PRISCUM

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The Times They are a Changin'

by William Ausich, PS President

"We live in interesting times." Perhaps this was never more true for the *Paleontological Society* and for scientific societies in general. I suspect that the future of our society has rarely seemed quite so much like entering unchartered waters. What role will paleontology play in college and university geoscience departments, what role will paleontology play in governmental agencies, what will the character of paleontological literature be like as we move toward more electronic publishing (how do you like reading this article in *Priscum* online?), etc.? Whereas the *Paleontological Society* Council does not have a crystal ball, members of council are well aware of the myriad of issues affecting our future, and they are committed to continue to achieve the goals of the *Society*. Council needs your involvement in many ways:

1) Please continue to convey the excitement of paleontology to your students and colleagues.
2) Please continue to be involved in *Paleontological Society* events – sponsor a symposium, attend meetings and short courses, sponsor *Paleontological Society Distinguished Speakers* at your institution.
3) Involve students at all levels in these *Paleontological Society* activities.
4) Volunteer for *Society* offices – the pay won't attract you, but the significance of the *Society* should.
5) Perhaps most important, be vigilant with your library. Be certain that your library maintains (or starts again) their paper subscriptions to the *Journal of Paleontology* and *Paleobiology*.

Journal subscription costs are escalating rapidly, and this puts pressure on librarians to make cuts. Subscriptions to paper copies of our journals is what allows the *Society* to exist. Subscription to an electronic bundle of journals that includes the *Journal of Paleontology* and *Paleobiology* does not generate enough revenue for the *Society* to fund the production of these journals. If pressed, remind your librarians that the *Paleontological Society* is one of the "good guys" in this business. We are not responsible for the run-away inflation of journal costs. Unlike commercial pub-

Inside...

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lishers whose motivation is profit, our journals are produced by volunteers, and they are a bargain. If journal cuts are made they should not be done to publications like ours, whose societies are working to produce high-quality journals at as low a cost as possible.

National Park System

One example of a changing landscape for paleontology is the National Park System. Of course, *we* all know that the National Park System is really a park system devoted to preservation of special *geological* sites in the United States that just happen to also have interesting archeological, botanical, or zoological aspects. However, if the geological side of our parks has been under-realized during the past, this should not be true for the future. The National Park System is implementing a series of initiatives to more thoroughly document National Park System geological and paleontological resources and to start newly funded research and educational programs. Paleontology will be a major part of these initiatives.

With this in the background, the highly publicized staff reorganization at Dinosaur National Monument made many question the commitment of the National Park Service to paleontology. How important is paleontology and geology to the mission of the National Park Service? Will the National Park Service continue to be an important venue through which paleontological research is part of its outreach mission? What may we expect for future access to National Park Service lands for education and research?

To address these questions, the American Geological Institute convened a meeting in Washington, D.C., "Paleontology in the National Park System," during December to address these concerns and to establish linkages for implementation of the larger National Park System initiatives. The meeting included representatives from the American Geological Institute, Geological Society of America, National Park Service, National Science Foundation, Paleontological Society, Society of Vertebrate Paleontology, U.S. Geological Survey, and U.S. National Museum. I was asked to represent the PS at this meeting. This half-day meeting covered a wide agenda but concentrated on specifics of Dinosaur National Monument and on the general initiatives being developed within the National Park Service. This meeting followed another meeting held a few weeks earlier entitled, "AGI Advisory Committee on Geoscience Outreach for the National Parks."

In preparing for this meeting and at the meeting, I learned about many paleontology programs already in place in the National Park System. Did you know the following?

1) The National Park Service convenes a *Fossil Resource Conference*. Published proceedings are a product of these conferences.
2) The National Park Service also publishes *Paleontologic Research Volumes, Park Paleontology Newsletters, Park Paleontology Surveys,* and *Technical Reports*.
3) The National Park Service is planning to hire a Visiting Chief Scientist, who could be a paleontologist.
4) The National Park Service has a new, streamlined permit system.
5) The National Park Service is developing a literature data base for the geology and paleontology of the National Parks.
6) Fossil locality information is exempt from the Freedom of Information Act.
7) Student internships are available with the National Park Service.

The results from the December meeting, "Paleontology in the National Park System" are that paleontology is expected to have an increasing role in the National Park System. Outreach to the public, K-12 education, university education, and academic research all should benefit as the proposed initiatives come on line. However, an important caveat is that the paleontological community must be involved to help to develop policy and to work with staff of individual parks to implement the paleontological resource plans.

Action items and recommendations from the December meeting include the following:

1) A paleontologist should be appointed to the National Park Service Advisory Board.
2) Individual National Parks, park clusters, or parks in a region (as appropriate) need input from the paleontological community as geologic resource plans are being developed in order to identify and prioritize educational issues and research priorities.
3) A paleontologist should be appointed to the AGI ad hoc education committee.
4) A Geological Sciences Advisory Board should be considered for the National ParkService.

Those of us going into the meeting looking for explanations left the meeting realizing that a future is planned to have a much expanded role for paleontology in the National Parks System. The paleontological community is needed to help define these initiatives. Those interested in learning more about these issues or those wanting to become involved with specific projects can do so at the following web addresses:

•NPS Natural Resources page: http://www1.nature.nps.gov/

•NPS Science page: http://www1.nature.nps.gov/science/index.htm

•NPS Geologic Resources Division page: http://www2.nature.nps.gov/grd/>

•NPS Paleontology: http://www2.nature.nps.gov/grd/geology/paleo/index.htm

•CESU info: http://www.cesu.org/cesu/

•Canon Science Scholars: http://www.nature.nps.gov/canonscholarships/

•Sabbaticals in Parks: http://www.nature.nps.gov/Sabbaticals/

•NPS automated research permit site: http//science.nature.nps.gov/permits/index.html>

Thanks are appropriate to AGI, M. Ray Thomasson and David Applegate, for initiating and hosting this important exchange between the National Park Service and the paleontological community.

Please feel free to contact members of council for any ideas that will help make the *Paleontological Soci-*

ety even better.

Treasurer's Report for Fiscal 2002

by Mark E. Patzkowsky, Treasurer

I am happy to report that the transfer of the office of Treasurer from Morgantown, VA to State College, PA is now complete. Tom Kammer closed the books for 2002 and I began as acting Treasurer on January 1, 2003. I want to thank Tom for all of his efforts over the past six years. He left the office in good shape and he was diligent in making for a smooth transfer of the office.

Your Society remains in strong financial shape. Assets at the end of 2002 totaled $1,594,872, which was a decrease of $54,944 from the end of 2001, about half of the decrease for fiscal 2001. Cash in bank accounts was $165,314, which was up by $43,429. Investments were $1,429,558, which was down by $98,373. The decline in investments resulted from $40,000 budgeted for Society operations, and a net loss of $58,373 (3.8%) in our investment portfolio. Investment allocations were approximately 40% stock mutual funds, 40% bond mutual funds, and 20% cash.

Total income was $470,440. This included $354,984 from dues and subscriptions to our journals, $12,444 from donations, $22,810 from page charges, $10,395 from Special Studies publications, $27,844 from royalties, $475 from bank interest, $1,488 from rental lists, and $40,000 from investment income.

Total expenses were $431,586. A detailed listing of expenses will be provided at the Annual Business Meeting and Luncheon at the Annual GSA Meeting in Seattle. Some of the more notable expenses included: $238,957 to print our two journals plus the associated Memoirs; $55,128 for editorial costs of the two journals; $43,470 for Business Management of our journals and Society memberships by Allen Press; $11,628 for Special Studies publications; $14,011 for student research grants; $13,085 for PalSIRP grants; and $27,915 for overhead to operate the Society (meeting expenses, travel by Council members, insurance). This overhead cost was only 6.5% of total expenses.

Once again, I want to remind all Society members to please renew your journal subscriptions early, certainly by December 31 each year. Early renewals could save the Society thousands of dollars in business management fees by Allen Press if we don't have to send out so many renewal notices plus stop and then restart journal subscriptions to late-paying members.

PS-Sponsored GSA Sessions

by Mark A. Wilson, PS Program Coordinator

Paleontological Society members are always encouraged to submit short course and topical session proposals, and now funds are available to defray travel expenses for speakers who do not normally attend annual GSA meetings. If you are considering a short course or topical session proposal, please contact the Paleontological Society Program Coordinator, Mark Wilson (mwilson@wooster.edu). The next opening for a short course is November 2006. Topical session proposals for the 2004 GSA meeting (November 7-10, 2004, in Denver) must be submitted by the session organizers to GSA by January 16, 2004. Paleontological Society sponsorship should be obtained prior to submitting a proposal to GSA. To facilitate consideration of sponsorship, please submit ideas to Mark Wilson as soon as possible (especially if you wish to request funding for the session).

Reviews of PS-Sponsored Sessions at the GSA Annual Meeting in Denver

Predators, Prey, and their Fossil Record: The PS Short Course

by M. Kowalewski and P. H. Kelley (organizers)

Direct interactions among organisms are important ecological mechanisms that may play a key role in evolution. Predation has been recognized as a significant ecological force, although the importance of predation in shaping the history of life is still debated. The fossil record is the primary source of data needed to address this issue. In recent years, paleontologists have provided critical documentation of prey-predator interactions over evolutionary timescales and generated numerous fruitful hypotheses regarding the role of predation in the history of life. The increasing importance of predation-related research in paleontology is reflected by the 2002 GSA Short Course, *The Fossil Record of Predation.*

The short course offered a comprehensive, up-to-date overview of current understanding of the fossil record of predation from a variety of areas, including micropaleontology, invertebrate paleontology, paleoentomology, vertebrate paleontology, and anthropology. The papers provided diverse and rich evidence of predator-prey interactions through time, from individual interactions to global-scale secular trends, which can be used to test increasingly complex hypotheses. Based on the individual papers contributed by the presenters (see list at the end of this article), the content and conclusions of the short course can be summarized as follows.

The first part of the short course reviewed a variety of methods applicable in studying the fossil record of predation. Trace fossils are a rich source of quantifiable data on predation, and various analytical approaches for studying traces can be fruitful depending on the nature of the material and the goals of the researcher. Coprolites and stomach contents also provide a wealth of direct data on predator-prey interactions and reveal the diet of ancient predators, from marine invertebrates to terrestrial vertebrates. Exceptional preservation events, taphonomic patterns, and indirect evidence provided by functional morphology and phylogenetic affinities are also useful to paleontologists.

Anthropologists use a distinct set of qualitative and quantitative methods to study hunting behavior of hominids, which distinguish scavenging from predation and differentiate butchering behaviors (e.g. skinning, meat-stripping, or sectioning of carcasses). Promising research directions on methodologies applicable to the fossil record include laboratory experiments, observations of present-day ecosystems, and numerical modeling. The methodological chapters indicate that we need to continue improving our statistical tools and analytical strategies and work together to establish some general methodological guidelines for studying the fossil record of predation.

The second part of the short course impressively documented fossil predator-prey interactions but also pointed to numerous temporal and taxonomic gaps in our knowledge. The fossil record of microorganisms provides insights into primary producers and secondary consumers in marine ecosystems and indicates a long-term increase in the complexity of the trophic structure of marine ecosystems. The marine invertebrate fossil record of predation suggests that long-term evolutionary changes in predation pressure are linked to episodes of abrupt biotic reorganization during and after mass extinctions punctuated by longer interludes of relative stability. Moreover, the evolution of predation in the pelagic realm may have been largely decoupled from that in benthic ecosystems. The marine fossil record provides a strong case for predation on shelled organisms as early as the latest Precambrian with a further intensification of predation during the middle Paleozoic paralleled by an increase in potentially defensive traits of the prey skeleton (e.g. spinosity). In contrast, late Paleozoic forms may have taken refuge in smaller size and resistant, thick-walled skeletons. Episodic, but generally increasing, predation pressure on marine organisms appears to have occurred through the Mesozoic-Cenozoic. Predation in benthic communities may have intensified substantially in the Late Cretaceous-early Cenozoic with the evolution of neogastropods, varied crustaceans, and durophagous fish. In the early to mid Mesozoic, large-predator guilds were filled primarily by marine reptiles, whereas neoselachian sharks, teleosts and marine mammals dominated these niches in the Late Cretaceous to Cenozoic.

The marine invertebrate record provides evidence for parasite-host interactions with a nearly even distribution of reported cases since the Cambrian. However, few criteria are available to distinguish parasitism from predation, commensalism, or mutualism and only in exceptional cases (e.g. platyceratid-crinoid interactions) is the evidence for parasitism compelling. Terrestrial and freshwater invertebrates also provide a diverse fossil record of predation, parasitoidism, and parasitism, with evidence for carnivory (e.g. taxonomic affiliation, fossil structural and functional attributes, damage, gut contents, coprolites, and predator-avoidance traits) occurring from the mid-Paleozoic onwards. However, only 12 invertebrate phyla have become carnivorous in the continental realm and only the two most diverse groups (nematodes and arthropods) have a comparatively good fossil record.

Major groups of amniote predators, such as theropod dinosaurs and carnivorous synapsids, offer a continuous fossil record of predator-prey interactions in the terrestrial realm. Diet and hunting behavior of theropods can be inferred from functional morphology, taphonomic associations with probable prey, bite marks, gut contents, coprolites, and trackways. The taxonomic composition of dinosaurian predator-prey systems varied in time and space. Following the K/T extinction, carnivorous birds remained prominent predators through the Cenozoic. Significant parallels occurred in the diversification of non-mammalian synapsid predators in the late Carboniferous–Triassic and the Cenozoic radiation of mammalian predators: both groups evolved sabertooth forms as well as short-snouted, powerful biting predators. Each radiation is characterized by repeated patterns in which one or a few clades evolved large size and dominated the carnivore guild for several million years, but then declined to be replaced by new taxa. Both non-mammalian and mammalian synapsid clades show temporal trends towards larger body size and hypercarnivory.

The last part of the short course introduced models on the origin and history of predation as well as the evolutionary role of predator-prey interactions through time. Existing data on early life and theoretical considerations suggest that predation may have played an important role in major transitions such as the origin of eukaryotic cells, multicellularity (as a means of acquiring larger size), decline of stromatolites, diversification of acritarchs, and the Cambrian explosion. Predation may have been a decisive selective force in the transition from simple, mostly microbial, ecosystems to ones with complex food webs and higher-order consumers. Since the Cambrian explosion, the diversity of predators and their proportional representation in the total fauna have increased, implying that ecosystems have increased their ability to support either more predators or more specialization among predators. This pattern may be linked to a secular increase in diversity and biomass of primary producers and changes in composition of prey taxa.

The evolutionary importance of predation remains a hotly pursued topic. Predator-prey arms races may be driven by two related processes: escalation (enemy-driven evolution, in which the role of prey in the evolution of the predator is downplayed) and coevolution (involving reciprocal adaptation of predators and prey to one another). In the fossil record, the two processes are distinguished most reliably when the predator-prey system is viewed in the context of other species that may influence the interaction, allowing for ranking of selective agents. Scale also affects the role of escalation and coevolution: prey are likely to exert some selective pressure on their predators over ecological time scales, but predators may still exact primary control over evolutionary timescales by influencing prey phenotypes and restricting prey distribution. Predators likely control the overall directionality in evolution due to inequalities of predator and prey in control of resources. Indeed, predators have the evolutionary upper hand over the long run, especially in expression of sensory capacities, locomotor performance, and the application of force, and only in passive defenses (armor, toxicity, large body size) does escalation favor the prey. Evidence from the fossil record points to temporal increases in both predator power and prey defenses. These escalatory increases have proceeded episodically against a backdrop of generally increasing productivity and increasing top-down evolutionary control by high-energy predators.

To our knowledge, this short course and the associated edited volume (*Paleontological Society Special*

Paper 8) represent the first synthesis focused on the paleobiology of predation. We hope that this short course will stimulate further research on predation and aid future investigators in identifying new, exciting directions of study.

We thank the following contributors to the volume (paper presenters in bold). Methods section: **Michal Kowalewski; Karen Chin; Gary Haynes.** Patterns section: **Jere Lipps** and Stephen Culver; **Carlton Brett and Sally Walker; Tomasz Baumiller** and Forest Gahn; **Conrad Labandeira; James Farlow** and Thomas Holtz; **Blaire Van Valkenburgh** and Ian Jenkins. Processes section: **Stefan Bengtson; Richard Bambach; Gregory Dietl** and Patricia Kelley; **Geerat Vermeij**.

Kowalewski, M., and Kelley, P.H., eds., 2002, The Fossil Record of Predation. *Paleontological Society Special Papers,* v. 8, Paleontological Society, Yale Printing Service, New Haven, CT, 398pp. (ISSN: 1089-3326).

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Wetlands Through Time

by W. DiMichele and S. Greb (organizers)

The "Wetlands Through Time" theme session was jointly sponsored by the Paleontological Society and the Coal Division of the Geological Society of America. The Coal Division has long been an organizational centerpoint for research on the biology, particularly the paleobotany, of ancient wetlands, to the extent such research increases our understanding of the origin of coal. This was reflected in the strongly "coal-centered" line-up of the theme session, including numerous presentations on the vegetation, ecology and sedimentology of late Paleozoic age coal-bearing sequences. Accompanying these were talks on vertebrates and invertebrates of wetland habitats, wetlands geochemistry, and the relationship between peat-forming and mineral-substrate wetlands.

Presentation of the talks in stratigraphic order revealed the rapid development of ecological complexity within wetland habitats, followed by long periods of conservative composition and dynamics. Beginning in the Late Ordovician or Early Silurian, the first land plants appeared to be obligate dwellers of wet substrates. Yet, substantial peat deposits did not form until the Late Devonian, by which time terrestrial plants had begun broad colonization of the land surface. These earliest peat-forming mires were populated by structurally simple plant communities. By the Early Carboniferous, plant communities of wetland environments had become very complex, manifested in sub-habitat differentiation, multi-stratified canopies, and diverse vines and ground cover. Although the taxonomic composition of late Paleozoic wetlands was vastly different from that of the Mesozoic and Cenozoic, these communities were essentially structurally, and probably dynamically, modern. Also, just as modern mires show temporal successions in plant types, so do those of many late Paleozoic coals. In fact, the spatial and temporal succession of mire types reflected in the petrography and palynology of some coals controls coal quality, and so has a direct influence on the economics and mineability of the coal.

Although the record of vertebrates and invertebrates in wetland habitats is much less well documented than that of plants, numerous presentations in the session noted the importance of wetland facies for the preservation of ecologically and evolutionarily significant invertebrate and vertebrate fossils. For example, the preservation of some of the earliest reptiles in lycopod tree stumps at Joggins shows the importance of wetland facies for providing a record of early terrestrial vertebrates as well as possibly recording an ecological guild within an ancient wetland ecosystem. New discoveries of Early Carboniferous vertebrates make it clear that terrestrialized forms appeared earlier than had been previously thought and hint at a mostly unseen radiation of many groups. The complexity of plant-insect interactions also is increasingly well documented, though the Carboniferous evidence continues to suggest that food webs were fueled more by detritivory than herbivory. Modernization of such food webs apparently was a Permian, possibly Late Permian, occurrence.

The use of geochemistry to study wetlands is a powerful tool used primarily for the study of post-Paleozoic deposits. The study of paleoclimates has brought increasing reliance on geochemical studies of paleosols to understand the composition of ancient atmospheres, even to evaluate methane efflux from wetland habitats. Wetland paleosols from all parts of the record are being used increasingly to estimate precipitation and mean annual temperature of the geologic past. Likewise, evidence of wetland development in a wide variety of facies, including paloesols, can be useful in interpreting transgressive successions, thereby becoming an important tool in determining past sea-level changes.

Wetlands, broadly construed, make up an enormous fraction of the terrestrial fossil record. The accumulation in wetlands of peat deposits, the parent material of coals, also makes this kind of ecosystem a major part of our fossil energy resources. Consequently, wetlands are the direct or indirect focus of much of the work done on terrestrial rocks. As such, an understanding of their dynamics and the degree to which they are representative of or capture larger patterns of ecology and evolution is essential if the terrestrial record is to be used to expand theory in these areas.

Developing Perspectives on the Ecological Context of Biological Evolution Across the Neoproterozoic-Cambrian Transition

by L. Babcock (organizer)

The late Neoproterozoic-Cambrian interval was a time of significant reorganization at all levels in biological systems. Evolutionary events through that time interval took place in the context of a rapidly changing world: supercontinent splitting and rifting, melting of widespread continental glaciers, rising sea level, and increasing oxygenation of the world ocean and atmosphere. Our understanding of evolutionary innovations in organisms, together with the rates and trends of those innovations, continues to come into sharper focus through the application of innovative philosophical approaches, methodologies, and technological advances. At the 2002 Annual Meeting of the Geological Society of America (GSA) in Denver, the Paleontological Society sponsored a theme session whose purpose was to address our evolving understanding of changes in ecological conditions that mediated, or stemmed from, the dramatic changes that occurred in the biosphere across the Neoproterozoic-Cambrian transition. The theme session was co-sponsored by the GSA Geobiology and Geomicrobiology Division.

Early in the session, speakers addressed Neoproterozoic ecology, beginning with the radiation of multicellular organisms in the wake of a snowball Earth (S. H. Xiao et al.), and continuing through to the end of the Neoproterozoic (M. E. Clapham and G. M. Narbonne). In addition to providing an improved perspective on the stratigraphic succession of metazoans and metaphytes that developed following the decline of Marinoan glaciers, attention was focused repeatedly on the role that exceptional preservation plays in our understanding of the largely non-shelly Neoproterozoic biota. Emerging techniques of investigating fossils (such as computed tomographic analysis; J. W. Hagadorn and S. H. Xiao), and analyses of microbiotas (N. J. Butterfield; S. Q. Dornbos and D. J. Bottjer; S. H. Xiao et al.,) offered fascinating new insight into the morphology of some poorly known fossil forms. An overview of the Proterozoic trace fossil record (S. Jensen et al.), which provides important evidence concerning the appearance time of bilaterian animals, helped to fill in some of the details of early metazoan history during the late Neoproterozoic.

Many talks in the session focused on aspects of the biotic changes across Neoproterozoic-Cambrian transition. Factors influencing the development of resistant, including biomineralized, skeletons were touched upon in many of the talks. The genetic toolkit necessary for producing a complex array of animals seems to have been in place well before the start of the Cambrian (C. R. Marshall). Evidence was provided that Ediacaran biotas had a trophic structure similar to that of many Cambrian biotas (and modern soft-bodied communities), except for the lack of a deeper infaunal component. Ediacaran biotas evidently consisted of herbivores, detritovores, tiered suspension-feeders, and predators (J. H. Lipps and M. A. Fedonkin). The role of predation pressure as an important forcing factor in the development of resistant skeletons, including those composed of chitin and those reinforced with calcium carbonate, calcium phosphate, or silica, emerged in several talks. This continuing discussion about predation in the Neoproterozoic-Cambrian, which dovetailed nicely with the PS-sponsored short course on predation, was placed in context, however, through examination of the multiple causes and origins of biomineralized skeletons (S. Bengtson). An apparent pulse in Ca^{+} concentration in seawater during the Cambrian may have helped trigger metabolic changes in metazoans, resulting in calcification of the skeletons of some animals (S. T. Brennan et al.). Mounting evidence for an Early Paleozoic Marine Revolution, driven largely by predation pressure, was developed through the example of an early Cambrian trilobite interpreted as both prey to certain arthropods, and predator of infaunal worms or microorganisms (L. E. Babcock and J. S. Peel). The notion of an Early Paleozoic Marine Revolution provides an interesting link between the concepts of the Cambrian explosion and the Cambrian substrate revolution. Adaptive radiation of metazoans during the Cambrian was linked to the decline of mat-dominated communities, and their replacement by more heavily burrowed substrates, as benthic animals were forced to adapt to the mixed layer in subtidal, soft substrates (D. J. Bottjer and S. Q. Dornbos).

The remaining themes addressed by speakers in the session involved the taphonomic influences on paleoecological interpretation, and biogeography. The intra-Cambrian decline of preserved small shelly fossils was attributed to closure of a phosphatization window that accompanied a real decline in their diversity (S. M. Porter). Following closure of the phosphatization window, the frequency of preservation of non-biomineralized tissues in shales increased above background levels for a relatively short interval of Cambrian time. Multiple diagenetic pathways for the preservation of biomineralized skeletons and non-biomineralized tissues in Burgess Shale-type biotas were documented from localities in Laurentia (E. S. Skinner et al.). Finally, evidence was presented suggesting that Cambrian thrombolite-forming microbialites were restricted to the Laurentian paleocontinent (R. S. Shapiro).

Together, the talks presented in the Neoproterozoic-Cambrian theme session provided a fresh outlook on the ecological context of Neoproterozoic to Cambrian biotic evolution, and on the preserved record of changes in the biosphere during that critical interval of time.

Evolutionary Paleobiology and Paleoecology of the Bivalvia

by C. M. Tang and P. D. Roopnarine (organizers)

Given their long and abundant fossil record—and the ability to observe and study extant forms—bivalves can easily serve as a model system for evolutionary and systematic studies. In addition, as Tang pointed out in her introductory talk, bivalves are one of the most ecologically diverse taxa, living in all aquatic ecosystems, surviving in different substrates and employing different feeding strategies. Bivalves have even served as reef-builders and as hosts for chemosymbiotic and photosymbiotic bacteria. But despite all of these good reasons for studying bivalves, there are actually few paleontologists and malacologists who identify themselves as "bivalve workers."

The PS-sponsored session *Evolutionary Paleobiology and Paleoecology of the Bivalvia* at the Denver 2002 GSA Annual Meeting was organized to highlight new techniques applicable for studying various aspects of bivalves and provide case studies of bivalves in evolutionary and paleoecological studies. Speakers in this session ranged from undergraduate and graduate students to senior scientists; they included modern biologists, geochemists, systematists and paleoecologists (and even a couple astrobiologists!)

Bivalve systematics was covered in a number of talks which displayed a range of approaches. Medina gave an overview of molecular systematic work concerning the placement of bivalves among invertebrate groups and molecular traits unique to bivalves. Runnegar discussed ancient groups of mollusks and Campbell combined paleontological and molecular datasets.

In paleoecology, Goodwin highlighted the unique contribution bivalves can make in high-resolution reconstruction of paleoclimates, Herbert discussed the use of bivalves in examining escalation and predation in the fossil record and Anderson took advantage of the trophic diversity of bivalves to test paleoceanographic productivity models. Chamberlain provided an ecological look at early freshwater bivalves. Bivalve shell beds were used by Boyer as a proxy for paleocommunity turnover and two papers (Filkorn and Fall) looked at rudist assemblages—some of the most specialized bivalves ever.

Bivalves were used as model systems in a number of talks. Roopnarine used bivalves to examine levels of morphological integration, Pantel used pectenids to examine relationships between changes in morphology and paleocommunity composition, and Schneider examined taxonomic models using bivalves.

Given the breadth and activity of on-going bivalve research, perhaps we shouldn't be concerned that "Friends of Bivalves" get-togethers have gone extinct at GSA. But the session made clear that there is still plenty of room for both established and young paleontologists to use bivalves to better understand the history of life and evolutionary patterns in the fossil record.

Three Billions Years of Reef Evolution

by G. D. Stanley and P. Copper (organizers)

Reefs are enduring marine ecosystems extending back to the Archean. The biotic and geologic history of reefs has been affected by such physical, chemical and biotic factors as changes in the atmosphere, nutrients, seawater chemistry, sedimentation, and of course, biotic innovation during the evolution of many new reef groups. There have been many new developments in the field of reef research and this PS-sponsored GSA theme session took a look at some of these directions. The session took place during two days and addressed multifarious interdisciplinary themes dealing with reefs. Part I, held all day on Sunday, dealt mostly with a chronological development of reefs through time, while part II, held on Monday, dealt with thematic developments in both reefs and ancient, onshore-offshore communities. By summarizing recent advances in the field, the session helped stimulate a better understanding of where we are in reef studies and it also demonstrated that the reef theme continues to foster interactions within a broad and disciplinary spectrum of geology and paleobiology.

Part I began with Precambrian stromatolitic reefs of the Proterozoic as well presented by Noel James and Guy Narbonne who showcased reef examples in the transition between microbes and biofilm structures and the prelude to metazoan reefs. Proterozoic reefs also were addressed by L. C. Kah and coauthors who related sea-level change to explain the structure of 1.3 Ga reefs in Arctic Canada and Kelly Batten and coauthors, who dealt with stromatolitic and calcimicrobial buildups in Neoproterozoic rocks of the northwest territories of Canada. Moving into the Early Cambrian, Melissa Hicks addressed archeocyathids reefs and why the first metazoan, skeletonized reefs of the Paleozoic disappeared for forty million years. This was followed by Brian Pratt who enlightened the audience with details of Upper Ordovician microbial reefs found in subsurface rocks of Saskatchewan, Canada, illustrating examples that seem to defy the paradigm of reef evolution. Late Ordovician bryozoan-crinozoan reefs were the subject that Bill Berry used to illustrate the role of siliciclastic sediments in reef development. Paul Copper next presented most spectacular Late Devonian reefs from the western Canadian Arctic. These developed on the margins of a giant distal delta complex, during the mid- to late Frasnian before they were extinguished in the end-Frasnian extinctions. Dave Brenzinski and Al Kollar next presentated a lecture on Carboniferous buildups after the Frasnian-Famennian extinction. Here, Lower Mississippian mounds in Missouri and Arkansas record some of the very early reef-like communities of the Carboniferous. Mudmounds are not all tropical features as we learned from Fred Krause and Selim Sayegh. Mudmounds attained wide latitudinal distributions and ranged from the Proterozoic to the present, when cool or cold marine water invaded the seafloor.

Mesozoic reefs were the subject of Sara Pruss and David Bottjer who focused on the Early Triassic Virgin Member of the Moenkopi Formation, not long after the devastating end-Permian extinction. This was followed by George Stanley's overview of Middle Triassic to Early Jurassic reef building. This interval witnessed the rise of modern corals and several extinction events. Claudia Johnson covered cretaceous reefs. Her lecture addressed the Late Cretaceous of the Caribbean region and the change from coral-algal to rudist-dominated reefs.

Cenozoic reefs concluded the program. There was a lecture by Tom Stemann who posed the question of what happened to coral communities during the problematic Eocene period. Ken Johnson followed up by delivering an outstanding discussion on reef diversity trends during the Oligocene to Miocene reef transition, extracting specimen-based data from Antigua, Jamaica, and Puerto Rico. Results suggest that coral diversity actually is higher during episodes of high productivity when reef development is poor.

Sessions closed late Monday morning with a diverse range of Cenozoic reef or reef-related topics centered on the topics from the past and present. The themes generally dealt with recognition of similar patterns in modern and ancient reef settings, particularly how we could deduce major reef factors (e.g., diversity, framework, hurricane stress, etc.) in Cenozoic fossil reefs. This included excellent models for the "present may be the key to the [near] past", and the reverse, "the past is the key to the future", as well as experimental ways in which we could induce modern reef biota to secrete skeletons like those of the past 70 million years.

Paul Krutak took the audience on a compare-and-contrast trip of Oligo-Miocene reefs as seen in Gulf of Mexico drill core, and modern patch reefs of the Veracruz area in the Gulf: this is how the economic, 'petroleum' view of the reef window can extract useful data about ancient settings, as well as shed light on oil and gas source rocks. John Dawson focused on the relationship in deep-water azooxanthellate corals between biogeography and diversity; his data base indicated that for much of the Neogene, a high Caribbean endemism was striking, but that this changed in the Recent to cosmopolitan taxa. Speciation, or introduction of species, accelerated with Pleistocene glaciations: however, some bias exists; as of 129 modern taxa, only 8 (6%) have a fossil record.

Pamela Hallock followed with a lucid, well-illustrated description of Miocene reefs from Australia's Marion Plateau ODP Leg 194, and how these reacted to climatic swings from the Miocene descent into global icehouse conditions. Dave Meyer covered the relationship between the preservation of Pleistocene in situ reef frameworks in areas of the western Caribbean where hurricane frequencies were low, and showed how this could be compared with what happens on the lee sides of modern hurricane-stressed reefs. Next, Al Curran covered further Caribbean examples of shallow-water reefs from both the Yucatan and Bahama platform, each with different settings, one the outer storm-exposed western flank of the open Atlantic, and the other on a continental flank at Belize and Mexcio.

The classic Low Isles reef of the GBR province, eastern Australia where reef flat corals are commonly almost completely exposed at very low tides, were given a 70 year historical review (by Tom Frank from the Queensland research group), to show how the complex had changed almost within recent human memory, with the advent of the first biological descriptions and photographs. These showed major temporal shifts of reef communities, beach and mangrove setting in what would be a geological instant. How de we find geo-proxies for bleaching events? How we detect these events was the topic discussed by Sande Burr, who established that bleached corals show differing ratios of Sr, Se and Ag, and also show septal 'wear', that could be used as markers for indication paleo-bleaching events.

What happens when we play around with low-Mg artificial seawater and living red algae, to try to induce them to behave as they might have in the late Cretaceous? Ries Justin (Johns Hopkins) gave an interesting account as to how this could be done experimentally. Dennis Hubbard gave an energetic, highly instructive and superb display about Pleistocene and Holocene reef patterns and what they could tell us about the future in reefs, using examples and models from the tropical Atlantic.

Remaining talks covered topics only peripherally connected to reefs or carbonates, e.g. Cretaceous 'parasitic' symbiosis in echinoids (Donovan), Carboniferous brachiopod communities from Idaho (Butts), wonderfully illustrated analogues of modern shallow-water crinoids with Cretaceous *Uintacrinus* (Messing), oxygenation of Appalachian benthic life in the Middle Devonian (Sessa), the paleobiology of forams as deduced from stable isotopes (MacLeod), late Cretaceous ammonoid paleoecology (Moriya), and mosasaur taxonomy (Maisch). In other words, we still have a lot to learn about the micro-nature of reef and tropical peri-reef biota, as well as the larger seascape they may produce or alter.

The two-day, PS-sponsored session presented papers exploring a wide array of reef topics. Rather than simply blow-by-blow descriptions, most lectures extracted productive themes that could impact on reefs of any age. Lectures in this session exhibited the kinds of interdisciplinary approaches necessary to foster a better understanding of Earth history how reefs have responded to it.

Phenotypic Variation: Discriminating Between Evolution and Environment

by P. Kaplan and S. J. Hageman (organizers)

As paleontologists interested in questions of speciation, population dynamics, development, opportunism, constraint, phylogeny, versatility, or a host of other evolutionary issues, we are operationally tied to the original genetic variance that controlled these processes. But the fossil record is almost exclusively one of phenotypes — not genomes, not neurologies, but morphologies and behaviors. Thus, the ability to draw expressly genetic and expressly nongenetic inferences from morphology is critical to a synthetic evolutionary paleobiology. In an exciting theme session at Denver GSA 2002, paleontologists and evolutionary biologists met to consider these issues and share their successes in pinning down the causes and consequences of phenotypic variation.

Due to the session's focus on evolutionary processes applicable to any organism, we were able to attract a taxonomically and stratigraphically broad audience. Amphibians (David Pfennig), fungi (Karen Hughes & Ron Petersen), mammals (David Polly; Michael Wilson), crustaceans (Roger Kaesler; Jeff Agnew & Laurie Anderson), bivalves (James Crampton & Andrew Gale; Jennifer Stempien, Michal Kowalewski & Gwen Daley), brachiopods (Paul Harnik, Mary Otoo & Amy Carey; Gayle Levy & Steve Holland), bryozoans (Steve Hageman), gastropods (Rob Guralinick; Jim Freiheit, Steve Schellenberg & Dana Geary), and trilobites (Peter Kaplan) all contributed to the speakers' presentations, which focused on terrestrial, marine, and lacustrine fossil assemblages across much of the Phanerozoic. All this breadth might serve to scatter a session's coherence, but in this case the theme held strong as speakers detailed the unique opportunities for study in each of the aforementioned taxa, times, and environments. The session brought together not only a range of paleobiological questions and spatiotemporal scales, but also a range of study scopes. Cutting-edge morphometric contributions from student presenters complemented presentations by accomplished researchers of long-term, macroscale projects.

Perhaps most exciting was the reciprocal illumination of neontological and paleontological approaches to phenotypic questions. Naturally, the two approaches are fit for attacking different aspects of phenotypic problems; paleontologists have easier access to time-series and (for marine settings) a broader range of sampleable environments, while neontologists have access to genetic sequences and can manipulate their organisms and environments. Hearing these perspectives, approaches, and techniques in succession had the synergistic effect of reinforcing and deepening interpretations from one presentation to the next. Where paleontologists made thorough use of morphometrics, ordination, and stratophenetic analysis, neontologists attacked other aspects of the phenotype using known environmental parameters, genetically determined heritabilities, rearing experiments, and genetic sequences. Where paleontologists and neontologists met was on the importance of individual development for understanding phenotypic response and its environmental and genetic controls. Stable isotope profiles were used in determining the effect of growth rate on fossil morphologies, while rearing experiments revealed genetic canalization in supposed ecotypes in living populations. Ontogenetic trajectories of shape were effectively utilized by paleontologists and neontologists alike in resolving environmental influences on morphology. Evolutionary developmental biology remains a fruitful area for research into the building of phenotypes and their natural variation.

The phenotype session was such a success thanks to the interdisciplinary interaction of neontological and paleontological perspectives. But the attendance of neontological guest speakers at a geological conference could not have taken place without the sponsorship of the Paleontological Society. We were pleased to find such strong support in this endeavor from the society, contributors and from audience attendance. Our thanks again to all.

Advances in the Fossil Record of Insects and Terrestrial Arthropods

by R. E. Nelson (organizer)

The session was co-sponsored by the PS and the Geobiology and Geomicrobiology Sections of GSA. A dozen presentations covered studies on deposits ranging in age from Carboniferous to late Pleistocene, including discussion of a new, exciting specific site to look for arthropod remains (inside root casts - A. Smith and others) and a rich but previously unreported fauna (Stewart Valley fauna, middle Miocene - D. Smith). A leadoff paper by Easterday outlined the critical foundation contributions made by S. H. Scudder to the early development of paleo-entomology (s.l.) in North America. Labandeira and Santiago-Blay presented evidence from the middle Pennsylvanian that the basal condition for holometabolous insects is for larval abdominal segments to bear clawed appendages, and that this has been genetically suppressed (by the Distal-less gene) in modern members of the clade. Archibald and Farrell presented evidence that mild winters in a temperate climate result in increased species richness in faunas, as evidenced by Eocene assemblages from the Pacific Northwest.

Lubkin reported on her preliminary studies of exquisitely preserved carbonized three-dimensional Cretaceous insect remains from northern New Jersey. Moe and D. Smith reported a Diptera-based reappraisal of paleoclimate and paleoelevation for the Florissant Formation (Oligocene) of Colorado, based on Diptera, to warm-temperate and low- to mid-elevation; most other appraisals of paleoelevation for Florissant are for higher elevations. Devore and others presented evidence for complex insect-plant interactions (particularly involving galls in bald cypress and borings in oak acorns) from the Miocene Yakima Canyon Fm. of Washington, one of the few permineralized floras so studied.

Zinovjev reported on late Pleistocene (ca. 24-28 ka) assemblages from western Siberia that have no modern analogues, though consisting of extant species found today in diverse nonoverlapping habitats; Lemdahl's work in southern Sweden based on woodborers and other insects refuted long-held assumptions that heavy grazing by late Pleistocene megafauna was responsible for maintaining primeval postglacial forest structure, and that fire seemed to have been more important. Nelson and others reported that insects associated with the ca. 11,500-year-old Hyde Park, NY, mastodon imply conditions comparable to current central Labrador for eastern New York at the time the animal was alive.

This was the second annual session dealing with the fossil record of insects and terrestrial arthropods at a GSA national meeting, and a third has been proposed for the 2003 annual meeting of GSA in Seattle.

Paleobiogeography: Integrating Plate Tectonics and Evolution

by B. S. Lieberman (organizer)

The aim of the session was to bring together a diverse set of researchers in several areas exploring the relationship between plate tectonics and evolution. The session primarily emphasized talks by paleontologists using fossil data on organismal distribution and evolution, but also included geologists using computer approaches in paleogeographic reconstructions and those involved in paleomagnetics research. The theme session was comprised of a set of invited speakers, voluntary submissions, and also talks recommended by the Technical Program committee at GSA, and their cooperation and that of Paleo. Society council in helping to put this together was much appreciated. Although admittedly biased, I thought the session was a smashing success, bringing together a broad array of speakers on a variety of topics who got to address a large target audience that participated in lively discussion.

The session got off to a fine start with Tony Hallam's presentation. Tony is one of the pioneering figures in paleobiogeography and it was great to have his entertaining and erudite perspective on the emergence of vicariance biogeography out of a tradition that stretched back to Darwin and Wegener. Carl Stock and Judith Burry-Stock's presentation on biogeographic patterns in Devonian stromatoporoids came next. As part of an important area of research, they considered the role that various tectonically mediated barriers played in defining the geometry of species' geographic ranges and contributing to biogeographic differentiation. Alycia Rode then spoke on some innovative research she is performing using Geographic Information Systems (GIS) to study how invasive species may have contributed to the Late Devonian biodiversity crisis. In the first extensive application of GIS to the marine invertebrate fossil record she used a series of computer animations to show how species shifted their geographic ranges through time during the Late Devonian interval. She also considered how these shifts were associated with changes in sea-level and correlated with variations in parameters like speciation and extinction rates; an added twist was that distributions were directly mapped onto Late Devonian paleogeography. Alycia Rode's work is exciting because it provides a new way of tracking geographic range analytically in the fossil record and potentially opens up a whole new area of research in paleobiogeography and paleontology.

An important subset of talks in this session considered the effects tectonic events had on oceanographic circulation, which subsequently impacted evolutionary and biogeographic patterns in planktonic marine organisms. For instance, Dan Goldman, Hilary Janousek, Chuck Mitchell, and Jorg Maletz had a fine perspective on the dynamics of biogeography and diversity in Ordovician graptolites. Their work was important in several respects including the fact that they could look at how tectonic controls and oceanographic factors influenced organisms leading up to the time just before a mass extinction. Eduardo Koutsoukos continued the theme of looking at planktonic organisms, this time Cretaceous forams from the South Atlantic, by considering how oceanography influenced biogeographic patterns in these organisms. Susan Schultz, Laurie Collins, Bill Berggren, and Marie-Pierre Aubry also considered biogeographic patterns in forams, but to study a key event in earth history, the joining of North America and South America at the Panamanian Isthmus. This tectonic event and its oceanographic consequences had a host of important evolutionary and biogeographic effects on marine faunas which they ably considered in their talk. Finally, Sreepat Jain focused on biogeographic and biostratigraphic patterns in Jurassic ammonites from the Indian subcontinent. This is an important region biogeographically because of its position on the Gondwanan margin, and the talk introduced many in the audience to a new set of interesting biostratigraphic and biogeographic patterns.

Although "invertebrate" fossils were the primary focus of most talks, vertebrates were also represented. Sankar Chatterjee and Chris Scotese gave an illuminating and well-illustrated talk on the biogeography of Indian dinosaur faunas. They considered whether or not India, during its northward movement out of Gondwana, may have slid past and come into contact with parts of the Arabian Peninsula; they also presented exciting information regarding the possible sighting of a terminal Cretaceous meteor crater near Deccan trap outflows. In another interesting talk, Anne Weil presented compelling evidence that there were a series of profound range expansion events by several mammal clades in the Late Cretaceous and early Cenozoic that came to span Asia and Laurentia. This is more evidence that vicariance is not the only biogeographic process that produces congruent patterns; geo-dispersal, at times ignored by neontologists, yet a major feature of the fossil record, is one such important process. Paul Smith, Philip Donoghue and Ivan Sansom presented an excellent conclusion for the talks with a vertebrate paleobiogeography focus by concentrating on some of the key features in early vertebrate evolution, especially those during the Ordovician radiation, and relating these to tectonic events. Their emphasis was on evaluating phylogenetic paleobiogeographic patterns, and they showed several detailed and well resolved cladograms summarizing major events in early vertebrate evolution. Their talk also provided significant new data bearing on the distribution of microvertebrate remains.

One of the compelling talks in the symposium was the presentation by Chris Scotese, even though it did not focus explicitly on the distribution of fossils. He has been at the forefront of scientists using computer-based methods to study paleogeography. His reconstructions synthesize data from a variety of fields including paleomagnetics, paleoclimate, and paleontology, and in his talk he also added important information about confidence limits regarding various paleogeographic reconstructions at different times in earth history. The talk included several spectacular animations where the plates were literally put in motion and allowed to fly across the screen, compressing tens of millions of years of earth history to tens of seconds. Scotese's work uses cutting edge computer applications and integration of data into a GIS framework; he also hinted at an even more exciting future for the field of paleogeographic reconstruction.

The session also featured several talks emphasizing the relationship between late Neoproterozoic and Cambrian tectonic events and biological evolution. Noel Heim and Nigel Hughes presented some interesting results from a new Middle Cambrian fauna they have uncovered from the Himalayas. They focused on several examples of species showing intraspecific variation and used these to consider and adduce paleobiogeographic patterns. Ben Waggoner's talk emphasized the paleobiogeography of the Ediacarans during the late Neoproterozoic. These unusual organisms whose biological affinities have been much debated lived during a profound set of climatic and tectonic changes. Waggoner used parsimony analysis of distributional data for Ediacaran genera, and also statistical analyses, to develop a valuable perspective on paleobiogeographic patterns. He recognized a biogeographic signature preserved in the Ediacarans related to the breakup of Rodinia, and also described several issues related to faunal sampling that are important when evaluating the paleobiogeography of this enigmatic group. Finally, Joe Meert and I combined our disparate databases from paleomagnetics and trilobite phylogenetic biogeography to evaluate the paleogeography of the late Neoproterozoic and Early Cambrian. This time period brackets the breakup of the supercontinent Rodinia and the assembly and breakup of the supercontinent Pannotia. In a Reese's Peanut Butter Cup moment, to quote Meert, we realized that a useful way to study paleogeography is to evaluate the competing signatures from very different data sets. In particular, we sought to uncover which aspects of Neoproterozoic and Early Cambrian paleogeography are well resolved, and which aspects seem less well supported. First, Meert described evidence that the tectonic signature in trilobites is most compatible with late Neoproterozoic tectonic events, suggesting that the evolution of this group, and by extension other euarthropods, extends back at least into the 550-600 Ma interval. Among other tectonic patterns, we found no compelling evidence that one or more episodes of True Polar Wander occurred during this time period.

The symposium ended as I summarized various theoretical and practical issues in paleobiogeography. I especially focused on the strong evidence that the Earth and its biota have coevolved, including the fact that different time periods with different Earth history signatures also have corresponding differences in their biological signatures. I presented evidence from phylogenies of trilobite clades and also molecular systematic studies of modern freshwater mollusks species that this is true of biogeographic differentiation at a variety of hierarchical levels. These differing biological signatures include differences in biogeographic patterns and also rates of evolution. Finally, I emphasized how extinction is an important process that can critically influence a scientist's ability to resolve biogeographic patterns in studies that exclude fossil lineages. In short, it was a fun morning that hopefully pointed out some future areas of growth in paleontology and paleobiogeography.

The Geology & Paleonotology Update from NSF

by Richard Lane, Program Director, NSF

This report summarizes changes and activities that are taking place in the Geology and Paleontology Program at NSF. These can be divided into several categories, and include: Organization, People, Budget, Special Programs/Initiatives, and Program News.

Organization: We are guardedly optimistic that exciting changes in the organization of the Geology and Paleontology (GE) Program are on the horizon. As most of you know, scientifically, GE represents an inordinately large chunk of the Earth Sciences, being the funding home for Geomorphology, Sedimentology, Stratigraphy, Paleontology and Low Temperature Geochemistry. With the current NSF focus of using science to help solve human and societal needs, this area of the Earth Sciences takes on a new level of importance. For these and other reasons, we are developing a plan to reorganize GE into three programs (Earth Surface Processes, Stratigraphy and Paleobiology, and a third program in the area of Biogeosciences/Low Temperature Geochemistry). It is hoped that this organization will be implemented within the next year, but that is dependent upon FY 2003 budgets and FTE allocations that are still not resolved. The current expertise of the Program Directors covers the latter two areas and thus, if implemented, requires the hiring on one full time Program Director for the new Earth Surface Processes Program. For those of you seasoned earth surface process scientists who are interested in a career change, please be alert for a future announcement of such an opening (possible!!) at NSF.

People: GE is staffed by two permanent Program Directors—H. Richard Lane and Enriqueta Barrera—and one Program Assistant—Felicia Smith. The EAR Division, directed by Hermann Zimmerman, has recently hired two people to act as EAR Division Section Heads. Jim Whitcomb has been hired as the Section Head for the Special Projects Section and Walt Snyder, Boise State, was hired as an interim Section Head for the Research Grants Section, the latter being that section in which GE resides. Many other EAR Division staffing changes have occurred in the last couple years and the current staff can be found on the EAR Division website at http://www.geo.nsf.gov/ear/start.htm.

Budget: Congress and the President have NSF on track for doubling its budget in 5 years. This fiscal year (2003), EAR is receiving a 12.45% increase. Along with these recent NSF budget increases, the GE Program has fared budgetarily very well over the last several years. Nevertheless, the program is not nearly where it needs to be relative to the size of the community and the proposal pressure it handles. Although not yet finalized, we anticipate our FY 2003 budget to be approximately 11.1 million dollars.

Special Programs: There are numerous NSF special programs that should be of interest to the GE community as funding sources. These special programs generally last for 3-5 years, require multidisciplinary team approaches, and commonly fund larger requests. Some of these include:

Collaborations in Mathematical Geosciences (CMG): http://www.nsf.gov/pubs/2003/nsf03508/nsf03508.pdf

Assembling the Tree of Life (ATOL): http://www.nsf.gov/pubs/2003/nsf03536/nsf03536.pdf

Biocomplexity in the Environment (BE): Integrated Research and Education in Environmental Systems: http://www.nsf.gov/pubs/2002/nsf02167/nsf02167.htm

Earth System History (ESH): http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf02191

Information Technology Research (ITR): http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf02168

Research in the Biogeosciences: http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf02172

Major Research Instrumentation (MRI): http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf01171
We are told that there are a lot of opportunities for small to medium size schools in the MRI Program.

Margins http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf02110

Faculty Early Career Development (CAREER) Program: http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf02111

Science and Technology Centers (STC): Information on the next competition will be forthcoming soon

Geoinformatics: NSF is emphasizing the need for development of a cyberinfrastructure across all of science and engineering. The community has coined the term «GeoInformatics» for cyberinfrastructure applied to the Earth Sciences. GeoInformatics is an information technology system that will provide earth scientists with the tools necessary to conduct the next generation of geoscience research. GeoInformatics is designed to take advantage of powerful new information technologies such as Geographical Information Systems (GIS), remote sensing, scientific visualization, information networks, and wireless applications in a truly integrated manner. The emphasis of a GeoInformatics system is on providing seamless and easy access to: 1) extant and future earth science research data, 2) research-grade tools to manipulate, mine and analyze interdisciplinary data, and 3) computational resources necessary to model Earth-system processes. The «system» would include a scalable hierarchy to accommodate expansion, contraction, and relocation of resources as needed. The network must be highly interoperable with scientific and data model standards. The management structure will ensure community-based oversight of the system

NCED: The University of Minnesota's St. Anthony Falls Laboratory (SAFL), Univ. California—Berkeley, the Science Museum of Minnesota, MIT, Princeton University, and Fond du Lac Tribal and Community College have received a five-year (renewable for up to 5 additional years), $19.3 million Science and Technology Center (STC) grant from the National Science Foundation for a new National Center for Earth-surface Dynamics (NCED). For more information see http://www.nced.umn.edu. The STC Program is a resource our community probably could be utilizing more effectively by applying for other centers such as NCED.

Earthscope: Earthscope is funded!! For more information see http://www.earthscope.org.

CUAHSI: The Consortium of Universities for Advancement of the Hydrologic Science, Inc. is a consortium of 68 universities that was organized to foster advancements in the hydrologic sciences, in the broadest sense of that term, by: (1) developing, prioritizing and disseminating a broad-based research and education agenda for the hydrologic sciences derived from a continuous process that engages both research and applications professionals; (2) identifying the resources needed to advance this agenda and facilitating the acquisition of these resources for use by the hydrologic sciences community; and (3) enhancing the visibility, appreciation, understanding, and utility of hydrologic science through programs of education, outreach, and technology transfer.

Although there are 68 participating universities at this time, participation is unlimited. If you are interested in your university participating, please contact Marshall Moss at memos@worldnet.att.net or Rick Hooper at rhooper@agu.org. Additional information can be found at http://www.cuahsi.org.

Program News

Submission Deadlines: GE is changing proposal submission deadlines from the former ones to July 15 and January 15. This change will take place immediately so that the next deadline will be July 15, 2003. In this scenario, the fall panel will be held in late October or early November and the spring panel will be in late April or early May. This does not affect other programs within EAR; they will remain with the traditional June1 and December 1 deadlines.

Rate of Funding Success: The average annual proposal funding success at NSF is about 30%. Since 1999, the percentage success in GE has hovered at or just below this level (e.g., 1999-30%; 2000-28%; 2001-28%; 2002-27%). We are being asked at the highest levels of NSF to increase the monetary size of our grants while extending their duration. This is counter to the way that we have been apportioning available GE funds to PIs. However, for the long-term financial health and growth of NSF and GE, we feel compelled to follow the instructions given us. Therefore, we encourage you to consider submitting financially larger grants of greater duration. This may lead to a lower rate of success for submitted proposals. Of course, within this scenario, those of you who are successful will not be expected to be submitting proposals as frequently. One possible way to approach this problem would be to submit fewer collaborative proposals. Collaborative proposals are basically one project grouped under several proposals from different institutions. If you, the PIs were to submit one proposal through one institution as a group of subawards, it would increase the average individual cost of each proposal. However, there are two obvious problems with this approach for the PIs: 1) it ups the overhead because both the parent and daughter institutions charge overhead costs, and 2) only the person at the parent institution is a PI, all others are co-PIs, even though overhead and full funding is accorded them. In this case where NSF wants to increase the average budget size of proposals, the first problem should not be a consideration; however, the second problem may have consequences for tenure, etc.

The Paleontological Society Distinguished Lecturer Program

By Christoper G. Maples, Former Councilor

Each year the Paleontological Society selects outstanding scientists whose works encompass a wide variety of paleontological topics as Paleontological Society Distinguished Lecturers. Each Distinguished Lecturer has national and international stature in paleontology, has traveled widely, and has published extensively. Each is also known as an excellent speaker who can communicate the interest and importance of their research topics. This program is intended to make available lecturers for inclusion in departmental speaker series or other college and university forums.

The Paleontological Society Distinguished Lecturers, topics, and short abstracts of presentations for the 2002-2004 academic years are listed below. Additional information is available on The Paleontological Society homepage at: http://www.paleosoc.org/speakerseries.html. If your department is interested in inviting one or more Distinguished Lecturer to your institution, please contact the speaker directly. Although financial arrangements must be made directly with each speaker, all Paleontological Society Distinguished Lecturers have agreed to be available on an expenses-only basis.

The Paleontological Society hopes that you take advantage of this opportunity. Paleontology is a dynamic discipline, and these speakers will certainly convey the excitement and timeliness of our science. If you have any questions regarding the Paleontological Society Distinguished Lecturer program, please feel free to contact me at: cmaples@indiana.edu.

ACADEMIC YEARS 2002–2003 DISTINGUISHED LECTURERS

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Simultaneous Illumination - Phylogenetic Approaches toward Crocodylian History

Crocodylians are often dismissed as "living fossils" little changed since they first appear in the Mesozoic. Although a limited number of morphotypes have arisen during the group's history, crocodylian phylogeny is much more dynamic than often acknowledged. A phylogenetic approach reveals a complex biogeographic history. By considering both fossil and molecular estimates of divergence timing, the geographic distributions of most extant crocodylian lineages require the crossing of a major marine barrier at least once—for example, three different lineages crossed the Atlantic during the Late Tertiary.

Studies of diversity over time suggest that crocodylian diversity showed two diversity peaks—one in the Eocene, and another in the Miocene. A phylogenetic perspective reveals differences between these peaks. Clades with minimum origination dates in the Cretaceous or Early Tertiary are morphologically uniform, but geographically widespread. Crocodylian faunas during the early Tertiary tend to be phylogenetically composite. In contrast, crocodylian faunas of the later Tertiary tend to be more endemic. Climate change is usually seen as the primary agent behind crocodylian diversity changes over time, but increased separation between continental land-masses during the later Tertiary may have prevented widespread dispersal of specialized clades, allowing multiple endemic radiations to occur. This suggests that tectonics may be partially responsible for an increase in crocodylian diversity early in the Neogene.

A phylogenetic perspective enhances our interpretation of temporal patterns, because the biogeographic details recovered from the calibrated phylogeny are not evident from counts of taxa over time. And re-examination of curated specimens is critical for the recovery of these patterns, as taxonomic philosophies have fluctuated over time, and published classifications may not mirror phylogenetic relationships. (Talk can be given for general, intermediate, and specialist audiences)

The Science of Sue

The skeleton of FMNH PR2081 (popularly known as "Sue") is the largest, most complete, and best preserved *Tyrannosaurus rex* ever collected. It reveals structures thought to be absent from tyrannosaurids and other derived theropods (such as a proatlas arch), but also suggests that some features thought to be present in tyrannosaurids were not present at all (such as the bony sternum). There are several abnormalities, including healed fractures in the trunk ribs and fused caudal vertebrae that appear not to result from fracture. Exostotic bone in the fused caudals grew around caudal muscular bands, preserving a natural mold of the tail musculature. None of the abnormalities on the jaw are healed bite marks.

A high-resolution computed tomographic (CT) analysis of the skull generated 748 2-mm-thick slices. Inspection of both the raw slices and 3-D models generated from them allowed the preparation team to see obscured objects before they were manually exposed. These images reveal internal details not previously accessible in intact tyrannosaurid skulls, such as the ossified medial wall of the maxillary antrum and the internal morphology of the pneumatic recesses, which may have communicated with pneumatic chambers in the neck vertebrae. They also permit the creation of a digital endocast that goes beyond those made through destructive means by preserving nerve pathways all the way through the braincase and internal details of the otic capsule. It reveals an interesting combination of ancestral and derived features relative to the brains of living dinosaurs and other archosaurs. The endocast confirms the presence of a large olfactory nerve and reveals greatly enlarged olfactory bulbs relative to those in other nonavian theropods, suggesting that smell was emphasized in the sensory repertoire of *Tyrannosaurus*.

A chevron bone was found during preparation that fits between the first two tail vertebrae. The absence of this bone was one reason "Sue" was thought to be female. A close examination of other criteria used to sex dinosaurs reveals further interesting complications. (Talk can be given for general, intermediate, and specialist audiences)

Differing Temporal Expectations for Crocodylian Phylogeny: Molecules versus Stratigraphy

Different sources of temporal information—the stratigraphic distribution of fossils and molecular distances between extant species—can yield very different estimates. These do not represent "conflict" in the same sense that different data sets may support different trees, as temporal estimates are limited by known incompleteness (the fossil record) and labile assumptions (a priori estimates of molecular evolutionary rate). Moreover, disparity may result more from failure to address the same phylogenetic question with different data sets.

Different temporal predictions for crocodylian phylogeny illustrate all of these points. In the most famous disparity, fossils have long been used to indicate a Mesozoic divergence between *Gavialis gangeticus* (the Indian gharial) and any other living crocodylian, whereas molecular distances have suggested divergences as recently as 20 million years. Reevaluation of the fossil evidence makes any divergence in the Cenozoic unlikely, and this disparity may result in large measure from an invalid assumption of clocklike evolution over the entire group. Other comparisons calibrated by fossils - especially among caimans—suggest unreasonably high rates of molecular evolution, and indicate the presence of significant ghost lineages in the fossil record. Addition of new fossil information can recalibrate hypothesized rates of evolution, and the degree of revision can depend not only on the temporal distance between fossils, but on the distance between the relevant fossils and the Recent.

Finally, some indicated disparities stemmed from a lack of rigorous phylogenetic hypotheses for some fossil groups. Molecular distances indicated a Late Tertiary divergence within the widespread genus *Crocodylus*, long thought to be an ancient group; close examination of fossils assigned to *Crocodylus* instead suggests a divergence among living *Crocodylus* no earlier than the Miocene. (Talk can be given for general, intermediate, and specialist audiences)

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Coastal Plain Stratigraphy: It Isn't Just Layers Any More (and Probably Never Was)

Studies over the last two decades in the stratigraphy of the Atlantic Coastal Plain have shown that simple models of stratigraphic units (and their related aquifers and confining units) being thicker downdip and pinching out updip are seldom accurate. Discontinuous lenses of sediments are as common as simple continuous layers, and wide thickness variations are the norm. Current work in South Carolina has led me to speculate that anomalous patterns of erosion preserved in Paleocene and Eocene sediments represent scour caused by an eddy system of the predecessor of the present Gulf Stream. I will also bring up any new developments in the ongoing study of the stratigraphy of the sediments filling the Chesapeake Bay impact structure. (Semi-technical, for stratigraphers and hydrologists)

Biostratigraphy, Paleoecology, and Biogeography: What's Signal? What's Noise?

Biostratigraphers love the lowest and highest stratigraphic occurrences of taxa (FADs and LADs). But not all FADs and LADs are created equal. In any given stratigraphic succession, some taxa first occur because they evolved in that area at that time. Others first occur for purely ecological reasons or due to immigration. Instead of bemoaning the ecological misfits, we should use them, but not for biostratigraphy. The technique of graphic correlation is explained. I demonstrate how it easily tests the hypothesis of synchroneity. Nonsynchronous FADs and LADs should immediately be excluded from further consideration for correlation. But they should not be excluded from the overall analysis. A diachronous event cries out for paleoceanographic, paleoecological, or post-depositional interpretation. Dinoflagellates from the Miocene of Florida illustrate concepts such as climatically influenced patterns of immigration. (Semi-technical, for geologists and paleontologists)

Dinoflagellates: My Favorite Fossils

Dinoflagellates are organisms that cause red tides in modern seas. The dinoflagellate *Pfiesteria* has been called the "cell from hell" by the news media. Dinoflagellates are common in the fossil record from the Late Triassic onward. In many instances, when the sediments are too far downdip to have good pollen and too far onshore to have a good calcareous microfossil assemblage, dinoflagellates provide key biostratigraphic and paleoecologic information. (Not too technical, for geologists and biologists, and interested amateurs—everyone will learn something)

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Is the Late Ordovician Mass Extinction an Artifact of Stratigraphic Resolution?

The Late Ordovician mass extinction was contemporaneous with rapid advance and retreat of continental glaciation in Gondwana. Integrated, multidisciplinary, high-resolution study of shelf and basin stratigraphic successions in central Nevada and comparison with data from other tropical paleo-plates indicate that, while habit loss and resulting pulses of extinction were driven by rapid glacioeustatic sea-level and associated oceanographic changes, extinctions were gradual, diachronous, and sporadic. The Late Ordovician was a time of major biotic crises, but not of sudden global extinction.

An Actualistic Model of Graptolite Biogeography

The Finney-Berry model of graptolite biogeography views graptolite biogeography from a new perspective, focusing attention on the habitat in which graptolites flourished rather than on the differentiation of faunas into provinces and biofacies. It emphasizes the dynamic and ephemeral nature of graptolite habitats, in contrast to previous models in which graptolite faunas were segregated laterally by water-mass specificity or vertically by depth zonation into rather static biotopes. Moreover, the Finney-Berry model has important implications with regard to dispersal, provincialism, and the nature of the graptolite record.

Gold, Graptolites, and the Paleogeographic Affinity of the Roberts Mountains Allochthon

Graptolite faunas of the Pacific Province were first described in large part by Australian paleontologists of the late 19th and early 20th centuries, because graptolite biostratigraphy was critical for recognizing structures and thus directing exploitation of the Victorian gold fields. A similar situation exists today in the Carlin Trend of north central Nevada where annual gold production approaches 5 million ounces. Gold is hosted largely by Silurian-Devonian carbonate rocks of the lower plate of the Roberts Mountains thrust, but ore bodies in surface outcrops of lower plate rocks have largely been exploited. Future exploration efforts are now in areas where lower plate rocks are covered by the Roberts Mountains allochthon, composed of a thick, structurally complex, poorly exposed, deep-water, stratigraphic succession of Cambrian-Devonian age. Exploration efforts require that these rocks be mapped to determine depth to lower plate rocks and through-passing structures; geologic mapping is dependent on understanding the stratigraphic succession; and graptolite biostratigraphy has proven to be the most effective means of reconstructing the stratigraphy and recognizing distinctive stratigraphic intervals. Reconstruction of the stratigraphic succession and comparison with the coeval rocks of the lower plate demonstrate that the Roberts Mountains allochthon is not an exotic terrane. Its stratigraphic succession accumulated in deepwater outboard of the carbonate platform along the Cordilleran margin of Laurentia, and several distinctive sedimentological event can be recognized in both the basinal and platform successions.

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Events at the Cenomanian-Turonian Boundary: The Dissection of a Mass Extinction

The Cenomanian-Turonian boundary has long been recognized as an interval of major biotic change, and is coeval with one of the largest rises in sea-level to have occurred in the post-Palaeozoic. The association between mass extinction in the marine realm and sea-level change is well documented, but perplexing, since it seems implausible that sea-level change could actually cause a major extinction. However, large scale cycles of sea-level change can and do alter the ratio of shallow to deep marine continental shelf deposits preserved in the rock record both regionally and globally. Events around the Cenomanian-Turonian boundary in western Europe are reviewed in terms of geographical and ecological patterns and a phylogenetic framework for sea urchins is used to investigate the roles of sampling and extinction in deriving these patterns. This approach introduces a surprising degree of uncertainty about the size, duration and even the reality of the mass extinction event.

Megabias in the Marine Fossil Record and Its Implications for Charting the Geological History of Diversity

Patterns of origination, extinction and standing diversity through time are inferred from tallies of taxa preserved in the fossil record. This approach generally assumes, however, that sampling of the fossil record is effectively uniform over time. Although recent evidence suggests that our sampling of the available rock record has been very thorough, there is also overwhelming evidence that the rock record available for sampling is itself distorted by major systematic biases. Data on rock outcrop area compiled for post-Palaeozoic sediments from western Europe at stage level show a strongly cyclical pattern corresponding to first and second order sequence stratigraphical cycles, and changes in standing diversity and origination rates over timescales measured in 10s of millions of years turn out to be strongly correlated with surface outcrop area. Many of the taxonomic patterns that have been described from the fossil record conform to a species/area effect. Whether this arises primarily from sampling bias, or from changing surface area of marine shelf seas through time and its effect on biodiversity remains problematic.

The Paleobiology of Echinoids

Echinoids have a wonderfully complex endoskeleton that is a trove of information for palaeobiologists. Their skeletal ultrastructure provides a means of reconstructing soft tissue with confidence and the microarchitecture of structures such as tubercles and pore-pairs can be analyzed in terms of their biomechanical function. This talk will review the sorts of evidence that can be called upon when trying to reconstruct the autecology of fossil echinoids.

ACADEMIC YEARS 2003–2004 DISTINGUISHED LECTURERS

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The Ecology of Pennsylvanian-age Tropical Coal Swamps

Tropical peat-forming environments, or mires, were among the most prominent features of Late Carboniferous terrestrial landscapes. These habitats were home to a unique wetland flora that specialized in low nutrient conditions and high water tables. The dominant plants comprise five major groups. The bizarre tree lycopsids were spore-producers, dominant during the Early and Middle Pennsylvanian; they are bark supported and similar to colonial organisms in construction. The spore producing marattialean tree ferns dominated Late Pennsylvanian mires; they are root supported. Other locally important groups were the seed-producing medullosans and cordaites, and the spore producing sphenopids. Major extinctions at the Middle-Late Pennsylvanian boundary entirely restructured these mires and led to a major decline in wetland landscape heterogeneity. The ecology of this transition reveals lottery-like dynamics, the ascendancy of opportunists, and shortening of resource gradients.

Decline and Fall of the Primeval Forest: Rain-forest Replacement During the Permo-Carboniferous Transition

The transition from the Carboniferous to the Permian brought about major vegetational changes in the tropics, reflective of long term trends in warming and drying. These changes correspond, in part, to the termination of southern hemisphere glaciation. During this transition, a tropical wetland biome is replaced by a biome characteristic of seasonally dry conditions. The two biomes share few species in common, and the transition begins episodically during the Late Pennsylvanian. By the later Early Permian, a third biome can be detected, yet more adapted to xeric conditions, that replaces the seasonally dry biome, and that contains a number of precocious “Mesozoic” taxa. The plants of each subsequent biome are progressively more derived evolutionarily, suggesting a strong relationship between landscape position and evolutionary innovation in the terrestrial biosphere.

Evolutionary Assembly and Dynamics of Tropical Forests During the Paleozoic

The major classes of vascular plants appear during the Middle to Late Devonian. These classes represent distinct body plans. They also occupy different parts of the lowland resource gradient. Lycopsids occupy wetlands. Seed plants occupy terra firma settings.

Sphenopsids are most abundant in aggradational environments. Ferns are opportunistic weeds. This pattern develops as the groups begin to appear and is set by the early part of the Carboniferous, probably contributing to the termination of evolutionary innovation at the class-level scale of architectural distinctiveness. The overlap of high-level phylogenetic lineages with ecological centroids is unique to the late Paleozoic and confers a distinct constraint on ecosystem dynamics that lasts through the Carboniferous and into the Permian. Incumbent groups retain their ecological dominance within their respective spheres until environmentally induced extinctions eliminate or significantly reduce their "hegemony," opening up resources for colonization by members of other groups. The ultimate rise of seed plants to dominance in many kinds of environments was made possible by these extinctions rather than inherently superior biology.

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The Eocene-Oligocene Transition – Insights to Climate Change and Causes of Mass Extinction from Stable Isotope Analyses of Biogenic Materials

From both a biological and climatological perspective, the Eocene-Oligocene transition is one of the fundamental turning points in Cenozoic earth history. Global cooling brought on by tectonic and oceanographic changes took place on both gradual and episodic time scales, and affected the global biota in a variety of ways, culminating in mass extinctions at both the middle-late Eocene and Eocene-Oligocene boundaries. Stable oxygen isotopic analyses of molluscan shell and fish otolith carbonate reveal the pattern of climate change throughout this transition, in terms of both mean annual temperature and seasonality. Ongoing research in the US Gulf Coastal Plain, the Antarctic Peninsula, and the Belgian Basin highlight differences in the pattern of climate change from low to high latitudes. High-resolution data from the Gulf Coast in particular suggest a causal link between increasing seasonality, cooler winters, and the ongoing faunal extinctions.

Tales from the Clam: What You Can Learn about Climate, Growth, and Ancient Seawater from Multi-Annual Records Archived in Molluscan Shells

Improvements in our ability to incrementally sample accretionary carbonates at very high resolution have opened the door to many fruitful avenues of research. Biogenic carbonates from long-lived macrofauna are ideal for this approach, for they record in their shell chemistry the changing conditions experienced throughout the lifetime of the animal. Stable isotopic profiles across multi-year growth trajectories go beyond the single analyses typical of microfossil research and can therefore yield estimates not only of mean temperature but also of seasonality, a crucial variable controlling the biogeographic distributions of organisms today. In addition, these records provide a clock by which to measure the changing growth rates of organisms, and hence can provide the information often needed for ecological and evolutionary studies. A smorgasbord of recent research on clam chemistry illustrates the applications of this approach to studies of past climate, ontogeny (life history), and the composition of ancient oceans.

Perspectives on the Current Status of Long-Term Faunal Stability... Is Coordinated Stasis Still Coordinated?

Coordinated stasis is a pattern of taxonomic and ecologic stability of faunal assemblages over geologic time proposed to typify the record of many shallow shelf sequences. The suggestion that patterns of punctuated equilibria may characterize not only the morphological evolution of species but also the sorting of taxa into relatively stable long-term associations was met with initial skepticism, some of it rather acerbic. If such a pattern can be substantiated, however, the implications are significant and far-reaching for paleobiology and ecology. Since its introduction, workers in various areas of paleontology have conducted studies that have bearing on the issue. Data from the Paleogene of the US Gulf Coast and the Devonian of New York illustrate the complexity of the problem.

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The Latitudinal Diversity Gradient – The Past is the Key to the Present

Understanding the factors that influence biodiversity remains the central issue of the life-sciences. This is true more than ever, given the alarming rate of extinction in the Recent. As such, paleontology needs to attack the relevant problems of biodiversity at all scales of space and time. The latitudinal diversity gradient, in which the number of species decreases away from the Tropics, is arguably the most widely-recognized and well-studied pattern of biodiversity. The diversity gradient is recognized among both plants and animals, and both on land and in the ocean. Understanding the gradient would be a major step forward in understanding diversity. But, despite over a century of research, there still are a dozen or more competing hypotheses to explain the pattern. Although several studies have demonstrated that the latitudinal diversity gradient exists at different points in time during the Phanerozoic, few studies have examined how the gradient changes *through* time. Such a deep-time approach provides an opportunity to test some of the competing hypotheses in a manner unavailable to the ecologist. An example using Carboniferous brachiopods suggests that (a) the latitudinal diversity gradient probably is not simply a function of diversification and expansion away from the Tropics, and (b) that the study of diversity gradients may be a useful, new tool for inferring paleoclimate.

Escalation in the Paleozoic: A 400 Million Year Old Murder Mystery

Escalation, the hypothesis that a species' enemies get progressively more dangerous through time and so become the primary agents of natural selection, may be a fundamental explanation for observed evolutionary and ecological patterns. However, virtually all of the hard evidence supporting escalation has come from the Cretaceous to Recent. Study of Paleozoic predator-prey systems, which involve taxa related only distantly to modern predators and prey, provides a second, independent, test of whether escalation can be generalized as an evolutionary "law". During the mid-Paleozoic, predation appears to intensify, and plausible prey taxa seem to adapt to this increase. But is this general pattern rigorous proof of escalation? The present work illustrates some of the problems inherent in analyzing predation in the fossil record, as well as techniques to solve those problems. The current results provide insight into escalation in the mid-Paleozoic at multiple scales, from detailed bed by bed analysis of prey morphology and traces of predation to global trends in diversity, morphology, evolution, and extinction.

NEW BOOKS FOR REVIEW

This section of the newsletter includes lists of books and reviews received by the Books Review Editor for the Paleontological Society. Volunteered reviews will be accepted if concisely written and of general interest. Books listed may be requested for review with the understanding that the resultant review will be ready for publication of the next issue of *Priscum.* Contact the Book Review Editor: Greg Retallack, Department of Geological Sciences, University of Oregon, Eugene, OR 97403-1272: gregr@darkwing.uoregon.edu.

Carter, D.R. and Beaupré, G.S., 2001, SKELETAL FUNCTION AND FORM: MECHANOBIOLOGY OF SKELETAL DEVELOPMENT, AGING AND REGENERATION. Cambridge University Press, Cambridge, 318 p, hardcover $80.00.

Dewing, K., 1999, LATE ORDOVICIAN AND EARLY SILURIAN STROPHOMENID BRACHIOPODS OF ANTICOSTI ISLAND, QUEBEC, CANADA. Palaeontographica Candaiana, No. 17, 143 p., paperback, $62.00.

Eckhardt, R.B., 2000, HUMAN PALEOBIOLOGY. Cambridge University Press, Cambridge, 350 p., hardcover, $80.00.

Harbaugh, J.W., Watney, W.L., Rankey, E.C., Slingerland, R., Goldstein, R.H., and Franseen, E.K., editors, 1999, NUMERICAL EXPERIMENTS IN STRATIGRAPHY: RECENT ADVANCES IN STRATIGRAPHIC AND SEDIMENTOLOGIC COMPUTER SIMULATIONS. Society of Economic Paleontologists and Mineralogists Special Publication No. 62, 362 p., hardcover member $120.00, non-member $170.

Harris, P.M., Saller, A.H., and Simo, J.A.T., editors, 1999, ADVANCES IN CARBONATE SEQUENCE STRATIGRAPHY: APPLICATION TO RESERVOIRS, OUTCROPS AND MODELS. Society of Economic Paleontologists and Mineralogists Special Paper no. 63, 421 p., hardcover member $105.50, non-member $148.00.

Hobbs, P.V., 2001, INTRODUCTION TO ATMOSPHERIC CHEMISTRY. Cambridge University Press, Cambridge, 262 p., hardcover 69.95, paperback $24.95.

Hodge, P., 2001, HIGHER THAN EVEREST: AN ADVENTURER'S GUIDE TO THE SOLAR SYSTEM. Cambridge University Press, Cambridge, 247 p., hardcover $27.95.

McGhee, G.R., 1999, THEORETICAL MORPHOLOGY: THE CONCEPT AND ITS APPLICATIONS. Columbia University press, New York, 316 p., hardcover $60.00, paperback $26.50.

Nowland, G.S., 1999, PALEOSCENE: A SERIES OF PAPERS ON PALEONTOLOGY REPRINTED FROM GEOSCIENCE CANADA. Geoscience Canada Reprint Series no. 7, 308 p., paperback $34.00.

Rigby, J.K. and Chatterton, B.D.E., 1999, SILURIAN (WENLOCKIAN) DEMOSPONGES FROM AVALANCHE LAKE AREA OF MACKENZIE MOUNTAINS, SOUTHWESTERN DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES, CANADA. Palaeontographica Canadiana, No. 16, 43 p., paperback $35.00.

Swindler, D.R., 2002, PRIMATE DENTITION: AN INTRODUCTION TO THE TEETH OF NON-HUMAN PRIMATES. Cambridge University Press, Cambridge, 296 p.

Thurman, H.V. and Trujillo, A.P., 1999, ESSENTIALS OF OCEANOGRAPHY (6th edition). Prentice-Hall, Upper Saddle River, New Jersey, 527 p., paperback $61.33.

West, R., 2000, PLANT LIFE OF THE QUATERNARY COLD STAGES: EVIDENCE FROM THE BRITISH ISLES. Cambridge University Press, Cambridge, 320 p., hardcover $105.00.

BIOTIC RESPONSE TO GLOBAL CHANGE: THE LAST 145 MILLION YEARS, edited by Stephen J. Culver and Peter F. Rawson, 2000; Cambridge University Press, Cambridge, xiii+501 p.: $95.00 (hardback).

For those of you who are searching for key references to support your seminar course on environmental change, might I suggest that you look no further than this substantial volume? Steve Culver and Pete Rawson have edited a weighty, readable contribution to the current debate regarding environmental change, focusing on the evidence provided by the fossil and rock records of the Cretaceous and Cenozoic.

Biotic Response is generally well-produced, although my copy was badly printed on some of the earlier pages. The text is generally highly readable, even entertaining, and contains much of interest to all paleontologists. Some figures are poor, with interference patterns replacing solid greys (e.g., fig. 4.5), or are printed in strange orientations, with stratigraphic columns being mounted on their sides (such as figs. 22.1-22.4) and disjunct pollen diagrams, not adjacent, but parallel, stretching over two pages (e.g., figs. 18.2, 18.5). The reference list spans 75 pages and, at my estimation, includes over 1,500 entries, making it an exciting research resource in its own right, although there are hiccups (compare the two Ross and Skelton references, for example). The lengthy index appears to be entirely adequate. If one thing is missing, it is more illustrations of the organisms that are being discussed, which would be appreciated by any non-paleontologist that picks up this volume.

The editors indicate that *Biotic Response* is aimed at advanced students and researchers. It is in many ways a typical review volume, with chapters varying from somewhat tired rehashes (rare, I'm please to say) to exciting discussions of the state of play in selected fields of research. The structure includes introductory chapters to the Cretaceous and Cenozoic (Chs. 1 and 2), followed by discussions of data, analyzes and patterns based on selected groups of microfossils (Chs. 3-6), marine vertebrates and (mainly) invertebrates (Chs. 7-14), terrestrial plants (Chs. 15-18), and terrestrial invertebrates and (mainly) vertebrates (Chs. 19-25). However, to gain an overview of the conclusions, the reader might like to start at Chapter 26, in which the editors briefly summarize the principal conclusions and patterns identified in the text.

If I have one criticism of *Biotic Response*, it is that too many authors are hesitant. The structure of several chapters is to review the fossil record of a group, with discussion of relationships and evolutionary trends. Environmental changes during the selected interval are then discussed late in the chapter and often the interpretation is a hesitant 'maybe' regarding any causal relationship. While I appreciate the difficulties of identifying cause and effect in the fossil record, there seems to be a shyness to make comparisons with coeval groups with similar ecological requirements that may provide supporting data. In this respect, the arrangement of *Biotic Response* under taxonomic groups works against it; examination of all data concerning particular intervals or events may well have been scientifically stronger, although I appreciate the difficulties in finding suitable authors for such chapters. Nevertheless, I enjoyed many of the chapters in this book.

One feature of *Biotic Responses* that should excite an American audience is that the authors are based mainly in the UK, thus presenting in one volume an overview that, in some instances, may be in contrast with those current on the other side of the Atlantic. Indeed, *Biotic Responses* contains much of relevance for anyone with an interest in the debate concerning global environmental change, including much hard data and some conclusions that vary from the well-known to the surprising. Having said this, *Biotic Response* will, understandably, be read mainly by paleontologists; consequently, it is up to us to make sure that it reaches a wider audience.

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EVOLUTIONARY CATASTROPHES: THE SCIENCE OF MASS EXTINCTION, by V. Courtillot, 2002. Cambridge University Press, Cambridge, 173 p., paperback $16.00

After a spectacular opening play by the impacts team, it is now half time, and the score is impacts 1, traps 7. With this sporting analogy, Courtillot rests his case on the great debate of the past two decades whether mass extinctions are caused by asteroid-comet impacts or massive eruptions of continental flood basalts. In this new English edition of an earlier French work, he no longer denies the evidence of the Alvarezes (pere et fils) that there was a massive impact at the Cretaceous-Tertiary boundary. Evidence of the crater, shocked quartz, iridium, and spherules are now quite convincing to Courtillot, although dissenting voices among paleontologists and sedimentologists are all mentioned, but less favorably than in the earlier edition. On the other hand, it really does give one pause how the various mass extinctions coincide in time with various flood basalts: end-Guadalupian Emeishan Basalts, end-Permian Siberian traps, end-Triassic Newark volcanics, end-Jurassic Parana-Etendeka traps, Aptian Rajmahal traps, end-Cenomanian Madagascar basalts, end-Cretaceous Deccan traps, end-Paleocene Brito-Arctic volcanics, early Oligocene Ethiopia-Yemen basalts. The problems are end-Pliensbachian, and end-Bajocian extinctions, but more recent dating shows that these may correspond to Ferrar-Karoo basalts and Antarctic basalts respectively. The middle Miocene Columbia River basalts are also a problem for Courtillot, because not associated with a mass extinction, but there was considerable turnover of mammals at this time (Hemingfordian North American land mammal age).

Massive release of atmospheric carbon dioxide, water vapor and sulfur dioxide is a part of Courtillot's scenario of volcanogenic extinction, which he argues was particularly effective because multimillenial greenhouses were preceded immediately by volcanic winters from dust and other aerosols. These arguments struck a chord with me because I have subsequently found that these critical intervals are also times of elevated atmospheric carbon dioxide, judging from the stomatal index of leaves of *Ginkgo* and related plants. Furthermore, many of these times were also times of such dramatic carbon isotopic excursions that only release of methane from clathrates is a reasonable explanation, as is best known at the end-Paleocene. The methane could have been destabilized from permafrost by volcanic eruption or from marine deposits and permafrost by volcanogenic greenhouse. Methane and its oxidation product carbon dioxide would further exacerbate greenhouse warming. Something else is needed, because as Paul Wignall has recently shown, extinction magnitude does not correlate well with estimated gas release from eruptions alone.

Courtillot characterizes the debate as Nemesis and her asteroids versus Shiva and his flood basalts (including a photograph of him carved into Deccan basalt). But Mike Rampino has suggested that Shiva the destroyer is most appropriate for the asteroid theory and Chuck Landis and colleagues have suggested the Hawaiian goddess Pelée as a more appropriate representation of the volcanic hypothesis. I have added the Norse Ragnarok for the methane fueled versions of catastrophe, so these hypotheses are now reaching mythic proportions!

Among a variety of personal reminiscences, Courtillot recounts the excitement of the plate tectonic revolution. He outlines the emerging theory of hot spots, which can usually be traced back to flood basalts. He also points out a curious relationship with frequency of magnetic reversals, which show a series of increasing peaks from a long normal Early Cretaceous superchon, and before that peaked in the late Jurassic as a culmination of ever-larger peaks after a long reversed early Permian superchron. Uncannily, the two biggest extinctions at the end of the Permian and Cretaceous are at the first peak of rapid reversals after a quiescent superchon. This remains unexplained.

As Courtillot admits, the game is not over, but the playing of it has been an inspiration. Your non-geological friends will probably enjoy this book, but you may also get a pleasant and rewarding evening out of it. The equally engaging *T. rex and the Crater of Doom* by Walter Alvarez is also recommended for a comparable audience, as an entertaining account of the impact hypothesis. In both books we get to know interesting and remarkable men.

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QUATERNARY CLIMATE, ENVIRONMENTS, AND MAGNETISM, edited by Barbara H. Maher and Roy Thompson. 1999. Cambridge University Press, Cambridge, 390 pp., hardcover $120.00.

For geologists, paleontologists, and geophysicists who work with Tertiary and earlier rocks, the term "paleomagnetism" is associated with solving problems of magnetostratigraphic correlation, or determining paleolatitudes or tectonic rotations. But as this fascinating volume shows, there is a small, but productive, subset of geologists who use different magnetic tools in understanding climates and environments of the Quaternary. These scientists measure not magnetic polarity or magnetic direction, but a whole suite of magnetic characteristics of sediments and sedimentary rocks (such as susceptibility, hysteresis, isothermal remanence, and other properties) that reveal many other interesting stories

As the historical introduction to the subject by Bradley and Heller points out, the field actually began in 1926 (very early in the days of any kind of paleomagnetic study) with Gustav Ising's measurements of magnetic susceptibility and natural remanence in varved lake sediments. Maher et al. then follow with a chapter describing the fundamental principles of Quaternary paleomagnetism, and giving a good background to the subject for those who have at least a passing familiarity with Quaternary geology and the principles of rock magnetism. The remaining chapters of the book then summarize and review the major subfields of research within Quaternary paleomagnetism. Stoner and Andrews show how magnetic susceptibility measurements of North Atlantic cores have proven excellent tools for detecting climatic changes, since pulses of ice growth and melting increase or decrease the volume of magnetic minerals in these fine-grained deep-sea sediments. Maher and Thompson show (in two different chapters) how magnetic susceptibility measurements of Chinese loess and eolian dust in the Indian Ocean are excellent climatic indicators, since the magnetic content of these sediments is largely determined by wind-driven particles in ancient monsoonal climates.

Hesse and Stolz discuss the discovery that much of the magnetite in the deep sea comes from magnetotactic bacteria, and show how these "magnetofossils" are highly sensitive to water-depth and oxygenation changes driven by climate change. Snowball and Torii describe how the occurrence of iron sulphides is a useful paleoclimatic tool, especially in the recognition of poorly oxygenated or brackish water environments. Dearing discusses the ways in which magnetic content (as measured by susceptibility) of lake sediments is a powerful paleoclimatic indicator. Petrovsky and Ellwood point out that modern human-induced pollution produces a variety of tiny magnetic particles (particularly heavy metals released from smelters, and from coal-burning power plants) that can be detected and used as powerful tools for tracking down sources of pollution in the modern environment. Lund and Schwartz discuss how measurements of the fluctuations in paleointensity in lake sediments and marine cores are also highly sensitive to climate change (once the data have been standardized for grain size). Finally, Langereis and Dekkers discuss how highly cyclical marine deposits of the northern Mediterranean vary not only in their sedimentary properties, but also in their magnetic properties. Like isotopic curves and other proxies of the Milankovitch cyclicity, the magnetic intensity (as measured by anhysteretic remanent magnetization) tracks the orbital variations of the earth at a very high resolution, allowing correlation by cycle patterns to the nearest few hundred years. Such incredible detail is a real eye-opener for those of us accustomed to much coarser resolution in the pre-Quaternary record. For that reason and many others, I highly recommend this well-written and organized book to anyone interested in the latest tools for understanding climatic change.

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EVOLUTION OF HERBIVORY IN TERRESTRIAL VERTEBRATES: PERSPECTIVES FROM THE FOSSIL RECORD, edited by Hans-Dieter Sues. 2000. Cambridge University Press, Cambridge, 256 pp., hardcover $89.00.

When we look across fields of grazing cattle or sheep, or contemplate the huge diversity of hoofed mammals on the Serengeti Plain, it seems normal and natural that there have always been large numbers of herbivores on the landscape. In ecology classes, we are taught that the terrestrial food pyramid has much more bio-mass of herbivores than of the predators that feed upon them, and that a large standing crop of herbivores is essential in any trophic system to convey the energy of plant matter to other animals in the food web.

It comes as a complete surprise to most people, then, to find out that not only has it not always been this way, but that large areas of rapidly growing plants (such as grasses) and herbivores feeding upon them are a relatively recent innovation in the history of life. Like many other ecological concepts founded strictly on the modern biota, the concept of food pyramids and food webs needs drastic rethinking the further back we go in time. For most of life's history (from 3.5 to 0.5 billion years ago), there was no "food pyramid" or "food web"—just an uncropped layer of cyanobacteria and later eukaryotic algae forming a "Planet of the Scum." When the first grazing invertebrates arose in the latest Proterozoic, the landscape was changed forever, but as Bambach and others have shown, even in the Cambrian and Early Ordovician, the levels of ecological complexity did not yet match the food webs of present, and many guilds still had no occupants.

This is true not only of the marine realm, but also of terrestrial ecosystems as well. Simple vascular land plants and arthropods that fed upon them arose the Late Ordovician and Early Silurian, but the first land vertebrates did not appear until the Late Devonian, more than 70 million years later (a time lag longer than the entire Cenozoic). For most of the early history of vertebrates, all these terrestrial tetrapods were predators. The first likely herbivorous vertebrates do not appear until the Late Carboniferous, and they were rare. Clearly, the "food web" we take for granted was very different than the one we have today. Vertebrates fed on other vertebrates, or on insects and other arthropods, which were their only means of obtaining nutrition derived from plants.

Why did the evolution of herbivory take so long? Surely, the abundance of plant resources suggests that some sort of early tetrapod should have mastered the trick of eating this untapped reservoir of energy, and flourished in great numbers. But as Sues and also Reisz and Sues point out, herbivory takes many specialized adaptations that do not arise easily; they formed adaptive thresholds to eating plants directly. First of all, vertebrates do not have the natural enzymes to break down many plant materials, so they need specialized gut bacteria to digest cellulose and obtain nutrition from plants. This, in turn, demands a much longer digestive tract to allow bacterial fermentation, and a barrel-shaped rib cage for this huge gut. Most early tetrapods had simple peg-like teeth for grabbing prey, so herbivores needed to develop teeth for cropping and grinding plants, and eventually some even evolved jaws that can move back and forth in a chewing motion. Reisz and Sues discuss the appearance of these features in tetrapods, and discuss how herbivory might be recognized in an extinct taxon. The surprising conclusion is how late herbivory appeared, but it did nevertheless arise at least 12 times independently. Even more surprising, herbivores did not become common until the Late Permian with the appearance of several groups of herbivorous synapsids (especially dinocephalians and dicynodonts), the huge pareiasaur reptiles, and eventually herbivorous archosaurs (such as the rhynchosaurs and aetosaurs) in the Triassic.

Barrett and also Upchurch and Barrett discuss some of the paradoxes of Mesozoic herbivores, especially the huge sauropod dinosaurs, the largest terrestrial animals that ever lived. Despite their huge body size, sauropods did not have complicated dental batteries (such as those found in duckbill dinosaurs or horned dinosaurs), but simple peglike or spatulate teeth. Upchurch and Barrett speculate that the differences in neck length, head shape, and tooth shape may have allowed sauropods to feed at different levels of the tree canopy, and on different parts of plants, so that a high diversity of taxa (up to 14 genera in the Morrison Formation, with as many as six from one locality) could live in the same place. Still, their study does not address the fundamental problem that most of the plants that fueled sauropods (such as slow-growing conifers, ginkgoes, and cycads) do not recover from animal damage well, and do not grow as rapidly as angiosperms. Tiffney has speculated that ferns provided the rapid-growing "fodder" in the Jurassic before angiosperms arose, but clearly not all the pieces of this puzzle have been discovered.

Weishampel and Jianu use the method of ghost lineages to show that the apparent diversity of herbivores at any given time in the Mesozoic is a gross underestimate, and that many more lineages must have been present, making a totally different picture of how diversity changed through time.

Rensberger analyzes patterns of dental wear and cusp shape to discuss how herbivory first arose in mammals. Janis looks at the diversity patterns of different feeding groups of mammals (as defined by tooth morphology, and by body size) through the Paleogene. Her methods capture the well-known increase in diversity in the Paleocene, and the increase in body size of the larger herbivores by the Eocene, as well as the eventual replacement of ungulates with simple rounded ("bunodont") cusps for omnivorous diets by those with different configurations of crests ("lophs") and higher-crowned teeth. Her data also reveal paradoxes as well. For example, despite the prevalence of dense forests in the Paleocene and early Eocene, few ungulates were specialized leaf-eaters until the middle Eocene. Then there is a significant diversity increase in taxa (especially leaf eaters) continuing through the late Eocene and Oligocene, even though climate was cooling and changing, and the dense forests were largely gone by the early Oligocene. Janis provides additional analyses (such as plotting climates in a "dry-wet" axis as well as the simple temperature axis) to address the complexities of the real data, although some puzzles still have no good explanation.

Finally, MacFadden provides a review of the recent literature on the development of grasslands and grazers in the Neogene. The simplistic story that mammals evolved high-crowned teeth ("hypsodonty") for eating gritty grasses is now complicated by the fact that such teeth appeared in many lineages at 15-16 Ma, but the isotopic signal for abundant C4 grasslands (the dominant type found in temperate and tropical latitudes) did not appear until 7 Ma. Why did hypsodonty appear 8 million years before abundant grasslands? Were there C3 grasslands, as some suggest? If so, we have no modern analogues for such vegetation, since C3 grasslands occur today only in high latitudes or high altitudes. Were conditions drier so that the plants had more gritty dust on them? Clearly, the isotopic data have demolished the simplistic stories that we still tell our undergraduates, and leave as many questions to be answered as they have solved.

This volume was based on a symposium at NAPC-96 in Washington, D.C, but not published until more than four years later. Consequently, some of the papers have suffered because of new developments that have occurred in the four years from presentation to publication. Nonetheless, it is nicely produced, and yields many provocative papers that are of interest to anyone who has though about terrestrial paleoecology.

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GENETICS, PALEONTOLOGY AND MACROEVOLUTION (second edition), by Jeffrey S. Levinton, 2001. Cambridge University Press, New York, 617 pp., paperback $55.00;

and

EVOLUTION (third edition), Monroe W. Strickberger, 2000, Jones and Bartlett, Sudbury, Massachusetts, Jones & Bartlett, 721 pp., hardcover $83.95.

Did paleontology ever sit at the high table? In the 1970s, paleontology began to shake its status of subservience to genetics and Neo-Darwinism, and proclaim that the fossil record taught us things that could not be observed in lab mice or Galapagos finches. At the 1980 Chicago evolution conference, paleontology's challenge to the hegemony of the fruit flies first made an impact. During the 1980s, the importance of stasis as an unexplained phenomenon began to have an effect on the Neo-Darwinian orthodoxy, and the hierarchical thinking that led to models of species sorting were developed and published. In 1984, one of the doyens of the Neo-Darwinists, John Maynard Smith, wrote, "Paleontologists have too long been missing from the high table. Welcome back" (*Nature*, v. 309, p. 402). It seemed as though paleontology was finally going to be a major player in the community of evolutionary biology, and take part in the societies and journals (such as *Evolution*, founded in part by paleontologists) that had long been the domain of geneticists.

The year 2002 marked the thirtieth anniversary of the Eldredge and Gould punctuated equilibrium paper, which profoundly changed the way paleontology works. So much so that debates about the relative importance of punctuation have ceased, and recent papers in journals like *Paleobiology* take stasis and punctuation for granted, and rarely mention gradualism. Among paleontologists, the punctuated equilibrium pattern is now assumed as given, and the controversies have now moved into areas regarding macroevolutionary patterns and processes, coordinated stasis, mechanisms for evolutionary explosions, and the random effects of mass extinction events on otherwise well-adapted organisms.

The year 2002 also marked the passing of our most eloquent spokesman, Stephen Jay Gould, even as his long-awaited magnum opus, *The Structure of Evolutionary Theory* (Harvard University Press) was finally published. Yet despite the glowing remarks in obituaries, there were rumblings by evolutionary biologists that Gould and the paleontological challenge were wrongheaded in their views of evolution, and will be soon regarded as a "minor footnote" (see remarks summarized by Shermer, 2002, *Social Studies of Science*, v. 32, p. 489-524).

So how effective was the paleontological revolution in changing the thinking of orthodox Neo-Darwinists? Combing the pages of recent issues of *Evolution* shows even fewer papers by paleontologists than before, and evolution meetings have had even fewer paleontologists participating than in the 1980s. Paleontology continues to be balkanized into GSA meetings, North American Paleontological Conferences and the like, with little or no cross-fertilization from neontologists, who seldom consider paleontological issues in their own meetings. If it seemed that paleontologists were going to have an impact on evolutionary theory in the 1980s, we have lost considerable ground since then.

Perhaps the most revealing barometers of the thinking of the evolutionary biology mainstream are textbooks adopted to teach future generations of biologists. Two of the most widely used are Strickberger's *Evolution* (now in its third edition) and Levinton's *Genetics, Paleontology, and Macroevolution* (already in its second edition). Surely 30 years since the debates began, these books have had a chance to digest what paleontologists have been saying, and modify their strict Neo-Darwinian views to a "new and general theory of evolution" (as Gould suggested in 1980)?

However, a closer examination of both books is profoundly disappointing for paleontologists. Strickberger's book was first published in 1990, but it could have been written in the 1960s. It takes the student through all the basic topics in history of evolutionary thought, genetics and molecular evolution, and then a phylum-by-phylum tour of the animal kingdom that assumes the student has had no previous exposure to most groups of animals or plants in basic biology. Punctuated equilibrium rates only half a page (p. 599-600), and even this mention completely misses the point of all the arguments of the past 30 years, dismissing the debate as a minor quibble about rates of speciation. Even more disturbing is the antiquated level of presentation of the major topics of animal evolution, with diagram after diagram that have long been abandoned by paleontologists familiar with the cutting edge of research. For example, the "hypothetical ancestral mollusc" makes a surprise reappearance (p. 377); the idea that jaws are modified gill arches (long discredited in vertebrate paleontology) is still promulgated (p. 402); the ancient division of Reptilia into four subclasses based on temporal fenestra reappears (p. 420), with the even more outdated notion that Synapsida ("mammal-like reptiles") had anything to do with the Reptilia as now defined; archaic ideas of Mesozoic mammal evolution also are featured (p. 449); and scattered throughout are outdated wastebasket taxa (such as "Eupantotheria," "Agnatha," and "Thecodontia") and 30-year-old diagrams of the evolutionary relationships of groups that show no relationship at all—each taxon independently arises from some paraphyletic ancestral group as if the past 30 years of phylogenetic studies have learned nothing. Symptomatic of this outdated approach is the cutesy animation printed on the lower right corner of each odd-numbered page, which form a flip book showing a primitive tetrapod crawling out on land to catch insects. As explained on the title page, this reflects the old notions that tetrapods crawled out of the water to escape predators or catch new prey—but completely ignores all the new evidence from *Acanthostega* and other recent finds that suggest four-legged animals evolved their limbs while remaining fully aquatic, and not in response to a need to crawl up on land.

If Strickberger's book is clueless because it is intended for beginning-level undergrads without much background, Levinton's is clueless at the advanced level. It is clearly aimed at the graduate student and professional, but it still misunderstands the fundamental nature of the important discoveries made by paleontologists. Page after page, it takes on polemical tone to defense of Neo-Darwinism, completely unwilling to concede that important things have been learned. For example, Levinton's coverage of the punctuated equilibrium debate either selectively chooses examples that support his biases, or focuses on gradualistic studies that have long since been discredited—completely misrepresenting the general consensus among paleontologists that gradualism is rare, and that punctuation and stasis are real and important phenomena. And where paleontology has fundamentally changed the way we see evolution, his "revisionist history" conveniently rewrites the past as if Neo-Darwinists saw it this way all along. For example, he states (p. 146) that stasis was the expectation of the orthodoxy for many years, but that comes as a complete surprise to most of us who are familiar with the normal way evolution is taught (or even how some of his contemporaries, such as Strickberger, present old-fashioned Neo-Darwinism as panselectionism and adaptationism). Even Mayr (1992, in *The Dynamics of Evolution,* A. Somit and S.A. Peterson, eds.) conceded that the prevalence of stasis was a surprise to the Neo-Darwinians, and could not be easily explained by neontologists. Yet the real paradox is not just that stasis is prevalent, but that it occurs even in the face of environmental change that Neo-Darwinists would argue demand morphological change (e.g., Prothero, 1999, *GSA Today,* v. 10, no. 7, p. 1-11). The tired old "escape clause" of stabilizing selection does not apply here—these environments are clearly changing rapidly, yet organisms fail to respond to these drastic environmental fluctuations. Reading Levinton's book generates almost the same sense of frustration that reading a creationist book does. Levinton's lack of firsthand experience with fossils and what they really show is readily apparent. If he had wrestled with the paradoxes posed by paleontology with a more open mind, it would be fair, but as he reveals from the opening pages, his biases are clear and he is out to discredit those who would challenge the Neo-Darwinian orthodoxy. Such positions may be defensible in court, but such closemindedness and lack of firsthand familiarity with the facts are not conducive to breaking through the confusion and find a newer, better theory of evolution.

If these books are representative of what neontologists think of the paleontological record, then truly we have not had any real effect on their worldview, and have not taken a seat at the "high table." Now that Gould is gone and few of us have an impact on them, will there be any future hope that our discoveries and viewpoint will affect the evolutionary biology textbooks of the future?

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AN INTRODUCTION TO APPLIED BIOGEOGRAPHY, by Ian F. Spellerberg and John W.D. Sawyer; Cambridge University Press, Cambridge, 243 p. Hardcover $70.00; paperback $26.00.

In selecting *Applied Biogeography* for review, I was motivated, in part, by a desire to glimpse the world of the biogeographer and of the paleobiogeographer, having been intrigued by Bruce Lieberman's book (2000, *Paleobiogeography, Using Fossils to Study Global Change, Plate Tectonics and Evolution*: Plenum, NY) and subsequent scathing review by Humphries (2002, J. Paleont.,76(6):1110-1112). Admittedly, the applied approach taken in Spellerberg and Sawyer's book and the more theoretical approach of Lieberman made comparison a bit like apples and oranges; however, it also presented an opportunity to see what, if any, theoretical approaches are actually used for solving practical problems. If Spellerberg and Sawyer's book is any indication, then practically none of the tools taught in graduate courses or vigorously debated, such as cladistics, are actually used to solve practical problems. To quote: "In this small book we have had to be selective with reference to the areas of biogeography discussed. We have chosen not to include any further information in this introductory text on cladistic and vicariance biogeography, despite the current popularity of these subdisciplines." These two subjects never again appear in the book. The use of GIS in biogeography is similarly given only passing mention. Analytical methods are given only cursory coverage, although an understanding of (at least) the meanings of the methods, which typically form the core of texts on biogeography, would seem to be important in any applications derived from their interpretation. These observations indicate that (paleo)biogeography and its applications remain a heterogeneous concoction, the flavor of which is born from the authors' personal experiences and biases, rather than a coherent, well-defined discipline. But, back to the review.

Both of the authors are New Zealanders; Spellerberg was previously from the UK. Thus, many of the examples in the book are drawn from their extensive experiences in these localities. There are very few typos, the tables are well constructed and needed, and most of the figures are clear and also useful. Some of the maps, however, suffered degradation in reproduction and the pattern fills are uneven. Overall, the production of the book and its resulting quality is high.

Clearly, *Applied Biogeography* attempts to cover a lot of territory (pun intended) in its 243 pages. Chapter 1 covers definitions and subdivisions of biogeography, the classification schemes used for plants and for animals, a history of biogeography, a definition and history of ecology, an overview of the applications of biogeography, brief mention of the last frontiers for human exploration (the oceans and other planets), the structure of the book, references and figures, all in 23 pages. Considerable space and attention in the book is allotted to topics of historical interest, such as a full-page reproduction of the agenda for the June 16, 1857, meeting of the Linnaean Society. While such an approach provides a good historical foundation for modern studies, it does so at the expense of discussions of modern approaches and methods.

Chapter 2 discusses the scales and classifications of biogeographical studies; that is, at what scales have biogeographical studies been conducted and for what applications? Approximately half of the chapter is devoted to the important historical developments and tracings of the various intellectual campaigns that have been waged regarding how particular biogeographic regions should be drawn. The chapter then goes into interesting implications of defining biogeographic regions and their impact on such topics as identifying regions of biologically productive areas and locating priority areas for conservation and research.

Chapter 3 focuses on the applications of island biogeography. Again, a large portion of the chapter is concerned with historically important studies of island biogeography, then moves on to discuss the application of island biogeography to the study of evolution and speciation. The chapter wraps up with a brief discussion on the applications of biogeography to the conservation and restoration of island biota.

Chapter 4 again attempts to deal with a very large subject in a swift manner, covering paleontology, paleoecology, geologic time, the evolution of Phanerozoic climates and plate tectonics, all on the first 16 pages of the chapter. The second half of the chapter, however, reviews the interesting human impacts on the distribution of biota, and, conversely, how the distribution of species has affected the distribution of society and culture. For example, many species native to certain regions have been used to construct musical instruments by indigenous populations, such as certain species of bamboo for making panpipes. Certainly, the distribution of species affects local cuisines to the extent that local cuisines are, in fact, a function of the distribution of local species. Chapter 4, then is important in showing how biogeography has had such a profound impact on the cultural and diversification of humans.

Chapter 5 discusses the application of biogeography to studies of the ecological patterns and distributions of species. Although ecology and the study of species distributions are typically highly quantitative disciplines, the approach taken herein is again more broad brush, and describes the distribution of a few selected real and hypothetical species. Similarly, the factors affecting the distribution of species are also swiftly dealt with. One interesting application of the distribution of species is mentioned at the end of the chapter, which is the use of biocontrol agents for pest management. Having seen the very interesting use of biocontrol agents for managing pests at a winery in California, I was a disappointed to see only a passing mention of it in this book.

Chapter 6 discusses the collection, storage and retrieval of biogeographical data, answering the questions: Where do the data come from? How are they collected? Where are they stored? How are they presented and published? These topics are discussed briefly in the first part of this chapter, which then goes on to discuss "recent" developments, such as the use of computers and Geographical Information Systems for mapping species' distributions. The authors make the important point of questioning the advisability of making the geographic distributions of some species widely available. For example, broadcasts of the distributions of rare or endangered species may be used by people wanting to collect those species, thus undermining one of the most important applications of biogeography, i.e., the conservation of such species.

An important application of biogeography is to study the effects of habitat fragmentation, particularly those caused by the activities of humans, which is the subject of chapter 7. The study of habitat fragmentation may have some surprising results. For example, the authors describe one study in England on the effects of heathland (open, uncultivated tracts of land) fragmentation in the distribution of invertebrates. Surprisingly, no correlation was found between the area of a heathland and the abundance of species. It was found that where diverse vegetation occurs adjacent to the heathlands, there was a tendency for invertebrate species richness to be greater. The implications for this biogeographical research on conserving species diversity in heathlands are clear.

Chapter 8 covers a similar topic in focusing on the biogeographical applications to the study of linear features, which can be barriers (such as roads, railways, power line swaths, etc.) or linear habitats (such as hedgerows). This topic is important because of the human tendency to raze large tracts of habitats for use in agriculture. The applications of biogeographic information for mitigating the affects of habitat destruction are clearly discussed in this chapter, and the authors present examples of sophisticated uses of the distribution of species to promote abundance and richness of indigenous species in agricultural areas. For example, researchers in England have devised specific criteria for managing the margins of crop fields to include buffer zones not only for species' habitats along the hedgerows and immediately adjacent area, but also to keep some species out of the crops. Such techniques can also be used to cultivate habitats to support predators of crop pests, which, in turn, can lead to reduction in the need for environmentally damaging chemical pesticides. In one of the most interesting parts of the book, the authors discuss the applications of biogeographic information on the design of towns and cities such that humans can coexist in greater harmony with nature, and use nature to mitigate some of the problems of cities. For example, designing cities with significant areas of vegetative cover can help reduce problems of runoff. Another interesting example discussed building linear cities in order to bring solutions to energy, transport, social and ecological problems.

The final chapter (9) takes a look ahead at the role of biogeography in understanding the affects of climate change, and predicts that many countries will have clearing houses of biogeographical information to manage resources, conserve nature, enhance public health and restore native ecological zones. GIS modeling will be (and, in fact, already is) used to summarize a vast amount of information to make determinations and predictions of the variables that most strongly affect species distributions. Applications of biogeography will, therefore, be crucial in a rational approach to managing resources and the environment.

In summary, *An Introduction to Applied Biogeography* is a well-written and produced book that takes a broad look at the history and applications of biogeography. The book should be useful to people in such diverse fields as city planning, architecture, farming, and nature conservancy. The main criticisms are that the book tries to cover too much ground, giving the impression of being unfocused, leaving the reader dazed, and covering some very important topics in a cursory manner. The benefits of the book in demonstrating the uses of biogeography, however, outweigh these criticisms, and it is a valuable addition to any library.

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Upcoming Meetings of Paleontologic Interest

2003

April 25-26 The Micropalaeontological Society's Foraminiferal Group (TMS-FG) Spring Meeting, Kiel, BRD
http://www.tmsoc.org

May 2-4 Mid-Continent Paleobotanical Collo-

	quium, Chicago, IL http://www.fieldmuseum.org/research_collections/geology/mpc.htm
May 7-9	GSA Rocky Mountain Section Meeting, Durango, CO
May 21-22	The Evolutionary Legacy of the Ice Ages contact: Suzi.white@royalsoc.ac.uk
June 3-8	Bioevents: Their Stratigraphic Records, Patterns and Causes, Caravaca de la Cruz, ESP
June 6-10	Western Society of Malacologists Annual Meeting, Los Angeles, CA http://www.nhm.org/research/malacology/avaldes/wsm/losangeles.html
June 12-14	Short Course: Applied Micropaleontology, Bonn, BRD http://www.Paleontology.uni-bonn.de/mitarbeiter/LANGER/INDEX.HTM
August 3-7	9th International Symposium on Fossil Cnidaria and Porifera, Graz, Austria http://www.paleoweb.net/cnidaria.
August 3-9	Third International Conference on Large Meteorite Impacts, Nördlingen, BRD http://www.lpi.usra.edu/meetings/largeimpacts2003/
Oct. 5-8	Joint Meeting of the American Association of Stratigraphic Palynologists, the Canadian Association of Palynologists, and the North American Micropaleontological Section of SEPM, Niagara Peninsula, CN http://www.palynology.org/meet_AASP36.html.
Oct. 27-30	1st International Conference on Palaeontology of Southeast Asia (ICPSEA) at Mahasarakham University, Thailand http://www.msu.ac.th/bpc/index.html
Nov. 2-5	Geological Society of America Annual Meeting. Seattle, WA http://www.geosociety.org/meetings/