnosky et al.; 2017; Kowalewski et al., 2015
13	W	Nov 25	Reading Day	
13	F	Nov 27	Feathered Dinosaur Day	
14	M	Nov 30	Term Presentations	
14	W	Dec 2	Term Presentations	
	Tue	Dec 8	***Final Papers due 10:00 am at end of final exam period**	

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit <http://disability.tamu.edu>.

Academic Integrity

For additional information please visit: <http://aggiehonor.tamu.edu>

"An Aggie does not lie, cheat, or steal, or tolerate those who do."

Tentative Reading List

Week 1 – Ecology and the Fossil Record

Jackson, Jeremy BC, and Douglas H. Erwin. "What can we learn about ecology and evolution from the fossil record?." *Trends in Ecology & Evolution* 21, no. 6 (2006): 322-328.

Lamsdell, James C., Curtis R. Congreve, Melanie J. Hopkins, Andrew Z. Krug, and Mark E. Patzkowsky. "Phylogenetic paleoecology: tree-thinking and ecology in deep time." *Trends in ecology & evolution* 32, no. 6 (2017): 452-463.

Week 2 – Controls on the Distribution of Organisms

Jablonski, David, Karl W. Flessa, and James W. Valentine. "Biogeography and paleobiology." *Paleobiology* 11, no. 1 (1985): 75-90.

Jablonski, David, and Richard A. Lutz. "Larval ecology of marine benthic invertebrates: paleobiological implications." *Biological Reviews* 58, no. 1 (1983): 21-89.

Jackson, Stephen T. "Out of the garden and into the cooler? A Quaternary perspective on deep-time paleoecology." *The Paleontological Society Papers* 6 (2000): 287-308.

Kreft, Holger, and Walter Jetz. "Global patterns and determinants of vascular plant diversity." *Proceedings of the National Academy of Sciences* 104, no. 14 (2007): 5925-5930

Belanger, Christina L., David Jablonski, Kaustuv Roy, Sarah K. Berke, Andrew Z. Krug, and James W. Valentine. "Global environmental predictors of benthic marine biogeographic structure." *Proceedings of the National Academy of Sciences* 109, no. 35 (2012): 14046-14051.

Week 3 - Sampling and Taphonomic considerations

Kidwell, Susan M., and Karl W. Flessa. "The quality of the fossil record: populations, species, and communities." *Annual Review of Ecology and Systematics* 26, no. 1 (1995): 269-299.

- Benton, Michael J., Alexander M. Dunhill, Graeme T. Lloyd, and Felix G. Marx. "Assessing the quality of the fossil record: insights from vertebrates." *Geological Society, London, Special Publications* 358, no. 1 (2011): 63-94.
- Behrensmeyer, Anna K. "Taphonomic and ecologic information from bone weathering." *Paleobiology* 4, no. 2 (1978): 150-162.
- Parsons-Hubbard, Karla. "Molluscan taphofacies in recent carbonate reef/lagoon systems and their application to sub-fossil samples from reef cores." *Palaaios* 20, no. 2 (2005): 175-191.
- Bulinski, Katherine V. "Analysis of sample-level properties along a paleoenvironmental gradient: the behavior of evenness as a function of sample size." *Palaeogeography, Palaeoclimatology, Palaeoecology* 253, no. 3-4 (2007): 490-508.

Week 4 - Taxonomic Diversity – local/regional

- Powell, Matthew G., and Michal Kowalewski. "Increase in evenness and sampled alpha diversity through the Phanerozoic: comparison of early Paleozoic and Cenozoic marine fossil assemblages." *Geology* 30, no. 4 (2002): 331-334.
- Close, Roger A., Roger BJ Benson, John Alroy, Anna K. Behrensmeyer, Juan Benito, Matthew T. Carrano, Terri J. Cleary et al. "Diversity dynamics of Phanerozoic terrestrial tetrapods at the local-community scale." *Nature ecology & evolution* 3, no. 4 (2019): 590-597.
- Wilson, M. V^H, and A. Shmida. "Measuring beta diversity with presence-absence data." *The Journal of Ecology* (1984): 1055-1064.
- Baselga, Andrés. "Partitioning the turnover and nestedness components of beta diversity." *Global ecology and biogeography* 19, no. 1 (2010): 134-143.
- Layout, Karen M. "A quantitative null model of additive diversity partitioning: examining the response of beta diversity to extinction." *Paleobiology* 33, no. 1 (2007): 116-124.

Week 5 – Taxonomic Diversity – global trends

- Sepkoski, J. John. "A factor analytic description of the Phanerozoic marine fossil record." *Paleobiology* 7, no. 1 (1981): 36-53.
- Alroy, John, Martin Aberhan, David J. Bottjer, Michael Foote, Franz T. Fürsich, Peter J. Harries, Austin JW Hendy et al. "Phanerozoic trends in the global diversity of marine invertebrates." *Science* 321, no. 5885 (2008): 97-100.
- Niklas, Karl J. "Patterns of vascular plant diversification in the fossil record: proof and conjecture." *Annals of the Missouri Botanical Garden* (1988): 35-54.
- Alroy, John. "Successive approximations of diversity curves: ten more years in the library." *Geology* 28, no. 11 (2000): 1023-1026. [Mammals]
- Alroy, John. "New methods for quantifying macroevolutionary patterns and processes." *Paleobiology* 26, no. 4 (2000): 707-733. [Mammals]

Week 6 – Primary Productivity

- Background: Martin, Ronald E. "Secular increase in nutrient levels through the Phanerozoic: implications for productivity, biomass, and diversity of the marine biosphere." *Palaaios* (1996): 209-219.
- Bambach, R. K., 1993. Seafood through time: Changes in biomass, energetics, and productivity in the marine ecosystem. *Paleobiology* 19:372-397. Pfd.
- Bambach, R. K., 1999. Energetics in the Global Marine Fauna: A connection between terrestrial diversification and change in the marine biosphere. *Geobios* 32(2):131-144.
- Allmon, Warren D., and Ronald E. Martin. "Seafood through time revisited: the Phanerozoic increase in marine trophic resources and its macroevolutionary consequences." *Paleobiology* 40, no. 2 (2014): 256-287.
- Bond, W. J. "The tortoise and the hare: ecology of angiosperm dominance and gymnosperm persistence." *Biological Journal of the Linnean Society* 36, no. 3 (1989): 227-249.
- Boyce, C. Kevin, and Maciej A. Zwieniecki. "The prospects for constraining productivity through time with the whole-plant physiology of fossils." *New Phytologist* 223, no. 1 (2019): 40-49.

Week 7 – Herbivory and Predation

- TIFFNEY, BH. "The role of vertebrate herbivory in the evolution of land plants." *Palaeobotanist (Lucknow)* 41 (1992): 87-97.
- Curran, E. D., Laker, R., Flynn, A. G., Fogt, K. K., Stradtman, H., & Wing, S. L. (2016). Consequences of elevated temperature and pCO₂ on insect folivory at the ecosystem level: perspectives from the fossil record. *Ecology and evolution*, 6(13), 4318–4331. <https://doi.org/10.1002/ece3.2203>
- Vermeij, Gerard J. "The Mesozoic marine revolution: evidence from snails, predators and grazers." *Paleobiology* 3, no. 3 (1977): 245-258.
- Huntley, John Warren, and Michał Kowalewski. "Strong coupling of predation intensity and diversity in the Phanerozoic fossil record." *Proceedings of the National Academy of Sciences* 104, no. 38 (2007): 15006-15010.
- Selly, Tara, John Warren Huntley, Kevin L. Shelton, and James D. Schiffbauer. "Ichnofossil record of selective predation by Cambrian trilobites." *Palaeogeography, Palaeoclimatology, Palaeoecology* 444 (2016): 28-38.

Week 8 – Ancient Communities

Background: Gleason, H. A. 1926. The individualistic concept of the plant association. *Bulletin of the Torrey Botanical Club* 53: 7-26; Clements, F. E. 1936. Nature and structure of the climax. *Journal of Ecology* 24: 252-284.; Hoffman, 1979. Community paleoecology as an epiphenomenal science. *Paleobiology* 5(4): 357-379.

Miller, W., III. 1993. Models of recurrent fossil assemblages. *Lethaia* 26:182-183

Jablonski, David, and J. John Sepkoski Jr. "Paleobiology, community ecology, and scales of ecological pattern." *Ecology* 77, no. 5 (1996): 1367-1378.

Olszewski, Thomas D. "Persistence of high diversity in non-equilibrium ecological communities: implications for modern and fossil ecosystems." *Proceedings of the Royal Society B: Biological Sciences* 279, no. 1727 (2012): 230-236.

Williams, John W., and Stephen T. Jackson. "Novel climates, no-analog communities, and ecological surprises." *Frontiers in Ecology and the Environment* 5, no. 9 (2007): 475-482.

Week 9 – Functional Ecology

Bottjer, D. J. and W. I. Ausich. 1986. Phanerozoic development of tiering in soft substrata suspension-feeding communities. *Paleobiology* 12(4): 400-420.

Bush, A. M., & Bambach, R. K. (2011). Paleoecologic megatrends in marine metazoa. *Annual Review of Earth and Planetary Sciences*, 39, 241-269.

Laird, Joshua D., and Christina L. Belanger. "Quantifying successional change and ecological similarity among Cretaceous and modern cold-seep faunas." *Paleobiology* 45, no. 1 (2019): 114-135.

Roopnarine, Peter D., and Kenneth D. Angielczyk. "Community stability and selective extinction during the Permian-Triassic mass extinction." *Science* 350, no. 6256 (2015): 90-93.

Dunne, Jennifer A., Conrad C. Labandeira, and Richard J. Williams. "Highly resolved early Eocene food webs show development of modern trophic structure after the end-Cretaceous extinction." *Proceedings of the Royal Society B: Biological Sciences* 281, no. 1782 (2014): 20133280.

Week 10 – Mass Extinctions and Ecological Upheaval

Kowalewski, Michał, and Karl W. Flessa. "Improving with age: the fossil record of lingulide brachiopods and the nature of taphonomic megabiases." *Geology* 24, no. 11 (1996): 977-980.

Benson, Roger B.J., Richard J. Butler, Johan Lindgren, and Adam S. Smith. "Mesozoic marine tetrapod diversity: mass extinctions and temporal heterogeneity in geological megabiases affecting vertebrates." *Proceedings of the Royal Society B: Biological Sciences* 277, no. 1683 (2010): 829-834.

- Smith, Andrew B., Andrew S. Gale, and Neale EA Monks. "Sea-level change and rock-record bias in the Cretaceous: a problem for extinction and biodiversity studies." *Paleobiology* 27, no. 2 (2001): 241-253.
- Droser, Mary L., David J. Bottjer, Peter M. Sheehan, and George R. McGhee Jr. "Decoupling of taxonomic and ecologic severity of Phanerozoic marine mass extinctions." *Geology* 28, no. 8 (2000): 675-678.
- Rees, P. M. 2002. Land-plant diversity and the end-Permian mass extinction. *Geology* 30(9): 827-830.
- Muscente, A. D., Anirudh Prabhu, Hao Zhong, Ahmed Eleish, Michael B. Meyer, Peter Fox, Robert M. Hazen, and Andrew H. Knoll. "Quantifying ecological impacts of mass extinctions with network analysis of fossil communities." *Proceedings of the National Academy of Sciences* 115, no. 20 (2018): 5217-5222.

Week 11 – Gradients in Ecology and Environment

- Holland, Steven M. "The signatures of patches and gradients in ecological ordinations." *Palaios* 20, no. 6 (2005): 573-580
- Scarponi, Daniele, and Michal Kowalewski. "Stratigraphic paleoecology: bathymetric signatures and sequence overprint of mollusk associations from upper Quaternary sequences of the Po Plain, Italy." *Geology* 32, no. 11 (2004): 989-992.
- Tomašových, Adam, and Susan M. Kidwell. "Preservation of spatial and environmental gradients by death assemblages." *Paleobiology* 35, no. 1 (2009): 119-145.
- Jackson, S. T. and Overpeck, J. T., 2000. Responses of plant populations and communities to environmental changes of the late Quaternary. In: Erwin, D. H. and Wing, S. L. (eds.) Deep Time: Paleobiology's Perspective. *Paleobiology* Vol 26 (4) Supplement: 194-220.
- Fraser, Danielle. "Can latitudinal richness gradients be measured in the terrestrial fossil record?." *Paleobiology* 43, no. 3 (2017): 479-494.

Week 12 – Conservation Paleobiology

- Background: Dietl, Gregory P., and Karl W. Flessa. "Conservation paleobiology: putting the dead to work." *Trends in Ecology & Evolution* 26, no. 1 (2011): 30-37.; Dietl, Gregory P., Susan M. Kidwell, Mark Brenner, David A. Burney, Karl W. Flessa, Stephen T. Jackson, and Paul L. Koch. "Conservation paleobiology: leveraging knowledge of the past to inform conservation and restoration." *Annual Review of Earth and Planetary Sciences* 43 (2015): 79-103.; Jackson, Jeremy BC, Michael X. Kirby, Wolfgang H. Berger, Karen A. Bjorndal, Louis W. Botsford, Bruce J. Bourque, Roger H. Bradbury et al. "Historical overfishing and the recent collapse of coastal ecosystems." *Science* 293, no. 5530 (2001): 629-637
- Rick, Torben C., and Rowan Lockwood. "Integrating paleobiology, archeology, and history to inform biological conservation." *Conservation Biology* 27, no. 1 (2013): 45-54.
- Smith, Jansen A., Stephen R. Durham, and Gregory P. Dietl. "Conceptions of long-term data among marine conservation biologists and what conservation paleobiologists need to know." In *Marine conservation paleobiology*, pp. 23-54. Springer, Cham, 2018.
- Kidwell, Susan M. "Discordance between living and death assemblages as evidence for anthropogenic ecological change." *Proceedings of the National Academy of Sciences* 104, no. 45 (2007): 17701-17706.
- Terry, R.C., 2010. The dead do not lie: using skeletal remains for rapid assessment of historical small-mammal community baselines. *Proceedings of the Royal Society B: Biological Sciences*, 277(1685), pp.1193-1201.

Week 13 – Conservation Paleobiology Continued....

- Kowalewski, Michał, Jacalyn M. Wittmer, Troy A. Dexter, Alessandro Amorosi, and Daniele Scarponi. "Differential responses of marine communities to natural and anthropogenic changes." *Proceedings of the Royal Society B: Biological Sciences* 282, no. 1803 (2015): 20142990.
- Barnosky, Anthony D., Elizabeth A. Hadly, Patrick Gonzalez, Jason Head, P. David Polly, A. Michelle Lawing, Jussi T. Eronen et al. "Merging paleobiology with conservation biology to guide the future of terrestrial ecosystems." *Science* 355, no. 6325 (2017): eaah4787.