GEOL 651 – PALEOECOLOGICAL COMMUNITY ANALYSIS SYLLABUS

Instructor: Thomas Olszewski
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Time and Place: Monday and Wednesday, 9:00-10:20, Halbouty 174

Office Hours: Monday, 2:00-3:00
Tuesday, 9:00-10:00
or by appointment

Prerequisite: A basic course in statistics or instructor permission

Course Description: The main aim of this course is to learn how to make use of the full potential of community-type paleoecological data. Students will learn the statistical basis, use, and limitations of a variety of quantitative techniques including the measurement of diversity and diversity partitioning, cluster analysis to define biotic associations, and gradient analysis using both standard and canonical ordination techniques. Some mathematical background will be reviewed, but the focus will be on application of methods to problems like the identification and characterization of biofacies, the use of gradient analysis in constraining stratigraphic interpretations, and analysis of diversity and turnover to identify stratigraphic unconformities. Introduction of paleoecological concepts and the preservation of living communities in the fossil record will be incorporated through readings from the peer-reviewed literature and discussion in class. The assignments focus on analyzing and interpreting a real data set; the aim is to gain practice in paleoecological interpretation of diversity and compositional data.

Learning Goals: Students who successfully complete the course will be able to apply quantitative techniques in their own research involving the identification, characterization, and application of fossil ecological communities.

Recommended Texts:

McCune, B., and Grace, J.B., 2002, Analysis of Ecological Communities. MjM Software Design, 300 p. (This book explains most of the methods covered in this course in a clear manner for novice users and also provides useful context for preparation of data and interpretation of results.)

Legendre, P., and Legendre, L., 1998, Numerical Ecology. Elsevier, 853 p. (This book is a comprehensive (overwhelming) reference on the analysis of multivariate ecological data. It is not an introductory level text, but is an excellent reference manual for practitioners of multivariate analysis in ecology – students should be able to understand this text after successfully completing the course.)

Topical Readings:

1) Shi, G.R., 1993, Multivariate data analysis in palaeoecology and palaeobiogeography–a review. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 105, p. 199-234. (A introductory review paper on multivariate methods that are common in paleontology. A reasonable list of what will be covered in this course, but beware that not all recommendations made by Shi are sound.)

2) Austin, H.W., 1983, Sample size: How much is enough? Quality and Quantity, v. 17, p. 239-245.

3) Hoffman, A., 1979, Community paleoecology as an epiphenomenal science. Paleobiology, v. 5, p. 357-379. (A classic paper on the nature of communities by the gadfly of paleontology. Hoffman established himself as a community paleoecologist – this essay is an attempt to wrestle with the difficulties of the community concept from someone who paid his dues. Difficult due to its dialectic presentation.)

4) Ricklefs, R.E., 2008, Disintegration of the ecological community. American Naturalist, v. 172, p. 741-750. (Ricklefs uses the most recent developments in landscape ecology, metapopulation theory, and macroecology to offer a new ecological community concept that addresses and resolves the difficulties raised by Hoffman 30 years earlier.)

5) Ludvigsen, R., Westrop, S.R., Pratt, B.R., Tuffnell, P.A., and Young, G.A., 1986, Dual biostratigraphy: zones and biofacies. Geosciences Canada, v. 13, p. 139-154. (A concise description of the relationship between biofacies and biozones in the fossil record and how they are related to modern analytical approaches.)

6) Whittaker, R.H., 1967, Gradient analysis of vegetation. Biological Reviews, v. 42, p. 207-264. (The paper in which Whittaker laid out the conceptual foundation of ecological gradients.)

7) Holland, S.M., Miller, A.I., Meyers, D.L., and Dattilo, B.F., 2001, The detection and importance of subtle biofacies within a single lithofacies: the Upper Ordovician Kope Formation of the Cincinnati, Ohio region. Palaios, v. 16, p. 205-217. (A straightforward example of how quantifying ecological gradients in the fossil record can provide new insight.)

8) Sepkoski, J.J., Jr., 1981, A factor analytic description of the Phanerozoic marine fossil record. Paleobiology, v. 7, p. 36-53. (Sepkoski's paper that defined the three great Evolutionary Faunas – although most criticisms have aimed at the data, you should think very carefully about the method he used and whether it recognizes or imposes the pattern that has been so heavily cited ever since.)

9) Imbrie, J. and Kipp, N.G., 1971, A new micropaleontological method for quantitative paleoclimatology: application to a late Pleistocene Caribbean core. in Turekian, K.K., ed., The late Cenozoic glacial ages, p. 71-147. (A pioneering work in both paleoecological theory and method [namely, transfer functions]. This approach is still the primary means of mapping Quaternary sea surface temperatures and climate. A groundbreaking accomplishment in 20th century paleontology.)

Grading:

Participation, Quizzes, Homework,:	10%	
Report #1:	15%	
Report #2:	15%	
Report #3:	15%	
Report #4:	15%	
Final Poster Presentation:	30%	

Letter grades will be assigned on the following scale: A ≥ 90%, B ≥ 80%, C ≥ 70%, D ≥ 60%, F < 60%.

Each student will pick an appropriate data set (subject to the instructor's approval) to explore using the techniques taught in class. Each of the reports listed above will describe exploration of the data using a different technique. Reports should be 3-5 pages of text, can include unlimited figures (with captions cited in the text), and should cite appropriate references. All methods covered are included in the VEGAN library in R (a powerful statistical analysis shareware program that can be downloaded and installed for free) or other software available on campus. The final assignment will be a meeting-style poster synthesizing the results of each student's analyses and will be presented in a poster session in lieu of a final exam. Posters will be evaluated on use of methods, soundness of interpretations, and presentation style.

Attendance, punctuality, preparation, and attitude will be included in the participation part of the grade. Assignments are due at the beginning of class on the set date. Late assignments will be docked one full letter grade for each day late (i.e., after 4 days, no credit will be given); if, for some reason, meeting a deadline will not be possible, the student must contact the instructor **beforehand** (see contact information at the top of the syllabus) or provide an official university excuse. Quizzes can be given at any time in class with or without prior announcement. This class will follow the University's policy for excused absences. For more information, please see Section 7 of the student rules: http://student-rules.tamu.edu.

Expectations: Maximizing the quality of the educational experience requires effort from both the instructor and the student. As the instructor, I will do everything I can to provide you with access to necessary materials and expose you to fundamental concepts through lectures, readings, and assignments. I will make myself available as a resource outside of class when you are working through this material. I expect that you, as a student, will actively participate in the learning process. When something is confusing or unclear, you are expected to ask questions in class, see me for further clarification outside of class, or make the effort to teach yourself from other sources if necessary. I expect you to take an active role in your education rather than passively handing over all responsibility to me, your advisor, or anyone else. I will do what I can to help you master quantitative community analysis, but I expect an equal degree of engagement and effort from you.

Academic Integrity: It is the responsibility of students and instructors to help maintain scholastic integrity at Texas A&M University by refusing to participate in or tolerate scholastic dishonesty. Commission of any of the following acts shall constitute scholastic dishonesty: inappropriately acquiring information, inappropriately providing information, plagiarism, conspiracy to cheat, fabrication of information, and violation of departmental or college rules. This listing is not exclusive of any other acts that may reasonably be said to constitute scholastic dishonesty. Punishments for scholastic dishonesty may include the following: appropriate grade penalty up to and including an F in the course, letter of reprimand, conduct probation, expulsion, dismissal, or suspension. See the Texas A&M University Student Rules (the source of this blurb) for a more complete statement on the definition and possible consequences of academic dishonesty. More information can also be obtained from Student Conflict Resolution Services (http://studentlife.tamu.edu/scrs/).

Copyright and Plagiarism Policy: All materials used in this class are copyrighted. These materials include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless permission is expressly granted.

As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, http://student-rules.tamu.edu/, under the section "Scholastic Dishonesty."

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AGGIE CODE OF HONOR:

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

The Honor Code, based on the long-standing affirmation that An Aggie does not lie, cheat, or steal or tolerate those who do, is fundamental to the value of the A&M experience. Know the Code. http://www.tamu.edu/aggiehonor

Disability Statement: 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 the Department of Student Life, Services for Students with Disabilities in Room B118 of Cain Hall. The phone number is 845-1637.

Schedule of Topics
(Subject to change at instructor's discretion)

Section 1. Introduction: The Fossil Record of Ecological Communities

Week 1 – Introduction – Multivariate Analysis & Communities
– The Nature of Community-type Data – Transformation and Standardization
Week 2 – Measuring Similarity – Similarity/Difference Coefficients
– Review of Linear Algebra – Definitions and Notation
Week 3 – Review of Linear Algebra – Fundamental Geometry
– Review of Linear Algebra – Regression and Correlation
(Data Set Report)

Section 2. The Concept of Fossil Gradients in Space and Time

Week 4 – Parametric Ordination – Principal Components Analysis
– Parametric Ordination – Factor Analysis
Week 5 – Parametric Ordination – Principal Coordinates Analysis
– Parametric Ordination – Correspondence Analysis
Week 6 – Issues in the Interpretation of Ordinations

Section 3. Tying Fossil Gradients to Specific Environmental Controls

– Canonical Techniques – Redundancy Analysis
Week 7 – Canonical Techniques – Canonical Correspondence Analysis
– Canonical Techniques – Co-Correspondence Analysis
(Parametric Ordination Report)

Week 8 – Canonical Techniques – Co-Inertia Analysis

Section 4. Dealing with Non-linear Ecological Responses and Post-mortem Alteration

– Non-Parametric Ordination – Non-Metric Multi-Dimensional Scaling

Week 9 – Non-Parametric Ordination – NMDS and Flexible Shortest Path Adjustment

Section 5. Identifying and Defining Biofacies

– Cluster Analysis – Aims and Strategies

Week 10 – Cluster Analysis – Divisive Algorithms

– Cluster Analysis – Agglomerative Algorithms

Week 11 – Cluster Analysis – Interpretation

Section 6. Characterizing the Structure of Fossil Communities

– Measuring Diversity – Abundance Distributions

(Non-Parametric Ordination Report)

Week 12 – Measuring Diversity – Evenness and Diversity Indices

– Measuring Diversity – Counting Rules and Sampling Strategies

Week 13 – Measuring Diversity – Richness and Rarefaction

– Thanksgiving – No Class

Week 14 – Measuring Diversity – Diversity Partitioning

– Measuring Diversity – Diversity at Different Scales

Finals Week **– FINAL POSTER PRESENTATIONS & REPORTS**