Priscum

NEWSLETTER OF THE Paleontological SOCIETY

VOLUME 25, ISSUE 1

Paleontological Society Student Survey, Part II: Report on Student Career Development

INSIDE THIS ISSUE

By Emily Orzechoswki (The University of California, Berkeley)

Student Representative

Here I present the second of a two-part summary of the 2017 Paleontological Society student survey on experiences and recommendations with respect to: 1) diversity and inclusion, and 2) career development. In total, 290 former and current paleontologists participated in our anonymous survey (that's a 35% survey invitation response rate; thank you!). For further information on survey scope and protocol please refer to Paleontological Society Student Survey, Part I: Report on Student Diversity & Inclusion (published in the Fall 2017 *Priscum*).

Why survey career development?

Diverse and meaningful career development experiences are critical for both academic and non-academic post-graduate success. The Paleontological Society aims to provide such experiences for its undergraduate and graduate student members. Here I summarize current and former paleontology students' career goals, experiences, and support for new Paleontological Society career development resources.

Former Student Experiences and Current Student Goals

The majority of current students surveyed report planning to continue in paleontology research upon graduation (Figure 1). However, this result is tempered by former students' experiences, the majority of whom report struggling to continue in paleontology research after graduation (Figure 1). These results underscore the fact that post-graduate opportunities in academic paleontology are relatively limited in number and competitive. Although students may aim to continue in academia through the majority of their time in school, post-graduation is a transition point for many who ultimately decide to leave paleontology research careers (17 out of 21 former students who left paleontology report deciding to leave after graduation). These survey findings highlight the critical importance of encouraging students to gain diverse career experiences and supporting professional development and training (non-academic and academic) for post-doctoral professionals.

Recommendations

Pooled recommendations from current and former paleontology students are outlined below with respect to support

Paleontological Society Student Survey, Part II: Report on Student Career Development

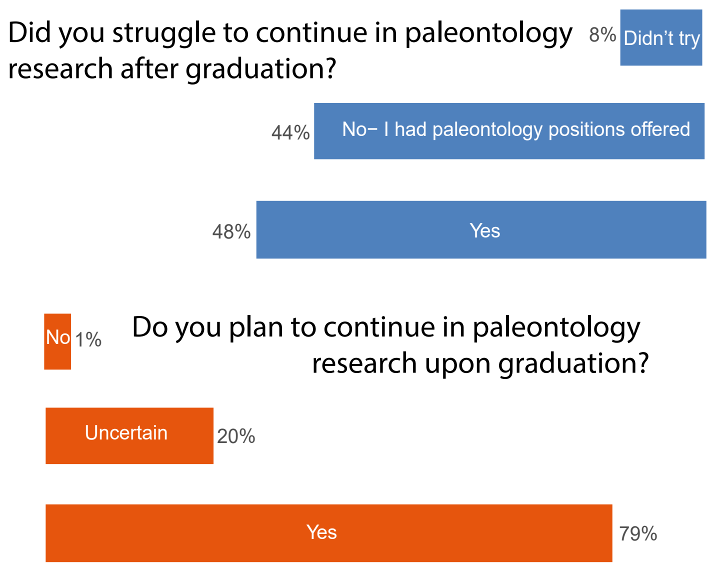


Figure 1. Former students' (n = 202) post-graduate career experiences (top) & current students' (n = 98) post-graduate career goals (bottom).

for PS-sponsored courses (Figure 2) and PS professional development resources (Figure 3). Former and current students' rankings are generally congruent, with only one major disagreement that I discuss below.

Current and former students most highly value multi-week courses (Analytical Paleontology, Stratigraphy & Biostratigraphy, and Taphonomy); these courses give students access to intense learning environments where they can build strong camaraderie (Figure 2). Among the proposed Geological Society of America (GSA) shortcourses, survey participants most strongly endorse "Communicating Science to the Public," which firmly indicates that public outreach and communication skills are highly valued in paleontology careers (Figure 2).

The most enthusiastically supported professional development resources are feedback on Student Research Grants, job/ internship postings, academia-focused career events, and the Student Poster Competition, all of which the PS is currently providing (Figure 3)! The least popular resource is non-academia focused career events (Figure 3). However, this result is driven entirely by current student survey results and is likely due to the fact that most students tend not to consider non-academic positions until graduation (as is shown in Figure 1). Most former student survey participants moderately or highly support providing non-academia focused career events.

PS Plan of Action: Already in Effect

- Merit review feedback provided for Student Research Grant applicants
- On to the Future grant enhancement (provides financial support for underrepresented students to attend GSA)
- PS Summer Policy Internship at American Geosciences Institute
- PS Mentorship luncheon at GSA with speakers from academic and non-academic careers
- PS-sponsored Analytical Paleobiology Short Course (July-August 2018)
- Student Poster Competition at GSA
- Women in paleontology mixer at GSA 2017 & 2018

Planned for the Near Future

- Enhanced early career networking opportunities (see Career Development plan of action)
- Graduate student talk award session at GSA
- Mentorship program for undergraduate and graduate students
- PS-sponsored student sections and student conferences

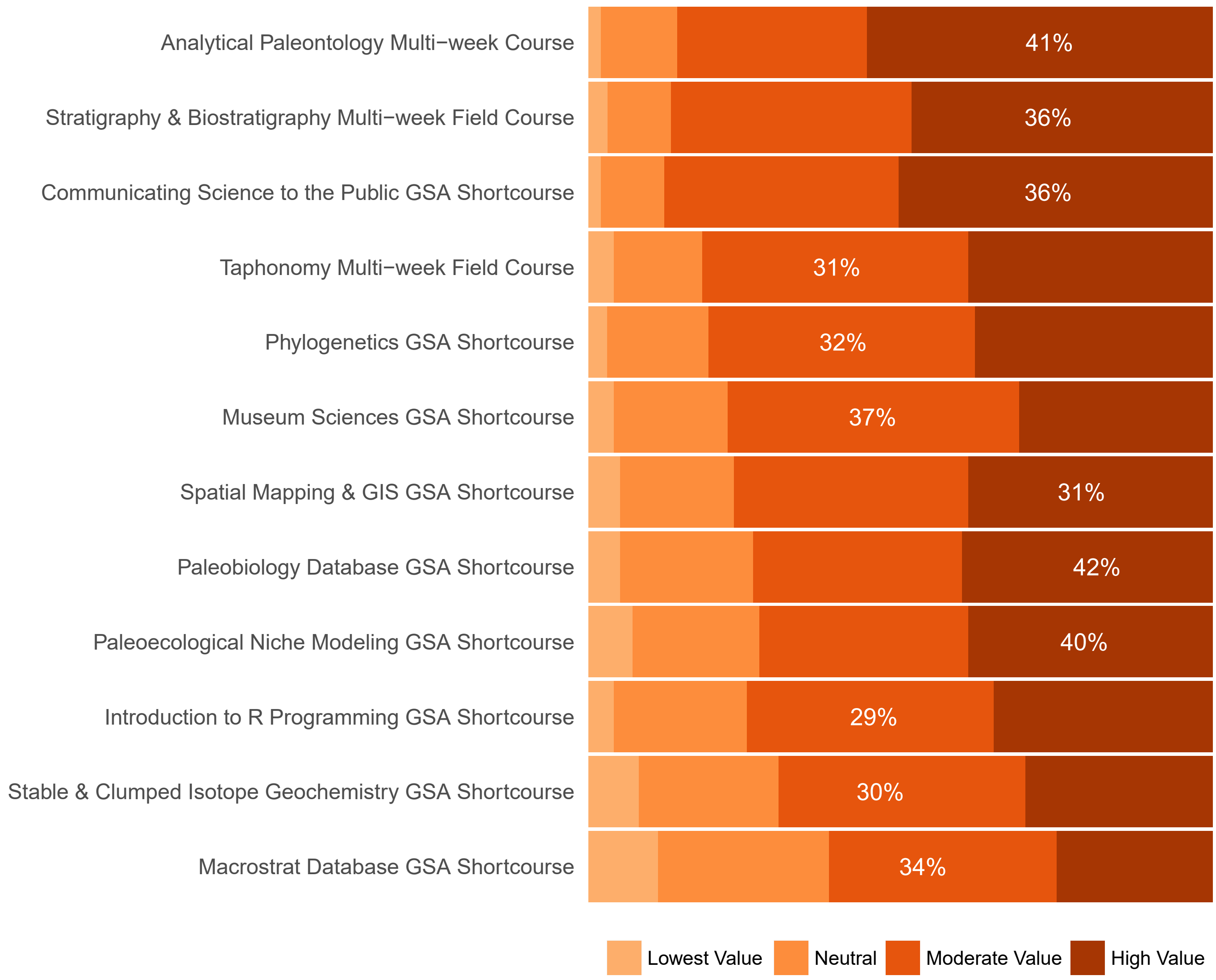


Figure 2. Survey recommendations for student courses.

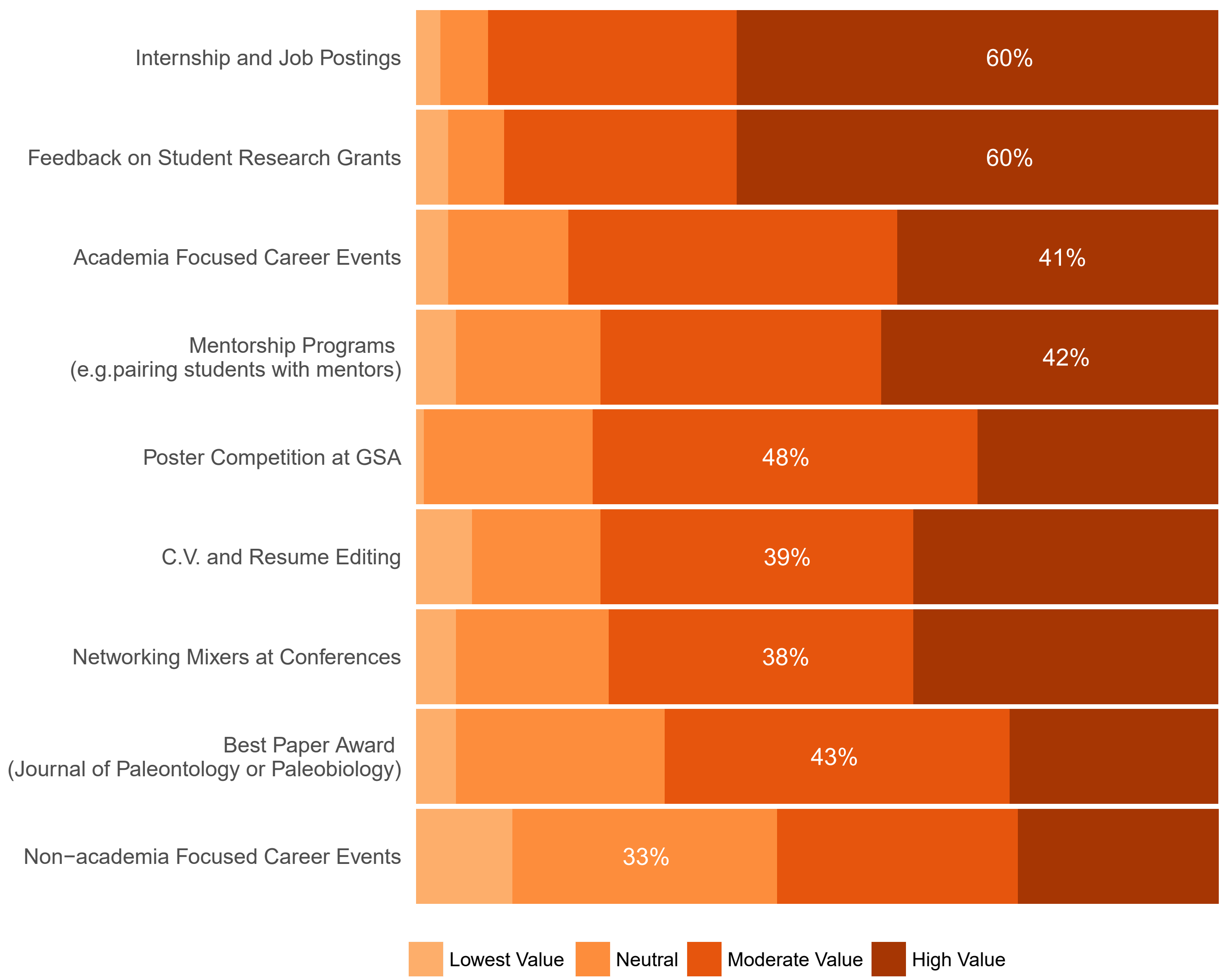


Figure 3. Survey recommendations for professional development resources.

Women in Paleo Mixer a success at GSA 2017

By Emily Orzechowski (The University of California, Berkeley)
Student Representative

On Tuesday October 24, 2017 the Paleontological Society hosted its first annual "Women in Paleo" mixer at the Geological Society of America conference in Seattle, Washington. More than 200 women identified* professionals attended the event from institutions around the globe. Over food and drinks students of all degree levels, educators, postdoctoral researchers, professors, industry professionals, museum staff and scientific illustrators conversed and shared their experiences of being women in paleontology.

Student Representatives Sharon McMullen and Emily Orzechowski organized the event with the goal of providing a platform for engagement and networking of women paleontologists on all career levels. In a career path with low retention rates among women – particularly at the postdoctoral researcher, lecturer, assistant professor, and associate professor career levels – strong connectedness is critical for morale and success.

The next Women in Paleo Mixer will be held at the Geological Society of America conference in Indianapolis on Tuesday evening Nov 6th. We hope to see you there!

Women identified paleontologists mix, mingle, and play pool during the "Women in Paleo" mixer held at GSA 2017. (Photo credit: Sharon McMullen.)

**women identified refers to individuals who experience through the lens of women in body, spirit, identity past, present, future and fluid (Gender Equity Resource Center).*

Time Scavengers: Teaching the public about climate change and evolution through scientists' experiences

By Adriane R. Lam (University of Massachesetts, Amherst) and Jennifer E. Bauer (The University of Tennessee, Knoxville)

This past year saw tumultuous changes in the U.S. government, most of which was is the lack of regard for the Earth's overall health and care about our natural resources. Most scientists would agree that now more than ever is the time to speak up and out about the importance of CO2 regulations and the effects of a warming climate on life on Earth. More recently, the shrinkage of National Parks, such as Bear's Ears, and allowing the teaching of 'alternative theories' in public schools alongside or in place of evolution, highlight the importance of advocating for preservation of our natural resources and education of the nation's youth. To communicate the importance of climate change and evolution, there are several websites, most through national agencies (e.g., NOAA, NASA, EPA, NSCE) that include climate- and/or evolution-related information and educational pages for public consumption. However, this information is often full of scientific jargon not appropriate for students nor easy for the layperson to digest.

The lack of comprehensive and accessible educational materials and sites explaining what climate change is and its effects on our planet and the importance of fossils and evolutionary education was glaring to us, Adriane and Jen, two Ph.D. students in paleoceanography and evolutionary paleoecology, respectively. The problem became especially amplified around and after the 2016 presidential election. Social media platforms such as Facebook and Twitter became echo chambers of conservative news outlets and Republican constituents. Phrases such as 'I don't even know a real scientist', 'climate change is a liberal hoax', and 'I'm not a scientist, I can't understand' were rampant. It was during this time of frustration that an idea was born: what if we could create a website to combat some of the issues and stigmas surrounding climate change and evolution through a series of static informational pages and blogs? It was during one fateful day in December of 2016 that this idea evolved into a reality with a few texts sent between friends and a 2 hour-long Google Hangouts session. Thus, the education outreach and science communication website Time Scavengers was created (www.timescavengers.blog).

Through the early months of 2017, static pages were built under three major headings: 'Introductory Material', where we have pages that explain how geologists created and continue to fine-tune the geologic time scale, as well as include supporting paleoclimate and paleontology pages;

'Climate Change', which currently includes five major pages that step through the effects of increasing atmospheric CO_2 and how we know that humans are significantly warming the Earth; and 'Evolution', where important concepts to understanding evolution can be found. Most of the images on the 'Climate Change' and 'Evolution' pages are created by us or modified from pre-existing figures/images to be more accessible to non-scientists. More recently, we have expanded the static pages to include 'Educational Materials', where K-12 and undergraduate-level classroom activities are linked, and 'Additional Information', pages that link to paleo-related blogs, podcasts, and books. Future endeavors for the static pages include expanding on the 'Climate Change' and 'Evolution' pages, and adding in additional classroom resources. Both of us also plan to post classroom and education outreach materials we design from our own research projects.

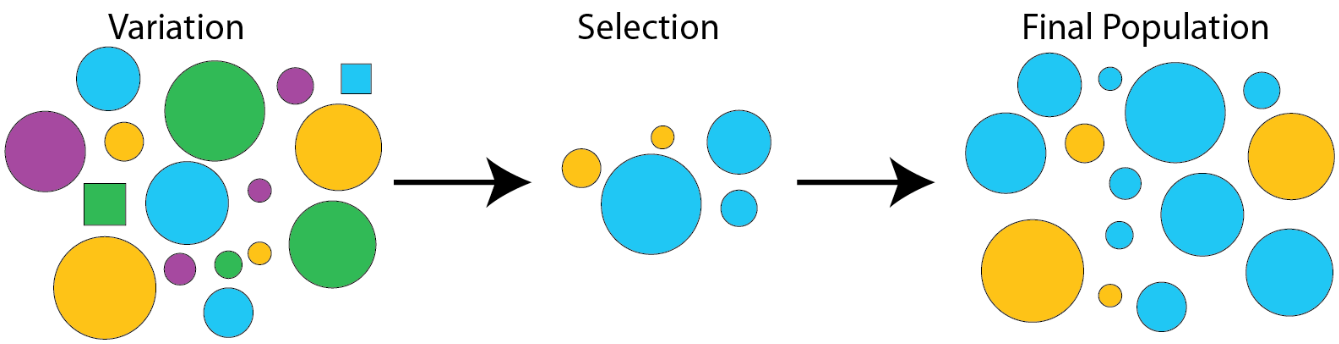
In addition to static pages, the site contains six blog components: 'Field Excursions', 'Meet the Scientist', 'Education and Outreach', 'Climate and Paleo News', 'Science Byte', and 'Byte of Life'. The purpose of these blogs is to pull back the curtain, so to speak, on the lives of scientists. Namely, the 'Science Byte' blog is where we post about aspects of our research, from washing and sieving forams to 3D scanning museum specimens to presenting our research at conferences. In short, this is a space where we explain how and where we obtain our data from, and to a certain extent, how we interpret that data to determine changes in the Earth's oceans and life through time. The public is introduced to different scientists and how their work impacts the greater good of humanity and Earth's life through our 'Meet the Scientist' blog. Our newest blog, 'Byte of Life', is designed for other academics and students, in which we share our more personal stories about our journeys and experiences in academia. Each of the blog components provides a unique look into how scientists conduct research, examine data, and navigate their scientific lives.

The real highlight of Time Scavengers is not our blogs or static pages, but our nine collaborators that we recruited to help us with editing and adding content to the blog pages. Currently, our collaborators range from assistant professors to graduate students to avocational paleontologists, with research interests spanning Cenozoic and Mesozoic paleoceanography and plankton evolution, Paleozoic paleoecology and paleobiogeography, to stratigraphy and sedimentology. All of us are from differing backgrounds, and several identify as belonging to marginalized groups. The rich experiences and diverse backgrounds of our collaborators make for impactful blog posts that are far-reaching, connecting with both public interests and academic life.

But the purpose of Time Scavengers is not simply blogging and making pages to educate the public. The site is also an experiment, as we are trying to determine the most impactful content ('impactful' meaning reaching more people of different age groups and interests on several social media platforms) for which to teach climate and evolutionary sciences. We are also experimenting with paid advertisements on Facebook and Twitter, to see if this is an effective way to reach more people. The site was originally built for the general public, but in more recent months has morphed into a space for teacher (K-12) support. We can target persons in specific areas, such as teachers that are employed in states that allow alternative theories to evolution to be taught in the classroom. The first such advertising experiment indicated that sharing into groups, especially on Facebook, is a more effective way to reach audiences than paid advertisements. We would love to hear advice from others who have any experience with reaching a broader audience through social media platforms.

Our journey with Time Scavengers has, thus far, been an extremely positive experience. Even though we strive for simplicity and easy-to-digest material and information on our site, we're still learning the best ways in which to do this. Among other things, we have learned that education outreach and science communication are not easy, but we have greatly sharpened our skills over the past year through blogging and writing articles. We invite any interested member of the Paleontological Society to join us on building content, whether it be through static pages or writing a post for one of our blogs (we're always looking for scientists to write for our 'Meet the Scientist' blog!). We are especially interested in hearing from members who have experience connecting with K-12 educators and how you have supported them in their earth science teaching endeavors.

If you are interested in connecting with the Time Scavengers community, please reach out to us at timescavengers@gmail.com. We are also on Facebook and Twitter (@TimeScavengers)!



Welcome to the 11th North American Paleontological Convention—Celebrating 50 Years

11TH NORTH AMERICAN PALEONTOLOGICAL CONVENTION

JUNE 23 - 27, 2019 RIVERSIDE, CALIFORNIA

Call for Symposium Proposals

NAPC is an international conference held every 4-5 years that brings together all branches of paleontology and fields related to the history of life (vertebrate, invertebrate, paleobotany, micropaleontology, paleo-related organic and inorganic geochemistry, paleoecology, paleoclimatology, and astrobiology) for a joint meeting typically hosted on a campus. The meeting comprises participant-suggested symposia and topical sessions. Please consider proposing a symposium for NAPC2019 and submitting your suggestion to the organizers by 30th September 2018. Please send: Symposium title, brief synopsis of symposium, names of organizers, full or half day and any plans for invited speakers to: NAPC2019@ucr.edu. A half-day symposium is 14 x 12 (talk) +3 (questions) minute talks, and commonly attract a mix of invited and volunteered abstracts.

The meeting attracts professional scientists, graduate and undergraduate students, amateur paleontologists, and interested members of the public. Its purpose is to exchange research findings, define future directions, and be a forum for extended and relaxed interactions between professionals and early career scientists, most particularly graduate and undergraduate students. NAPC meetings are generally less formal than annual association meetings, and allow time for more extended and relaxed interactions. They also serve a major role in public outreach through public lectures and other activities. Fieldtrips associated with the meeting provide participants opportunity to explore the regional paleontological resources.

Dates

The conference will be held from Sunday 23rd June 2019 through to Thursday 27th June 2019, with symposia running on Sunday 23th and Monday 24th, and on Wednesday 26th and Thursday 27th. On Tuesday 25th there will be a mid-meeting break, with a variety of scheduled workshops and fieldtrips. Other fieldtrips will run both pre-and post-conference.

Venue

One of the ten UC campuses, UCR is home to nearly 25,000 students and has a long history of research strength in paleontology and allied fields. The meeting will take place in the new University Hub, which contains an array of meeting rooms and spaces of various sizes that are appropriate for virtually all activities planned, ranging from plenary sessions to smaller symposia and group meetings, to exhibits and posters. In addition, most participants will be housed in UCR's new Glenmor Residence Hall; dining and recreational facilities will also be available. Other accommodation options are available nearby off campus.

Field Trips

A variety of field trips will be offered in association with the meeting. We anticipate a mixture of those in the local region, and others further afield in western North America. Titles include:

- Extinction events and biodiversification in the Cambro-Ordovician of the eastern Basin and Range (3-5 days)
- Barstovian Biostratigraphy: Barstow and Cajon Valley (1 day)
- Late Oligocene to Late Early Miocene Molluscan and Mammalian Biostratigraphy of Sespe, Vaqueros, and Lower Topanga Formations at Calabasas and Saddle Peaks, Santa Monica Mountains National Recreation Area, Los Angeles County, California (1 day)
- Stratigraphy and Paleontology of the Palos Verdes Peninsula (1 day - mid meeting)
- LeBrea Tarpits and the Alf Museum (1 day - mid meeting)
- Low tide visit to Crystal Cove State Park, Laguna Beach, and Newport Pleistocene terrace (1 day-mid meeting)

Several additional multi-day trips will be announced shortly.

Welcome to the 11th North American Paleontological Convention

Confirmed Mid-meeting Workshops

Numerical Biochronology: Sequencing Large Numbers of Paleobiologic First- and Last-Appearance Events

Instructor: Prof. Peter Sadler, University of California Riverside

Hands-on application to real Paleozoic data sets will explore a range of options in the CONOP (CONstrained OPtimization) software, written for Windows (XP, 7, 10) 32-bit and 64-bit operating systems (or Windows emulation on Mac computers). Course notes, the CONOP program and data-manager, manuals and sample datasets will be provided to all participants. CONOP conducts brute-force, trial-and-error searches that employ a simple physical analogy rather than esoteric mathematics. We will use it to mimic the logic of several different seriation programs.

Timetree Methods for Beginners

Instructor: Prof. Mark Springer, University of California Riverside

An overview of commonly used methods and programs for constructing timetrees with molecular data and calibrations from the fossil record. ... we are also planning other workshops including those with a museum-based theme, and the interface of paleontology and public policy.

Additional Programs

There will be spouse and family activities, grad student and post doc specific activities.

Local Museums

Southern California is rich in museums with substantial research collections in paleontology. NAPC will offer various opportunities to visit these institutions. Those wishing to visit collections for research purposes are encouraged to contact relevant staff, understanding that opportunities may be limited by demand.

Important Dates

30 September 2018 – Symposium Proposal Deadline

Communications

Updates on workshop, field trip, and symposia proposal information is available on www.napc2019.ucr.edu

Matters related to the meeting may be addressed to: NAPC2019@ucr.edu

Follow us on Facebook (NAPC2019)
Look for us on Instagram

We invite others interested in sponsoring NAPC to contact us at the address above.

NAPC 2019 Organizing Committee Members

- Nicole Bonuso, California State University, Fullerton
- David Bottjer, University of Southern California
- Mary Droser, University of California, Riverside
- Doug Eernise, California State University, Fullerton
- Robert Gaines, Pomona College
- Austin Hendy, Natural History Museum of Los Angeles County
- Nigel Hughes, University of California, Riverside
- David Jacobs, University of California, Los Angeles
- Jess Miller-Camp, University of California, Riverside
- Richard Norris, Scripps Institute, University of California, San Diego
- Susannah Porter, University of California, Santa Barbara
- Kaustav Roy, University of California, San Diego
- Peter Sadler, University of California, Riverside
- Mark Springer, University of California, Riverside
- Xiaoming Wang, Natural History Museum of Los Angeles County
- Michael Vendrasco, Pasadena City College

Current NAPC 2019 Sponsors

11TH NORTH AMERICAN
PALEONTOLOGICAL CONVENTION

JUNE 23 - 27, 2019 RIVERSIDE, CALIFORNIA

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Environmental Dynamics and Geo-Ecology Institute
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NATURAL
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Paleontological Society Short Course 2018

Pedagogy and Technology in the Modern Paleontology Classroom

Saturday, November 3rd

9 am - 5 pm

Indiana Convention Center, Indianapolis, IN

Organized by Phoebe Cohen, Rowan Lockwood, and Lisa Boush

Free & open to all paleontologists and educators

Morning: Talks by paleontologists and science educators on best practices in teaching paleontology. Topics include active learning , flipped classrooms, incorporating research into teaching, kinesthetic learning, how students learn, diversity and inclusion in the classroom, and confronting prior conceptions.

Afternoon: Hands-on workshop on teaching with databases and online tools including the Paleobiology Database, Macrostrat, Rockd, and Neotoma

Please register in advance by October 15th by submitting your name and sample syllabus if relevant: https://wmsas.qualtrics.com/jfe/form/SV_1ANYpn3N2JPpyOV

Paleontological SOCIETY

for more information & a list of speakers visit paleosoc.org/2018-ps-short-course-presenters

GSA 2018
4-7 November
Indianapolis, Indiana, USA

2018 Arthur James Boucot Research Grant Awardees

Dr. Brian A. Atkinson
Natural History Museum and Biodiversity Institute, University of Kansas
Diversity of Cretaceous permineralized floras along western North America: Shedding light on a possible biogeographic link between Vancouver Island and Southern California

Dr. Holly Woodward Ballard
Center for Health Sciences, Oklahoma State University
Osteohistology permits a robust ontogenetic assessment of the extinct dire wolf (Canis dirus) and life history comparisons with the extant gray wolf (Canis lupus)

Dr. Selena R. Cole
National Museum of Natural History, Smithsonian Institution
Phylogenetic paleoecology of crinoid echinoderms from the Upper Ordovician (Katian)

Berchin Laterstatte
Dr. Rosie L. Oakes
Academy of Natural Sciences, Drexel University
Preparing for a change: using modern and legacy collections to create a pre-ocean acidification baseline for pteropods

Dr. Leigh Anne Riedman
University of California, Santa Barbara
Eukaryotic richness across the Neoproterozoic Bitter Springs carbon isotopic anomaly

2018 Norman Newell Early Career Grant Awardees

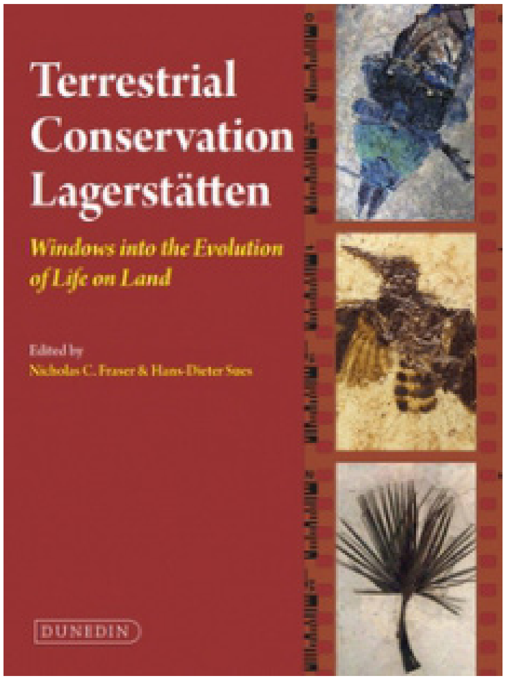
Dr. Jonathan Calede
Ohio State University, Marion
The evolution, ecology, and adaptive radiation of North American gophers

Dr. Ashley A. Dineen
California Academy Sciences
Temporal and spatial dynamics of ecospace occupation during the Permo-Triassic mass extinction

Dr. David Adler Gold
California Institute of Technology / UC Davis
The evolution of brachiopod biomineralization: a comparative genetics approach

Dr. Benjamin J. Linzmeier
Northwestern University
Ecology of ancient and modern squid from statolith geochemistry

Book Review—Terrestrial Conservation Lagerstätten: Windows into the Evolution of Life on Land



Conservation Lagerstätten: Windows into the Evolution of Life on Land. Dunedin Academic Press, Edinburgh. 450 pp. (£165.00 cloth.)

Reviewed by Thomas A. Hegna (Western Illinois University)

Terrestrial Conservation Lagerstätten (*TCL*) is a fantastic volume—it treats nine terrestrial Lagerstätten in scholarly detail, each written by experts on the particular Lagerstätte. The articles are complete and full of full-color graphics—including spectacular fossil images. Each chapter is fully referenced. The sites treated are (in geological order): 1) the Rhynie and Windyfield Cherts, 2) the East Kirkton Lagerstätte, 3) the Madygen Lagerstätte, 4) the Solite Quarry, 5) the Yanliao Biota, 6) the Jehol Biota, 7) the Santana Formation, 8) the Messel Pit Fossil Site, and a final chapter covering 9) Extraordinary Lagerstätten in Amber (but focusing heavily on the Cretaceous Burmese amber). Of these chapters, over half have not been treated in a similar manner in previous books on fossil Lagerstätten (chapters 2, 3, 4, 5, & 9). This last fact justifies the book's rather steep price (about 230 $US at present exchange rates). Due to its price, this volume is probably more likely to find its home in library collections rather than personal libraries.

In producing such a volume, the editors faced the choice of being laissez-faire or enforcing certain content. This volume would have benefited from a more dictatorial approach—enforcing the presence of locality maps and stratigraphic columns, for example, which are absent from several chapters. These pieces of information are vital pieces of context for understanding the preservation. Figures and pictures are variably integrated into the chapters, with most chapters opting for an in-chapter organization of the figures, but with one chapter (chapter 9) opting instead for the figures all being located at the end of the chapter in a sort of appendix. Having a common organization to the chapters would have helped hold the chapters together.

The Devonian Rhynie and Windyfield Cherts chapter is expertly written by Nigel Trewin and Hans Kerp. It contains an extensive section on the historical background of study of the site. The Rhynie Chert alone was treated by Selden and Nudds' *Evolution of Fossil Ecosystems*, but the treatment in *TCL* is aimed much more at a scholarly audience. The inclusion of the Windyfield Chert in this chapter is good, as the two are essentially coeval and poorly differentiated from one another.

The Mississippian-aged East Kirkton Lagerstätte is a site that, in my opinion, stretches the definition of a conservation Lagerstätte. I don't mean this to be pejorative, as the taphonomy of the skeletons in the East Kirkton Lagerstätte is fascinating, but actual soft-tissue preservation is very rare there. No previously written chapter has covered this site in comparable detail.

The Triassic Madygen Lagerstätte chapter is penned by a large team headed by Sebastian Voigt. No previous work in English covers this unique Lagerstätte. The geology of the area is covered very thoroughly, which helps to put its unique vertebrates (including *Longisquama* and *Sharovipteryx*) into context.

The Triassic Solite Quarry is another Lagerstätte that has received no attention in previous volumes on Lagerstätten. The summary here is a welcome development. I personally love the insects from the quarry, which look ghostly in the images in the chapter.

The Jurassic Yanliao Biota (a.k.a. the 'Daohugou Biota' of other authors) is a great addition to the English-language literature. The fossils from the Yanliao Biota as well as the younger Jehol Biota have been long known, but poorly differentiated in the literature. This chapter, plus the following chapter on the Jehol Biota, helps to remedy that. One minor quibble: some abbreviations used on the stratigraphic column are not defined in the chapter.

The Cretaceous Jehol Biota chapter is replete with beautiful illustrations and is well written and thorough with regards to the vertebrates and insects from the site. However, the chapter would have benefited from the inclusion of a stratigraphic column and locality map to further differentiate it from the older Yanliao Biota.

The Cretaceous Santana Formation chapter is written by David Martill and Paulo Brito tackles the geology of the region so as to adequately differentiate the Santana Formation from the underlying Crato Formation. This chapter is another solid inclusion in the book. Though this site has been treated in books and chapters before, readers will find new material in this synthesis

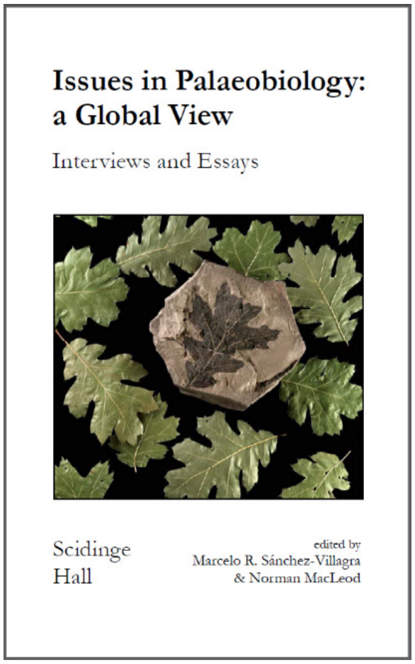
The Eocene Messel Pit Fossil Site chapter is written by Stephan Schaal, and it contains some of the most spectacular, full-page illustrations of the book. It contains an excellent section on the comparative geology of maar lake formation and taphonomy.

The Extraordinary Lagerstätten in Amber chapter, with particular reference to the Cretaceous of Burma, by David Grimaldi and Andrew Ross, can be seen as an addendum to the book *Biodiversity of Fossils in Amber from the Major World Deposits* that came out in 2010. The chapter in *TCL* is, in some ways, in the shadow of that book. Amber deposits are often the most terrestrial of all of the terrestrial conservation Lagerstätte, so trying to cover all aspects of amber preservation in a chapter is an ambitious goal. Because so much work on the Burmese amber is ongoing, the chapter has "work-in-progress" feel to it. One minor quibble: figure 1 lacks a key to abbreviations.

After perusing the book, I am of the opinion that another chapter was needed, or perhaps an expanded introduction. This additional chapter would wrestle with the question as to what qualifies as a terrestrial conservation Lagerstätte. The implicit definition in *TCL* seems to be inconsistent based on the included Lagerstätten. Terrestrial: nearly all Lagerstätte require some sort of body of water for their preservation (cave deposits are an exception and Riversleigh [Australia] is not in this volume). At what point does a Lagerstätte become too aquatic? The editors state in the introduction that " . . . essentially all . . ." terrestrial conservation Lagerstätten have been included in this volume. Perhaps I am being too persnickety, but there are a number of other Lagerstätten that have been left out of this volume that could well make claim to being terrestrial conservation Lagerstätten. Almost any insect-bearing deposit could be argued to be a *TCL*, as they preserve soft-parts without any mineralization. The book *Fossil Insects* by David Penney and James E. Jepson lists at least 45 non-amber, insect-bearing sites that are not included in the present book! Furthermore, sites like the East Kirkton Lagerstätte have only very rare soft-tissue preservation. Other sites for inclusion include Quercy (France), Riversleigh (Australia), Rancho La Brea (USA), Solnhofen (Germany), Las Hoyas (Spain), etc.

Lastly, I would like to note that some minor corrections to two chapters have been posted on the website: http://www.dunedinacademicpress.co.uk/page/detail/Terrestrial-Conservation-Lagerstatten/?K=9781780460147. These corrections concern a table in the Jehol Biota chapter and a figure in the Amber Lagerstätte chapter.

Book Review—Issues in Palaeobiology: A Global View. Interviews and Essays



Sánchez-Villagra, M. R. and N. MacLeod, eds. 2014. ***Issues in Palaeobiology: A Global View*. *Interviews and Essays***. Scidinge Hall Verlag Zürich, Tübingen, Germany, 289 pp. ($18.00 paper.)

Reviewed by Phil Novack-Gottshall (Benedictine University)

As a geological science, paleontology is intrinsically global. We go where the rocks are, and they're basically everywhere. Yet the scientists doing the science are often "Western," trained and/or working in North America, Europe, and countries long-associated with such areas. [This unfairly over-simplified sentiment obviously overlooks historically critical paleontologists and their centers throughout Asia (Ishijima, Barsbold, Yang Zhongjian, Zhou Mingzhen, and Grabau), Africa (Boonstra, Brain), Central and South America (Ameghino, Bonaparte, de Paula Couto, Reig, Price, d'Angelo), and elsewhere.] Marcelo Sánchez-Villagra and Norm MacLeod, the editors of *Issues in Paleobiology: A Global View (Interview and Essays)*, set out to evaluate the current state of paleontological research around the world through a series of interviews with 22 paleontologists of diverse interests born in, having trained in, or currently working in at least 14 different countries spanning all continents except Antarctica.

I expected the essays to reflect varied global perspectives and approaches to paleontology, with discussion of how differences in world view, cultural peculiarities, educational and governmental infrastructures, even cuisines and arts influence how the science of paleontology plays out in practice, even if manifested subtly. (I'm confident my own paternal ancestors' religiously-based migration circa 1700 to William Penn's experiment in the New World and our lineage's latter gestation in Lutheran-Mennonite agriculture play at least some role in my simultaneous comfort for and wanderlust against white-bread stability that led to my enjoyment of programming-based analyses, my lack of interest in phylogenetics—my genealogy is exceedingly boring and well documented—and the giddy excitement of fantasizing about ancient Paleozoic worlds.)

Instead, I was surprised in this volume by the exceptional uniformity of paleontological science conducted around the world. Nearly all paleontologists, regardless of heritage and training, fit the following formula: (A) study a particular taxonomic group + (B) of a particular age (usually an era but sometimes a period) + (C) use a particular methodology (morphometrics, cladistics and systematics, paleoclimatology and paleoecology, or biostratigraphy) + (D) study important questions (evolutionary reactions to extinction or climate change, use of fossils as climate or environmental proxies, processes of evolution and speciation, etc.). General? Sure. But it says a lot about both the versatility of our discipline, and how it can embrace everyone's peculiar peccadillos, choosing the subject, time and approach that is most comforting to our worldview, skills, and interests.

Although it is unclear whether each essay is a transcript of an actual interview, a written manuscript, or some combination, each of the 22 essays is structured as responses to five questions (paraphrased here): What unanswered paleontological questions are most important today? How does your research contribute? What new questions might your research open up? What are the weaknesses of your research approach? And, why did you become a paleontologist?

The most enjoyable part to read, and I think most informative for understanding global experiences, is the last question. Some—like Carlos Jaramillo, Dieter Korn, and myself who entered college and graduate school in the 1980s to 1990s—were inspired heavily by the writings of Stephen Jay Gould, who vividly represented not only the excitement of modern paleontology and evolutionary biology, but also its approachability. Others, like Christine Janis, Michael Lee, Bruce MacFadden and Marcelo Sánchez-Villagra, were inspired after childhoods visiting museums (especially dinosaurs) and zoos and spending time outdoors. Others (Kevin Boyce, P. David Polly) were initially more historians than biologists at heart. And there are those "accidental paleontologists" (*sensu* Norm MacLeod), such as Zhe-Xi Luo's entryway in China, where the government made a stark offer: study geology or give up your opportunity for college to someone else. Or like Marcelle BouDagher-Fadel, where the Lebanese civil war broke out as she was headed to take her collegiate pre-medical examination, leading instead to a new career as a micropaleontologist.

Sprinkled sporadically in the essays is the commonly perceived "clash" between field- and specimen-based systematists and biostratigraphers and the more analytically minded paleobiologists, or at least the loss of information and skills from the former specialists. There is no denying the success of the "paleobiological revolution", with many contributing paleontologists—including Michael Hautmann, Jes Rust, Anusuya Chinsamy-Turan, Francisco Goin, Da-yong Jiang, Jukka Jernvall, Michael Lee, Zhe-Xi Luo,V. Louise Roth, Norm MacLeod, among others—maintaining an active focus on biodiversity, phylogenetics, ontogeny and development, radiations, and mass extinctions in their research. Yet the collective research mentioned in the volume, even when at service of genuinely biological hypotheses, speaks very well to the vibrant field- and specimen-based research being conducted throughout the paleontological universe. Very few of the contributing paleontologists do not include fieldwork and museum specimens as active components of their research. (Along these lines, it is worth reminding readers of the Paleontological Society's support for such "classical" paleontological research via the Arthur J. Boucot Research Grant, funded by his estate.) It is definitely true, as noted herein by Dieter Korn and David Polly (and analyzed formally in Payne, et al., 2012), that such "traditional" paleontological research is not as well cited as it ought to be when assimilated within larger synthetic analyses. David Lazarus even proclaims that the paleobiological revolution has been so successful in bridging paleontology and biology that at times paleontology may have lost its deep connections with geology, a critical bridge needed to appreciate the stratigraphic and environmental context of fossil specimens and increasingly necessary for geochemical and isotopic studies.

One notable addition from the 1980s "Gouldian agenda" is the emergence of climate-change research evidenced within the volume. This is not surprising given the magnitude of the crisis and our field's ability to add a temporal dimension to its study and solutions. Several of the volume's contributors play major roles in such research, working on climate proxies (Jennifer McElwain), how ancient organisms reacted to changing climates (Carlos Jaramillo, P. David Polly, Christine Janis, Bruce MacFadden), and the long-term consequences for such global changes (Kevin Boyce, Sergio Vizcaino). Such research clearly demonstrates the vibrant resonance of modern paleontology.

Paleontologists have long been frustrated with the ongoing cuts in paleontologists, support staff, and museum curators across many institutions, even closures of entire departments. One pattern that emerges in this volume, however, is the growth in new global centers of paleontology—some first-generation, others a renaissance, in regions such as Egypt, Columbia, and China—including new institutes of paleontology, many of which not only include public outreach and education arms, but also include burgeoning undergraduate and graduate programs in paleontology. Carlos Jaramillo and Marcelo Sánchez-Villagra, for example, both advocate strongly for more support for Central and South American paleontology, including both new expeditions and training for future paleontologists from such regions. And Hesham Sallam is leading the way toward a new generation of Egyptian paleontologists. Such initiatives must be supported by all paleontologists and their professional societies, lest they fall the way of sadly typical and much-too-short-lived US initiatives like NCEAS and NESCent. (A short reminder here is warranted that the PS complements the Boucot Grant above with the Norman Newell Grant for early career paleontologists.) Like all successful educational programs, it takes a critical mass to ensure the success of such future training centers, not quite easy but eminently plausible given well-placed strategic support.

Not surprising given its editor's background, the volume has a strong preponderance of Argentinians (14%), Europeans (36%), and vertebrate paleontologists (59% of contributors). It might have benefitted from inclusion of paleontologists from Mexico, Canada, India, and Asian countries other than China, more female paleontologists (contributing 23% of the volume), and perhaps additional voices that represent the "analytical paleobiological" (*sensu* Schopf, Gould, Raup, and Sepkoski) community. But

Book Review—Ichnoentomology: Insect Traces in Soils and Paleosols

this is a minor weakness in an enjoyable and refreshing volume. Despite the editors' recommendations to read the answers as a roadmap of the future of our field, I seem to share Kevin Boyce's cheeky admonition that "if some old man—like I now am—thinks [some research question] is important, then it is the *present* of paleontology; not the future." Overall, the volume attests to the rich tapestry of research we paleontologists pursue throughout the world.

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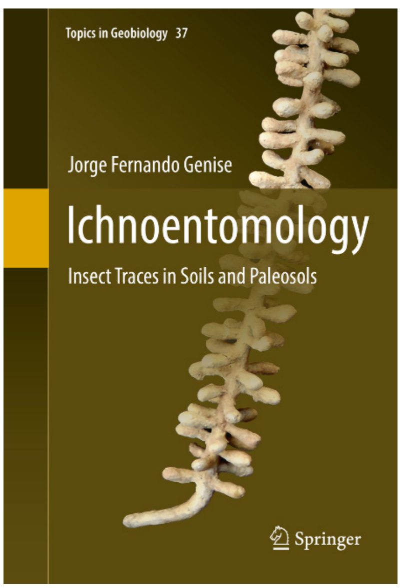

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Reviewed by Gerhard C. Cadée (NIOZ Royal Netherlands Institute for Sea Research)

In a Foreword, two well-known ichnologists Louis A. Buatois and M. Gabriela Mángano write that they met Jorge Genise in 1993 for the first time in Santa Rosa during the first Argentinean meeting of Ichnology. Genise was by training an entomologist, with interests far beyond insect systematics, working on terrestrial ichnofaunas from a biological standpoint. Since then, Buatois, Genise and Mángano started together to revitalize the field of continental ichnology. Jorge and his group of students have provided ichnologists, paleobiologists, sedimentologists, and stratigraphers with a conceptual and taxonomic framework to understand and classify continental trace fossils. Before Genise started his ichnological researches, paleosol ichnotaxa had been described, but their paleobiological and paleoethological meaning was poorly known. In ichnology, ichnofacies models were mainly based on the marine environment. Thanks to Genise and his group, this has changed drastically. This book therefore opens a new field for a broader readership.

This is not an easy book to review. According to the author (Introduction p. 3) it is "a very concentrated overview on all insect trace fossils" and "each chapter is written with the aim of giving tools and literature on all insect trace fossils." The book starts with a chapter on the different wall types that an insect trace may show. However the author (p. 3) advices us also how to read the book: "The last chapter [22, Paleoenvironmental Analysis and Ichnoentomological Synthesis], which also deals with the function of walls, can be read first." Then, one will appreciate "why it was necessary to devote so many pages and chapters to the recognition of insect trace fossils, their walls (Chap. 2), shapes and fillings (Chap. 3), their classification and ichnotaxonomy (Chaps. 4–6), and their detailed descriptions and interpretations for the different groups of insects (Chaps. 7–14)."

The title *Ichnoentomology* is somewhat misleading for good reasons: comparison with insect traces, Genise also has included chapters on traces in soils by organisms other than insects: crustaceans, earthworms, vertebrates, and roots; insect trace fossils in other substrates (wood, leaves, and bones), and finishes with evidence of evolution in insect behavior and on ichnofabric and ichnofacies in paleosols. He also writes that "the book was thought as a circular tale that readers can start in any chapter without losing the thread." I followed his advice and agree that each chapter can be a starting point, but as an introduction to ichnoentomology it gives a real *mer a boire*. However, for those who want to become up-to-date in one of the many subjects dealt with here, it gives an excellent, well-illustrated overview, including many references (72 pages!) for further reading.

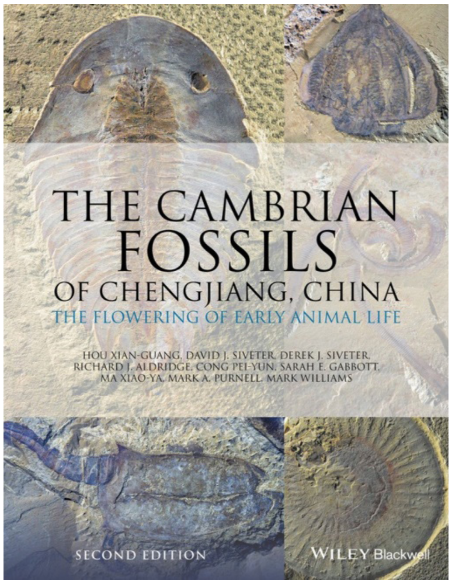
What I very much liked in Genise's book is his interest also in the oldest literature on the subject. He often also reproduces the nice illustrations of these early authors. He includes, for instance, the *Souvenirs Entomologiques* (1879-1899) by J. Henri Fabre, one of my hero naturalists also, and "L'Homère des Insectes" according to Victor Hugo. In chapter 7 ("Dung Beetle Masonry"), Genise cites Fabre's work as still one of the most detailed, accurate but also amusing and literary writings on insect behavior and nests, particularly his contributions on dung beetles. Interesting for him as an Argentinean: Fabre also writes on some Argentinean species (*Les Boussiers des Pampas*) based on material sent to Fabre by F. Judulien (also known as Jean Brethes). Genise uses several of Fabre's photographs.

To me, chapter 19 on trace fossils as the physical evidence of evolution of insect behavior was one of the most interesting. It starts with a brief but well-written history on how ideas on evolution and behavior evolved, mentioning briefly some founding fathers of ethology such as Tinbergen Lorenz and Baerends and Seilacher as the first to propose the use of trace fossils to study evolution of behavior. However, he also warns us that quite different organisms may produce very similar traces, so we need to be sure that there is no other taxon capable of producing the same traces, which might not always be easy.

I hope Genise will also give us in the future a kind of course textbook comparable to Seilachers *Trace Fossil Analysis* (2007) in which Seilacher intended to confer not knowledge, but skill. Genise's many schematic drawings of the traces illustrating a couple of chapters (e.g., figs. 9.4, 11.5, 11.16, 15.4, etc.) could be the basis for such a course book. I agree with Seilacher (2007), that paleoichnology seems to be a field with no limits to coining new ichnotaxa; the divergence between lumpers and splitters is extremely wide in this field, he writes. It should, like Seilachers *Trace Fossil Analysis,* concentrate on the more distinctive and representative ichnogenera. I also realize that such a task might be difficult: insects form the largest phylum of animals on earth and their diversity is immense.

I am sure this book will remain for a long time an important source of information. I don't agree with the author's expectations (Preface p. XVII) that perhaps some students, maybe from other countries and in the future, find a copy of it on a dirty library shelf and decide to inspect it. Ichnologists now can't ignore Genise's magnum opus.

The absence of an index with, for example, all (ichno) species names mentioned in the text makes consulting this book difficult. Maybe Springer didn't want it to become larger, but this is a severe omission. Wouldn't it be possible still to make one available online?



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Reviewed by (Paul Selden, Paleontological Institute, University of Kansas)

This is a an update of the very successful The Cambrian Fossils of Chengjiang, China, by many of the same authors, to incorporate the vast amount of new material that has been discovered since the first edition was published in 2004.

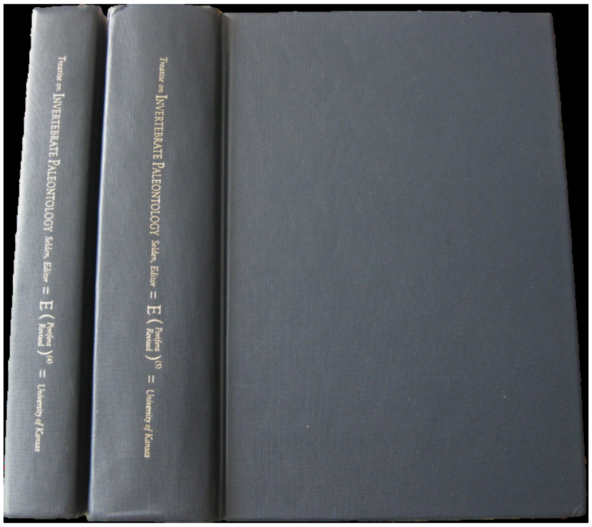
The main structure of the book remains the same. Part 1, the Geological and Evolutionary Setting of the Biota, puts the Chengjiang Fossil-Lagerstätte into the context of Cambrian time and evolutionary events of the early Paleozoic, and discusses the history of discovery of the localities and the taphonomy and paleoecology of the biota.

Part 2, the bulk of the book, describes in systematic order each of the important fossil species from the biota, which ranges from algae through ctenophores, sponges, cnidarians, lophophorates, annelids, priapulids, lobopodians, a great many arthropods, chaetognaths, hemichordates, vetulicolians, chordates, and quite a few organisms of uncertain affinity.

The introductory chapters have been skillfully updated to include some recent controversies, e.g. about Precambrian events, and basal relationships within animal phylogeny. Nevertheless, the content in this book remains uncontroversial. The descriptions report morphological investigations and any disputes without promoting a particular standpoint. The diagrams have been redrawn to update the information; they are clear and beautifully colored. The main text has new pencil reconstructions of many of the animals. The whole arrangement of the phyla within the second part of the book has also necessarily been changed to follow newer ideas of phylogeny, which is most helpful. Many genera have found new homes following more recent research.

The new edition is a larger size as well (letter rather than quarto), and with a different typeface (Minion rather than Palatino); the larger pictures and double-column text makes the book more attractive, gives room for more information, and makes it easier to read. Overall, the writing is accessible yet informative and authoritative. The genus and species descriptions could be challenging to some readers without a zoological dictionary at hand, but this book is designed for paleontologists, not casual readers.

This book is a necessary revision of the Chengjiang biota, and is still the only accessible reference to the biota in English. The work is authoritative and highly illustrated; the high-quality illustrations were, and are, an immensely important aspect of the work. They show just how beautifully preserved these soft-bodied animals are and how, with the requisite skills, this extraordinary detail can be illustrated. It is essential that this book be on every paleobiologist's bookshelf.



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Reviewed by Phil Novack-Gottshall (Benedictine University)

The publication of a new *Treatise* volume is always a welcomed event to be celebrated, and in this case, it's a double celebration! In 2003 and 2004, under the decades-long leadership of the late J. Keith Rigby, Sr., the first revised *Treatise* volumes of the Porifera were published as volumes 2 and 3. This was the first comprehensive revision of the phylum since 1955's original Part E by de Laubenfels, which also included Okulitch's pioneering chapter on archaeocyaths, later revised by Dorothy Hill in 1972. The 2003 and 2004 revisions started in 1987, with substantial earlier work initiated by Robin Reid and Robert Finks in the 1970s. The task of revising the enormously diverse "hypercalcified" sponges and allied taxa here in volumes 4 and 5 also started in the late 1980s under the leadership of Barry Webby, completing the revision of the phylum.

The earlier 2003 and 2004 revisions focused on demosponges and hexactinellids (vol. 2 and 3) and heteractinids (vol. 3), with the end of volume 3 systematically describing several "hypercalcified" sponges. The final volumes (parts 4 and 5 published in 2015) focus on these "hypercalcified" groups, those sponges with non-spiculate, rigid calcareous basal skeletons that have played enormously important framework roles in reefs throughout the Phanerozoic. These forms include stromatoporoids, chaetetids, sclerosponges, chambered sphinctozoans, reticular (non-chambered) inozoans, and archaeocyaths, all of which are now rooted firmly within the phylum Porifera. The primary synapomorphy uniting these diverse taxa is the presence of a similar aquiferous system that, presumably using choanocytes, draws feeding currents across (in the case of astrorhizae) and through the porous body for suspension feeding, as well as for respiratory and other physiological functions. Although many of these taxa lack spicules as adults, there is now evidence of diagenetically altered spicules in early ontogenetic stages in some chaetetids and Mesozoic stromatoporoids. (Although hypothetical on my part, perhaps it may turn out to be the case that all the nonspiculate stromatoporoids, archaeocyaths, and others retained spicules in their earliest settlement phases.)

SEM photography of microstructure in fossil and living taxa combined with the discovery of unusual extant stromatoporoids and chaetetid-like "living fossils" starting fifty years ago have resolved numerous systematic questions that have plagued the systematics of sponges and allied taxa for decades. Although the traditional sponge classes Hexactinellida, Calcarea, and Demospongiae remain intact—and they continue to be defined in terms of their distinct spicule mineralogies and morphologies—mineralogy itself no longer holds hegemony as primary criterion. Membership of Demospongiae has changed the most, now including many taxa with siliceous spicules in addition to those with proteinaceous spongin, and several living "hypercalcified" demosponges having siliceous spicules attached by calcareous cements early in ontogeny. Other valid classes include the Paleozoic Heteractinida, Stromatoporoidea, and Archaeocyatha, and the problematic archaeocyath-like groups Radiocyatha and Cribricyatha, whose affinities remain uncertain.

Given the more than 1,200 pages in the two volumes—approximately the number of sponge genera cataloged in volumes 2 and 3—it is impossible to provide even a cursory summary, but here are some highlights.

Francoise Debrenne, Andrey Zhuravlev, and Peter Kruse cover the 307 genus-rich Archaeocyatha in volume 5, considering them a monophyletic class of Cambrian sponge with probable affinities to the demosponges. The traditional breakdown between Regulares and Irregulares has proven phylogenetically unsound (Debrenne, et al. 1989). Instead, the archaeocyaths are divided into six orders, with most "Regulares" placed in the order Ajacicyathida and most "Irregulares" placed in the order Archaeocyathida *sensu strictu*. The ontogenetic development of archaeocyaths has been extensively studied in recent years, and the taxonomic classification is now largely established based on differences in these ontogenetic sequences while avoiding traits liable to vary ecophenotypically.

Colin Stearn, Barry Webby, Heldur Nestor, Stephen Kershaw, and Carl Stock cover the Stromatoporoidea in both volumes 4 and 5, which they consider a separate monophyletic class of sponge with 125 genera in seven orders. Stromatoporoids are defined according to the internal structure of their basal skeleton and lack of spicules. Taxa historically defined by superficial "stromatoporoid" growth habit include many non-stromatoporoid lineages that are more likely hypercalcified demosponges. (*Calcifibrospongia* and *Astrosclera* are examples of extant demosponges with convergent stromatoporoid-like growth habit.) Originating in the Middle Ordovician, all stromatoporoids *sensu strictu* perished by the latest Devonian, with the possible exceptions of the clathrodictyid *Kyklopora* in the Carboniferous (Serpukhovian) and the labechiid *Lophiostroma* in the Triassic, although there is some debate as to whether either or both are true stromatoporoids.

Chaetetids, discussed in volume 4, represent a polyphyletic group of demosponges instead of tabulate corals (as in prior *Treatise* volumes); however, some previously considered chaetetids remain as putative tabulate problematica (e.g., *Lichenaria*, *Staphylopora, Amsassia, Barrandeolites, Tiverina)*. The genus *Chaetetes* is considered a form genus and the traditional chaetetid subclasses Tetractinomorpha and Ceractinomorpha are abandoned as polyphyletic.

Sphinctozoans (=thalamids) and inozoans are now deemed polyphyletic and used only to describe hypercalcified sponges with and without chambers, respectively. Despite their calcareous skeletons, most of the 160 sphinctozoan genera and 100 inozoan genera are now considered members of the Demospongiae, but some taxa remain members of the Calcarea. The demosponge *Vaceletia* and calcarean *Peronidella* are extant examples of sphinctozoan and inozoans growth forms, respectively. Most of the higher-level sphinctozoan and inozoan taxonomy in volume 4 (by Baba Senowbari-Daryan and Keith Rigby before his death in 2012) remains unchanged from those proposed a decade ago by Finks and Rigby in volume 3, but there are a few changes. The class is re-spelled as Demospongiae to align with standard zoological practice. Tetractinomorpha and Ceractinomorpha are now abandoned as demosponge subclasses because they are polyphyletic. Order Verticillitida replaces order Vaceletida by priority. Senowbari-Daryan and Rigby no longer include hypercalcified sphinctozoan or inozoan sponges in the subclass Calcaronea—they move sphinctozoan orders Sphaerocoeliida and Lithonida and inozoan order Stellispongiida to subclass Calcinea—although Barry Webby maintains all these orders within subclass Calcaronea in his phylum-level systematic overview on page xlix.

Jean Vacelet, Philippe Willenz, and Willard Hartman contribute an important chapter in volume 4 covering the biology and ecology of all 19 genera of extant hypercalcified demosponge and calcarean sponges, primarily living in shaded reef crevices, submarine caves, deep cliffs, and other refugia. Ronald West and Rachel Wood add in the 48 extant and fossil (primarily Mesozoic) chaetetid- and stromatoporoid-like taxa, with 3 living "chaetetid" genera (*Acanthochaetetes, Ceratoporella,* and *Merlia*), and Stearn and Stock catalog the 65 post-Devonian stromatoporoid-like genera.

The terms "coralline sponges," Sclerospongiae, Ischyrospongiae, and Pharetronida (the order once used to contain sphinctozoans and inozoans) are abandoned as obsolete or no longer justified phylogenetically.

As always, the *Treatise* comprehensively and efficiently catalogs and describes broad taxonomic classifications, morphological diagnoses and illustrations and stratigraphic ranges for all valid and questionable genera, biostratigraphic zonation, diversity curves for many higher taxa, biogeography and faunal provinciality, functional morphology, paleoecology, ontogeny and growth habits, and extensive discussion of the biology of the few extant hypercalcified sponges. The glossary is notable for including obsolete and problematic terms the authors recommend be disused, which is an excellent practical choice that allows efficient understanding of current and past terminology. The use of cladistics remains rare in this phylum, reflecting in large part difficulties in identifying informative and consistently fossilizable character states. Essentially all of the relatively few extant hypercalcified species have undergone molecular confirmation of their systematic positions.

It is worth emphasizing that many of these taxonomic shufflings are nothing new to sponge workers, with most of the critical evidences first discovered in the 1970s (e.g., Hartman and Goreau, 1966; Vacelet, 1977), some much earlier (e.g., Kirkpatrick 1908, 1912). The enormous value of the *Treatise on Invertebrate Paleontology* series—in my opinion among the most important published monographs in the history of science—is that it not only provides a single, authoritative, and comprehensive reference for non-specialists in the group being studied, but it also creates the opportunity, increasingly precious but ever crucial, for dedicated systematists of diverse opinions to arrive at a productive consensus over matters that matter enormously for all paleontologists.

I will share my sole pet peeve with the *Treatise* practice, generally continued in these printed volumes, of not including scale bars in most figured illustrations and photographs. Body size is of such fundamental importance for identifying many species and for understanding the biology of the organisms, that excluding a scale bar is no longer excusable. Nearly all figures provide a magnification scale (i.e., x2, x0.333), but when viewed electronically in pdf format, that scale is essentially lost in digital conversion. These current *Treatise* volumes are better than most others because sponge workers shift between field photos, macroscopic images, and microstructure so frequently that they are accustomed to include scale bars, and most modern thin-section and SEM microscope images include scale bars by default. I strongly encourage future contributors to choose scale bars over magnification scales wherever possible, and even to superimpose new scale bars over re-published images in future printings. It would also be possible, if laborious, to overlay scale bars in the digital editions of past editions.

These latest volumes are essential reading for those studying ancient reefs, given the central role of these sponges as framework and accessory members: archaeocyaths in the Cambrian, stromatoporoids in the Middle Paleozoic, and chaetetids, sphinctozoans, and inozoans in the late Paleozoic–Mesozoic. (A reminder that all Paleontological Society members can take advantage of a 20% discount on bound volumes and can access for free electronic and text-searchable pdf versions of published volumes and unprinted chapters for forthcoming volumes as a perk of membership; log in at the members-only page at https://paleosoc.org/benefits-of-membership-in-the-paleontological-society/paleontological-society-members-login-only/. This is an amazing value-added for membership in the Society.) As with all *Treatise* volumes, also demand that your institutional library purchase print editions of these volumes, and purchase the complete run for your research library while you're at it. No respectable science library is complete without the *Treatise*.

As is any such masterful compendium that spans many decades to bring to fruition, the final publication is always a time for celebration. However, in reading the list of the dedicated authors and editors, we are reminded again of the many profound recent losses in our discipline: late editor Roger Kaesler whose critical role was maintained by Bruce Lieberman and currently Paul Selden, late Assistant Editor Jill Hardesty, and the losses of contributing authors Willard Hartman and J. Keith Rigby, Sr. These *Treatise* volumes surely attest to the transformative power of our paleontological discipline to better understand the living through the contributions of the deceased.

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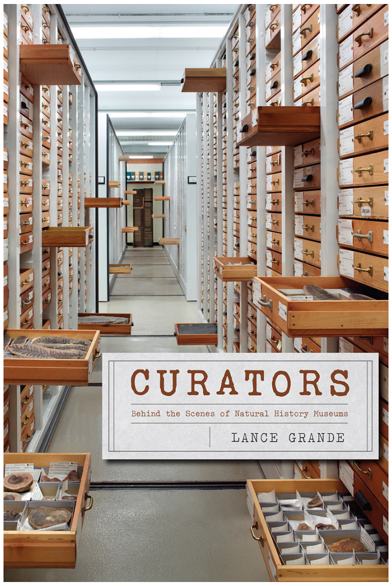

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Reviewed by John Clay Bruner (University of Alberta)

Dr. Lance Grande is the Negaunee Distinguished Service Curator at the Field Museum of Natural History in Chicago, Illinois. Grande is the author of more than 100 books and scientific articles, including *The Lost World of Fossil Lake: Snapshots from Deep Time* (2013), and *Gems and Gemstones: Timeless Natural Beauty of the Mineral World* (2009). Grande tells the reader in the Preface to this book, "I came to realize that few people understood what a natural history museum curator does. That realization was the first impetus for me to write this book." Grande tells what a curator is by telling his autobiography and introducing us to curators he has met during his career.

Grande grew up in Richfield, a suburb of Minneapolis, with his parents and three sisters, working in a series of part-time jobs after graduating high school, and attending Normandale Junior College. He was a medic in the U.S. Army. He started working towards a business degree in 1973 at the University of Minnesota. In August 1974, his friend Hans Radke came back from a trip to southwestern Wyoming and gave him a gift of a fossil fish that changed his life. It was a 52 m.y. Green River Fm. *Knightia eocaena*. Grande brought the fish into U of M's Geology Department to a professor of paleontology, Dr. Robert E. Sloan. Asked to identify the fossil fish, Sloan said no but if Grande took his paleontology course, he would be able to identify it himself. Grande took the course, and liked it so much that he changed his major to geology. Grande went on for a double master's program in geology and zoology. His master's thesis title was "The Paleontology of the Green River Formation, with a Review of the Fish Fauna." Grande sent a copy of his thesis to Colin Patterson who curated the world's largest fossil fish collection at the British Museum of Natural History in London. Patterson was very encouraging and told Grande to enter a Ph.D. program at City University of New York under the care of Donn E. Rosen and Gareth J. Nelson, curators at the American Museum of Natural History. Rosen wrote Grande offering a four-year fellowship covering all costs and living expenses. After the first year of his Ph.D. program, Grande took his preliminary exam and passed three of the four sections but was down-graded in one section because of his cladistic influence in his answers. Grande had nearly been stopped by AMNH politics between the cladists and the traditional evolutionary taxonomists. Grande writes, "The experience taught me the depths to which scientific controversy can reach in a high-powered academic environment, especially in a time when established tradition is being aggressively challenged."

In Chapter 2, Grande tells how he was hired by the Field Museum of Natural History (FMNH) after completing his Ph.D. and began work in September 1983 as an assistant curator in the Geology Department. One of Grande's assets for getting the job was his well-established field program collecting Green River Fm. fossils, which all started with a gift of a fossil fish from his friend Hans Radke.

Chapter 3 discusses Grande's study site. Grande first collected the Fossil Butte Member (FBM) of the Green River Fm. in September 1975 and has been going back for two-to-three weeks a year for 33 years. Grande built up a complex network of personal connections with FBM landowners, stone quarries, fossil collectors, commercial fossil dealers, local universities, museum curators, National Park Service (NPS) employees, and public officials from Wyoming. Grande became an advocate of a citizen-science approach to paleontology. His network of commercial and amateur fossil collectors would notify him when something new or unusual was found in one of the FBM quarries. "This approach is a crowd-sourced method of resource collecting that harnesses the efforts of large numbers of amateurs and non-scientists." The National Park Service in the 1980s hired Grande as a consultant to help design a paleontological museum for FBM national monument. NPS staff and park interns often work with Grande's field crews to receive training. In the last 13 years, Grande has taught a field paleontology course called "Stones and Bones" through the University of Chicago, combining paleontological excavation for his research with educational training of highly motivated students. At the end of each course, he gives each student their own specimen of *Knightia eocaena*, usually a specimen they had collected themselves. "Maybe as this little fish sits on their bookshelf at home, it will help keep their interest in paleontology alive and growing as it did for me," Grande writes.

In Chapter 4, Grande tells of his first international project with the most unusual scientist he has ever known, Shelton Pleasants Applegate, curator and professor at the National Autonomous University of Mexico (UNAM). NSF had funded a grant to quarry Tlayúa Fm. Albian, Cretaceous fossils from a quarry in Tepexi de Rodríguez, Puebla, in a collaborative effort with the UNAM. Despite an earthquake in Mexico City, riding in Shelly's ghost mobile through the desert, and a bomb threat on the return flight from Mexico City, the 2.5-year project resulted in hundreds of fossils excavated and placed in the UNAM paleontological collections, a small collection to start Tepexi de Rodríguez's local museum called Mueum Pie de Vaca, and a sample of the collections sent to the FMNH.

In Chapter 5, Grande describes how he met and started a long-term collaborative research program on rayfin fishes with Willy Bemis, professor of biology at the University of Massachusetts. Grande called him the brother he never had. Willy Bemis and Grande developed a strong network of international colleagues in their travels to Russia, Israel, Japan, Italy, Spain, Germany, Belgium, Austria, France, England, Canada, Mexico, and in the USA: Utah, Colorado, Kansas, Alabama, California, Wyoming, Pennsylvania, Massachusetts, Connecticut, New York, and Washington, D.C. Their research required hundreds of rayfin skeletons. Willy came up with their most successful collecting venture in the Alabama Deep Sea Fishing Rodeo, the largest fishing tournament in the world. By offering free filleting services to the incoming boats, and a $200 prize for the most unusual fish, Willy, with a crew of students, volunteers, and visiting ichthyologists, was able to obtain hundreds of specimens for the FMNH and the University of Massachusetts.

Chapter 6 describes how the largest specimen of *Tyrannosaurus rex* was found by Sue Hendrickson, collected, seized by the Federal government, auctioned to the FMNH, and finally put on display there.

Chapter 7 briefly discusses a series of curators at the FMNH and their specialities: Greg Mueller (mushrooms); Rick Ree (flowering plants); Thorsten Lumbach (lichens); Michael Dillon (South American plants); John Bates (central African bird diversity); Meenakshi Wadhwa (meterorites); Philipp Heck (meterorites); Ken Angielczyk (dicynodont reptiles); Janet Voight (marine biology); Petra Sierwald (spiders); Shannon Hackett (evolution of birds); Corrie Saux Moreau (ants); Gary Feinman (anthropology and evolution of early economic systems); Ryan Williams (archaeology, Wari people of Peru); Bill Parkinson (archaeology, stone age man); John Terrell (human culture in the tropical Pacific); Robert Martin (evolution of primate biology and behavior); and, Chapurukha Makokha Kusimba (African archaeology and ethnology).

Chapter 8 discusses Karl Patterson (K-P) Schmidt (1890-1957) who was a curator of amphibians and reptiles at the FMNH from 1922 to 1955. K-P named more than 200 new species of reptiles, and was editor of the leading herpetological journal of the day, *Copeia*. He was elected to the National Academy of Science in 1956. In 1923 in Belize, K-P rediscovered Morelet's crocodile *Crocodylus moreletii*, a species that had only been reported once previously, in 1851. Grande recounted the tale of how on September 25, 1957, while identifying a live snake sent from Lincoln Park Zoo for identification, he was bitten and died. K-P had grabbed the snake too far back behind the head, which allowed the boomslang, *Dispholidus typus*, to maneuver and bite him on the thumb. K-P sucked as much venom out of the bite he could, but did not seek medical help and decided to start a log of his reaction to the bite. His notes were published posthumously by Clifford H. Pope in *Copeia*.

Chapter 9 describes how, after 21 years as a curator, Grande became the FMNH's vice president (later senior vice president) and head of Collections and Research (C & R) in 2004. The most challenging issue Grande had to face while heading C&R was budgeting for the division during the national financial crisis of 2007–8 and the global recession of 2008–12. The number of curatorial positions of 38 in 2004 declined to 21 by 2014. By using incentivized voluntary retirement for curators over 55 years of age and voluntary departures, the FMNH was able to avoid firing tenured curators.

Chapter 10 describes how in 2006 Grande was asked to redo the Grainger Hall of Gems exhibit last renovated in 1985. Besides scouring the FMNH collections, he went to the Oceanview mine near Pala, California and collected a tourmaline. Grande was able to persuade donors to donate jewelry, gold coins, and settings for jewelry. One special donor, Mrs. Thuy Ngo Nguyen donated millions of dollars worth of jewelry to the Grainger Hall of Gems.

Chapter 11 begins with the work of Franz Uri Boas, the first curator of anthropology at the FMNH who brought with him a collection of 400 human remains, forming the foundation of the museum's anthropology collection. Boas was followed by William Holmes, and then George Dorsey, who both were very aggressive in collecting archaeological material for the FMNH. William Duncan Strong was hired in 1927, fresh out of graduate school, as an assistant curator of anthropology at the FMNH. He was ordered to dig up 22 marked Inuit graves from Zoar, an abandoned Moravian mission in Labrador. For 83 years the remains sat in the FMNH until they were repatriated. The remains were reburied in the Zoar mission site on June 22, 2011.

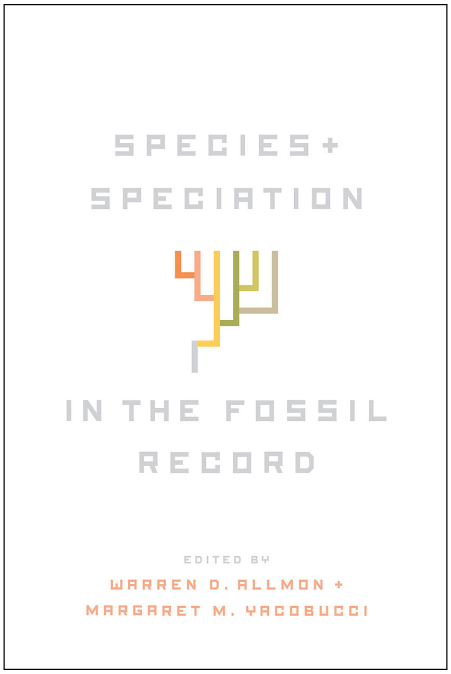
Chapter 12 deals with three Pattersons and the lions of Tsavo. Two lions from East Africa on display at the FMNH are credited with having killed over 150 people. Col. John Henry Patterson (1867-1947) was an engineer for the British railroad, game hunter, and British soldier. A pair of lions had brought construction on the Uganda Railway project near the Tsavo River to a standstill by coming into the worker' camps and feeding on them. Col. Patterson was hired to oversee the building of the railroad bridge over the Tsavo River. He eventually shot and killed the two lions. He sold their skins to the FMNH where they were mounted for display. Col. Patterson asked the director of the FMNH, Stanley Field to give his son Bryan Patterson a job at the FMNH. Bryan started in the Geology department as a preparator. He worked his way up to departmental assistant and was eventually made a curator. He was elected President of the Society of Vertebrate Paleontology in 1948. In 1955, he accepted a tenured professorship in vertebrate paleontology at Harvard University. In 1963, he was elected to the National Academy of Sciences. The third Patterson is of no relation to the first two. Bruce Patterson is curator of Mammals. His research focuses mostly on bats, rodents, and smaller mammals, and also on host-parasite

Book Review—Species and Speciation in the Fossil Record

coevolution. In 1998, Bruce began research on modern-day lions of Tsavo. Bruce studied the skulls of the FMNH man-eaters, which had been acquired with the skins. One of the man-eaters had severe tooth and jaw problems which would have made it very painful for the lion to make a killing bite to a struggling prey. Humans would have been a softer and easier prey.

Chapter 13 discusses saving the planet's ecosystems. Grande discusses Larry Heaney's three decades of research on the rain forests of the Philippines. Larry Heaney is curator of mammals at the FMNH. Larry and his collaborators have discovered dozens of new species of animals and plants endemic to the Phillippines. They have used their research to convince the Phillippine government to establish several national park reserves within the rain forest. Rüdiger Bieler, curator of invertebrates at the FMNH, is working with others on a project to re-skin dead coral heads with the living tissue of the same species that formed the coral. The rejuvenated coral structures return to their former role as the "rain forest of the sea."

Chapter 14 ("Where do we go from here?") discusses the need for natural history museums and better educating the public. Senior scientists must address the problem of scientific illiteracy. Curators should increase their efforts to engage the general public.



Allmon, W. D. and M. M. Yacobucci, eds. 2016. *Species and Speciation in the Fossil Record.* University of Chicago Press. Chicago, IL, 384 pp. ($45.50 cloth, $7.00–45.50 e-book with 30% PS discount.)

Reviewed by Andrej Spiridonov (Vilnius University and Nature Research Centre)

The fossil record presents the preeminent evidence for the evolutionary origins and subsequent development of life on the Earth. One of the key components in the discussion of the evolutionary process is the definition of entities that are involved and explained by the theory. Starting from Darwin, and arguably even before that, the so called "species problem" emerged. Apparent discreteness of phenotypic variants in nature called for the explanation of these discontinuities. Numerous species concepts originated in the subsequent centuries of research. Paleontology deserves its special place in the realm of evolution, since here species are studied in all of their grandeur, in the time-transgressive framework. This poses its unique problems in definitions and applicability of neontologically based concepts (i.e. "biological" species concept). Additionally, paleontology is poised with the fundamental incompleteness of its material (not to say that every modern species is described based on the "complete" set of information), which makes comparison of neontologically and paleontologically defined species (even if agreed-on in concept) far from straight forward.

In the new book *Species and Speciation in the Fossil Record* edited by Warren D. Allmon and Margaret M. Yacobucci, a group of authors make a new and interesting assault on the centuries-old problem. Even though there were several treatments of species and speciation problems in paleontology in a book format in the past, a new look, which encompasses modern development in evolutionary biology, mathematical modelling, and in paleontology itself, was badly needed. I see the current attempt made by the author as a starting point for this new discussion, and a more rigorous and better practice of species description and speciation research in paleontology.

The book is composed of fourteen chapters that conceptually can be subdivided based on their content in the following categories: (A) conceptual, philosophical and historical foundations of the species concept in paleontology (Introduction, Chapters 1–3); (B) species definition, recognition and comparison issues in selected clades (Chapters 9–11); (C) methods for studying stages of speciation and their relation to the duration of lineages (Chapters 4 and 6); and (D) case studies directed toward detection and characterization of evolutionary rates and modes of speciation and phenotypic change (Chapters 5, 7, 8, and 12–14).

The general consensus of the conceptual parts of the book (Allmon and Yacobucci; David Sepkoski; Miller III; Allmon) is that the most adequate and "capturing-all" species concept is the evolutionary lineage concept, which sidesteps the very restrictive (and case-specific) assumption of interbreeding of organisms (untestable in paleontology, and not applicable outside sexually reproducing organisms), strict monophyly (because a lineage can form through hybridogenesis, and descendant species can coexist with their progenitors), or even time-independent trait distinctness (the level of phenotypic difference between closely related species could vary greatly through the life-time of the lineage). This definition is very broad, and it encompasses essential species features such as its individuality (which can be sustained not only through the exchange of genetic material) and potentially its phenotypically ephemeral character. Although all authors of the book presented their conceptual and empirical work based on the studies on sexually reproducing animals, the *species-as-a-lineage* definition should be indispensable for the study of the whole spectrum of life.

The parts of the book which were focused on the taxonomic study of species in the fossil record (Chapters 9 by Schweitzer and Feldman, 10 by Ausich, and 11 by Bemis) made a good job elucidating problems which taxonomists face when describing species level taxa from fossil material. One major lesson that can be learned from these discussions is that the fossil species are usually described from different sets of characters than their modern counterparts. The cures for that (on the side of paleontologists) could be (A) a search for the skeletal correlates of diagnostic soft tissue characters and/or (B) more thorough redescription of modern species with respect to the characters that are relevant for paleontologists. This is especially true for the case of cryptic species, which need more attention from the paleontological community. These procedures would certainly better tie together both data sets, and make applications of many neontological techniques of evolutionary research in paleontology more credible.

Chapters 4 (Allmon and Sampson) and 6 (Liow and Ergon) deserve special attention because they provided basics of what could be called "species reproductive biology." The basic idea of Allmon and Sampson is that in order for a population to develop into a fully established species, a whole set of conditions, with their specific ecological and genetical processes and characteristic times scales, should be completed in a specific sequence. This framework gives us a clue of what we should search for and expect in order to prove or disprove certain theories of speciation. This could be the start of the new agenda for paleobiological research. Chapter 6 by Liow and Ergon describes a statistical framework for the detection of lineage age-dependant speciation processes. The problem is certainly not trivial, because apparent speciation-age distributions are formed as a result of convolution of species survival and origination functions. In a similar vein, the detection of differential time-dependant speciation probabilities could elucidate us about the populational, biogeographical and ecological conditions which enabled speciation events.

Chapters that discussed issues in studying evolutionary rates and modes in the fossil record are very diverse and quite eclectic. Hageman in Chapter 5 proposed a new way of studying and conceptualizing evolution in lineages by plotting normalized maximum lineage-specific genetic distances against their similarly normalized phenotypic distances. Such phenotype-genotype spaces could be interpreted in a meaningful way in classifying patterns and rates of evolutionary change. The author discussed application of this technique to phylogenies of modern organisms calibrated with the fossils. I think the application of such normalized genotype-phenotype spaces could be even more promising in studies that have simultaneous access to ancient DNA and fossil phenotypes.

Budd and Pandolfi (chapter 7) studied patterns of phenotypic variation (ecophenotypy vs. abundant polymorphism) in modern as well as fossil coral species. Such studies are very important because they provide the basis of species recognition in related groups in the fossil record. Yacobucci (chapter 8), on the other hand, thoroughly integrated distributional, developmental and ecological information on ammonites in a comprehensive and testable model of speciation in this exquisitely preserved and abundant fossil group. Stigall (chapter 12) discussed her and others' works related to species invasions and their role in speciation processes, and mechanisms of their interaction that could promote or conversely inhibit originations. This is one of the few attempts to explicitly acknowledge spatiality of species and speciation processes. Hopkins and Lidgard in chapter 13 analysed possible "tautology effects" in defining evolutionary modes in fossil lineages. This could happen when the studies of evolutionary rates are restricted to those characters that are pre-selected for taxonomic purposes (and thus by definition stable through the duration of a species). The authors warn us that we should be more careful in our research design and be more agnostic to characters that will be included in our tests of evolutionary modes. In the final chapter (14), Prothero and his numerous colleagues presented results of morphometric studies of vertebrates from the La Brea tar pits. Apparently all of the studied lineages show stasis in the face of dramatic changes in climate during the later part of the last ice age and the Holocene. It reminds us of the puzzling nature of the phenomenon and its apparent discordance with the prediction of modern evolutionary theory.

If I could point to the one major shortcoming of the presented book, it certainly should be the lack of attention to the recent developments in quantitative stratigraphy. Most paleontological discussions of the analysis of speciation events ramble about the fundamental restriction in the resolution of the fossil record, pointing out its large "granularity," the crude spatial and temporal binning. There are, however, already significant advances in biochronology of the first and the last appearance events that could achieve an order-of-magnitude higher accuracy and precision (up to tens of Ka) in correlation and thus synchronization of processes compared to the usual zonation (Sadler, et al., 2003; Sadler 2004). Cyclostratigraphy and astrochronology, which is based on the detection of climatic signals modulated by certain quasiperiodic celestial processes, could be used in developing accurate (in a limit of ≈ 10 Ka) time scales for global records (Hinnov and Ogg, 2007). Currently underexplored are cross-recurrence plots, which are limited only by the sampling rate and time-averaging of sediments, and that could utilize any temporally and spatially coherent signals for high-resolution correlation (Spiridonov, 2017). An application of high-resolution species-level quantitative stratigraphy for solving macroevolutionary problems have already revealed impressive and unexpected results. For example, the Silurian, previously considered one of the dullest and the most stable time periods, apparently was characterized by constant recurrence of extinction events of high amplitude (Crampton, et al., 2016). At the current conceptual and technological level of development, fine-grained characterization of macrobiological processes, including species originations, is mostly constrained by the lack of interests in these developments (and to a lesser extent by the finances needed for abundant sampling) by the researchers. We certainly can come closer to ecological time scales. But in order to achieve that, the macroevolutionary community should be more interested in stratigraphy and especially in its modern developments. The old dichotomy paleobiology vs. stratigraphy in paleontology is certainly outdated.

Overall this book is a much needed step forward for a better and more rigorous evolutionary paleobiology. The diversity of topics and discussed clade-specific cases are certainly engaging and thought-provoking for many paleontologists. This book is a "must have" for any paleontologist because it touches the central aspect of our science, namely the description and explanation of the patterns of biotic diversity in the geological past.

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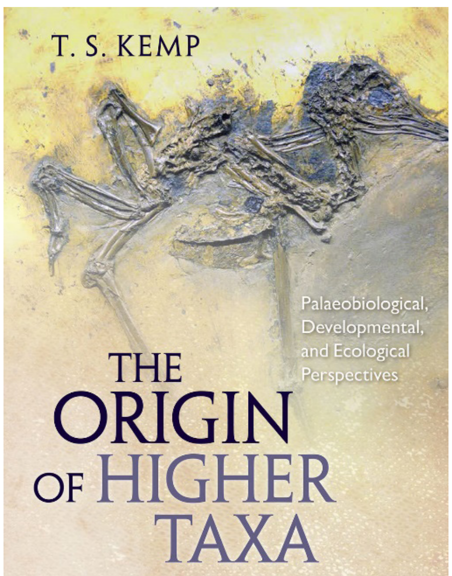

Kemp, T. S. 2015. *The Origin of Higher Taxa: Palaeobiological, Developmental, and Ecological Perspectives.* University of Chicago Press. Chicago, IL, 320 pp. ($84.00 cloth, $34.30 paper, $7.00–34.30 e-book with 30% PS discount.)

Reviewed by G. Alex Janevski (Shell Oil USA)

The most striking indication that T. S. Kemp's volume is not a run-of-the-mill treatment of fossils is the ambitious title: *The Origin of Higher Taxa*. It's probably not a coincidence that this title evokes *On the Origin of Species* (Darwin 1859), or *The Origin of Phyla* (Valentine 2004). I would argue that *The Origin of Higher Taxa* instead finds a place in succession with shorter, theoretical texts, couched in the Modern Synthesis, that began with *Tempo and Mode* (Simpson 1944) and matured with *Macroevolution* (Stanley 1979). The title also evokes a field that has often been the playground of paleobiologists: the first appearance of new body plans, fodder for everything from one of the most popular treatments of paleontology in *Wonderful Life* (Gould 1989), to the biggest cultural controversy in science; evolution, and human origins, in particular. A similar book many centuries ago might have been ensconced within the *scala naturae* and written about how the "highest" earthly taxon, human beings, arose. Human origins are now so well-understood that we are just another ape and not a higher taxon at all, such that *Homo sapiens* merits only a passing mention in Kemp's work. How far we've come.

Which raises the question: what are higher taxa? Kemp states in the Preface that he intends to show a counterpoint to the view "that all evolution can be adequately explained by simple intrapopulational selection." To do so, Kemp devotes two chapters to defining the problem. In Chapter 1 he restates from the Preface the book's central question: are there unique processes or circumstances that apply to the origin of new higher taxa? In Chapter 2 he then asks what, exactly, is a higher taxon? Kemp's discussion is cogent, in spite of sometimes nebulous ideas like species concepts, as he literally asks, "are higher taxa real?" After discussing the evidence for higher taxa, Kemp concludes with a sort of "we know it because we see it" view that higher taxa are real entities.

Chapter 3 is belied by a title that sounds borrowed from a centuries-old biological treatise ("The Nature of Organisms"). It is apt as Kemp delves deep into a discussion of the relationship of evolvability to organismal complexity, integration, and modularity. He describes the "correlated progression model" of evolution (CPM), his model of evolutionary change (Kemp 2007). CPM is compared to modular (e.g., mosaic) evolution, in which tightly linked parts of an organism (a module) can evolve, while the rest of the organism does not, and atomistic evolution, in which all traits can evolve independently. Kemp faults modular evolution because modules may not exist, at least not for evolutionarily appreciable spans of time. Atomistic evolution is dismissed as convenient for phylogenetics, but not capable of capturing the complexities of evolutionary change. CPM falls in between these two models—every trait is potentially correlated with other traits, with varying strengths of linkages. Some linkages may be strong enough that we would describe that linked group as a module, and I suspect this may always have been a mental model for modular evolution. However, Kemp does a service in clarifying the models and their implications, and lays the groundwork for arguing for CPM, which becomes the book's thesis.

Chapter 4 is the first focused on paleontology, with introductory discussions that can be skipped by some readers, although they may benefit non-paleontologists. A section on phylogeny includes a basic explanation of cladistics, but with context of the changing role of fossils in phylogeny, from being ignored by some workers, to being crucial for calibrating molecular clocks. Kemp's treatment ascribes the superiority of molecular to morphological approaches due to data availability and relative objectivity of the former, while also describing the role that fossils play in understanding the evolution of higher taxa.

Chapter 5 delves heavily into developmental biology, where he recapitulates recapitulation and provides a few examples of the role of heterochrony in the appearance of new higher taxa, but surprisingly (intentionally?) leaves out discussion of "hopeful monsters." Following a theme of a chapter devoted to subdisciplines of biology, Chapter 6 targets ecology, and the discussion herein is the most theoretical, with special attention paid to whether gradients and landscapes could result in the evolution of higher taxa, particularly multi-dimensional landscapes. Here he states that key innovations alone cannot give rise to new higher taxa, because new taxa require changes across multiple traits, seeming to require the CPM to give rise to a new higher taxon.

Chapters 7 and 8 focus on the two major divisions of study in paleontology, invertebrates and vertebrates. I was skeptical of treating all invertebrate phyla within a single chapter and experts may find fault with such a summary approach. However, I thought the treatment of the Cambrian Explosion and the phylogenetic debates within major groups to be nicely summarized. Chapter 8, at 50 pages, was the longest, likely reflecting Kemp's interests, and partly due to a fossil record that he rightly argues is "more informative" as regards the origin of the main groups. I found this chapter to be less concise than the rest of the book, with the taxonomy esoteric; the story is the same for each group as Kemp argues that they evolved by way of the CPM.

The final chapter summarizes Kemp's thesis, that the CPM is the reason for the appearance of higher taxa, the previously presented evidence for it, and a short discussion of epistemology and whether paleobiological hypotheses are scientific. I'll refrain from opening wide this Pandora's Box on the nature of science and simply say that Kemp equivocates by saying that some are scientific, some less-so-, and others not at all, mostly due to the ease of testability of the hypotheses, rather than on their scientific merit or explanatory power. He concludes that explaining the origin of higher taxa, however, is a task of valid scientific pursuit.

Paleontologists who are more theoretically inclined and who have the most interest in what the fossil record suggests about the mechanisms of evolution itself will have the most interest in this book. Whereas both *Tempo and Mode* and *Macroevolution* presented patterns in the fossil record that begged for explanation (which were then provided), the *Origin of Higher Taxa* instead spends most of its time with the explanation (the CPM) already in mind, and builds around it. The passage of time will determine whether Kemp's attempt finds a spot on the shelf next to those major theoretical texts. I would argue that it comes close enough and deserves to be read for its concise synthesis. Only further testing will tell if the CPM can explain what we see as higher taxa.

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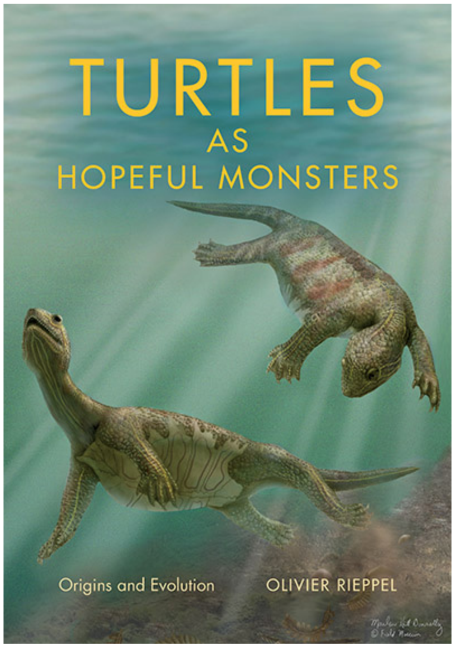
Book Review—Turtles as Hopeful Monsters: Origins and Evolution



Rieppel, O. 2017. *Turtles as Hopeful Monsters: Origins and Evolution*. Indiana University Press, Bloomington & Indianapolis, IN, 216 pp. ($31.50 cloth, $31.49 e-book with 30% PS discount.)

Reviewed by Asher Lichtig (New Mexico Museum of Natural History)

Turtles as Hopeful Monsters by Oliver Rieppel provides an overview of the history of study of the origin of the turtle shell. This review is intermingled with stories of impactful individuals in the life of the author and their contributions to both Rieppel's ideas and the modern evolutionary synthesis. This narrative proves both entertaining and informative as to the ideas surrounding the question "what is macroevolution?": microevolution on a longer time scale, or a process dotted with burst and leaps producing new body plans?

The book furthermore provides an extensive review of the history of turtle embryology back to its roots in the 1840's. This information is then weaved back into his interpretation of the oldest fossil turtle *Odontochelys* to provide an interesting argument as to the origin of the turtle shell. Incidentally, Rieppel repeats the incorrect age assignment of 220 Ma to *Odontochelys* which is closer to 235± 2Ma (Lichtig, et al., 2017).

Chapter 1 introduces the issue of the long-standing anonymity as to turtle's closest relatives or what is the sister group to turtles. Chapter 2 discusses some of the basics of reptile classification and its development before and after the development of cladistic methodology. Chapter 3 focusses on levels of evolution and the question is whether there a difference other than scale between microevolution and macroevolution, arguing that macroevolution is more than just microevolution over a longer period. Chapter 4 elaborates on chapter 3 focusing on the "hopeful monsters" hypothesis of Richard Goldschmidt. Chapter 5 discusses the origin of the turtle shell in particular, covering the embryological observations related to this in great detail. In the sixth and final chapter, Rieppel lays out the history of fossil collecting in southwest China and the animals found alongside the oldest turtle *Odontochelys*, finishing with a quick dismissive response to Reisz and Head's (2008) alternative interpretation of *Odontochelys* relationships

This book's greatest shortcoming is the lack of coverage of alternative hypotheses presented by recent work that receive only passing attention. This is more than offset by the intricate detail of the history of study of turtle shell formation. *Turtles as Hopeful Monsters* is quite thorough if one-sided and well worth reading.

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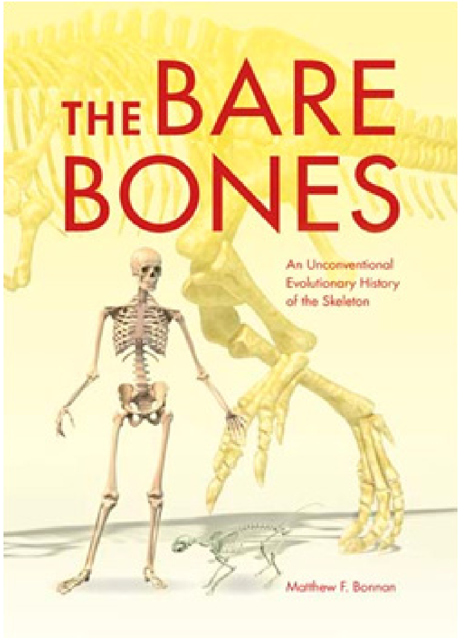
Book Review—The Bare Bones: An Unconventional Evolutionary History of the Skeleton



Bonnan, M. F. 2016. *The Bare Bones: An Unconventional Evolutionary History of the Skeleton*. Indiana University Press, Bloomington & Indianapolis, IN, 508 pp. ($52.50 cloth, $52.49 e-book with 30% PS discount.)

Reviewed by Thomas A. Hegna (Western Illinois University)

When explaining functional morphology, it is difficult to escape the tempting trap of distilling it down to just-so stories—narrative stories that connect form with function while leaving out the science. Matthew Bonnan's first book, *The Bare Bones*, does an amazing job of connecting form with function without sacrificing the science. *The Bare Bones* is a narrative history of vertebrate evolution through the lens of functional morphology. Indeed, the title rather undersells the book's scope—the book covers more than just the skeleton, but the evolution of the whole, integrated animal. In doing so, it completes the journey through vertebrate evolution while staying relatively accessible to layperson and expert alike. The book's predecessor is L. Radinsky's *Evolution of Vertebrate Design*, but in the over 30 years since its publication, no other comparable book for the lay audience has appeared.

The first part of the book outlines the central analogy—comparing the vertebrate 'chassis' to the automobile chassis. It also covers the basic background information for vertebrate paleontology: evolution and geology. (I must note here that the book makes a rare error here—it confuses mineral replacement with recrystallization. This is a point more obvious to an invertebrate paleontologist where the transition from aragonite to calcite is more common.) These topics form an important foundation for understanding the content of the rest of the book.

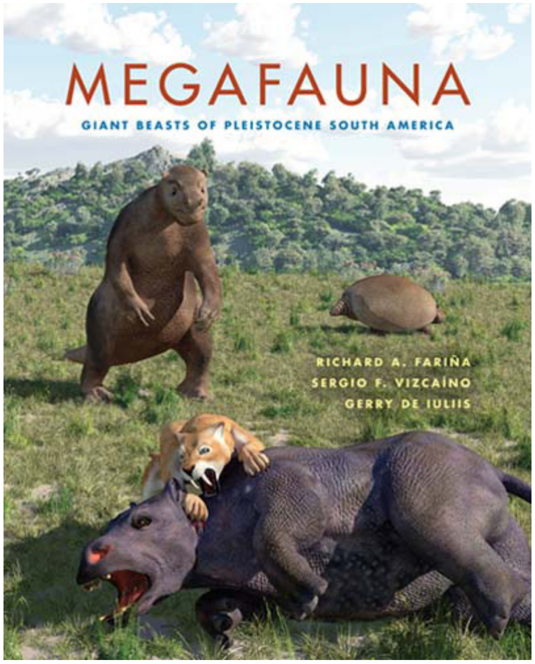
The meat of the book is given in parts two through seven, where the history of vertebrates is traced from the Cambrian until today. At various stages, exemplar taxa (both living and extinct) are examined to better understand the changes taking place in the vertebrate 'chassis'. These are illustrated with original illustrations that highlight the functional significance of the anatomy. All of this is done with a firm grounding in phylogenetics that drives home the evolutionary nature of anatomy and the historical 'baggage' that we each carry with us in our skeleton.

It is instructive to compare the book with another recent tome on functional morphology, the invertebrate-centric *Morphodynamics* by A. Seilacher and A. Gishlick. *Morphodynamics* is an easier read and carries more diverse, elegant analogies for functional explanations. *The Bare Bones*, on the other hand, shows its strength in its logical organization, its taxonomic thoroughness, and its commitment to phylogenetic context.

The book is a weighty tome. At 475 pages of text (not counting the thorough references and the index), it is a long read, but well worth it. The reader will be rewarded with an understanding of the origins of the functional and anatomical diversity of vertebrates alive today (as well as those extinct). This book is ideal for a class or seminar on comparative vertebrate anatomy or vertebrate evolution.

In all, Bonnan gives his readers a thorough and well-grounded account of vertebrate evolution, tracing its history from our earliest ancestors. I sincerely hope that this is the first book of many for Bonnan!

Book Review—Megafauna: Giant Beasts of Pleistocene South America



Fariña, R. A.; S. F. Vizcaíno, and G. De Iuliis. 2013. *Megafauna: Giant Beasts of Pleistocene South America*. Indiana University Press, Bloomington & Indianapolis, IN, 448 pp. ($45.50 cloth, $6.99 e-book with 30% PS discount.)

Reviewed by Ephraim Nissan (London, England)

This cleverly done, instructive, thematically wide-ranging book is very important not only for the fossil mammals of South America, but also for North American paleomammals (as the book discusses interchange through the Isthmus of Panama when it became available), and for the world history of mammals, because the reasoning provided on the remarkable peculiarities found in South America is relevant for what went on or did not occur elsewhere.

The South American fauna still has some peculiarities concerning size, but there is no megafauna (except imported horses, and the odd elephant or giraffe at the zoo). A case in point is the capybara, the largest extant rodent at 60 kg, quite large for a rodent, yet not a particularly large mammal. But fossil capybaras could reach 150 kg (cf., pp. 195–196), and there existed even larger rodent taxa. The chinchilloid rodent *Phoberomys* weighed as much as 700 kg, like a buffalo (p. 196). Curiously, it is only on page 317 that a statement is made to the effect that megamammals are those mammals that when adult weigh over 1000 kg.

"Remains of the Pleistocene fauna are common in mid-latitude South America, especially in Uruguay and Buenos Aires Province, Argentina; many such fossils had already been collected and housed in museums and personal collections by the end of the nineteenth century" (p. 277). "Despite such an early and auspicious beginning, the study and our understanding of South America's extinct mammals has generally lagged behind those from most other continents" (x), as though the too odd fauna was "antiquated curiosities of 'better' and 'more modern' mammalian designs" (x). In contrast: "The picture that has begun to emerge is that of a marvelous biota that resists being pigeonholed" (x), and "enlightens our concept of mammal-ness and enhances our knowledge of the past" (x).

One of the things about this book is that it is undemanding of the readers in its earlier part, but grows more and more technical, while remaining discursive enough to encourage less prepared readers not to desist. But the more you proceed, the more you realize how much this volume has to offer paleontologists. It evaluates the history of research into the fossil mammals of South America, and discusses several cutting-edge understandings, while also offering its own important hypotheses, which it argues for by marshalling interdisciplinary knowledge. But it also explains the various disciplinary perspectives in a manner that would not discourage such readers of good will who are learning while reading, and at the same time in the end the specialists are likely to be admiring rather than blasé.

It would be wrong to assume that what the book under review does for South America is similar to what the two volumes of *Evolution of Tertiary Mammals of North America* (Janis, et al. 1998, 2008; cf., Nissan 2000, 2009) did for North American paleo-mammalogy. The approach, the amount devoted to discussion, and how thoroughly and systematically the data are presented per taxon are very different. That is a matter for the future, for South America, and for the time being, to find data genus-by-genus and species-by-species, the literature about given taxonomical groups will have to do (e.g., Edmund 1985, 1996; MacFadden 1992; Cifelli 1993; De Iuliis 1996; Alberdi and Prado 2004; Christiansen 2008; Vizcaíno and Loughry 2008; Cartelle, et al. 2009).

Rather, arguably the book under review here is an enabler for future developments, because it provides a signal service in debating thoroughly a multitude of topics that it would be wrong to take for granted. What is more, it manages to do this almost seamlessly, and readably as far as this is feasible, including when the text gets technical in anatomy, mathematics, and biomechanics.

The jacket illustration, "Megafauna Landscape," is by Sebastián Tambusso. In the foreground, a sabertooth (a felid: earlier on, South America had a sabertooth marsupial, *Thylacosmilus:* cf. on p. 139)—this is a *Smilodon,* interpreted as "an ambush hunter that used its forelimbs for subduing prey and thus imparting an accurate, mortal blow with its … canines" (p. 190)—high on adrenaline, has begun to rip the flesh of the short neck of a live, fallen, scared large herbivore. It is a toxodon, a massive notoungulate with peculiar incisors: curved inside in the upper jaw, and a spadelike one in the lower jaw (p. 203). Tambusso was right to make this dentition very conspicuous; reconstructuions of *Toxodon* by other artists I have come across missed out on the teeth.

Meanwhile, behind the back of the sabertooth, a gigantic ground sloth, a *Megatherium,* standing bipedally, is watching and waiting for a chance. This reflects a hypothesis argued for in this book. It proposes on page 305 that *Megatherium* incorporated flesh into its diet. Its sheer bulk, along with the biomechanical aptitude to hit powerfully, enabled it to bully medium-sized carnivorans (typically, *Smilodon*) into renouncing their meal in favor of the *Megatherium*. This is, among the other things, an interesting twist on the dearth (concerning which, see pp. 291, 297–300) of large carnivores in South America, after the terror birds of the Early Cenozoic disappeared. Moreover, the *Megatherium* on the cover is hairless, which is something else that this book (pp. 213–214, 259) argues for (as already claimed in Fariña 2002). In the past, artists reconstructed *Megatherium* based on different assumptions.

Still in the jacket illustration, which reflects hypotheses made in the book, on the front cover from a distance one can see a ring-tailed *Glyptodon* uninvolved in the drama in the forefront. In the back cover, a continuation of the jacket illustration, two glyptodontines of the species *Doedicurus clavicaudatus* (cf., p. 245), with long bony clubs as tails, proceed in the same direction but opposite verse, i.e., they are positioned head to tail to each other, for the time being in apparent indolence, but quite possibly, they are about to fight and try to break each other's armor. The biomechanics of delivering blows with such tails to an opponent's carapace is explained on pages 246–248. Meanwhile, two human hunters, half-hidden in the vegetation, watch from a distance. In a sense, on the dust cover they are representatives of much of Chapter 9. Human hunters-gatherers in relation to glyptodonts are the subject of Politis and Gutiérrez (1998), and perhaps the illustrator has specifically that article in mind.

In a sense, the jacket illustration responds to a landscape of South American (in particular, Argentinean) paleomammals—Pleistocene megafauna as understood a little over one century ago—painted towards the end of the 19th century, and reproduced and discussed on pages 275–276.

In the preface-cum-acknowledgements, a shorter Spanish-language book (Fariña and Vizcaíno 1995) is mentioned as a precursor, from which some material was reused. Chapter 1 is "Paleontology and Science: What is Science?." It begins referring to peculiarities of extant South American fauna, whose largest mammal is the tapir, and which "boasts no true megamammals" (p. 3), even though the capybara (at 60 kg) is the largest rodent, and the giant armadillo and the giant anteater are the biggest extant xenarthrans (p. 3). "It was Charles Darwin himself who corrected Buffon: rather than absence, the reality for huge South American mammals is recent demise" (p. 3).

The rest of Chapter 1 is a felicitous introduction to paleontology within evolutionary biology, and a discussion of lay attitudes to the discipline, in particular scepticism, widespread misunderstanding of what science is, and relation to religion, including, for example, there being "a good number of evolutionary biologists" who also "maintain their spiritual faith" (p. 6). An important part of Chapter 1 clarifies that it is the comparative method that the discipline uses in the main, as the past phenomena it researches cannot be recreated in the laboratory (as opposed to modelled), even though, for example, the analysis of functional anatomy uses a combination of comparative and experimental methods (p. 10).

Chapter 1 then turns to explaining taphonomy and fossilization, and (in yet another section) Linnaeus and classification, and then again, stratigraphy and its early scholars: the 17th-century Nicolaus Steno and the principles he proposed (original horizontality, strata superposition, and lateral continuity); the 18th-century James Hutton and uniformitarianism; Darwin's friend Charles Lyell; William Smith and the ability to correlate rock units over large distances, by the principle of fossil succession, thus, biostratigraphy.

Chapter 2 is "Distinguished Paleomammalogists" (such who dealt with, or worked in, South America), with sections about Cuvier (who described and named *Megatherium americanum* and understood that this is a sloth), Darwin (who in 1834 collected remains of *Macrauchenia,* and like Richard Owen, related it to Camelidae, which is not its present-day place in classification), and Dámaso Antonio Larrañaga of Uruguay (who in 1814 collected remains of *Glyptodon* but mistook it for an armoured megathere). Larrañaga was a clergyman. His being described as "Presbiterian" (38) in the title of a section is not the *mot juste*.

On page 39, there is a pointer to Chapter 6 to find out about Teodoro Vilardebó (who is the subject of a box on p. 185) and Bernardo Berro (see pp. 168 and 184). Vilardebó and Berro found in 1838 the first described glyptodont. On page 184, we are told that Berro became president of Uruguay; I would add that later on he attempted a coup and was killed on February 19, 1868, after his party boycotted the elections. The photograph of Vilardebó reproduced in the book was apparently somewhat difficult to find. For completeness, refer to the portrait of Berro shown here.

A section in Chapter 2 is devoted to Francisco Javier Muniz, the first naturalist of Argentina, the discoverer of the sabertooth, *Smilodon*; Sarmiento (1885) is his biography. Next, there are sections that deal with Richard Owen ("in his prime, during much of the 1830s to the 1850s, he was known as the British Cuvier" p. 42), Peter Wilhelm Lund (a Dane, the father of Brazilian paleontology, who recovered over 12,000 specimens), Hermann Burmeister (a German-born leading Argentinean naturalist and museum director, whose 1874 work on glyptodonts is still quoted; Burmeister is the subject of a booklet by Birabén, 1968), and the Ameghino brothers, i.e., the legendary Florentino, whose "strengths lay in analysis and synthesis" (p. 54), and the indefatigable collector Carlos. Eventually, both brothers, in turn, became museum directors.

Further sections in Chapter 2 are devoted to the talented but arrogant John Bell Hatcher; to Lucas Kraglievich, admirable, wronged, and short-lived; George Gaylord Simpson, "a giant of the twentieth century" (p. 60); Carlos de Paula Couto, "the most important Brazilian mammalian paleontologist of the twentieth century" (p. 63); and (in Box 2.3) Cástor Cartelle (a Jesuit priest), an expert in fossil sloths (he has co-authored with Gerry De Iuliis, one of the authors of the book under review); and then Robert Hofstetter, "certainly the most influential twentieth-century paleomammalogist" (p. 67), whose principal focus was northwest South America (high Andes fossil fauna); and Rosendo Pascual, whose "efforts at the Museo de La Plata helped revitalize paleontology in Argentina" (p. 70). On pages 206–207, we are told about an error by Hofstetter, "unfortunately accepted by subsequent paleontologists, who labored for nearly 60 years under the mistaken impression of the past presence of strange megalonychids in Brazil," which "shows that even great paleontologists can be wrong."

Chapter 3 is "Geological and Ecological History of South America during the Cenozoic Era," which "provide[s] a broad outline of the tectonic, climatic, and biotic changes that occurred in South America over the course the Cenozoic [sic], focusing on the mammals, given that they have served as the main basis for establishing the biostratigraphic framework in South America" (p. 73).

In Chapter 3, after a section on plate tectonics, other sections explain paleoenvironmental change during the South American Cenozoic, how during that era the paleofloras and climates evolved, the stratigraphy and sequence of vertebrate faunas over the Cenozoic, and the Paleocenozoic Megacycle and its component parts. For example, in the Peligran Age (p. 83), one finds evidence of a toothed fossil platypus (akin to the tooth of the Australian genus *Obdurodon*).

During the Peligran, the Atlantic marine transgression into South America was so extensive, that according to different altitudes, apart from a long uninterrupted west, only parts of the east of the continent were above sea level as large islands (p. 86). What a contrast *vis-à-vis* the considerable portions of land (now under water) being exposed by lowered sea levels, along the eastern and especially southeastern coasts of South America (i.e., especially off Argentina's and southern Brazil's coast, and the Amazon estuary), during the Last Glacial Maximum (see Plates 6 and 10 after p. 276, Fig. 8.2 on p. 276, Fig. 8.2 on p. 278, and Fig. 9.8 on p. 337).

Box 3.1 on pages 86–87 introduces in general the native South American ungulates (possibly polyphyletic to modern Ungulata). "Over the course of the Prepatagonian Cycle, the younger of the Infracenozoic Supercycle, the native South American marsupials and ungulates reached their radiation climax" (p. 88); one genus from that time was the carnivorous bear-like marsupial *Callistoe vincei* (p. 89).

Box 3.2 (on p. 90) is devoted to the explorer George Musters, because the Mustersan Age fauna (35.3 to 28.8 Ma) was named after Lake Musters (89), which in turn was named after that explorer.

The late-Oligocene Deseadan Sybcycle (28 to 24 Ma) of the Patagonian Cycle saw new lineages of notoungulates and xenarthrans, the monkey *Branisella boliviana,* and the large, non-flying terror bird, the 2.5 m tall, 130 kg heavy *Phorusrhacos* (pp. 92–93). The genus was defined by Florentino Ameghino in 1887 (Ameghino, 1887); he had examined a mandible (I am now saying more than the book does), and he believed it was the mandible of an edentate mammal, so he described the genus accordingly. In 1891, *Phorusrhacos* was recognised to be a bird, but at that time, Moreno and Mercerat introduced the synonyms (no longer in use) *Stereornis, Darwinornis,* and *Owenornis*. The skull of *Phorusrhacos* was up to 60 cm long (p. 163).

In the Araucanian Subcycle (which at its beginning saw a change of vegetation), one comes across the jaguar-sized *Thylacosmilus atrox* (a marsupial sabertooth), as well as "the largest flying bird ever found, the giant teratornithid *Argentavis magnificens,* with a wingspan of 7 m and an estimated body mass of 60 kg" (p. 99), perhaps "a carrion eater that took advantage of the leftovers of the marsupial sabertooth" (p. 99), or even scared these away by kleptoparasitism, as at present spotted hyaenas do when they take over the prey of *Lycaon* canids in Africa (see in the caption of Fig. 3.17). The Miocene bird *Argentavis magnificens* is the subject of Vizcaíno and Fariña (1999).

In the Supracenozoic Supercycle, which only includes the Panpampian Cycle, "a radical change in the composition of the South American mammals took place" (p. 100), in particular at 3.3 Ma, as "37% of the genera and 53% of the species became extinct between the Chapadmalalan and the Barrancaloban" (p. 100), with the disappearance "of medium- and large-sized predators, either birds or mammals (see Chapter 8)" (p. 101), owing to tectonics or to asteroid impact. "Another important event that occurred during the Marplatan Age is the arrival of some newcomers of northern origin, but we will defer their story until their history in the northern continents is detailed in Chapter 4. We will also interrupt our narrative to treat the events that occurred in South America after the Marplatan (we'll return to this thread in Chapter 5), both because of what happened during Pleistocene times requires special consideration, and because we must first deal with the tectonic events, mainly the emergence of the Isthmus of Panama" (p. 101), which enabled faunal intermingling.

Chapter 4 is "Noth American Late Cenozoic Faunas," starting with a section entitled "Meanwhile, back in the north…," the next being "North American megafauna," beginning with the subsection "Proboscideans." Box 4.1 deals with Thomas Jefferson *qua* naturalist and his attempt to refute Buffon's inferiorization of American fauna: thus, Jefferson fingered the mastodon and the giant ground sloth.

In the subsection about the artiodactyls, Box 4.2 is "The extinction of the bison." Box 4.3 is "Confusing terms (oh, deer)" about such terms as *elk* and *moose* (p. 118). Also Box 6.3 on pages 229–230 is about names (but scientific ones). Animal common names, or vernacular zoonymy, are a broad subject, but also zoologists' handy common names such as *sabertooth* are part of zoonymy; see, for example, Nissan (2011, 2013 [2014], 2014).

The next subsections are "Perissodactyls" and "Carnivores (or, more accurately, carnivorans)." Box 4.4, "Mortal combat," is about the remains of two felid individuals of the genus *Nimravus* that supposedly fought each other so fiercely that they both perished (pp. 126–127), unless (which, the book claims, makes more sense) the remains are just of the same individual.

Preceded on page 134 by maps of how the Central American Seaway came gradually to be replaced with an isthmus—with either stretches of emergent land, or a coalesced volcanic arc, with a few marine corridors, before they closed up (p. 136), Chapter 5 is entitled "The Great American biotic Interchange [= GABI] and Pleistocene Habitats in South America." "Deer, pumas, jaguars, llamas, foxes, field mice, otters, and possibly peccaries and tapirs have ancestors that reached this continent less that about 3 Mya" (p. 135). Bear in mind that there used to be llamas in Florida in the Pleistocene (Webb 1974).

In 1950, George Gaylord Simpson categorized the faunal structure of South American mammals throughout the Cenozoic, into Stratum 1 (a closed system evolving in isolation, from the early Cenozoic), Stratum 2 being "an episode of restricted input, the ancient immigrants, into this closed system that occurred more or less during the late Eocene and Oligocene" (p. 137), and then Stratum 3, which "includes the arrival into South America of the vast majority of mammals from North America during the GABI" (p. 137), with mammals that went the other way as well, e.g., ground sloths. However, only the armadillo, opossum, and porcupine remain in North America. Incidentally, Neotropical porcupines, both extant and fossil, are the subject of Candela and Morrone (2003); cf. Wood (1985). As for the ground sloths, they lasted longer in the West Indies; the sloths of the West Indies are the subject of White and MacPhee (2001).

Stratum 1 includes the marsupials, as well as an assemblage of native ungulates (Meridiungulata), and the xenarthrans (armadillos, tree and ground sloths, anteaters, and glyptodonts). Stratum 2 (ancient immigrants) includes caviomorph rodents (an extant member is the capybara), and platyrrhine monkeys; their mode of arrival is puzzling and controversial (pp. 139–143). As for Stratum 3, the early Miocene saw perhaps the arrival of the earliest of the South American proboscideans (the Gomphotheridae, the subject of Shoshani, 1996)—unless they arrived in the Pleistocene (which is the common view), but "representatives of Elephantidae and Mammutidae did not enter South America" (p. 197)—and perhaps of tapirs, peccaries, and (in the mid-Miocene) raccoons (but these became extinct, and more raccoons came in the GABI: see Koepfli, et al. (2007)); and then, either in the Miocene, or later on, the mice-like Sigmodontinae arrived as well.

In the late Pliocene, the Marplatan Age saw the arrival of Mustelidae, Canidae, Equidae, and Camelidae. (South America's fossil equids are the subject of Alberdi and Prado, 2004 and cf. MacFadden, 1992.) The Ensenadan Age (early to mid-Pliocene) had seen the appearance of Hydrochoeridae (i.e., the capybara), Ursidae, Felidae, and Cervidae. (Pleistocene jaguars in *North* America are the subject of Kurten, 1973). Eventually, the Lujanian Age (in the late Pleistocene) witnessed the arrival of Leporidae and more Equidae (p. 144). "The extraordinary episode of extinction of the megafauna at the end of the Pleistocene [...] affected those that remained, those that left, and those that arrived, although perhaps to different degrees" (p. 150).

The section entitled "Geography and climate in the Pleistocene of South America" begins with the subsection "Useful approaches: astronomical forcing," which contains Box 5.1, "Milankovitch's three astronomical parameters." The next subsection is "Useful approaches: isotopes," comprising Box 5.2, "Using isotope ratios to estimate temperature." The next section is "Pleistocene habitats in South America." "The early [as well as late] Pleistocene land-mammal fauna of southern South America was dominated by grazers, followed by mixed feeders and carnivores, with browsers being much less diverse. This suggests that grasslands and steppes were widespread, with trees probably restricted to gallery forests" (pp. 157–158).

"Although in this book we focus on the large mammals of the mid-latitude plains and low hills of Argentina, Uruguay, and the southern-most part of Brazil, fossils of large mammals have been found in other places as well. Sometimes those other faunas have a slightly different taxonomic composition, albeit with allied genera" (p. 158). "Many of the mammals this book deals with may be found in the tropical part of South America, but different macraucheniid (*Xenorhinotherium*) and toxodontid (*Trigodonops, Mixotoxodon*) genera are present" (p. 158). "However, some of the ground sloths and glyptodonts seem to have felt more at home in the midlatitude regions, and therefore, the fauna reached its highest diversity there" (p. 158).

The next section ("Pleistocene communities") begins with vegetation history. Box 5.3 is about features of plants that apparently used to be dispersed when there still was a megafauna in South America, whereas now "a high proportion of a tree's fruit crop rots in the tree or on the ground beneath it without being taken by any potential dispersal agent" (p. 161), even in national parks with a high density of wild vertebrate populations. Cattle (and equids) instead eat such fallen fruits avidly: "The introduced large herbivores may re-enact many portions of the interaction the trees had with the extinct megafauna" (p. 162). Cf. the article "Neotropical anachronisms: the fruits the gomphotheres ate" (Janzen and Martin 1982). May I mention that plants with no longer the extinct animals that used (by mutualism) to disperse their seeds are also known from the Indian Ocean: John B. Iverson, an expert in world turtles, discussed the discontinued mutualism of the tambalacoque tree and discarded the hypothesis of dodo / tambalacoque mutualism in his paper "Tortoises, Not Dodos, and the Tambalacoque Tree" (Iverson 1987, reprinted as Appendix A of Nissan and Shimony 1996).

There is a section in Chapter 5 about vertebrates other than megamammals, such as giant tortoises, "now completely extinct on the South American mainland" (p. 163); where they were present, "the climate cannot have been particularly cool, as these ectotherms would have had trouble surviving cold nights" (p. 163). After a brief treatment of the avifauna (pp. 163–164), comes a section on small mammals, and then "Taphonomically interesting sites and specimens"" (with subsections on PehuénCó near Bahía Blanca, and on Ultima Esperanza Sound in Chilean Patagonia); and then a section entitled "Interactions between humans and megafauna at Estancia La Moderna" in Buenos Aires Province, also mentioning, for example, "Taima-Taima, a 13,000-year-old mastodont kill site in Venezuela" (p. 167). Next come the sections "Interactions between humans and megafauna at Piedra Museo" (in Patagonia), and "Interactions between humans and megafauna at Arroyo del Vizcaíno" (in Uruguay), which ends with a pointer to Chapter 9, where megafaunal extinctions are discussed.

Chapter 6, entitled "Bestiary," "explore[s] the Lujanian megafauna in all its fullness and diversity" (p. 171). "Our modern bestiary on Lujanian mammals contains facts and figures of Lujanian beasts that are sure to produce similar emotions in modern readers" (p. 171) to those produced by medieval allegorical bestiaries on their audience.

As an aside, consider that the *Physiologus,* a Christian allegorical bestiary from late antique Alexandria (Wellmann 1930, Brunner-Traut 1984), is the archetype of the medieval bestiaries of Latin Christianity; e.g., refer to Wood Rendell (1928), Bianciotto (1980), Clark and McMunn (1989), Kordecki (1996), Peil (1996), and Baxter (1998). (There is a twist to this: in the Greek magical papyri from Roman-age Egypt, imitations of animal cries are associated with magical polytheist formulae, and this in turn may have inspired—see Nissan (2014 [2016])—a deceptively naïve monotheist equivalent, putting biblical verses in the mouths of various animal kinds, sort of *Old MacDonald Had a Farm*, *EE-I-EE-I-O*. In fact, I do remember a neighborhood librarian entertaining children, who went like this: "And on that farm he had a... dinosaur! EE-I-EE-I-O, / With a [some improvised animal noise] here and a [noise] there," and so forth.) See Nissan and McLeish (in press) for additional discussion distinguishing between the fabulous bestiary and fabulous ideas about relations between beasts in the history of ideas, such as ideas between Roman antiquity and the 18th century about the relations between terrestrial quadrupeds and marine supposed equivalents. Or then, some given idea found in the *Physiologus* is sometimes just an instance of a fabulous theme about a folk-taxon (Nissan and Shemesh, in press).

Between pages 170 and 233, Chapter 6 comprises sections for the more representative genera. Such sections present an account of those taxa's "anatomy, general life habits, body size, diet, and topics concerned with their inferred habits" (p. 171), even on reported pathologies of fossil bears (p. 192), and their presumably sugar-related dental cavities. Those sections are preceded by sections on clades and their relationships. "The xenarthrans had enormous presence in the Lujanian" (p. 182).

Chapter 7, "Physics of the Giants," provides a rigorous discussion of the biomechanics of some of the megamammals. Box 7.1 on page 237 is about how Archimedes' principle is used in order to calculate the weight of paleomammals, by using scale models of allied taxa (e.g., of different species of glyptodonts), and weighing the volume of the water displaced. Box 7.1 is inserted into the section entitled "How do we tell a giant? A note on body size."

The next section, "How athletic were glyptodonts?," applies beam theory to the study of the strength of bones. The description of the calculations is readable. Fights between glyptodonts are argued for, through a rigorous discussion of biomechanics. Next, there is a section on digging (paleo) burrows as done by ground sloths, which were able to free their forearms for that task, as they "could easily have assumed a bipedal (though not erect) stance" (p. 251). This is also how the giant armadillo *Priodontes maximus* digs (p. 252).

Then come the sections "Was *Megatherium* a biped?" (comprising Box 7.2, "How to estimate the speed of a megathere"), and "Aggressive sloth," arguing for "aggressive use of the animal's large claws" (p. 256), the *Megatherium* forearms appearing to be optimised "for speed rather than for strength of extension" (p. 256). Blows were powerful: "The analysis of speed of the forearm of *Megatherium,* once the math has all been done, indicates that the animal could have moved its forearm at something more than 60° per second, which must have delivered a kinetic energy of about 2000 J [i.e, joules].This is impressive: it equals that of an object of 20 kg falling from a height of 10 m!" (p. 257). That *Megatherium* used its forearms and claws in order to hit, was already claimed by Fariña and Blanco (1996) in an article entitled "*Megatherium,* the stabber." But in contrast to *Megatherium,* cf. in the book under review, on page 286: "Mylodontids also have clear forelimb adaptations for digging, using their claws to help search for food." That was a different taxonomic group of ground sloths. The systematics of the subfamily Megatheriinae was reviewed in a bulky doctoral dissertation by one of the authors of the book under review here, Gerry De Iuliis (1996).

Following the section "Aggressive sloth" in Chapter 7, the next section is "Was *Megatherium* furry?" Using the equation for the flux of heat loss by conduction, it rather had a hairless skin (p. 259). The book under review disbelieves the idea that the gigantic sloth *Megatherium* had a thick furry coat (pp. 213–214); in the given section in in Chapter 7, the possibility it may have been largely hairless is argued for (p. 259); an earlier publication about that hypothesis was the article "*Megatherium,* el pelado" (Fariña 2002). The book also states: "[O]nly *Mylodon* [...] and *Nothrotheriops* [...] are known to have possessed a good thick fur coat" (p. 212). "The hide of *Mylodon,* found in a cave in Southern Patagonia, is one of the most remarkable fossil remains of this already astounding Lujanian fauna" (p. 207). There was a time when it was claimed that "ground sloths were corralled as though they were giant cattle" by humans (p. 208), inside an enclosure in a cave, but at present it is understood "that *Mylodon* and other animals used this and other caves in the area as natural shelters" (p. 209), and humans may have scavenged on this and other paleomammals.

"Was *Megatherium* furry?" is followed by the section entitled "The strength of dodging *Macrauchenia*." This long-necked, vaguely camelid-like herbivore was adapted to swerve at short distance when chased by a *Smilodon* (pp. 260–263). This was already discussed in the article "Swerving as the escape strategy of *Macrauchenia patachonica* (Mammalia: Litopterna)" (Fariña, et al. 2005). Swerving too early would have enabled the predator to reach the prey.

The subsequent sections are "The posture of *Toxodon*" (this is a massive animal we already came across when describing the jacket illustration), and "Masticatory function and geometry of the skulls of sloths," ending Chapter 7.

Chapter 8 is "General Paleoecology" (pp. 274–314), as "we are now ready to consider how this whole fauna worked together" (p. 275). Four sheets of colour plates are to be found after page 276. Sections of Chapter 8 include the following: "Paleoclimate, habitat, and floras of Luján and surrounding regions," "Flora and fauna from the LGM [i.e., Last Glacial Maximum] to the Holocene," "Composition of herbivores and carnivores of the paleomammalian fauna," "Estimation of population densities for fossil carnivores," "Niche partitioning," "Stable isotope geochemistry," "Ecology and size," and "Abundance of giants." This in turn is followed with "Productivity and climate," "Predators: a second imbalance?," "BMR and phylogenetic heritage" (which begins on p. 300, but BMR, for "basal metabolic rate," was introduced on p. 293, and for several pages preceding p. 300 it is not used again), and then "Cryptic flesh eaters?" (itself beginning on p. 304). Box 8.1, on page 309, is "Calculation of FEE." The acronym "FEE" stands for "the field energy expenditure (FEE, the average energy an animal expends for its usual functions)" (p. 295). The acronym "FEE" (like "BMR") does not appear in the index (not does "energy"). "FEE" is defined on page 295 and this time, too, sort of forgotten until the page where it reappears in the title of Box 8.1. In that box, we are shown, for example, how, by making an adjustment for the nearly 50% faster metabolism of carnivores *vis-à-vis* similar-sized herbivores, the maximum weight of a carnivorous land-mammal could reach one ton. And indeed, we are told in Box 8.1, the largest known carnivorous land-mammal reached 880 kg. This was the African Miocene creodont from Libya, *Megistotherium osteothlastes* (Savage 1973).

The next section is "A large river ruling the life and death of large South American Pleistocene mammals." That river was the Paleo-Paraná, or, the way the book spells its name, "Paleoparaná." Its now submerged floodplain and delta "would have provided a larger and much more productive territory for the megamammals" (p. 311), and we are told why. The last section in Chapter 8 is "What we want to know next."

Let us take a step backwards, to the beginning of Chapter 8, to a subject taken up again in that chapter's penultimate section, "A large river ruling the life and death of large South American Pleistocene mammals" (pp. 311–314). "The region between latitudes 33 and 37° S, bounded by the Pleistocene sand fields on the west and the present coast of the Río de la Plata (actually a large estuary) and the Atlantic Ocean on the east, has an extension of about 300,000 Km^2" (pp. 277–278). Page 311 further discusses the consequences of this. "Given that sea level was about 120 m (and perhaps more) below the present level during the final phase of the last glacial [...], the emerged land would have increased the land area to about 480,000 km^2, which represents an increase of about 60%. [...] Current paleogeographic reconstructions (Fig. 8.2 [on p. 278]) interpret the submerged region as the valley of a large river (the Paleoparaná), today covered by the Río de la Plata, and an immense delta, today submerged by the Atlantic Ocean" (p. 278). On page 311, we are told again that "current paleogeographic reconstructions [of the last glacial maximum] interpret the [by now] submerged region as the floodplain of that large river (today covered by the Río de la Plata) and an immense delta (now covered by the Atlantic Ocean)." The possibility of "submarine paleontology in the near future" is mentioned (p. 311). The book proposes "that mammals might have experienced seasonal migrations, to and from the occasionally flooded areas" (p. 312), like what observed in recent times "between the Serengeti and the Ngorongoro" in Africa (p. 312).

In the last section of Chapter 8, dealing with desiderata, we are told, "Analogies have been advanced as hypotheses between xenarthrans and sinosaurs and other archosaurs. For example, glyptodonts obviously exploited the same part of the ecomorphological space as ankylosaurs did in the Cretaceous in having been armored and possessed of heavy tails potentially used as clubs. *Armadillosuchus* among crocodiles [...] also bore heavy armor. Sloths have been compared to the advanced theropod therizinosaurs, such as *Nothronychus graffami* [...] To complete this view, anteaters with their adaptations for digging and tubular snouts have been proposed to parallel the theropod alvarezsaurids" (pp. 313–314). Senter (2005) actually referred to the theropod *Mononykus olecranus* as "a dinosaurian anteater."

Another theme in Chapter 8 is that "[t]he mammalian carnivore paleoguild seems to be depauperate, a hallmark peculiarity of Cenozoic South American mammalian faunas" (p. 291). See in Chapter 8 the section entitled "Predators: a second imbalance?" (pp. 297–300). In fact, the book looks for megamammals that had meat in their diet, and argues that one of them was *Megatherium*, supplementing opportunistically its herbivorous diet with meat. "Among sloths, the extremely low OSA [i.e., occlusal surface area] values for mylodontids might reflect poor food oral-processing abilities. If this were the case, these ground sloths, in order to maintain diets similar to those of the ungulates of equal body masses, would have been expected to compensate for the low efficiency in food processing by high fermentation capability in the digestive tract, lower metabolic requirements, or both" (p. 303). "The living tree sloths, *Bradypus* and *Coloepus,* have an extremely large four-chambered stomach, which can be considered equivalent to those of ruminants. Presumably, this might also be true for fossil sloths" (p. 303). "Surprisingly, *Megatherium americanum* seems to have followed a different route of specialization with an expected, or even higher, OSA value for a mammal of its size, and much larger if compared with mylodontids" (p. 303), the latter apparently being foregut fermenters, "while *M. americanum* would have been a hindgut fermenter" (p. 303), but if *Megatherium* (like living xenarthrans) did not have a cecum, "this is not congruent with hindgut fermentation" (p. 303). The book argues for "more intense food processing in the oral cavity [of *Megatherium*] than in mylodontids" (p. 303), considering features of *Megatherium* teeth. (Note by the way that the diet of another fossil ground sloth, *Northrotheriops shastensis,* was reconstructed from dung by molecular coproscopy, as described in Poinar, et al., 1998.)

In the next section, "Cryptic flesh eaters?," the book under review proposes that such teeth as *Megatherium* possessed suit herbivorous feeding being supplemented with the consumption of meat "taken in an opportunistic fashion" (p. 305): claws could have "rip[ped] carcasses (and perhaps even living animals)" (p. 305), then cutting the flesh into small pieces. "Finally, *Megatherium americanum* might have been an opportunistic scavenger that could have driven away a *Smilodon,* which would have had no desire to tangle with a bullying giant, that had captured the prey; this behaviour is termed kelptoparasitism" (p. 305). And indeed, the dust jacket shows a *Megatherium* in bipedal posture behind the back of a *Smilodon* about to kill a fallen *Taxodon*. "Bears are a possible analogue, but they never attained the size of the largest ground sloths" (p. 306). Besides, modern herbivores, "given the opportunity, will eat meat" (p. 306). In fact, I do recall reading (around 1990) a sighting report of an African antelope eating chicks; I spent the better part of a Sunday trying to trace that brief report or its bibliographic entry, to no avail. (Cattle being fed processed food derived from meat was blamed for mad cow disease, but that is another matter. Those cows did not ask to read the list of ingredients of what they were being fed.)

There is a discussion on pages 306–308 of the rib of a very large mammal, apparently of late Pleistocene origin, "with marks proposed to have been made by *Megatherium* teeth" (p. 307), possibly during scavenging, perhaps in order to obtain fat, or even just like what Sutcliffe (1977) discussed deer doing, when they chew bones and antlers to obtain minerals.

Chapter 9, "Extinction" (pp. 316–349), is a beautifully crafted survey-cum-discussion. It begins with a diagram showing size trends of large-sized South American mammals during the Cenozoic (p. 316). No taxa remain now in the 500-to-1000 kg and >1000 kg categories, but the previous two ages shown in the diagram (the Ensenadan and the Lujanian) saw the >1000 kg category peak at over ten taxa, whereas the immediately precedent age (the Chapadmalalan) saw the 500-to-1000 kg category peak at five taxa (reduced to four in the next two ages, as the largest rodent disappeared, as did the Tardigrada ground sloths from that category ending up in the >1000 kg bracket. In the Ensenadan, only Cingulata constituted the 500-to-1000 kg category).

"The various proposals put forth to explain the extinction events that occurred at the end of the late Pleistocene of South America fall into several categories: exclusively or primarily climate driven, exclusively or primarily human driven, some combination of climate and human activity, and extra-terrestrial (a relative newcomer to the game, and generally discounted)" (p. 317). There also is the infection hypothesis (Ferigolo 1999). By "extra-terrestrial," the book means the impact of one or more comets: especially, the quite controversial Younger Dryas impact hypothesis (also known as the Clovis comet hypothesis) that has been used by some in order to explain the onset of the Young Dryas cold period that resulted in the extinction of most of the megafauna of North America (such as camels, and the proboscideans), and in the demise of the Clovis human culture.

In Chapter 9, a long, interesting section (pp. 318–331) debunks the canard (manifest destiny of sort) of North American superiority in how relatively successful migrations of taxa between the Americas supposedly were, and how northern taxa supposedly outcompeted southern ones. For example, native ungulates were in decline in South America well before northern ungulates arrived. "Perhaps the rise and great success of xenarthrans in the mega-herbivore niche had something to do with it" (p. 329).

"North American mammals have done best in those niches that the native South American forms had not, for whatever reason, radiated into by the late Neogene and Quaternary. Thus, the carnivorans, sigmodontid rodents (field mice), and smaller ungulates (mainly cervids) are those that have been most successful" (p. 329). "That is, they faced little, if any, competition—quite the reverse of the idea normally espoused in the [northern] superiority hypothesis" (p. 329). "Contingency is to be considered the main cause, as in many other cases. To put it in colloquial terms, if you are already committed to being an anteater or sloth, it becomes difficult to enter and exploit the pronghorn or bison niche" (p. 329).

An important factor is that "[m]uch more of the North American landmass lies in a temperate belt as compared to the South American landmass, which offers a greater tropical region" (p. 330). "[D]uring the late Tertiary, uplift of the western Cordillera produced rain shadows and subhumid savanna corridors extending along a north–south axis" (p. 330), and once the Isthmus of Panama was in place, "those corridors provided a path along which temperate flora and fauna could pass back and forth" between the two by-then-connected landmasses of the two Americas (p. 330). Altitude rather than latitude provided new areas of temperate habitats.

The next section is "The role of intelligence": "we tend to hold other creatures to this standard, to the point of absurdity" (p. 331). It partly is a section about paleo-neurology. By comparison to armadillos, "one can conclude that the evolutionary strategy of glyptodonts was not based primarily on being particularly perspicacious" (p. 333): "this character was not very necessary for animals that given their large size and armor, quite efficiently warded off the dangers they faced, and that they did not need much of a brain to choose the patch of vegetation they were going to eat" (p. 333). Perhaps the latter statement is too cavalier: some herbivores, folivores (or omnivores like chimpanzees) need discerning ability to avoid toxic plants, and need learned knowledge that we, in an urban environment, most often no longer possess.

The brain size of South American fossil herbivores tends to fall below the expected range (p. 333), in comparison to more modern mammals, and the book explains the "tendency in the fauna of the globe to increase the variation in relative brain size as we get closer and closer to the present. In simple terms, the regions of the ecospace that remain available as an evolutionary novelty are those that can be occupied by more intelligent creatures" (p. 333). You sure? (By the way, in the caption to Paul Pierre Broca's photograph, I would have liked to see his years of birth and death.)

The next section is "The role of humans and climate: a mixed bag?" Among the other things, it considers possible migration routes for human incomers into northwestern North America at the end of the last glacial maximum, and, at the end of the section and chapter, "the discovery of the marks on a clavicle of the giant sloth *Lestodon* from the Arroyo del Vizcaíno site" (p. 346), in southern Uruguay—"87 marks (apart from the naturally made trampling marks) that had the features of all four types of human-made marks" (p. 347)—that suggest the presence, between 28 and 29 Ka, of a human community: "They may have been scarce, and become extinct or moved to tropical latitudes when the climate deteriorated" (p. 348).

That section also considers the causes and effects of increased tree cover and decrease of open areas during periodic interglacial periods (p. 342), or then the changed ratio being an effect of the disappearance of mega-herbivores (p. 345).

Chapter 9 is followed by "Epilogue: Lessons from the Deep Past" (pp. 351–352: less than two pages of text), in turn preceding four technical appendices, a large bibliography, and an adequate index. The first appendix, "A Primer on Skeletal Anatomy" (pp. 354–381), is the one that most resembles a chapter of the book. Appendix 2, "Skeletal Anatomy of Xenarthrans," is similar in that respect, only shorter. Appendix 3, "Equations used to Estimate Body masses Based on Dental and Skeletal Measurements and Their Respective Sources," is two pages and half crammed with lines in small type, each one an equation, most of them using logarithms, plus a citation of its respective source. Appendix 4, "Calculations," explains eight equations rather discursively. 21 pages of bibliography on three columns follow, and then a thematic index on pages 423–436 concludes this very rewarding book.

Lapses and typos are worth signaling, so they could be corrected when the book under review is reprinted. It is an important book, of lasting value. Note this contradiction: "*Bison latifrons* [...] had horns that spanned over 2.5 m" (p. 113, caption of Fig. 4.7), but "The largest recorded spread measures nearly 2.2 m from tip to tip." Grayson (1984), cited on page 333, is missing from the bibliography. Typos are only sporadic. I found "Tapirdae" (p. 325) for "Tapiridae"; "dipyletic" (p. 181) for "diphyletic"; "over the course the Cenozoic" for "over the course of the Cenozoic" (p. 73). The word "exulted" at the bottom of page 45 should be "exalted" instead. On page 48, both "Hermann" and the typo "Herrmann" occur. On page 127, of "*Smilodon,* a dirk-toothed Felidae," instead of the latter word (which is a plural noun, the name for the family), read "felid." On page 150, delete the first "to" from "These began in the Ensenadan Age (to early to middle Pleistocene, from ~2.6 Mya to 0.78 Mya)."

In Table 8.1 on page 281, one finds "extinct smalllllama)": the central l should be a blank space. On page 231, a Greek rho appears instead of a Greek pi in "καλυρτὸς 'veil', or more generally, 'cover'." On page 343, in the penultimate line of the first paragraph, "suffient" should be "sufficient." On page 142, in "together comprising Anthropoidea. Fossil anthopoids," replace the latter word with "anthropoids." Read "1932" in "Lucas Kraglievich (1886–1832, Fig. 2.22)" (p. 59). On page 50, in a passage about Florentino Ameghino, we are told he "was born perhaps in Liguri, Italy," which should read "in Liguria, Italy's northwestern-most coastal region" (Italian Liguri, stressed on the antepenult, means "Ligurians"). On page 119, in "the Americas were repopulated with horses of Eurasian descent during the 1400s," of course replace "1400s" with "from the 1490s onwards."

Spelling glitches include (my added emphasis on the superfluous vowel) "Notherotheriidae: Northrotheriops" (p. 325; cf. in the index on p. 431: "nothrotherrids and Nothrotheriidae," and "Nothrotheriinae" in the very long caption of Fig. 5.5 on p. 144). Also note on page 325 "*Onohippidion*," *vis-à-vis* "*Onohippidium*" in Table 9.1 on page 322 under Equidae (and the same in the index on p. 431). Besides, on page 322, in the penultimate line of Table 9.1, "*Steogmastodon*" should be "*Stegomastodon*." On page 321, in the last line of the first page of Table 9.1, "*Galicits*" should be "*Galictis*."

In the bibliography, on page 411, in the entry for Koepfli, et al. (2007), one finds "Carvnivora" for "Carnivora." In the penultimate entry of page 407, "12 279–299." Should rather be "12: 279–299." In the first entry of Cuvier on page 406, in "Cabinet d[a]Histoire Naturelle," the apostrophe became an "a" exponent. On page 412, in the entry for MacFadden, Solounias and Cerling (1999), a hyphen is missing from "5-millionyear-old horses from Florida."

Three remarks about Chapter 8: on page 284, *dicot* for *dicotyledon* is slangish, in "eating dicot (usually arboreous) material)," and puzzled readers would not find it in the dictionary. (The same could be said of "forbs" elsewhere in the book, for "Euphorbiaceae.") Note the newspaperese verbal form occurring e.g. in: "However, now that we've raised the point of facing competition" (p. 329). On page 286, read "their" for "its" in: "Within mylodontids, *Glossotherium robustum* and *Lestodon armatus,* the wide-muzzled sloths, were mostly bulk feeders, and the lips coupled with the tongue were used to pull out grass and herbaceous plants, which were probably its main dietary items." Incidentally, the mylodontine sloth commonly found in Uruguay, *Lestodon,* a "rhino- to elephant-sized beast[,] had a tibia (shinbone) as short as that of a 200kg mammal" (p. 212).

BMR (which does not appear in the index) is an acronym for "basal metabolic rate," introduced on page 293; it appears in an equation on page 294 (that equation admittedly contains a pun, because of how letters for the variables were chosen and juxtaposed). But then, I reckon, on page 300 the section titled "BMR and phylogenetic heritage" is obscure unless you had been reading in sequence or at any rate already know the acronym. As we have already seen, the same problem presents itself for the acronym FEE, for "the field energy expenditure (FEE, the average energy an animal expends for its usual functions)" (p. 295). The title of Box 8.1, on page 309, is "Calculation of FEE," but in between, the acronym has been sort of forgotten. The acronyms and "BMR," or for that matter, "energy," do not appear in the index. They should have.

This is an excellent volume. Its structure is complex, serving well the multitude of topics the authors managed to treat in a reader-friendly, yet rigorous manner that will satisfy both specialists and general paleontologists and the educated reader. Even as the treatment gets more and more technical, the presentation in the book is as readable as it feasibly could be. This book is likely to facilitate progress in the understanding of fossil mammals from the Americas.

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