Paleontological Society

# Priscum

The Newsletter of the Paleontological Society

Volume 26 | Issue 1
May 2021

Inside this issue



## Diversity, Equity, and Inclusion Matter in Paleontology

Building an inclusive and equitable Paleontological Society (see Section 12 of the Member Code of Conduct for definitions) is essential to realizing our core purpose — advancing the field of paleontology (see Article II of the Articles of Incorporation). However, like many other scientific societies, ours has historically only fostered a sense of belonging for a subset of individuals.

Consider your outreach experiences. Imagine visiting a series of first grade classrooms — overwhelmingly, the children are fascinated by dinosaur bones, scale trees, and trilobites — regardless of their identities. Now, reflect on your experiences in paleontological settings as an adult; do they include as much diversity as those elementary classrooms? Based on recent Paleontological Society membership data, they do not.

Science cannot be separated from humanity, and research has shown that scientific disciplines and societies are strengthened when everyone who is interested can be included and supported (Oreskes, 2021). However, there are serious and measurable barriers (e.g., Foxx et al., 2019; Marín-Spiotta et al., 2020; Núñez et al., 2020) that have led to and perpetuate the substantial lack of diversity and equitable treatment among members in our Society. Why should we take this issue seriously? Setting aside any social or moral arguments on the value of diversity, diverse perspectives have been shown to enhance innovation and progress (e.g., AlShebli et al., 2018; Nature, 2018), and contribute to the generation of robust and trustworthy scientific knowledge (Oreskes, 2021). Solving complex problems also benefits from a diversity of experiences and perspectives (Hofstra et al., 2020).

In this article, the Diversity and Inclusion Committee reviews the status of and proposes actions that can increase diversity, equity, and inclusivity in our Society.

### Where are we now?

Since the Paleontological Society (PS) was founded in 1908, its membership has been dominated by white men from the United States. Racial and ethnic diversity in the PS remain extremely low. More than 88% of respondents to PS membership surveys conducted in 2013 and 2019 self-identified as White (Stigall, 2013; unpublished data, 2019). These surveys revealed that, unlike the proportion of women, which has increased in younger age cohorts (Stigall, 2013), racial and ethnic diversity varied little among age groups, suggesting that substantial barriers to the inclusion of most racial and ethnic groups have persisted across generations of PS members. A membership survey conducted by the Palaeontological Association in 2018 revealed similar trends.

In the 2019 membership survey, 62% of respondents identified as male, ~36% as female, and ~3% as non-binary, genderqueer, another gender that was not listed, or declined to respond. The relative proportions of men and women of cisgender and transgender experience remain unknown, and data on members with gender identities other than man or woman (e.g., two-spirit, agender, etc.) were only collected in the most recent (2019) survey. As with their representation among Society membership, the proportion of women recognized as awardees has increased in recent years; nevertheless, executive leadership continues to be male-dominated, and there is a conspicuous decline in the proportion of women between the student and youngest professional age cohorts (Stigall, 2013; Cohen et al., 2019). While these surveys were incomplete in the scope of the information collected, their results indicate that historical factors alone cannot explain present membership trends or else diversity would have increased across all metrics in younger age cohorts. The data support what many PS members with marginalized identities already know from their lived experience —

# Diversity, Equity, and Inclusion Matter in Paleontology, continued

that very real barriers to diversity and inclusion persist in our Society.

A survey conducted by PS Student Representatives in 2017 revealed that women, people with disabilities, and members of racial and ethnic groups who do not identify as white reported much higher levels of disadvantage in peer camaraderie and mentorship, as well as discriminination and harassment in the workplace, field settings, and conferences than their non-minoritized peers (Orzechowski and McMullen, 2017). Some of these patterns have been detailed elsewhere (e.g., Black, 2018; Pickerell, 2020; Vissagi, 2020). Many of the reasons for the limited diversity in scientific societies are well known and span structural, institutional, and individual acts of discrimination (Marin-Spiotta et al., 2020). A culture of bias and exclusivity has been perpetuated by a widespread lack of understanding with respect to equity and identity and, at times, a reluctance to enact the policies needed to make our Society inclusive and safe.

In 2017, the PS Council recognized the importance of directly confronting barriers to participating in the field of paleontology and commissioned an *ad hoc* Diversity and Inclusion (D&I) Committee, which was formalized in 2018. The D&I Committee advocates for improving the culture of our Society so that it is inclusive and provides a sense of belonging to all its current and future members. Some key achievements of this Committee since its founding include:

- Development of a robust Policy on Non-Discrimination and Member Code of Conduct;
- Establishment of a strong Ethics Committee to investigate and recommend actions in response to alleged violations of this code;
- This IS PS – A team of PS leaders who have undergone training and serve to receive and report on alleged incidences of misconduct at PS-sponsored events;
- Drafting of statements and provision of resources on anti-racism;
- Completion of a "Best Practices for PS Social Media Communications" (2021) guide for PS leadership;
- Comprehensive revision of the existing membership demographic form to ensure that it is inclusive (pending implementation by the PS Executive Committee);
- Production of a webinar series in collaboration with the PS Student Representatives;
- Creation of new travel grant opportunities for PS members to attend conferences, such as the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) National Diversity Conference in Stem and the Annual National Association of Black Geoscientists (NABG) Conference;
- Expanded support for attending the Paleontological Society's Annual Meeting in conjunction with GSA through the On To the Future (OTF) program and through travel grants for PS members who are from marginalized groups or who may be unable to attend without support (e.g., those engaged in a career transition and/or holding adjunct, teaching, museum, or part-time positions);
- Supporting an expanded Student Ambassador program (administered by the Education and Outreach Committee).

Many of these initiatives directly address disparities in opportunity and access. While these actions have strengthened the foundation of our Society, critical work is still needed if we are to provide a welcoming space in which all identities are respected and included. Barriers to participating in the Society will persist until the work needed to change its culture of exclusivity (e.g., Holmes et al., 2020; Marín-Spiotta et al., 2020; Núñez et al., 2020) — based not on merit but on bias — has been undertaken by all of its members. For this reason, progress is difficult, as there is not yet a broad appreciation among all members that an inclusive PS supports everyone, including members of traditionally well represented groups.

## Moving forward

To continue to grow our Society and enrich the field of paleontology, the D&I Committee believes that every PS member must be empowered as an advocate for diversity, equity, and inclusivity. We sit at a watershed moment, when there are clear calls for scientific societies to remove barriers to participation (e.g., Morris et al., 2021). The success of the Unlearning Racism in Geoscience (URGE) program, which had more than 4500 participants across 300 institutions in the United States, demonstrates that geoscientists are prepared to educate themselves about systemic racism, discrimination, and other forms of bias, and to take the actions needed to make the geosciences more inclusive. **To assist our members in their efforts, the D&I Committee plans to facilitate training across our membership so that everyone feels equipped to become an advocate of diversity, equity, and inclusion**.

Meaningful mentorship is essential for supporting and retaining student and early career members from marginalized groups (Estrada et al., 2018; Martinez-Cola, 2020). **The D&I Committee supports bolstering PS participation in ongoing mentorship activities (e.g., OTF) and we plan to develop an in-house mentorship program**. Moreover, we also believe that mentorship should be rewarded; **we propose establishing awards to recognize our members for undertaking the work needed to increase diversity, equity, and inclusivity in paleontology through mentorship**. By supporting our current members, we will create a more inclusive culture that will enable us to attract interest, recruit, and retain members from a diversity of backgrounds.

By better including fossil clubs and other professional paleontology groups in the life and work of our Society, we can positively affect our field, as many of these groups directly engage with diverse communities of people who are interested in paleontology. This can create pathways and expand opportunities for learning about paleontology, as well as for recruiting those whose identities may be underrepresented in the field. In addition to the benefits with respect to diversity and inclusivity, broader engagement with fossil clubs fosters scientific literacy, helps raise awareness about ethics in fossil collecting, and is key in combating mistrust of the scientific community (Monroe, 2011; Varner, 2014). **The D&I Committee aims to enhance collaboration with fossil clubs through targeted outreach and our collaboration with the PS Avocational Liaison**.

It is essential that all of our members view the PS as a positive, inclusive, and professional environment, and this is especially true in conference settings. If we fail in this, we not only risk the attrition of talent and innovation in our field, but also the financial and professional standing of the Society. To thrive, our members must be able to expect that all aspects of their identities will be supported

# Diversity, Equity, and Inclusion Matter in Paleontology, continued

and respected. Bringing marginalized individuals into toxic environments causes emotional and professional harm and results in substantial losses of scientific potential. Many other societies, including the American Geophysical Union (AGU), the Ecological Society of America (ESA), the Association for Women in Science (AWIS), and the American Association for the Advancement of Sciences (AAAS) are already taking steps to become more inclusive. If the PS does not join our peers, we should not expect to remain one of the foremost societies in paleontology, as many of our members, especially those in younger age cohorts, may elect to withdraw the participation, volunteership, and funding that help to sustain us. **The D&I Committee is developing a robust plan to make our events (in-person and remote) safer and more inclusive for all of our members, as well as reflective of the values stated in the Policy on Non-Discrimination and Member Code of Conduct.**

The work we have outlined here cannot be undertaken by a single committee, nor can it be accomplished simply through the actions of individual members. Leadership is the greatest reflection of our societal culture. Representation of a diversity of identities and experiences at all levels, including executive leadership, is vital. The D&I Committee alone cannot effect widespread cultural change without the support of PS leadership. As demonstrated by the recent success of the "This IS PS" fundraising campaign (>$41,000), the membership of our Society values making the PS more inclusive and safe. We are grateful for this show of support which will allow the society to further expand its DEI efforts, but much work remains to be done. **The D&I Committee urges each member of the PS to demand transparency and accountability from those in positions of leadership, as well as clear commitments from candidates for PS offices to diversity, equity, and inclusion initiatives, and to nominate and elect leaders who will engage in such work for the benefit of our Society.**

In addition to changes in policy and the initiation of new programming to improve diversity, equity, and inclusivity in the PS, each member can help our Society move forward in a positive direction.

**We encourage each member, as they are able, to:**

- **Engage directly in the work of the Society.** Serve as a mentor, volunteer for a committee, or participate in initiatives that uplift and support members from marginalized groups. Developing a culture of belonging for all of our members requires all of us to join in this work.
- **Engage in training and expand your education related to diversity, equity, and inclusion.** Educate yourself by reading (see the PS and URGE resource lists), with training at your institutions or online through sources like the AGU Ethics and Equity Center and the American Association for Access, Equity and Diversity (AAAED), join a pod in programs like URGE and the AGU LANDing Academy, or participate in programs offered by our Society.

## We must evolve

The geosciences are the least racially and ethnically diverse among all science, technology, engineering, and mathematics (STEM) disciplines, and there has been no increase in this diversity over the past 40 years (Bernard and Cooperdock, 2018; Dowey et al., 2021). The reason for this stagnation is not a lack of good ideas or intentions. Many concrete ideas have been offered to improve diversity and inclusivity in our Society, some in *Priscum* (e.g., Stigall, 2013; Orzechowski and McMullen, 2017) and others in lists and motions shared with PS Council and the Executive Committee by the D&I Committee and many junior Councilors-at-Large. However, what is needed is a transformation in the culture of our Society; the existence of the PS D&I Committee is not sufficient to accomplish this goal.

The current position of the PS with respect to diversity and inclusion initiatives is relatively conservative. Both the National Academy of Sciences and the California Academy of Sciences have enacted policies that allow for the ejection of members, including fellows, found guilty of sexual harassment (California Academy of Sciences, 2020; Wadman, 2021). The AGU has initiated an eight-step strategic plan, workshop series, programs for departmental transformation, and has developed a dashboard to measure progress, among other programs outlined here. The AWIS has established awards recognizing members who work to promote diversity and inclusivity. The AAAS, of which the PS is a member, also has a suite of programs to support diversity and inclusion, including Sea Change. It is vital to the future of our Society that we join our peer organizations in providing robust programs aimed at eliminating disparities in access and inclusion in the field of paleontology that are rooted in bias and which are detrimental to scientific progress.

Societies, like species, must evolve to meet the challenges that emerge in their environments or else risk extinction. Racism, nationalism, sexism, transphobia, ageism, ableism, religious intolerance, homophobia, and vestigial colonialism continue to plague our Society more than 100 years since its founding; these same challenges threaten to undermine the relevance and survival of the field that we have inherited and create together. The point of diversity and inclusion programs and policies is not to have one group's dominance overtaken by another, nor to devalue the work of or punish our members who happen to have been born with identities that have conferred more privilege upon them. The point is that by welcoming, including, and respecting *all identities*, each one of us and every facet of our Society and our field may be enriched and strengthened to survive to the next generation.

It is the responsibility of every member of our Society to engage in the work needed to support and further the field of paleontology. This does not only include collecting fossils and reporting data in an ethical manner, but also recognizing each other's full humanity and treating each other with the dignity that we would wish for in return. The PS can become a safe and inclusive society, in which the diverse identities and perspectives that we might encounter in a classroom of fossil-loving first-graders is also what composes our field. Eliminating systemic barriers and building programs that help create an equitable, inclusive, and safe culture will take work from all of us. We look forward to working with each of you to accomplish this, and to thereby make our Society and our shared discipline more complete, innovative, and resilient than ever.

*--By The Paleontological Society Diversity and Inclusion Committee*

The members of the D&I Committee work and reside on the ancestral and sacred lands of the Adena, Coast Salish, Duwamish, Haudenosaunee, Hopewell, Kaskaskia, Lenape Hanki-nk (Lenni-Lenape), Manahoac, Myaamia (Miami), Muckleshoot, Muwekma, Nacotchtank, Ohlone, Onyota'a:ká (Oneida), Osage, Piscataway, Ramaytush, Seminole, Shawandasse Tule (Shawnee), Stillaguamish, Suquamish, Tamian, and Tumucua peoples of North America.

# Diversity, Equity, and Inclusion Matter in Paleontology, continued


References

AlShebli, B.K., Rahwan, T. and W.L. Woon. 2018. The preeminence of ethnic diversity in scientific collaboration. *Nature Communications* 9: 5163. https://doi.org/10.1038/s41467-018-07634-8

Bernard, R. E., and E.H. Cooperdock. 2018. No progress on diversity in 40 years. *Nature Geoscience* 11(5): 292-295. https://doi.org/10.1038/s41561-018-0116-6

Black, R. 2018. The many ways women get left out of paleontology. *Smithsonian Magazine.* https://www.smithsonianmag.com/science-nature/many-ways-women-get-left-out-paleontology-180969239/

California Academy of Sciences, 2020. Resolution of the Board of Trustees of the California Academy of Sciences. https://www.calacademy.org/sites/default/files/assets/docs/bot-resolution-fellows-code-of-conduct-web_201002.pdf

Cohen, P., Stigall, A.L., and C.M. Topaz. 2019. A gender analysis of the Paleontological Society: trends, gaps, and a way forward. *Geological Society of America, Abstracts with Programs* 51(5): 228938. https://doi: 10.1130/abs/2019AM-338938

Dowey, N.J., Barclay, J. Fernando, B., Giles, S. Houghton, J. Jackson, C. A-L., Mills, K., Newton, A. Rogers, S.L., and R. Williams. 2021. A UK perspective on tackling the geoscience racial diversity crisis in the Global North. *Earth ArXiv* preprint. https://doi.org/10.31223/osf.io/z4cju

Estrada, M., Hernandez, P.R., and P.W. Schultz. 2018. A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE—Life Sciences Education* 17(1): ar9. https://doi.org/10.1187/cbe.17-04-0066

Foxx, A.J., Barak, R.S., Lichtenberger, T.M., Richardson, L.K., Rodgers, A.J., and E.W. Williams. 2019. Evaluating the prevalence and quality of conference codes of conduct. *Proceedings of the National Academy of Sciences* 116(30): 14931-14936. https://doi.org/10.1073/pnas.1819409116

Hofstra, B., Kulkarni, V.V., Munoz-Najar Galvez, S, He, B., Jurafsky, D., and D.A. McFarland. 2020. The Diversity–Innovation paradox in science. *Proceedings of the National Academy of Sciences* 117 (17): 9284-9291. https://doi.org/10.1073/pnas.1915378117

Holmes, M.A., Myles, L., and B. Schneider. 2020. Diversity and equality in honours and awards programs–steps towards a fair representation of membership. *Advances in Geosciences* 53: 41-51. https://adgeo.copernicus.org/articles/53/41/2020/

Marín-Spiotta, E., Barnes, R.T., Berhe, A.A., Hastings, M.G., Mattheis, A., Schneider, B., and B.M. Williams. 2020. Hostile climates are barriers to diversifying the geosciences. *Advances in Geosciences* 53: 117–127. https://doi.org/10.5194/adgeo-53-117-2020.

Martinez-Cola, M. 2020. Collectors, nightlights, and allies, Oh My! White mentors in the academy. *Understanding and Dismantling Privilege* 10(1): 25-57. https://www.wpcjournal.com/article/view/20275

Monroe, M.C. 2011. Engaging the publics in environment decisions: strategies for environmental education and communication. *In* Gökçekus, H., Umut T., and J.W. LaMoreaux, eds., *Survival and sustainability: environmental concerns in the 21st century*. Springer Science & Business Media. https://link.springer.com/chapter/10.1007/978-3-540-95991-5_68

Morris, V., White, L., Fuentes, J.D., Atchison, C.L., Smythe, W.F., Burt, M., Williams, L., Tripati, A., Demoz, B.B, and R.A. Armstrong. 2021. *A Call to Action for an Anti-Racist Science Community from Geoscientists of Color: Listen, Act, Lead*. https://notimeforsilence.org

Nature editors. 2018. Science benefits from diversity. *Nature* 558: 5. https://doi: https://doi.org/10.1038/d41586-018-05326-3

Núñez, A.M., Rivera, J., and T. Hallmark. 2020. Applying an intersectionality lens to expand equity in the geosciences. *Journal of Geoscience Education* 68: 97-114. https://www.tandfonline.com/doi/full/10.1080/10899995.2019.1675131

Oreskes, N. 2021. *Why trust science?* Princeton University Press. https://press.princeton.edu/books/paperback/9780691212265/why-trust-science

Orzechowski, E., and S. McMullen. 2017. *Priscum* 24(1): 3-9. https://www.paleosoc.org/assets/docs/2017_10_Priscum-FINAL_101917.pdf

Pickerell, J. 2020. Scientists push against barriers to diversity in the field sciences. *Science*. https://doi:10.1126/science.caredit.abb6887

Stigall, A.L. 2013. Where are the women in Paleontology? *Priscum* 20(1): 1-3. https://www.paleosoc.org/assets/docs/Priscum_Winter2013.pdf

The Paleontological Association. 2018. *Diversity Study.* https://www.palass.org/association/diversity-study

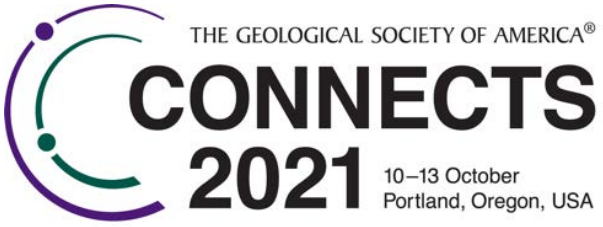
Varner, J. 2014. Scientific Outreach: toward effective public engagement with biological science. *BioScience* 64 (4): 333–340. https://doi.org/10.1093/biosci/biu021

Visaggi, C.C. 2020. Equity, Culture and Place in Teaching Paleontology: student-centered pedagogy for broadening participation. *Elements of Paleontology*. https://doi.org/10.1017/9781108681766

Wadman, M. 2021. National academy may eject two famous scientists for sexual harassment. *Science*. doi:10.1126/science.abi9923


## Upcoming opportunities: call for travel grant applications to be announced in summer

- GSA On to the Future Program: apply by May 28th
- Future of Paleontology Program: student support to attend GSA
- Travel grants to attend SACNAS, AISES and NABG
- Travel grants for members at career transitions or from marginalized background to attend GSA
- Biannual call for conference support: next call in Fall
- Invite a PS Distinguished Lecturer to your organization. The DL program can now fully fund speaker visits to HBCU, HSI, and TCUs.



# PS Development Developments

The Paleontological Society funds numerous programs that benefit our members and promote our science, ranging from grants to students and early career professionals, to publication of our world-caliber journals, to supporting programs at our meetings. Exciting new initiatives have been developed to increase the diversity and inclusiveness of our discipline. All these programs are funded by a combination of sources, including income from the journals, membership dues, and our wise investments. However, financial support by our members in the form of donations has been disappointing. In an average year, only about 15% of our members donate to the Society and only a small fraction of our support has come from donations, which has made it difficult to increase funding for existing programs and to support worthy new initiatives. Therefore, in 2020 the PS Council established a new Development Committee, with the aim of fostering a "culture of philanthropy" within the Society, where every member donates to the best of their means and interest.

The Committee consists of representatives from across the membership, including students, early-career, senior, and avocational paleontologists, from a wide variety of institutions. We interact and share membership with other committees, such as Education & Outreach and Diversity & Inclusion, to make sure that their interests are represented. It is not the role of the Development Committee to create new initiatives, but to find the means to fund them. Development Committee co-chairs are Patricia Kelley (kelleyp@uncw.edu) and Roy Plotnick (plotnick@uic.edu). Feel free to contact us at any time with questions about the work of the Committee.

This past year, the Development Committee concentrated on supporting the next generation of paleontologists, especially through the *Inclusive and Safe Paleontological Society* (This IS PS) initiative. Top priorities included increasing the number of travel awards, particularly to professional meetings that engage diverse early-career scientists; increasing the number of students the PS funds to participate in GSA's On to the Future program, which supports diverse students to attend their first annual GSA meeting; and expanding the PS Distinguished Lecturer Series by intentionally engaging with departments at Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges and Universities. During what is projected to be the first year of a three-year campaign, we raised more than $39,000 for this initiative, including a single $30,000 donation by a senior member.

In addition to this support for the "This IS PS!" fund, more than $42,000 was raised for other funds, including about $32,000 for the Student Research Fund. We are pleased to announce that a new named grant fund was established in memory of Leo Hickey, thanks to several generous gifts, including a single donation of $20,000 by a senior member of the PS.

Total donations to the PS in 2020 amounted to more than $84,000. We are grateful for the generosity of all those who donated to the PS this past year, especially in light of the impact of the pandemic on incomes and the many worthy competing demands for donations.

You can donate any time by clicking the link on the Paleontological Society webpage or when you renew your membership. Consider becoming a Contributing ($100), Sustaining ($250), Partner ($500), or Patron ($1000) member and commit to making it your annual practice. If these amounts are more than you want to pledge, then donate an amount you are comfortable with to one or more of our many funds. And if your situation does not allow a monetary donation, consider volunteering to serve on one of the many PS committees. This is your science and your Society. Your donation, of whatever amount, will protect the future of those who study the past!

*-Roy Plotnick and Trisha Kelley, Development Committee Co-Chairs*

# PaleoConnect

Please join us every other month for a student-led social hour aimed at connecting the paleontology student community. Furthermore, we hope to create a space that allows open dialog between students and committee members of the Paleontological Society (PS). During this social hour we will have a break-out room, hosted by a PS Student Representative, dedicated to students who wish to meet and chat with other students. Additional break-out rooms will be hosted by a committee member from the Development Committee, Diversity and Inclusion Committee as well as a program coordinator for PaleoConnect. This social hour is an opportunity to connect, network and seek support from peers. It is also an opportunity to voice ideas, feedback, and concerns with committee members as well as volunteer to help with initiatives that you are passionate about.

The main goal of the PaleoConnect program is to increase communication between students as well as give students an opportunity to shape the Paleontological Society to better serve the student community.

Prior events on Feb 26th and April 27th have been great successes.


There are many ways engage through PaleoConnect including:

- **PaleoConnect Peer-Mentorship:** participants are matched with students who have similar interests to exchange ideas, resources, and different experiences.
- **Coffee Hour Discussion Room:** Stuck on topic and need some good resources? Want to know more about a certain method? *What will my Quals even be like?!*You can host a discussion room during a PaleoConnect Coffee Hour and get suggestions, advice, and mentoring from your peers.
- To become more involved with PaleoConnect you can contact Amanda Godbold. To find out more ways to be involved in the Paleontological Society you can contact the Student Representatives, Jeanette Pirlo and Annaka Clement.

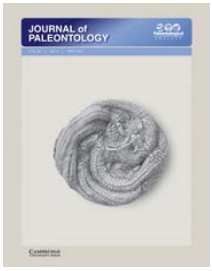
# Journal Corner

Use your membership to access the PaleoSociety Publications, The Treatise on Invertebrate Paleontology and more for free via the PS website: https://www.paleosoc.org/publications

Did you know that our publishing partner, Cambridge University Press is developing new partnerships with institutions that allow authors at that institution to receive open access waivers at no cost when they publish in the Journal of Paleontology and Paleobiology?

You might already be eligible publish open access in Journal of Paleontology & Paleobiology for free under your institution.

Check for your institution here!
https://www.cambridge.org/core/services/open-access-policies/waivers-discounts

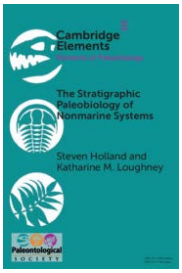



# Paleobiology Special Issue


A new special issue on **phylogenetic paleoecology** is available for open access in *Paleobiology* until June 18, 2021. The burgeoning field of phylogenetic paleoecology represents a synthesis of the related fields of macroecology and macroevolution. Through a combination of the data and methods of both disciplines, phylogenetic paleoecology leverages phylogenetic theory and quantitative paleoecology to explain the temporal and spatial variation in species diversity, distribution, and disparity. Phylogenetic paleoecology also incorporates modern statistical methods from paleoecology and biogeographic studies along with phylogenetic comparative methods, to determine whether similarity in traits between species is due to close evolutionary relationships or selective processes. Combining methods and multiple lines of data permits analysis of evolutionary dynamics to determine drivers of evolutionary change and the relative import of abiotic, biotic, and contingent historical processes in guiding evolutionary and ecological shifts across space and time.

# Elements of Paleontology

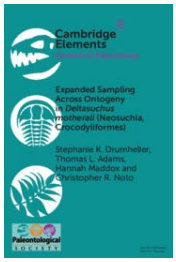
As Editor in Chief of the Paleontological Society's Book/Journal *Elements of Paleontology*, I wanted to draw your attention to two recently published articles that highlight the breadth of *Elements* as well as highlight some of the publishing capabilities of the series. *Elements* is more than just a series for the Paleontological Society Short Course Notes. It publishes longer articles on a variety of paleontological topics including education and outreach in paleontology, stratigraphy, taxonomy and paleontological methods and techniques, to name a few. As always, we are looking for content. Feel free to contact me concerning ideas for new elements and edited volumes.




The Stratigraphic Paleobiology of Nonmarine Systems by Steven Holland, University of Georgia; Katharine M. Loughney, University of Michigan

This paper reviews issues surrounding the interplay of sequence stratigraphy and the fossil record in terrestrial settings.

Abstract: The principles of stratigraphic paleobiology can be readily applied to the nonmarine fossil record. Consistent spatial and temporal patterns of accommodation and sedimentation in sedimentary basins are an important control on stratigraphic architecture. Temperature and precipitation covary with elevation, causing significant variation in community composition, and changes in base level cause elevation to undergo predictable changes. These principles lead to eight sets of hypotheses about the nonmarine fossil record. Three relate to long-term and cyclical patterns in the preservation of major fossil groups and their taphonomy, as well as the occurrence of fossil concentrations. The remaining hypotheses relate to the widespread occurrence of elevation-correlated gradients in community composition, long-term and cyclical trends in these communities, and the stratigraphic position of abrupt changes in community composition. Testing of these hypotheses makes the stratigraphic paleobiology of nonmarine systems a promising area of investigation.




Expanded Sampling Across Ontogeny in *Deltasuchus motherali* (Neosuchia, Crocodyliformes): Revealing Ecomorphological Niche Partitioning and Appalachian Endemism in Cenomanian Crocodyliforms by Stephanie K. Drumheller, University of Tennessee, Knoxville; Thomas L. Adams, Witte Museum; Hannah Maddox, University of Tennessee, Knoxville; Christopher R. Noto, University of Wisconsin, Parkside

This paper provides a complete description of the skull elements of the crocodyliform *Deltasuchus motherali*, providing insight into ontogeny and ecology. It also highlights the video capabilities of the Elements series.

Abstract: New material attributable to *Deltasuchus motherali*, a neosuchian from the Cenomanian of Texas, provides sampling across much of the ontogeny of this species. Detailed descriptions provide information about the paleobiology of this species, particularly with regards to how growth and development affected diet. Overall snout shape became progressively wider and more robust with age, suggesting that dietary shifts from juvenile to adult were not only a matter of size change, but of functional performance as well. These newly described elements provide additional characters upon which to base more robust phylogenetic analyses. The authors provide a revised diagnosis of this species, describing the new material and discussing incidents of apparent ontogenetic variation across the sampled population. The results of the ensuing phylogenetic analyses both situate *Deltasuchus* within an endemic clade of Appalachian crocodyliforms, separate and diagnosable from goniopholidids and pholidosaurs, herein referred to as Paluxysuchidae.

*By Colin Sumrall*

# PaleoSociety-AGI 2020 Summer Interns

The Paleontological Society sponsored two Virtually hosted two summer policy interns, Lyndsey Farrar and Stephanie Plaza-Torres, who advanced efforts including an AGI Critical Issues project to develop factsheets for Paleontological Society-sponsored project to explore best practices in data preservation.

I am extremely grateful to the Paleontological Society and the American Geosciences Institute for the opportunity to participate in the policy internship this summer. I have always been curious about how science and policy intersect and to see how our government operates. This summer I have seen this process firsthand through virtual congressional hearings on a variety of topics such as the expansion of national parks, the domestication of mineral supply chains, and the impact of COVID-19 on environmental justice.

My passion has always been collections and outreach and through this internship I had the opportunity to learn about how museums around the country and abroad, both big and small, public and private, operate. I was able to interview a wide variety of museum professionals and paleontologists, many of whom I would not have been able to meet with during a traditional AGI internship in Washington D.C. This internship turned out to be a great networking opportunity that would now have been possible without the virtual experience. I was also very grateful for the interactions that I had at the GSA annual conference and the excitement about our project was very encouraging.

Seeing how museums have adapted during the pandemic has been surprisingly encouraging. Many institutions were able to ramp up efforts on digitization while the staff was working from home. The amount of virtual outreach has exploded. I believe that outreach, especially virtually, is important for the future of museums. With virtual outreach, museums are able to reach people they may not have traditionally and people may now be able to learn about paleontology that they may not have access to otherwise.

-Lyndsey Farrar

Thanks to the Paleontological Society and the American Geosciences Institute for giving me the experience of being part of the policy world [virtually] for a summer. Before I started the internship, I felt a need to start exploring other social aspects of science and getting involved in efforts to push the paleontological community forward through policy, in addition to research.

This summer I got the chance to meet a wide variety of paleontology professionals, from the federal government, up to private institutions and museums, and even non-profit organizations. From them I learned the hardships that everyone faces to keep their institutions running, and all the efforts that individuals are putting towards making paleontology accessible, through educational resources, access to fossils, outreach, and research. It is not an easy task to increase transparency and accessibility, but the paleontological community is making strides forward. In particular, I got to learn about the intricacies of digital data. How connecting fossils to their publications can increase transparency of research, how the community is working together to develop standards to manage digital data, and how people are pushing forward innovative resources like 3D models of specimens, CT scan data, comprehensive museum directories, and other supplemental datasets from georeferencing and geochemical analyses.

If there is a main takeaway I took from this summer, it was that every contribution to hearing the scientific community's needs counts, and that advocating for what you think is right and necessary in society can make a difference even if it is a small contribution. I hope that after this experience I keep getting involved either in my university community at the University of Colorado Boulder, at my local government, and with people outside the scientific community.

Finally, I'd like to say thanks to Christopher Keane and Sandy Carlson. They were amazing mentors that made this experience unique. I am grateful for their mentorship and guidance.

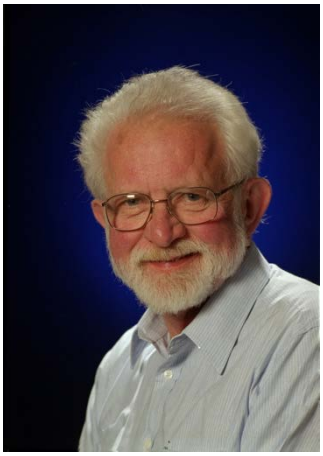
-Stephanie Plaza-Torres

## Seeking volunteers and officers

The PaleoSociety succeeds based on the work of outstanding volunteers like you. Consider volunteering to serve on a committee or run for office. We routinely post opportunities for service in the PaleoSociety blog: https://www.paleosoc.org/blog

Consider running for office! For the 2022 ballot, we will be seeking candidates for positions including President-elect, Representative at Large – senior position, and more! Serving on the Paleontological Society Council is a great way to use your time and energy to make our society even better!

# A tribute to William A. Clemens, Jr. (1932-2020)



William A. Clemens Jr., longtime Professor of Paleontology and Integrative Biology, Curator in the University of California Museum of Paleontology, Berkeley, and one of the greatest fossil mammal experts of the past century, passed away peacefully at his home in Berkeley on 17 November 2020, surrounded by family and letters and tributes from friends and colleagues around the globe. He was 88.

For 60 years Bill was one of the premier authorities in the world on the origin, diversification, and geographical spread of the first mammaliaforms, animals that include living mammal groups and also those mammalian precursors that eventually became extinct. His research focused on the Mesozoic and earliest Paleocene forms. During this interval most mammals were the size of shrews and smaller rodents. They are overwhelmingly represented by isolated teeth, or occasionally by partial or (rarely) entire jaws, the most durable parts of their otherwise fragile skeletons. Bill used the morphology of these remains to classify them, to discern their relationships to other groups, to chart their spread through time and space, and to infer the evolution of their diets and locomotory patterns.

Although Bill published on fossils throughout the Mesozoic and early Paleogene, his primary contributions fell into two-time intervals. The first was the Triassic-Jurassic boundary, which witnessed the rise and diversification of the first mammaliaforms. Their descendants radiated through the Mesozoic Era and include all living groups of mammals. These groups, then and now, are mainly known from the Northern Hemisphere, and Bill spent several years in Europe on Guggenheim and Humboldt Foundation awards describing their morphology and evolution.

The second interval of interest was the Cretaceous-Paleogene (K/Pg) boundary, a time when the great groups of Mesozoic dinosaurs became extinct, and the living groups of mammals began a great radiation. Although Bill and his students worked on most of these groups, he made particularly important contributions to our knowledge of marsupials, which radiated in North America before disappearing there in the early Tertiary, only to flourish in Europe, South America, and eventually Australia. He also pioneered our understanding of the early evolution of placental mammals, publishing on the earliest representatives of primates, hoofed mammals, and insectivorous lineages.

Bill's research was grounded in decades of fieldwork. Beginning in 1970 and continuing through 2019, he and his students and colleagues returned each summer to prospect and quarry the Upper Cretaceous and lower Paleogene deposits of eastern Montana, developing a detailed, stratigraphically controlled paleontological dataset and geologic framework for addressing questions of the timing and patterns of faunal change across the K/Pg boundary. His insights were gained painstakingly through the wholesale excavation and screen-washing of tons of sedimentary rock that had shown the promise of preserving thousands upon thousands of tiny fragments of fossil vertebrates.

The importance of all those fossils and that detailed stratigraphic framework was magnified in 1980 when UC Berkeley scientists Luis and Walter Alvarez and colleagues reported the discovery of anomalous quantities of the noble metal iridium at the K-Pg boundary, hypothesizing that an asteroid impact had caused the end-Cretaceous mass extinction. While scientists throughout the world were studying this extinction event in marine sections, Bill and his students and colleagues had long been developing the primary record of terrestrial extinction patterns in the U.S. Western Interior. To this day, vibrant conversations begun by Bill Clemens and Walter Alvarez in the 1980s continue on the patterns and causes of the end-Cretaceous extinctions, especially the relative roles of the impact, extensive volcanism, the retreat of the Western Interior Seaway, and other climatic changes.

Bill was the major professor of nearly two dozen PhD students and was a major influence on dozens of others, at Berkeley and around the globe, expanding the great Berkeley tradition in paleomammalogy. Beyond this, he served as President of the Society of Vertebrate Paleontology, Trustee and eventually President of the California Academy of Sciences, and Director of the University of California Museum of Paleontology. Bill was given the Romer-Simpson Medal and the Joseph T. Gregory Award by the Society of Vertebrate Paleontology, two of its highest honors. He was also a Fellow of the Geological Society of America. He was born in Berkeley, received his Bachelor's and PhD degrees at UC Berkeley, and served for seven years on the faculty at the University of Kansas before returning to join the Berkeley faculty from 1967 to 2002. Bill remained an active emeritus professor, participating in seminars and public programs at the Museum and serving on doctoral committees while pursuing his research. Always thoughtful and supportive, his legacy will be felt at Berkeley and beyond for many years to come.

*By UCMP staff*

# PS Supports Tribute to Mary Anning

The Paleontological Society is pleased to announce that we have become a Patron supporter of the initiative to design and emplace a stature of Mary Anning in Lyme Regis, England. We are excited to be part of this initiative that was led by 13-year-old Evie Swire as part of "Mary Anning Rocks" team.

Mary Anning was a legendary fossil collector extraordinaire during the first half of the 19th century.

The fossils that Mary Anning discovered along the Jurassic Coast (now a World Heritage site) were fundamental to the then-emerging science of paleontology in the UK and Europe.

With this donation we therefore celebrate the immense contributions of Mary Anning to the advancement of our science.

# Why Fossils Matter! New NGSS-mapped educational materials

The PaleoSociety Education and Outreach Committee, especially members Christy Visaggi, Tara Lepore, and Trish Smrecak, developed an incredible set of materials for Earth Science Week on behalf of the PS!

Please feel free to spread the word on these resources They created this flyer, had 10,000 copies made and delivered to put in the AGI packets for ESW. They also developed the "Fossil Use Cards" centering around the "materials in our lives" theme of ESW 2020. The cards were designed as full slides to be printed by teachers where each set of 4 is an example (fossil name, image of fossil, use, and fun facts). There were **25 examples of fossils** featured in the activity, and an additional 5 mineral/pseudofossil examples were also included at the end. Information on the fossils included 'themes' as well that could be used for learning – taxonomic group, era, habitat, etc.

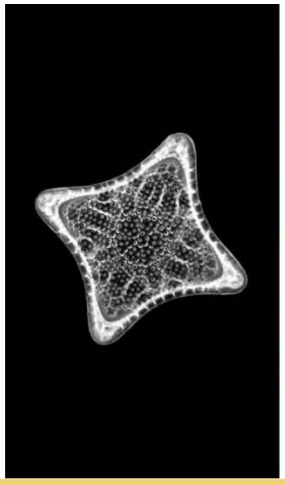
There is a Teacher's edition set that has the "key cards" for each example (and another copy of the fun facts) – see the last few slides in that for a "quick guide" of all examples included.

There is also a "Drag n' Drop" set of the examples that can be used for virtual learning without the need to print the cards.

The introductory document includes NGSS extension questions that has all relevant standards by grade level and related prompts included. There is a short Kahoot quiz to accompany the activity as well.

Lastly, they made a short evaluation form if people have comments, want to contact us, etc. Oh, and all photos in the cards were either creative commons or we received special permission to use upon requesting so they have all of that information saved.

*From Rowan Lockwood*



## Why Fossils Matter!

Which of the fossils above is used for fossil fuels?
(Hint: It's not from dinosaurs!)

**Did you know? Humans have used fossils for:**

-Powering machines -Solving crimes -Tools and jewelry
-Buildings and roads -Crafting medicines -Ceremonial activities
-Storytelling and art -Understanding the past -Studying climate

**Access engaging lesson activities on fossils:**

-Various mix and match card activities
-Next-Generation Science Standard (NGSS) aligned for grades K-12
-Explore fossils and their industrial, scientific, and cultural uses
-Print one deck and play countless ways!

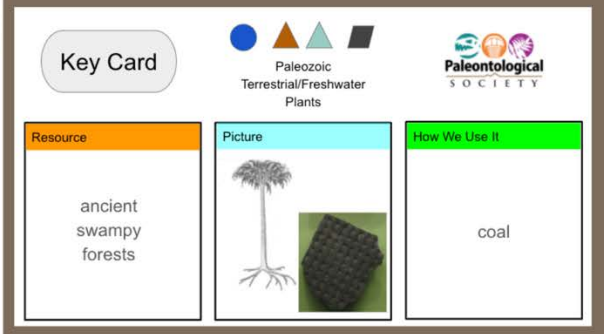
*To find the answer, learn more, and dig into great fossil activities, visit:*

**https://tinyurl.com/fossilusecards**

## Card-Sorting NGSS-Mapped Lessons

### Fact Cards

- Match images, fossil resources, and their uses
- Study fossil ages, environments, and more
- Apply scientific design process
- Analyze and interpret data
- Examine connections to human impacts
- Made adaptable for different learning goals




### Features

- Geologic timescale and deep time extensions
- Directly relate science to your students' daily lives
- Applicable to a wide range of age groups
- Activities to do in class or for remote learning
- Teacher and student card sets
- Fossil fun fact bonus cards
- Easy-to-use online quiz
- Fun, free, created by paleontologists!

# PS Ethics Committee Report

The Paleontological Society Ethics Committee is pleased to present its second annual report to Society members about its activities and investigations conducted in association with the PS Policy on Non-Discrimination and Member Code of Conduct.

## Development of a Reciprocity Agreement with GSA

In the summer of 2019, PS made a request to GSA to ban a PS member who was previously found to have violated the PS Code of Conduct from attending GSA meetings for a period of one year, including the 2019 GSA Annual Meeting in Phoenix AZ. We had hoped that GSA would be able to make an expeditious decision based on the weight and evidence of our findings in the case, but GSA instead sought to revisit the case, based partly on its concerns about due process for this individual, who is also a member of GSA. This, in turn, led us to withdraw the request. In the end, the violator chose not to attend the Phoenix GSA meeting, so the safety and well-being of other meeting attendees was not compromised. At the same time, PS remained dissatisfied with how the initial request was handled by GSA, and we raised the issue as a discussion point at a meeting in Phoenix of representatives from multiple societies who attended the semi-annual GSA/AGI associated societies business meeting and, again, during a follow-up discussion at the next meeting, which took place electronically in Spring 2020.

In the meantime, the views of GSA and its Ethics Officer, Nan Stout, have evolved, based in part on experiences and observations at the Phoenix GSA. This has led to a series of ongoing discussions with Ms. Stout about the establishment of a reciprocity agreement between the PS and GSA. At the Fall 2020 meeting of GSA's Governing Council, Ms. Stout received a general endorsement to move forward with development of a PS/GSA agreement focused on meetings, and, after additional discussions, we now have a draft agreement that will soon be presented to PS Council for its consideration. The agreement has two main facets related to participation in GSA meetings:

1. Provisions for GSA to be able to ban someone from attending its meetings for up to one year in response to a request from PS, without first conducting its own full ethics investigation.
2. Mechanisms for joint investigations of allegations arising from possible violations of either of our Codes at GSA meetings, with PS taking the lead in investigations of alleged violations that take place at PS-sponsored events at GSA meetings (contingent on the submission of an allegation report to PS).

The joint investigations envisioned in relation to item #2 will require revisions to the PS Code of Conduct, since there are no current provisions in the Code for collaboration with other professional societies. We also recognize the need to address Code violations that take place in venues other than meetings. We believe, however, that the initial agreement will be an important step in the right direction, given that our primary intersection with GSA relates to activities at meetings, and successful implementation will bolster confidence and expertise to move forward with additional dimensions.

## Development of an "Escrow" System to Hold Confidential Information Prior to Possible Submission of a Formal Allegation

During Spring 2020, Ethics Committee Co-Chairs Arnie Miller and Dena Smith-Nufio exchanged a series of emails and had conversations with an anonymous PS member who was the victim of sexual harassment in an earlier case that did not involve the PS. The anonymous correspondent conveyed the important concern that many, if not most, student and early-career members might hesitate—or chose not— to file allegations because of power differentials and fears of retaliation. As an alternative to submitting an allegation—at least initially—the correspondent advocated the development of an "escrow" system through which a victim could file a confidential report of a violation, where it would remain sealed unless and until the victim chose to move forward with an allegation(s), perhaps because the person filing the escrow report became aware that someone else had also filed an escrow report about the same alleged violator. Development of an escrow system would be very valuable in that it would provide an avenue for the preservation of vital information on a confidential platform at the same time that it would not force someone to file an allegation unless and until they are comfortable doing so.

The PS does not have the capability to develop and maintain its own secure cyberinfrastructure for such a system, but we became aware of a product called *Vault Platform* (VP) that may suit our needs well. A central feature of VP, called *GoTogether*, can allow the correspondent to elevate reports to the formal allegation stage if two or more confidential reports are filed about the same person. Over the past months, we've had discussions with a VP representative, who provided a brief demonstration of VP at the 2021 PS Midyear Council meeting, and we are currently exploring development of an agreement with VP that, among other things, would provide access to VP for all PS members via an app that can be accessed from a smartphone or computer.

## New Procedure for Self-Reporting

In Fall 2020, following a recommendation from the Ethics Committee, the PS Council voted to revise procedures for Self-Reporting of Professional Conduct. Whereas all nominees for PS offices, committees, and awards were previously required to fill out self-reporting forms, as were applicants for grants and authors of papers in PS publications, the new procedure calls for single, annual reporting by all PS members as part of member onboarding or renewal. Non-members, mainly applicants for Sepkoski/PALSIRP grants and some authors of manuscripts, are still required to complete an individual self-reporting form with each application or manuscript submission.

The new procedure was implemented with the beginning of member renewal/onboarding for 2021. Changes were made to the appropriate webpages and to the relevant section of the Code of Conduct to reflect the new procedures, and the self-reporting form now automatically appears as part of the online process that members use to renew or enroll.

## Allegations and Self-Reports

Since our previous blog in early 2020, the PS has received two allegations of violations of the PS Code of Conduct. In addition, three authors of manuscripts submitted to PS journals and one PS member who was renewing for 2021 checked the "Yes" box on the PS professional conduct self-reporting form, indicating that they were the subject of an investigation or had some other concern in the ethics arena that the Ethics Committee needed to address. Finally, we received information from GSA about a PS student member that necessitated action by the Ethics Committee and the PS Executive Committee.

# PS Ethics Committee Report, continued

*Allegations*

In early September 2020, we received a multifaceted allegation report submitted by a PS student member involving several possible violations alleged to have taken place over a one-year period, with three people accused of violating the PS Code of Conduct. Because of the case's complexity, the PS Council authorized us to engage a lawyer, Paula Brantner, who has been working with us on the investigation. As of this writing, we have interviewed five individuals concerning this case, and a sixth interview is planned for late April. Within the next month, we hope to draft our findings and recommendations for Council's review and consideration. Relevant details will be provided in our next report to PS members.

The second allegation, received in mid-September 2020, was submitted by a student and involved a possible violation of the code of conduct by a professional paleontologist with whom they were communicating electronically. We determined that neither the accuser nor the accused is a member of the PS, but are likely both members of the Society for Vertebrate Paleontology (SVP). We therefore contacted SVP for a discussion, and it appears that a similar complaint may have also been submitted to SVP. We followed up with the accuser to encourage them to work with SVP on the case, if they were not doing so already.

*Actions Related to Self-Reporting Forms*

In all of the cases where someone clicked the "Yes" box on the self-reporting form, we reached out directly to the individuals for a conversation. Following each conversation, the Ethics Committee made a decision that was reported back to the individual.

In one case, the author, who is a faculty member at a university outside of the United States, reported that they were the subject of an ongoing investigation into accusations of misconduct that would clearly violate our code, but which they contend are false and are the byproducts of intradepartmental rivalries amidst the politically-charged atmosphere currently engulfing their university and country. The author noted that the onset of the COVID pandemic put the investigation on hold, but is hoping that the case will be resolved soon. In the meantime, because the first author on the paper is a graduate student in the respondent's lab, and given the uncertainty about the case, we allowed this paper to move forward with review and possible publication, with the proviso that no additional papers submitted by this author would be considered until the university makes a final determination that is reported back to us.

In a second case, an author of a submitted paper reported that they had previously been among a group of authors charged with plagiarism on an unrelated 2016 paper co-written with an entirely different set of authors. Several investigations at different institutions had concluded that the accusations were entirely unfounded, but the author reported this information to us nonetheless, because the investigations had, after all, taken place. The ethics committee determined that there was no reason to hold up the current paper, and, furthermore, that the author need not click the "Yes" box in the future in relation to this specific case.

In a third case, the individual clicked "Yes" because they had been the subject of a PS investigation and finding in summer, 2019. In that investigation, it was determined that they had, indeed, violated the PS Code of Conduct, and several sanctions were communicated to this individual in association with our findings. However, because the sanctions did not include a proscription from publishing in PS journals, the individual was permitted to move forward with submission of their manuscript. That said, in addition to clicking the "Yes" box, the individual took the liberty of writing remarks directly on the form implying that they had been absolved of the 2019 allegations. Since this was clearly not the case, the individual was warned to avoid any future mischaracterizations of the outcome of the 2019 investigation, which, themselves, might constitute new violations of the PS Code of Conduct.

Finally, a member onboarding for 2021 clicked the "Yes" box because they had become caught up inadvertently in a case in 2007 involving possible unauthorized collection of fossil material while traveling in another country. During a conversation about the case and through investigation of media reports written at the time and in the years since, it became clear that the person was not at fault, and the Ethics Committee agreed that no action was needed on the part of the PS. We conveyed our findings back to the individual, as well as our thanks for bringing the issue to our attention.

## Review of Ethics Policies and Procedures

As mandated in the Code of Conduct, the President of the PS, Bill DiMichele, has appointed a committee of three individuals to conduct the inaugural, annual review of PS Ethics policies and procedures. Once completed, the committee's findings, and any resulting changes to the Code of Conduct, and/or its enforcement, will be conveyed to PS members.

## Concluding Remarks

A list of current members of the PS Ethics Committee is available here. Please feel free to reach out to a member(s) of the Committee if you have any questions or concerns about items in this report or about any other aspects of the Society's Ethics portfolio.

# Congratulations to the GSA 2020 Student Poster Winners!

*Undergraduate Winners*

1. **Amy Hagen** (Smith College): Evaluating redox conditions during the Cambrian SPICE event, Western Newfoundland, Canada
2. **Alaska Schubert** (Appalachian State University): Results of the summer 2020 paleontological field survey conducted in Badlands National Park, South Dakota
3. **Ashley Johnson** (University of Alberta): Identifying predatory fragmentation in the fossil record: A Paleozoic brachiopod example

*Graduate Winners*

1. **Evan Whiting** (University of Minnesota): First cranial fossil of a neonate *Champsosaurus* from the Paleocene of North America
2. **Kelly Tingle** (University of California, Santa Barbara): Organic preservation of vase-shaped microfossils from the late Tonian Chuar Group, Grand Canyon, Arizona
3. **Amelia Lindsay-Kaufman** (University of Missouri): Two novel biomineralized tubular fossils from the terminal Ediacaran, central Iran

# 2021 Norman Newell Early Career Grant Awardees

Congratulations to each of these early career paleontologists who will receive $5000 to support their research.

**Michael Donovan**
Cleveland Museum of Natural History
Title: Responses of insect herbivores to glacial-interglacial climatic fluctuations in the Middle Pennsylvanian-early Permian

**Camila Martinez**
Universidad EAFIT
Title: Paleoclimate estimations using wood functional traits

**Madeline Marshall**
Albion College
Title: Paleoecological comparison of nutrient-rich vs. nutrient-poor environments, Permian of southern Idaho

**Lucy Roberts**
University of Nottingham
Title: Novel ostracod geochemistry to reconstruct Quaternary palaeoclimates

# Join us for the Paleontological Society Annual Meeting!

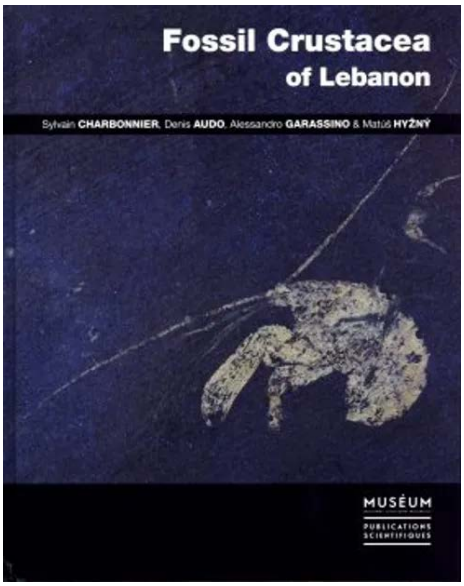
We are looking forward to a dynamic Annual Meeting this year. Our Annual meeting will be held in conjunction with GSA Connects 2021. Technical sessions will operate within the GSA platform and will require GSA registration (PS members can register at member rates regardless of GSA membership). Most PaleoSociety activities, including the annual award ceremony, will be held in a virtual platform and will be open to all members regardless of GSA registration. Select events will occur in-person in Portland. We look forward to connecting with you virtually or in-person in Portland.

As always, a wonderful selection of topical sessions has been proposed including this set that the PaleoSociety is sponsoring:

T13. Tectonics, Climate, and Life: Continental Drift, Large Igneous Provinces, and Global Change
T31. Assessing Causes, Consequences, and Timescales of Miocene Climate and Environmental Change
T68. Lacustrine Systems around the World
T78. Co-Evolution of Earth's Surface Environment and Eukaryotic Life after the Great Oxidation Event
T80. Foraminiferal Signals of Major Events in Mesozoic-Cenozoic Earth History
T81. Impacts of Volcanism on Global Climate and Oceans—Drivers of Mass Extinctions through the Phanerozoic
T82. Integrative Approaches to Understanding Mesozoic Environmental and Biologic Perturbations
T83. Future Leaders in Paleontology
T84. Cephalopods Present and Past: Evolution, Paleoecology, and Links to Paleoenvironmental Change
T85. In Memory of Joanne Kluessendorf: The Winifred Goldring Award and the Promise of Women in Paleontology
T86. New Insights on Arthropod Paleobiology
T87. New Perspectives on Phanerozoic Mass Extinctions and Environmental Perturbations
T88. Putting the Clocks Forward: Latest Advances in Heterochrony and Developmental Bias in Deep Time
T89. The Evolution of Early Phanerozoic Oceans: A Geobiological Perspective
T90. Biotic Interactions through Time
T91. Community Ecology and the Fossil Record: Diversity, Ecological Structure, and Paleoenvironmental Responses
T92. From the Burgess Shale to the Manis Mastodon: 500 Million Years of Environmental & Evolutionary Change in the Great Northwest
T93. Stratigraphy, Stasis, and Shales: A Celebration of the Careers of Carlton Brett and Gordon Baird
T94. The Neoproterozoic Earth-Life System
T95. Advances in Virtual Paleontology: Applications, Digitization, and Dissemination
T96. Phylogenetic Paleobiology: Combining Evolutionary Trees and Fossils to Understand the Evolution of Life
T102. Correlation of Global Stages, Series and Systems into North American Stratigraphic Successions
T104. Neogene and Quaternary Environmental Change in the Tropics: Recent Advances and Future Opportunities
T109. Life's Innovations from the Early Earth to the Search on Modern Mars: Honoring the Career of Andrew H. Knoll
T119. The Cretaceous-Paleogene Boundary: From Impact Cratering Processes to Mass Extinction Mechanisms
T123. Co-Evolution of Earth and Life
T140. Paleoclimate, Paleoenvironments, and Paleoceanography of Northwestern North America
T141. Reconstruction of Quaternary Paleoenvironments at Regional and Global Scales: A Tribute to Eric C. Grimm (1951–2020)

# —BOOK REVIEWS—

## Book Review: *Fossil Crustacea of Lebanon*




**Charbonnier, S., D. Audo, A. Garassino, and M. Hyžný. 2017. *Fossil Crustacea of Lebanon*. Muséum national d'Histoire naturelle Publications Scientifiques, 210:1-252.**

*Reviewed by Thomas A. Hegna (SUNY Fredonia, Fredonia, NY)*

The *Fossil Crustacea of Lebanon* represents another in a series of beautifully illustrated monographs headed by Sylvain Charbonnier (see Charbonnier, 2009; Charbonnier *et al.*, 2013). I'm already looking forward to Charbonnier's *next* monograph! In it, Charbonnier *et al.* take a neglected group of animals (the crustaceans) of Lebanon, and weave them into their own lavishly illustrated book. There have been other books on the Lebanon plattenkalks (Gayet *et al.*, 2003; Ghossein, 2000), but in both, crustaceans are a footnote to their main focus: the fish. The fish fauna of the Cretaceous (Santonian and Cenomanian) of Lebanon *is* fantastic, but so is the crustacean fauna, as Charbonnier *et al.* rightfully recognize.

The book begins with a short historical context section, which for my tastes is a bit too short. Stratigraphic columns for each of the four localities would have helped orient the reader to the geological differences and similarities between the sites. The short treatment of the historical and geological background means that already at page 31, one arrives at the meat of the book—the systematic paleontology.

The systematic section spans about 200 pages, and covers all groups of accepted malacostracans present in the Cretaceous of Lebanon (the light photographs (with a helpful section in the methods section explaining the significance of the imaging techniques). Many enigmatic thylacocephalans—likely crustaceans of some variety or another—were not included in the book, but were instead treated by Charbonnier in a separate publication: Charbonnier *et al.*, 2017). Covered in the book are the decapods, the isopods, the lophogastrids, the stomatopods and the scalpelliform barnacles. The fossils are beautifully illustrated with both UV light and plain specimens are illustrated by multiple images. Original historical type material is illustrated. This book contains thirteen new genera and twenty-one new species, while comprehensively reviewing others—in total treating seventy species.

Personally, I love these volume-level treatments of *Lagerstätten*. They pull together a vast amount of information and highlight the significance of the sites. The Lebanon sites have thus far been ignored in volumes on exceptional preservation, so a volume such as this is even more desirable.

Works Cited

Charbonnier, S. 2009. *Le Lagerstätte de la Voulte: un Environment Bathyal au Jurassique*. Publications Scientifiques du Muséum, Paris.

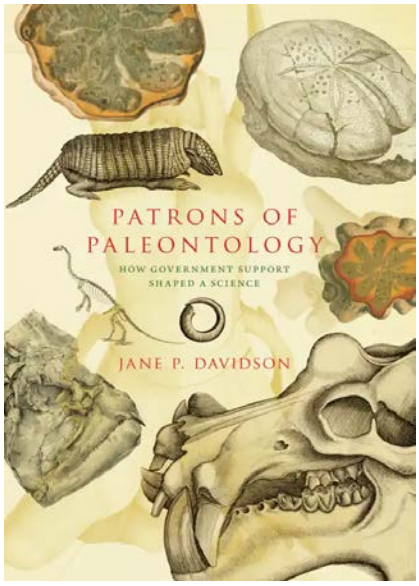
Charbonnier, S., A. Garassino, G. Schweigert, and M. Simpson. 2013. *A Worldwide Review of Fossil and Extant Glypheid and Litogastrid Lobsters:(Crustacea, Decapoda, Glypheoidea)*. Muséum national d'Histoire naturelle, Paris.

Charbonnier, S., G. Teruzzi, D. Audo, M. Lasseron, C. Haug, and J. T. Haug. 2017. New thylacocephalans from the Cretaceous Lagerstätten of Lebanon. *Bulletin de la Société Géologique de France* 188: 19.

Ghossein, S. K. 2000. *The Geology of Lebanon with a Review of the Fish Fauna*. Edmonton: Ghossein Museum. 185 pgs.

Gayet, M., A. Belouze, A., and P. Abi Saad. 2003. *Les Poissons Fossils*. Méolans-Revel: Editions désiris. 158 pgs.

# Book Review: *Patrons of Paleontology: How Government Support Shaped a Science*



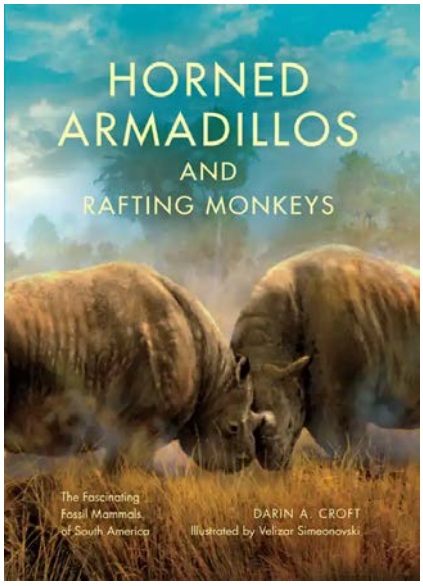

**Davidson, J. P. 2017. *Patrons of Paleontology: How Government Support Shaped a Science*. Indiana University Press, Bloomington & Indianapolis, IN, 256 pp. ($28.00 cloth, $6.99 e-book with 30% PS discount.)**

*Reviewed by Paul Barrett (Natural History Museum, London, UK)*

Who pays for palaeontological research and why? Part of the answer to this question is provided by *Patrons of Paleontology*, a broad survey of the assuredly important impact that government funding had on the early development of the subject, up to the end of the 19th Century. In this study, Jane Davidson adopts a catholic definition of 'government' to include not only national legislatures, but also individuals in positions of political influence or power, including aristocrats, landowners and ecclesiastical leaders, who patronized the developing science of palaeontology. Starting with examples of the early support given for the printing and distribution of publications mentioning fossils in the 15th Century (although the nature of fossils was unknown at this time)—through the intervention of curious clerics and counts—through to the more extensively documented influence of official geological surveys, Davidson documents the financial support that palaeontology received as it blossomed into a new science. In the opening parts of her thesis, Davidson summarizes early work in Europe, where the subject began, but the bulk of the book deals with the emergence of the discipline in the USA, with especial emphasis on figures in vertebrate palaeontology. On the basis of numerous examples, which are listed in chronological order, the author concludes that palaeontology has a lot to thank governments for: partly in terms of direct financial patronage to individual researchers, but primarily through their support of official state-level and national-level surveys, and especially the publications that these organisations produced. Indirect support was also critical: the intervention of the military, and the presence of their outposts in what were then remote areas, and the logistic support of the railroads were crucial in opening the extensive fossil fields of the American West. The roles of learned societies in Europe (primarily the UK) are also mentioned as these were populated by many establishment figures of the day, but as these were not part of 'the state' government influence in these cases is more inferred than explicit.

This will be a useful reference guide for anyone interested in the early history of the subject and some of the social and historical context in which it occurred. In many ways, it is a useful companion to books like Mark Jaffe's *The Gilded Dinosaur*, which give more sociological and political background to the figures doing the science. However, although the author makes a strong case for the strong influence of 'government' support on palaeontology, one important piece of the puzzle is missing. With the exception of several short statements, the reasons *why* governments (or wealthy power brokers) provided this funding are not explored in detail. Although it might seem obvious that governments would value catalogues of the materials in their territories in order to exploit them more efficiently and profitably, very few fossils are commercially valuable, so why would hard-headed politicians, with their eyes fixed on the tax-dollar (or pound, or franc), spend money on these pursuits? Although we know that early support was provided by figures that were intellectually or aesthetically interested in fossils, how did this transition into state-sponsored schemes? Many examples are provided showing *how* state interventions helped palaeontologists, but the book offers no direct examples of the opinions of the policymakers that facilitated this largesse (with the obvious exception of Thomas Jefferson), although this would require hunting through the private letters, published speeches or articles of numerous key public figures. It would be fascinating to know what factors drove legislatures to fund this science on the basis of documented evidence from the funders, rather than supposition. One potential driver, which is not mentioned by the author, is patrimony and prestige – could it be that simply having bigger, better or more abundant fossils was a source of national one-upmanship? Could other social agendas relating to education, secularization, *etc*., have been factors in persuading politicians to bank-roll relevant projects? A follow-up work concentrating on the responses of government figures would be a valuable addition to understanding the broader milieu in which palaeontology developed. Still, it is always encouraging to be reminded that past governments have valued the contribution of palaeontology; especially as we're now at a time when the US administration is actively undermining the protection of many productive palaeontological sites.

# Book Review: *Horned Armadillos and Rafting Monkeys: The Fascinating Fossil Mammals of South America*




**Croft, D. 2016. *Horned Armadillos and Rafting Monkeys: The Fascinating Fossil Mammals of South America*. Illustrated by V. Simeonovski. Indiana University Press, Bloomington & Indianapolis, IN, 320 pp. ($35.00 cloth, $6.99 e-book with 30% PS discount.)**

*Reviewer: Ephraim Nissan (London, England)*

"South America has a rich and fascinating fossil mammal record, the best among Southern Hemisphere continents" (p. ix), but "even many paleontologists" are unaware of "most of these mammals" (p. ix). The book under review, whose main focus is the Cenozoic era (including the last 66 million years: the Palaeogene, the Neogene, and the Quaternary), is enlightening, and Velizar Simeonovski's many illustrations set a high standard. They have a photographic realism that makes them stunningly effective. In particular, e.g., the closest blades of grass in the forefront look as though they were out of focus in a photograph, or then so are a tree's secondary branches in the background, so it really looks like a photograph. Of course, in the book there also are maps, diagrams, and photographs of skeletal items. The life reconstructions were made by the illustrator in consultation with the author: they had extensive discussions. However, "the plants are not necessarily those that would have been present in the area at the time" (p. x).

Croft is "an authority on the extinct mammals of native South America and is particularly interested in the ecology and evolution of notoungulates, the most diverse group of native South American hoofed mammals." Fairly enough, inside the book the first two images one comes across are (full-page, and facing each other) of an armadillo with two little horns above its nostrils, and of a leaping monkey, thus reflecting the book's main title. (The leaping monkey of the frontispiece is *Cebupithecia sarmientoi,* a relative of modern saki monkeys, and the same image also appears on p. 140.) The third image inside the book is on the next two facing pages, and reflects Croft's own main area of interest. It is captioned: "To anyone who has ever wondered what a notoungulate looked like." The front of the jacket cover shows "[t]wo male toxodontid notoungulates (*Trigodon*) test[ing] one another's strength during the mating season" (p. 186). The rhino-sized notoungulate *Toxodon platensis,* after whose genus the family is named, is discussed on pp. 236–237.

Chapters 1, "Time and Geography", and 2, "Introduction to Mammals", are followed with 15 chapters, each devoted to a particular site. After the bibliography ("Further Readings"), there are 17 appendices ("Alphabetical List of Species", "Families and Higher Taxonomic Groups", and then appendices for particular sites). A glossary and an index conclude the volume.

The rationale of organising the book as chapters per site is justified by the epigraph on the page preceding the table of contents: "Here is indeed an interesting mixture of creatures, and it takes only a modicum of human curiosity to want to know their history and to learn, as far as possible, how that mixture arose," a statement by George Gaylord Simpson.

Chapters 3 to 6 belong to Part I: "Early South American Phase and Trans-Atlantic Dispersal Interval", covering the sites Tiupampa (Bolivia), Itaboraí (Brazil), Gran Barranca (Argentina), and La Gran Hondonada (Argentina). The book is intended to provide a "walk through time provided by these 'snapshots' of ancient South American mammals and their communities" (p. x). Each site is introduced (there are photographs of present-day landscapes), before turning to individual taxa of the fossil fauna.

Subsections are each devoted to one particular species (sporadically, two species), not necessarily prominent at the given site, but coeval or present. On occasion, it is not even a mammal. "Most of the life reconstructions in this book are of single mammal species, but some include two species and/or a bird or reptile" (p. x). On occasion, a subsection is devoted to an animal taxon other than a mammal indeed. Subsection 15.1 is devoted to terror birds (pp. 192–193); "the first terror birds may have followed the same route [from Africa] to South America as caviomorph rodents and platyrrhine primates" (p. 192), which in turn perhaps "traversed the Atlantic Ocean on a floating island of vegetation expelled from the mouth of an African river after a storm" (p. 5). As for non-mammals again: "Crocodilians are touted as 'living fossils' that have changed little in hundreds of millions of years. Few extinct species refute this statement better than *Sebecus icaeorhinus*" (p. 52), whose skull was tall and narrow, and which had "eyes on the side of its head, and limbs specialized for an upright stance" (p. 52). Another crocodilian that appears in the book under review is a giant caiman (*Purussaurus neivensis*) shown in an image on p. 142 as it "finally strikes in a fury of mud and water after approaching a group of small litopterns." "*Purussaurus neivensis* was the undisputed king of the crocodilians at La Venta" (p. 142).

The criteria of organisation inside each subsection are spelled out. "Each reconstruction is accompanied by a succinct description of the animal's habits and characteristics and basic information about it including (1) size; (2) ecological characteristics; (3) evolutionary relationships; and (4) the meaning of its scientific name. Size estimates for each species were taken from the scientific literature or calculated firsthand based on fossil remains or those of closely related species (see also chapter 2). Ecological characteristics mainly focus on locomotion and diet, whereas evolutionary relationships provide some idea of how the species is classified (see also appendix 2). Intended meanings of scientific names were taken directly from the original publication on the species, though for many species (particularly those named by Florentino Ameghino), the author provided no explicit justification for why the name was

# Book Review: *Horned Armadillos and Rafting Monkey, cont.*

chosen" (p. x), and Croft inferred the etymological meaning.

Part II, "Late South American Phase", comprises Chapters 7 to 13, and the sites covered are Tinguiririca (Chile), Salla (Bolivia), Chucal (Chile), Santa Cruz (Argentina), La Venta (Colombia), Quebrada Honda (Bolivia), and Arroyo Chasicó (Argentina). Part III, "The Great American biotic Interchange (GABI) and the Interamerican Phase", includes Chapters 14 to 17, for the sites Acre (Brazil), Catamarca (Argentina), Chapadmalal (Argentina), and Tarija (Bolivia). The chapter for the latter has nine subsections, for ten species. "It is likely that peccaries dispersed to South America more than once during the GABI, perhaps on four separate occasions" (p. 212). "Tarija [a Pleistocene site] is one of the richest mammal sites in South America" (p. 217), and "more mammal species at Tarija belong to groups that dispersed to South America during the GABI than to groups native to that continent" (p. 217).

"This huge mountain chain [the Andes, even though they were lower than they are now] and a large latitudinal span [north to south] that straddles the equator have created a wide variety of climates and habitats in South America" (p. 4). Prior to the Isthmus of Panama coming into being, "most groups of South American mammals were found nowhere else" (p. 4), making the continent the equivalent of present-day Australia or Madagascar (p. 4). This isolation endured since 66 million years ago, to only a few million years ago. In the middle Cenozoic, two mammal groups, caviomorph rodents and platyrrhine monkeys, nevertheless appeared in South America, perhaps having "traversed the Atlantic Ocean on a floating island of vegetation expelled from the mouth of an African river after a storm" (p. 5). ["The late Miocene was the age of giant rodents, and *Phoberomys burmeisteri* was among the largest of them all. This species was clearly several times the size of the largest living rodent, the capybara" (p. 184) of South America. *Phoberomys burmeisteri* was as large as a grizzly bear (p. 185).]

For a while, "virtually the only predatory mammals in South America" (p. 12) were marsupials of the order Sparassodonta. On page 196 (but the same image appears inside the front cover, on facing pages), a gigantic raptor bird is shown descending on a sabre-toothed marsupial, "in an attempt to steal its pampathere prey", which has a bony armour, and "resembled armadillos in some respects, glyptodonts in others" (p. 196). The distant armadillo relative *Neoglyptatelus* resembles glyptodonts, and used to be thought of as one (p. 180), and yet: "Recent studies have shown that these unusual armadillos may be more closely related to glyptodonts and pampatheres ([sub]section 15.3) than to other armadillos" (pp. 180–181). The genus *Glyptodon* is discussed on pp. 222–223.

"The vast majority of native South American ungulates belong to four orders: Notoungulata, Litopterna, [large, tusk-bearing] Astrapotheria, and [the giant] Pyrotheria. Notoungulates and litopterns appear to be most closely related to perissodactyls (horses, rhinos, and tapirs) among mammals alive today" (p. 15). Even though these fossils are called 'ungulates', and all of them were herbivorous, only some of them "bore hooves, others had feet that ended in nails, claws, or something in between" (p. 15). Notoungulates were the group that had most species, and were "the most abundant ones at many sites" (p. 16).

Some notoungulates, the clawed, browsing Homalodotheriidae, resembled both chalicotheres (fossil perissodactyls) and giant sloths" (p. 170). Of both the chalicotheres and the Homalodotheriidae, it is unknown whether they walked like modern gorillas, on the knuckles of their forelimbs. As for sloths from South America, consider that because of the barrenness of its coastal habitat, *Thalassocnus natans* was adapted to feed in the sea: it swam and fed on marine plants (p. 182). This may seem against the grain of how we think about the locomotion of modern sloths, yet even these, which are notoriously slow, are quick instead when forced to swim in a river. For that matter, think of slugs in your garden: adults are very slow, but tiny juveniles run quite quickly, if they sense danger.

Of the pyrotheres, only one skull is known. "Well-developed muscles attached to the skull near" "the external opening of the nasal cavity [...] between the orbits (eye sockets) in *Pyrotherium* rather than at the tip of its snout" "sugges[t] that *Pyrotherium* possessed a large, mobile, elephant-like proboscis. Like some extinct elephants (order Proboscidea), *Pyrotherium* had upper and lower teeth enlarged into tusks, though *Pyrotherium* had two pairs of lower tusks as opposed to just one" (p. 102). In contrast, South American extinct relatives of elephants are the subject of Subsection 17.1 in the book under review (pp. 220–221). In contrast, Croft and Simeonovski do not accept the ascription of a proboscis to South America's Pleistocene lama-like giant litoptern *Macrauchenia patachonica* (p. 234).

Of the specific name *romeroi* of the genus *Pyrotherium,* Croft states that it honours "an Argentine geologist, Antonio A. Romero, but was accidentally misspelled 'romeri' when first published and is still misspelled occasionally" (p. 103). Not so. It wasn't accidental; rather, *romeri* as appearing in the earliest publication should be considered the correct form, and those who still write *romeri* are doubly correct: they adopt the spelling of the first publication, and quite simply, that is the grammatically correct Latin form of the word. The form *romeri* is the correct declensed form. It is the Latin regular genitive form of Latin masculine nouns or names of the second Latin nominal declension, whose ending is *-us* in the nominative case, and is *-o* in the ablative case, and such nouns or names typically correspond to Spanish (or Italian) names ending in -o. It is the choice to make the specific name *romeroi* that broke with the Latin tradition, apparently out of concern to retain Romero's surname in full. Another glitch is that while elaborating about a fossil anteater being misnamed *Neotamandua* (p. 138), Croft states that "a more appropriate name would have been *Paleomyrmecophaga*" (p. 139). But even though Croft prefers to write *paleo-* rather than *palaeo-* in English, he is plainly wrong to do the same in the Latin spelling of the Greek compound name which is a scientific name.

Among South America's fossil mammals, "Astrapotheres ('lightining beasts') [...] were mostly large to very large tusk-bearing animals [...] They were named 'lightining beasts' in allusion to brontotheres ('thunder beasts'), a group of large horned animals that were common in North American fossil faunas of about the same age" (pp. 16–17). This kind of naming by opposition is what I call *misantonyms*. (c.f., E. Nissan, 2013, Classes of proper names within misantonyms, O. Felecan and A. Bugheşiu, eds. *Onomastics in the Contemporary Public Space.* Cambridge Scholars Publishing, Newcastle, England, pp. 11–27). Among the geologically youngest astrapotheres, "*Granastrapotherium snorki* was the largest mammal at La Venta" (p. 146); it "was about the size of a rhino and had a head with a well-developed, mobile proboscis" (p. 146), and tusks like those of a hippo.

The Great American Biotic Interchange (GABI) saw the following groups arrive into South America from North America (pp. 17–19): Gomphotheriidae (which are proboscideans), Lagomorpha (rabbits and pikas), Eulipotyphila (shrews, moles and hedgehogs), Carnivora, Perissodactyla, Artiodactyla, and egg-laying Monotremata. The latter,

# Book Review: *Horned Armadillos and Rafting Monkey, cont.*

only represented outside Oceania by the platypus-like *Monotrematum sudamericanum,* which perhaps walked overland from Australia through ice-free Antarctica (p. 19).

Another odd occurrence, but this one very early—from the Palaeocene and Eocene—is that of a pantodont species in Bolivia, "the only occurrence of the group outside the Northern Hemisphere" (p. 34), and that animal was as small as a squirrel, its weight being perhaps 500g (p. 35), whereas some pantodonts "weighed up to half a ton, or 500 kg" (p. 34).

At Itaboraí in southeast Brazil, "there are more species of marsupials than placentals" (p. 37), and taxa discovered there "include: *Riostegotherium,* the oldest armadillo (and xenarthran); *Tetragon stylops,* the oldest member of the native South American ungulate order Astrapotheria; and two species that are the oldest unquestionable representatives of Sparassodonta, extinct meat-eating marsupials of South America" (p. 38). [Eventually, giant sparassodonts appeared: *Paraborhyaena* and *Proborhyaena* were perhaps 5-feet long (pp. 94–95). Subsection 15.2 is devoted to the sabre-toothed marsupial *Thylacosmilus atrox* (pp. 194–196). In a much more recent period, sabre-toothed big cats arrived in South America: it is a case of evolutionary convergence. Sabre-toothed cats from South America's Pleistocene are the subject of pp. 230–231. As for armadillos, the largest armadillo ever discovered is *Macroeuphractus outesi,* which was a predator, and whose head-body length was probably 4 feet, 1.25 cm (pp. 208–209). The "horned armadillo" is discussed on pp. 110–111, and is "only distantly related to living armadillos" (p. 110). "The horns of *Peltephilus* are actually highly modified osteoderms [plaques of the armour] rather than structures that grew from its skull" (p. 110).]

At Itaboraí, both plantigrade and digitigrade small ungulates were found (pp. 42–45). *Carodnia,* "the largest mammal of its time in South America" (p. 46), at up to 6 feet of length, was a xenungulate, from a group of the late Palaeocene and early Eocene (p. 46). The middle Eocene "could rightfully be called the Age of the Notungulates" (p. 49).

Notungulates included animals in a wide range of sizes. They also included large mammals, such as the toxodontid rhino-like (but hornless) *Nesodon* (pp. 114–115). And the family Leontiniidae "includes many large to very large species characteristic of late Oligocene and early Miocene sites in southern Argentina. In fact, the leontiniid genus *Colpodon* was so abundant from about 21 to 19 million years ago that Florentino Ameghino chose it as the defining mammal for fossil beds of that age" (p. 98).

Croft points out that the mole-like (or rather, by convergent evolution, golden-mole-like) *Necrolestes patagonensis,* whose "evolutionary relationships were unclear" until recently (p. 122), has turned out to have been "neither a marsupial nor a placental but rather part of a separate, ancient group of South American mammals known as meridiolestidans that was thought to have gone extinct some 60 million years ago" (p. 122), and *Necrolestes* appeared more than 40 million years later, this being an instance of the Lazarus effect, of reappearance after a long gap in the fossil record. Another example of convergent evolution is monodactyly (limbs supported solely by the middle digit) in living horses, and the South American fossil gracile litoptern *Thoatherium minusculum,* in which "the side digits are even more reduced (proportionately much shorter) in *Thoatherium* than they are in horses" (p. 130). But the cursorial browsing ungulate *Thoatherium,* phylogenetically distant from horses, had a head-body length of just about 2.5 feet (75 cm). [Extinct horses from South America's Pleistocene are the subject of pp. 232–233.]

Even at a relatively late stage, there were small animals among the notoungulates, such as the fossorial hegetotheriid *Paedotherium typicum,* which "was among the more common mammals at Chapadmalal" in Argentina (p. 214)—which is a Pliocene site, sea cliffs near the city of Mar del Plata (p. 203)—and "may have been the notoungulate equivalent of a modern rabbit (*Sylvilagus* spp.) or Chacoan mara (*Dolichotis salinicola*), both of which are small herbivores and fast runners that also live in burrows" (p. 214).

Palaeontologists might be interested to learn that an early occurrence, from late antiquity, of what appears to be the idea of ecological vicariance is found in two statements about the fabled zoology of *Bei 'Illay,* 'the High Places', i.e., the mountain ranges of Central Asia, including the Pamir and Himalaya ranges. In tractate *Ḥullin* (about meat), folio 59b, of the Babylonian Talmud, itself from Persian-ruled pre-Islamic Mesopotamia, it is stated in the Aramaic language: "Rab Judah said: The *qéresh* (i.e., unicorn [from Greek *keras,* 'horn']) is the gazelle of Bei 'Illay; the tiger is the lion of Bei 'Illay", which Marcus Jastrow in his 1903 dictionary (*Dictionary of the Targumim, the Talmud Babli and Yerushalmi, and the Midrashic Literature* (2 vols.). Luzac & Co., London; G.P. Putnam's Sons, New York; Trübner & Co., Leipzig; often reprinted by various publishers) explains on p. 520, col. 1, in the entry for *ṭigros:* "i. e., what the lion is in other regions." But the Talmudic text continues with fabulous claims ascribed to other sages: "Rab Kahana said: There is a distance of nine cubits from one ear to the other ear of the lion of Bei 'Illay. Rab Joseph said: The hide of the gazelle of Bei 'Illay is sixteen cubits long. The Emperor once said to Rabbi Joshua ben Ḥananiah, 'Your God is likened to a lion, for it is written: «The lion hath roared, who will not fear? The Lord God hath spoken, who can but prophesy?» (*Amos* 3:8). But what is the greatness of this? A horseman can kill the lion'! He replied: 'He has not been likened to the ordinary lion, but to the lion of Bei 'Illay!' 'I desire', said the Emperor, 'that you show it to me'. He replied: 'You cannot behold it'. 'Indeed', said the Emperor, 'I will see it'. He [Rabbi Joshua ben Ḥananiah] prayed and the lion set out from its place. When it was four hundred parasangs distant it roared once, and all pregnant women miscarried and the walls of Rome fell. When it was three hundred parasangs distant it roared again and all the molars and incisors of man fell out; even the Emperor himself fell from his throne to the ground. 'I beseech you', he implored, 'pray that it return to its place'. He prayed and it returned to its place." A different interpretation is found in "The Story of the Lion", being Section III on pp. 295–298 in an article by Reuven Kiperwasser and Dan D.Y. Shapira (2014, Encounters between Iranian myth and rabbinic mythmakers in the Babylonian Talmud. U. Gabbay and S. Secunda, eds. *Encounters by the Rivers of Babylon: Scholarly Conversations Between Jews, Iranians and Babylonians in Antiquity.* Texts and Studies in Ancient Judaism, v. 160. Mohr Siebeck, Tübingen, Germany, pp. 285–304). On p. 295, Kiperwasser and Shapira maintain that Bei 'Illay is "the highest area of the sky"; the lion, they claim, is a celestial lion from Mesopotamian, Iranic, or Anatolian myths (pp. 297–298), e.g. from the iconography of the goddess Ishtar with her standing on the back of an astral lion, or from that of Mithraism.

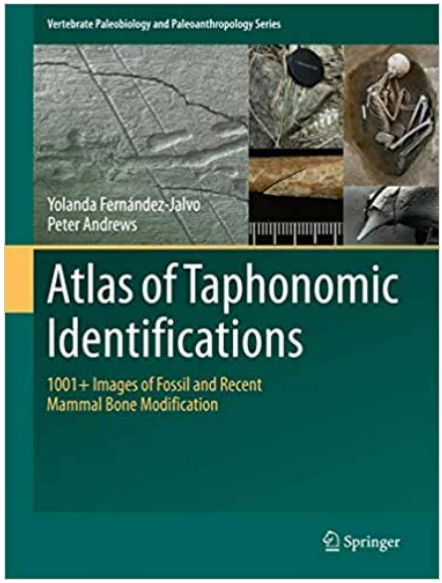
Quite reasonably given the two book's different scope and purposes, the approach in Croft's book is very different from the one found in another cleverly done 2013 volume about South America's fossil mammals I have reviewed for *Priscum,* namely, *Megafauna: Giant Beasts of Pleistocene South America* (R. A. Fariña, S. F. Vizcaíno, and

## Book Review: *Horned Armadillos and Rafting Monkey, cont.*

G. De Iuliis, Indiana University Press, Bloomington, IN).

The book under review here is a magnificent book, with splendid and exacting illustrations, a necessary update between two covers for specialists as well as for palaeontologists unfamiliar with South America. It is also an accessible book for the educated public. Darin Croft's writing project is unquestionably useful. Velizar Simeonovski has proposed a daunting challenge to the next generation of illustrators.

## Book Review: *Atlas of Taphonomic Identifications*




**Fernández-Jalvo, Y. and P. Andrews, eds. 2016. *Atlas of Taphonomic Identification: 1001+ Images of Fossil and Recent Mammal Bone Modification*. Springer Geology. Springer Netherlands, 359 pp. (€103.95 cloth, €103.95 paper, € 82.30 e-book.)**

*Reviewed by Karen A. Koy (Missouri Western State University, Saint Joseph, MO)*

The *Atlas of Taphonomic Identification* is an excellent resource for identification of common taphonomic modifications to bone. The information in this book is addressed to a broad audience of archeologists, anthropologists, paleontologists and forensic scientists. The information is presented in such a way that non-specialists and students would have an easy time understanding and using the text. This is not a book or manual of methodology, so the authors refer readers looking for more detailed information to other works. However, the second chapter briefly reviews methods of collection and experimentation to anchor the reader in the scientific fields involved.

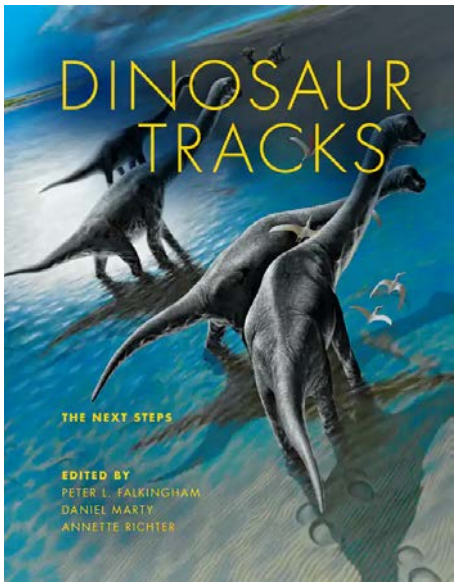
The main body of the atlas is divided into five sections: surface modifications, modifications affecting shape, modifications penetrating bone tissue, modification by loss of bone tissue or skeletal elements, and conclusions. Each section is split into chapters addressing the major types of each modification, rather than the agents of modification. For example, all discussion of puncture marks is contained within a single chapter rather than spread out between chapters on scavenging, human tool use, and abiotic processes. This makes the atlas easy to use as a reference.

Each chapter opens with 5–10 pages of text which go into detail about the agents and processes that cause that particular type of modification, its characteristics, and a description of how the different agents and processes affect the resultant modification. Each chapter ends with hundreds of atlas figures illustrating the text. They are referenced throughout the text, but I would have preferred a more comprehensive listing of the atlas subsections within the chapter text itself. For this, one has to go to the figure index at the back of the book, which does not subdivide the figures beyond type of modification and whether the modifying agent is organic or inorganic.

The photographs used for the atlas figures include both regular and microscopic images, including scanning electronic micrographs. The pictures themselves are excellent. There is a mix of color and black-and-white photographs, taken both in the field and laboratory. Each figure has a brief but informative caption. The majority of images are small (5.5 x 8.5 cm), similar in size to those found in the published literature. The subject of each image is clear for most of the images, although some of them would have benefitted from being a larger size, or having a portion of the picture enlarged. Many of the atlas pages have empty space that would have accommodated larger images.

Overall, this book is an excellent resource for professionals and students of many different scientific specialties. The authors discuss the taphonomy of modern and fossil material, and directly address the importance of taphonomy to paleontologists. The text is comprehensive in terms of agents and processes of bone modification, and present a state-of-the-art albeit brief summary of the field. The authors spend some time in the concluding remarks discussing new or understudied areas within taphonomy. I would recommend this for anyone who might encounter taphonomic issues in vertebrate remains, or indeed anyone with an interest in the subject.

# Book Review: *Dinosaur Tracks: The Next Steps*




**Falkingham, P.L., D. Marty, and A. Richter. 2016. *Dinosaur Tracks: The Next Steps*. Indiana University Press, Bloomington & Indianapolis, IN, 428 pp. ($28.00 cloth, $6.99 e-book with 30% PS discount.)**

*Reviewed by Andrej Spiridonov (Vilnius University, Lithuania & Nature Research Centre, Lithuania)*

Dinosaurs are one of the most spectacular discoveries that paleontology ever uncovered through its history. The fossils of skeletons (and on the rare occasions their soft tissues) reveal the appearance and functional capabilities of ancient beasts. Despite the richness of preserved body fossils, the behavior of extinct animals is strongly underdetermined by the evidence. This gap in our understanding of ethology of extinct animals is bridged by the study of trace fossils, which are disturbances of various solid and semi-solid substrates by biotic activity. In recent decades, the science of traces (ichnology) has enjoyed a period of enlightenment and rapid growth in its scope and diversity of techniques, and the questions applied to it.

The reviewed book represents a synthesis of the most recent dinosaur track studies, thus continuing the "Dinosaur Track Renaissance" that started in the 1980s and followed the general "Dinosaur Renaissance" that started in the 1970s (Bakker, 1971; Lockley, 1991). As explained in the Introduction, it is a publication resulting from the large symposium that was dedicated to dinosaur ichnology that happened in the Obernkirchen, Lower Saxony (Germany) during the year 2011. The book is very well illustrated by abundant figures with beautiful pictures of reconstructed landscapes, supplying scientific inference with artistic interpretation. The reviewed volume is organized in to four major parts: 1) Approaches and techniques for Studying Dinosaur Tracks; 2) Paleobiology and Evolution from Tracks; 3) Ichnotaxonomy and Trackmaker Identification; 4) Depositional Environments and Their Influence on the Track Record.

The first part of the book is concerned with development and implementation of optimal methods for the documentation, measurement, experimental neoichnological work, and managerial solutions toward conservation of dinosaur footprint tracksites. Chapter 1 tackles complex issues of track formation. It is a very interesting part because it explicitly reveals how different morphologies of traces could appear through the interaction of the kinetics and kinematics of limbs, the properties of a substratum, and the final appearance due to different modes of erosion. As is shown, even closely related taxa (e.g., modern analogues of some non-avian dinosaurs, the ratites) can be characterized by very distinct footprint morphologies. What's more interesting, is that even the same taxon can leave very different three-dimensional patterns in the sedimentary layer depending on the granulometric and hydraulic properties of the matrix and the pattern of motions of an animal. Therefore dinosaur trace studies and ichnology more generally is posed by a unique problem, conceptually similar to genotype → phenotype mapping, since there are multiple ways that phenotypes could be mapped to the ichnotypes through the medium of behavior and recording environment (phenotype → behavior → ichnotype). This could sound as a nightmare for taxonomy, but on the other hand, careful analysis of the context of ichnological patterns can yield unprecedented amounts of information about environment, mode of life, and behavioral characteristics of an animal or the whole paleocommunity. Chapter 2 is a very good introduction on the state-of-art application of photogrammetric and LiDAR techniques toward description, documentation, and analysis of landscape scale dinosaur tacks with often sub-millimeter resolution. Since the majority of fossil tracks, due to their dimensions, cannot be directly collected, this kind of "digital preservation" is a significant way forward in curatorial strategies. Chapter 3 presents a case study of geometric morphometric analysis of a large theropod from Münchehagen locality. By quantitatively analyzing motion of a single individual, different morphometric characters were tested for the usefulness in ichnotaxonomy. Chapter 4 presents a conceptual morphometric–typological approach for the measurement of dinosaur fossil footprints. It touches on the very important issue of finding homologies in fossil tracks, since depending on the points of view of researchers and on the modes of preservation, different features of the track could/should be used for the determination of dimensions. The authors propose the Solomonic solution, where all possible protocols for the measurement should be performed on a given track and documented in the publication. In this way, even very distinctly preserved tracks could be compared on some level, and other researchers could evaluate the level of exactitude of a given measurement, which often is unknown. In Chapter 5, experimental and numerical approaches are presented for the study of sediment kinetics under biomechanical disturbance by the tracers. The authors argue that in order to fully understand the nature of tracks, their full three-dimensional extent, and their shape, we need to understand behavior of a sedimentary matrix from the stand point of vector fields of movement of sedimentary particles. In chapter 6, the authors present a numerical scale for the evaluation of taphonomic quality of fossil dinosaur tracks. They characterize sets of features that should be observed, that indicate that a footprint is of sufficient quality for the erection of new taxa. Chapter 7 presents a qualitative evaluation scheme of global data base of dinosaur track sites for the managerial, curatorial and heritage preservation purpose. I've learned a staggering fact that to this day there is not a single one UNESCO site that is primarily dedicated to dinosaur trace fossils. Therefore, the described evaluation methodologies are extremely important in justifying the societal values of trace fossils toward local and global governments, and thus making ichnological record of ancient life more accessible and relevant for the general public.

# Book Review: *Dinosaur Tracks: The Next Steps, cont.*

The second part of the book reveals innovative examples of paleobiological inferences from dinosaur tracks. Chapter 8 reveals historical record of Iberian sauropod manus and pes tracks. By analyzing positional properties (e.g. gauge) and morphometric parameters, the authors found distinct trends in morphologies of footprints as well as in degrees of heteropody (differences in proportions of manus and pes). These patterns could be related to the displacements of sauropod faunas. Chapter 9 tested sauropod substrate grip by pes hypothesis, by using exquisitely preserved track of these giant dinosaurs. The study shows how certain biomechanical hypotheses could be falsified (or deemed highly unlikely) based on the ichnological evidence. Chapter 10 reveals the diversity of dinosaur swim tracks, and their study methods. It appears that swimming traces of dinosaurs are much more abundant than usually envisioned. This study shows that the majority of swimming tracks were left by non-avian theropod dinosaurs (even gigantic ones), which counters older suggestions that these dinosaurs avoided water. Therefore the presence or absence of swimming track of theropods could be counted as a crucial part of evidence for the interpretation of paleoecologies of Mesozoic ecosystems. Chapter 11 presents a global survey of "raptor" traces – the record of characteristic two-toed dinosaur footprints. At the time of writing of this chapter there were known just 16 deinonychosaurian tracksites, but most of them are just from the latest ten years or so. Possibly this is a result of insufficient attention toward this specific track type. Chapter 12 presents a geometric morphometric study of iganodontian tracks from the Germany through the lenses of individual, ontogenetic and taxonomic variability. The study presented a comprehensive protocol which encompasses a series of null model testing, going through which, the observed variance of morphology is explained by ever more encompassing causes. The authors find that sometimes qualitative placement of taxa could underestimate true levels of variability (and taxonomic diversity), by hindering recognition of distinct ontogenetic trajectories. This could be a fine example of how ichnological information should incorporate quantitative approaches in revealing patterns of individual variation between different taxonomic levels. In chapter 13, the authors explore ambiguities of "reverse engineering" of sauropod behavior from the observed track records. Usually the same configuration of footprints in a quadruped animal can be reached from different patterns of movement; therefore, without additional and independent information on crucial physical and behavioral characteristics of an animal, it is very difficult to place exact numbers on the speed and the patterns of locomotion. The authors suggest an evolutionary computer simulation approach with differing levels of externally imposed constrains in order to reveal an ensembles of possible behaviors that produced given sauropod tracks. Chapter 14 presents for the reader a concept of 4D tracks. These fossil tracks of dinosaurs and other animals are defined as those exquisitely preserved tracks that not only preserve details of fine morphology but also patterns of kinetics through the preservation of directed striations and voids left by scales or other protruding structures.

The ichnotaxonomy part starts from the chapter 15, which presents statistical analysis of Mesozoic bird tracks and compares them to non-avian theropod tracks. Exhaustive pairwise comparisons of different bird ichnotaxa revealed usefulness of *a priori* qualitative ichnotaxonomy. The ambiguities in statistical discriminations in most cases, in my mind, were caused mostly by drastic differences in sample sizes and/or very low sample sizes. Interestingly though, non-avian theropods can be distinguished from birds on the whole trackway level—thus they apparently walked differently. Chapter 16 tackles the problem of taxonomic placement of numerous ornithischian trackways in the famous "Chicken Yard" track site in Germany. Authors found that it is very difficult to distinguish true ornithopod tracks from degraded theropods tacks (which lack distinctive claw marks), thus confirming the necessity of taphonomic analysis before the start of an ichnotaxonomic exercise. Although, if the preservation in general is good, then theropods and ornithopods are easily distinguishable from each other on statistical morphometric grounds.

The sedimentological part of the book begins from the chapter 17, which tackles the problem of the formation of a highly "dinoturbated" (bioturbated by dinosaurs) tracksite from the Lower Saxony—the so-called "Chicken Yard." The authors employ taxonomic, statistical distributional and facies analyses in order to understand the reasons for the formation and high taxonomic diversity of this track site, concluding that it most probably represented a movement "corridor" on the shore of a large paleolake. Chapter 18 studies formational settings of dinosaur tracks in aeolian environments. In it, Mesozoic examples are compared with some modern analogues, thus suggesting possible ichnofacies interpretations for the deciphering of ancient paleogeographies and dinosaur paleoecological patterns. Chapter 19 presents results of an engineering-geological study of secondary features of sauropod tracks—the desiccation mudcracks, which can tell great many things about hydraulic and structural properties of ancient substrates which were preferred by dinosaurs. In the final chapter 20, the authors review and compile a database of the global temporal distributions of dinosaur tracks in shallow marine carbonate environments.

Authors reveal some interesting trends in abundance of tracks in time, and their taxonomic compositions, which point to the possible faunal successions of major dinosaur clades. But they are rightly cautious about very detailed inference, which is too premature in my opinion, given relatively sparse and highly uneven record of dinosaur footprints in given environments.

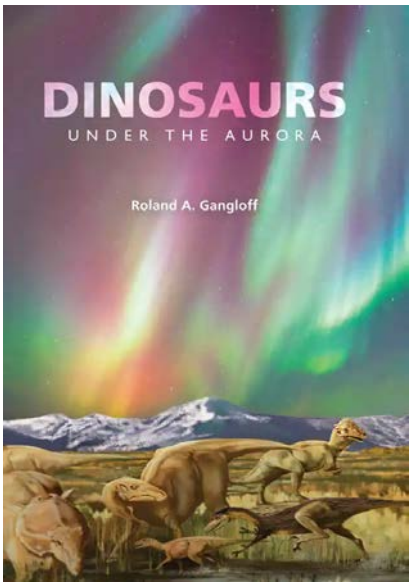
The reviewed book presents the widest breadth of the science of dinosaur tracks, with conceptual advances ranging from new approaches to ichnotaxonomy, to fine-scale sedimentological and engineering inferences, and computational biomechanical inverse modeling of behavior. Any scientist that considers the study of dinosaur (or other tetrapod) tracks should buy this book. For any person, scientifically informed illustrations presented in the book, will give a long-standing positive impression and thus show a value of dinosaur ichnology.

Works Cited

Bakker R.T. 1971. Dinosaur renaissance. *Scientific American* 233: 58-78.

Lockley, M.G. 1991. The dinosaur footprint renaissance. *Modern Geology* 16(1-2): 139-160.

# Book Review: *Dinosaurs Under the Aurora*




**Gangloff, R. A. 2012, *Dinosaurs Under the Aurora.* Indiana University Press, Bloomington & Indianapolis, IN, 192 pp. ($28.00 cloth, $6.99 e-book with 30% PS discount.)**

*Reviewed by Nina L. Baghai-Riding (Delta State University, Cleveland, MS)*

As a Master's student, I worked in a lab filled with plant fossils from the Alaskan North Slope (ANS), but sadly, no dinosaurs. Roland A. Gangloff's book, *Dinosaurs under the Aurora*, fills that gap.

Gangloff is an Emeritus Associate professor of Geology and Geophysics and former Museum Curator at the University of Alaska in Fairbanks. His book is written for dinosaur enthusiasts as well as those who possess an interest in the Arctic, especially Alaska. It is non-technical, but replete with facts. Paleontologists can use it as a reference since many dinosaur localities and species are described. Portions of the book incorporate a captivating, semi-autobiographical narrative of Gangloff's field experiences and studies of Upper Cretaceous dinosaurs from the ANS. Throughout the book, Gangloff's fascination of the Arctic is evident and stimulating. His embracing writing style and wry comments make reading this book enjoyable.

The book is divided into 10 chapters. Subheadings/short descriptions are written in bold along the margins throughout each chapter to add clarity. Figures and colored plates also are used effectively. At the end of the book, there is a notes section containing epigraphs and detailed historical accounts, a glossary, index, and literature cited section. Gangloff states that the purpose of the book is threefold: to provide an overview of Arctic dinosaurs, to describe methods and challenges of conducting dinosaur field research in Alaska, and to suggest possible directions of future dinosaur research in the Arctic. Gangloff also elucidates many fascinating aspects of dinosaur paleontology such as how dinosaurs evolved, how living birds descended from dinosaurs, whether dinosaurs were seasonal migrants or residents of polar latitudes, end of the Cretaceous extinctions, 'bloat and float' transport mechanisms of carcasses, and the social setting of dinosaurs.

Chapters 1–7 focus on the Arctic setting, dinosaur sites, and paleobiology of dinosaur assemblages. For example, in chapter one, Gangloff delivers a vivid description of the Arctic's environment: endless summer daylight, vast herds of caribou and reindeer, exposure of 'northern lights' during the dark chilly winters, the variegated colors of the tundra, and more. He notes logjams (large piles of dinosaur bones along the banks of rivers) were a mystic realm to Arctic inhabitants prior to European settlement; these indigenous populations assigned the bones to a subterranean world because they were unlike living animals. Additionally, Gangloff provides an overview as to how the science of paleontology began, what paleontology encompasses, and the geological time span from dinosaurs to mammoths on Alaska's North Slope.

Accounts of dinosaur discoveries that span from the east to west Arctic are addressed throughout Chapter 2. Descriptions of local geology and topography, leaders of field parties and the challenges they faced (9,000 mosquito bites a minute!), fossil preservation, collecting procedures, and the scientific significance of each locality are presented. Gangloff states how several dinosaur sites were accidental. For example, the first dinosaur discovery was made in 1960 by a field party sailing through the Svalbard Archipelago when studying marine rocks; two scientists onboard noticed 13 large three-toed early Cretaceous dinosaur tracks on a slab of sandstone that plunged onto a narrow beach. Additionally, a Russian paleobotanist from Saint Petersburg, Russia, found the first record of dinosaur eggshells in the Arctic associated with a plant assemblage

Black gold (oil) brought many geologists to the ANS in the 1960-1970s. In Chapter 3, Gangloff credits Robert Liscomb, a renowned geologist for Shell Oil Company, who collected, recorded, and reposited the first dinosaur samples from Alaska, while mapping rock exposures along the Colville River. The site designated as the 'Liscomb Bone Bed' (Campanian-Maastrichtian) was a startling discovery. Liscomb's field notes and data paved the way for future dinosaur research. Gangloff recounts that in the early 1980s, Charles Repenning with the USGS from Menlo Park, California, Wann Langston from the University of Texas at Austin, and William Clemens from the University of California at Berkeley, and others reestablished work on the Liscomb Bone Bed. Their efforts provided new insights about polar dinosaurs, but these results were preliminary.

Gangloff, a student of Clemens, explains how he felt responsible to continue the excavation on the Liscomb Bone Bed and associated sedimentary sites on the ANS during the late 1980s and 1990s. In Chapter 4, he traces the course of his field program, although his funds were meager initially. Gangloff explains how he incorporated teachers, students and volunteers to expand the latitudinal breadth and geological depth of his field work He describes unexpected challenges, such as navigating through low waters up the Colville River and ground squirrels cascading debris over field quadrats. Despite the challenges, cheerful excitement filled his campsites and positive attitudes prevailed. Funding opportunities and collaborations became available later. For example, in the 1990s the Bureau of Land Management, the U.S. Geological Survey, the University of Alaska at Anchorage, and Alaska's Division of Geological and Geophysical Survey provided boats, pilots, hot showers, etc. Consequently, 1996–1998 were banner years with the discovery of new deposits of dinosaur bones and footprints, petrified wood, and leaf remains.

'Taking fieldwork to a new level' is the theme of Chapter 5. Multiple universities outside Alaska, Chinook crews stationed in Fairbanks, Alaska, local educational programs and other field parties are helping to map, discover, excavate, and prepare dinosaur remains as well as conduct vertebrate taphonomic studies on the ANS. Funds from the

## Book Review: *Dinosaurs Under the Aurora, cont.*

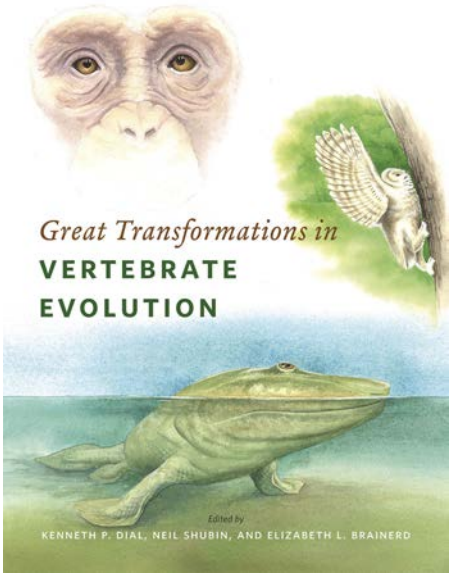
National Science Foundation and support from the U.S. Army in Alaska became available; plaster-jacketed *Pachyrhinosaurus* skulls, for example, were transported to the University of Alaska at Fairbanks by Army helicopters. Photographs and results of Important discoveries of hadrosaurs, tyrannosaurid, ornithomimids found at Kikak-Tegoseak Bone Bed and at Denali National Park from 2005–2007 also are emphasized. The second half of the chapter is devoted to major questions regarding dinosaur survival and behavior: whether long-distance migration can explain the distribution and survival of Arctic dinosaurs, how dinosaurs coped with high-latitudes, and what trackways reveal about migratory behavior.

In chapter 6, Gangloff discusses the Western Interior Seaway and how Alaska was like an island subcontinent, possessing long stretches of shorelines that were feeding grounds for dinosaurs. Late Cretaceous dinosaur food chains and feeding habits are reviewed for hadrosaurs (*Edmontosaurus*), the ceratopsians (*Pachyrhinosaurus* and *Alaskacephale*), ankylosaurs, gazelle-like ornithopods, and carnivores (*Trodon,* and *Albertosaurus*) from the ANS. Illustrations and photos help illustrate differences in dental morphology, jaw mechanics, skull bones, body size, and depositional environment settings of Arctic dinosaur groups.

Chapter 7, entitled 'Cretaceous dinosaur pathways in the paleo-Arctic and along the Western Interior Seaway', introduces trackway assemblages from Arctic coal and open-pit mining operations. For example, 6,000 three-toed footprints (some crossing one another) are documented from a 2,000 square foot (186 square meter) section at the Smoky River mines. Gangloff provides evidence of a Great Cordilleran migratory highway (Aptian-Turonian) along the western shoreline of the Western Interior Seaway that spanned from southern California to northern Alaska. Additionally, he proposes an Alaska-Asian connection (Berginia) based on the similarity of ichnofauna genera as well as a pathway into North America from northern Europe via Greenland (Barentsia). He adds that many Cretaceous dinosaur lineages may have migrated into North America as well as spread from north to south over a 25 million-year span.

After placing the fossils into a proper geologic context, Gangloff uses the last three chapters to discuss broader impacts of future studies for Arctic dinosaurs. Chapter 8 describe new technologies that evolved during the 18 years that Gangloff did fieldwork on the ANS: GPS for documenting sites, new epoxies and cements for repairing specimens in the field and construction of a permafrost tunnel to the Liscomb Bone Bed, the first of its kind. The tunnel allowed excavations to take place from May to September rather than from mid-July to early August. Chapter 9 highlights how global climate change and further exploration of coal, oil and gas beneath the arctic ice would likely yield more prolific dinosaur-bearing areas. At the end of Chapter 10, Gangloff encourages young men and women interested in Mesozoic paleontology to do research in the Alaskan arctic if they can endure the mental and physical challenges. I hope other paleontologists become inspired after reading his book and will want to conduct dinosaur research under the aurora.

## Book Review: *Great Transformations in Vertebrate Evolution*




**Dial, K.P., N. Shubin, and E.L. Brainerd. 2015. *Great Transformations in Vertebrate Evolution*. University of Chicago Press. Chicago, IL, 424 pp. ($94.50 cloth, $31.50 paper, $7.00 e-book with 30% PS discount.)**

*Reviewed by David Fastovsky (Univ. of Rhode Island, Kingston, RI)*

There was a time, not so long ago, when the basic transitions among vertebrates were thought to be well understood. As recently as 1985, Stahl, in the introduction to the Dover reprint of her seminal text, would write, "In the ten years since this book was written, a number of important fossils have been discovered and described. No one of them, however, has altered radically our ideas about the evolution of any group" (Stahl, 1985, p. vii). She cites a few range extensions as the best that paleontology could offer to our understanding of vertebrate evolutionary transformations. How could she have known that she was on the precipice of the "perfect storm" of cladistic methods, genomic sequencing, new techniques, and spectacular and unexpected discoveries in non-Western locales that would rewrite our understanding of the phylogenetic identities of, and the transitions of (among other groups) birds, whales, ichthyosaurs, humans and, just now coming on line, turtles? One senses a shift in the wind in Schultze and Trueb (1991) who, collating contributions six years after a 1985 conference, present a variety of papers on the origins of various groups of tetrapods. In that volume, the idea of birds-as-avian-dinosaurs is vetted in some detail, but the loyal opposition remained well-entrenched at that point. Schultze and Trueb (1991) present very little that would have truly shocked Al Romer.

Now into the genre of transitions contributions comes Dial *et al.* (2015), *Great Transformations in Vertebrate Evolution* (GTVE), a volume dedicated to the memory of the late, influential paleomammalogist Farish A. Jenkins, Jr. It's a thick (424 pp.), full-sized (8.5" X 11"), beautifully produced paperback, with spectacular full-color production and gorgeous illustrations. For content, it is divided into two Parts (I) "Origins and Transformations," the nuts and bolts of its subject; and (II) "Perspectives and Approaches," which takes wider perspectives on the question. The editors indicate in the Introduction that it is the questions that one asks which drive the investigations recorded in this volume, reflecting their perception that "the study of evolutionary transformations is now itself being transformed.

# Book Review: *Great Transformations in Vertebrate Evolution, cont.*

Part I consists of 15 contributions. In the spirit of the new way of asking questions, rather than wondering how particular organisms arose, the majority of the contributions are devoted to the origins and comparative anatomy of various structures. Thus we see articles on subjects like the origins of dentition, fin rays (in ray fins), necks, shoulders (two separate articles, one about mammals and one about "tetrapods"), archosauriform trunks and hindquarters, mammalian body size, and *Dimetrodon* tracks. Endothermy in mammals and birds is no less than twice viewed from the perspective of the nose. More conventional in approach are reviews of the evolution of placental reproduction in therians, the steps in becoming a whale, and the evolution of primate locomotion.

Superficially, the chapters are organized similarly. That is, none has an abstract; all are, to a greater or lesser extent, review articles of their subjects; which means that older ideas are included as well as newer ones. Comprehensive citations for both are included. In general, most adhere to the general subject—transformation; however, the use of the word "transformation" varies from article to article. For example, Lauder's offering on ray-finned fishes uses the word "transformation" to reflect transformation of function (locomotion and sensory) rather than of biological identity. It seems to me that both function and identity are properly regarded as types of evolutionary transformations; however, the ambiguity of the word leads to some issues (see below).

Following the Editors' intent, Part I is notable for the range of evidence that it brings to bear on particular problems (but see the contribution of Dial *et al.* in Part II for some of the impressive techniques that can be applied to living animals). Among the many modern (and transformative!) techniques recorded in Part I of this volume are X-ray reconstruction of moving morphology (XROMM) in an *Iguana* rib, gene patterning in *Mus* shoulder girdle assembly, CT scans of the cynodont *Massetognathus*, and quantitative analysis of effective mechanical advantage (EMA; the analysis of joint torque in mammals at a variety of scales). Two well-trod subjects that are presented as more conventional papers are Smith's review of placental evolution in therians, and Gingerich's review of whale evolution.

Part II ("Perspectives and Approaches"), ironically graced by a lovely illustration of whale evolution— ironically, because the Gingerich contribution on whale evolution appears in Part I— is even more broadly topically focused. Here, we see treatments of transformations in juveniles (including a discourse on the origin of avian flight), quantitative analysis of skeletal motions (using XROMM) in avian flight, evolution and development in archosaurs, teleost diversity and microevolution, the Triassic as the Age of Transformation (to modern tetrapod faunas), and a review of homoplasy in living amphibians. I am not convinced that the "perspectives and approaches" covered here are unique to Part II; but maybe it was hard to find a title for this material besides "Other Interesting and Relevant Stuff."

And perhaps that is exactly the problem: the great strength of this volume may also be its weakness. The editors assembled the 22 papers in it, as they note in the Introduction, because of a "need for interdisciplinary thinking" (p. 3). Historically, various obvious transitions—they cite the fin-to-limb tetrapod transition as an example—have ended up as *Scala Naturae*-style "caricatures;" a circumstance they intend to avoid here:

> Typical caricatures of great transformations, such as the march from chimp to human or a fish crawling out on land, reveal a persistent bias in what major shifts in evolution are and how they are interpreted. A historically dominant approach to great transformations has been the tendency to envision that anatomical, functional, and ecological changes go in lockstep from inefficient, primitive systems to more efficient advanced ones. One of the emergent themes of virtually every chapter of this volume is that the temporal place, morphological ad functional patterns, and ecological landscape of great transformation have rich textures of independent evolution, reversal, and evolutionary and ecological experimentation (Dial, *et al.*, 2016, p. 3).

It is true that this type of old-school approach is to be avoided, but the pitfalls of the adaptationist paradigm and the *Scala Naturae* are now broadly understood, having first been articulated by Gould and Lewontin (1979) and Gould (1989), respectively. So in a sense, it is almost a caricature itself to begin a cutting-edge volume in 2016 with the rejection of largely discredited ideas. Moreover, the complexity of interdisciplinary study is clearly required in a modern approach; who would argue that it is not?

In GTVE, the title promises neither consistency nor comprehensiveness, and thus readers will not be disappointed to learn that neither is achieved in this volume. In a sense this is not a surprise: all evolution can be perceived as "transformation;" therefore, anything to do with evolution would in a sense be appropriate in this volume. As readers will have noted, GTVE serves up offerings from a recounting of the glories of Triassic vertebrate evolution, to a review homoplasy in modern Lissamphibia, to the mechanics of making *Dimetrodon* trackways. If the governing equation of this volume is transformation = evolution, why not call it what it actually is, a treatment of some aspects of vertebrate evolution?

Overall, GTVE is a volume with excellent contributions, succumbing, however, to the non-fatal pitfalls of many collections of papers in edited volumes: it fails to treat its subject in any kind of consistent, comprehensive way. Instead, beginning with a self-evident premise—multidisciplinary work is desirable—and further poorly defining its subject (vertebrate transformations), such that it is far too large to encompass within a single volume, GTVE gives us instead a *dim sum* of topics, styles, and treatments of vertebrate evolution.

All that sounds like a terrible indictment, but it is not. Some of this volume's weakest qualities are also great strengths. Its signal virtues are that it presents a multiplicity of approaches, dynamic new insights, and the clear sense that since the days when we thought we understood the key contours of vertebrate evolution, things have become much more complicated, interesting, and exciting. Romer would be shocked, but I suspect that, once he got his brain wrapped around it all, he would have been trilled.

Works Cited

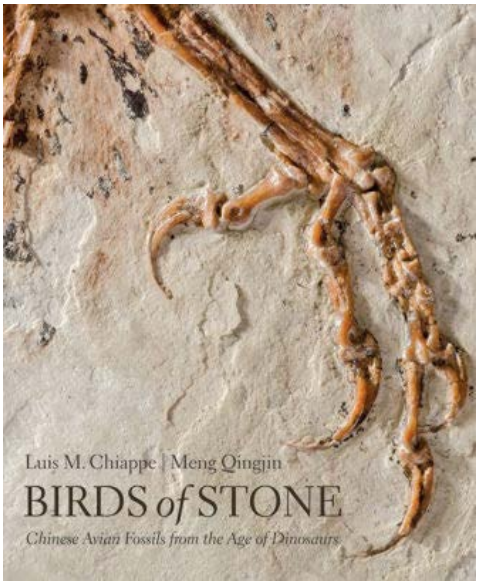

Gould, S.J. 1989. *Wonderful Life: the Burgess Shale and the Nature of History.* W.W. Norton, New York, 347 pp.

Gould, S.J., and R.C. Lewontin. 1979. The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. *Proceedings of the Royal Society of London Series B* 205: 581–598.

Schultze, H.-P., and L. Trueb, eds. 1991. *Origins of the Higher Groups of Tetrapods: Controversy and Consensus.* Comstock Publishing Associates, Ithaca, NY, 724 pp.

Stahl, B.J. 1985. *Vertebrate History: Problems in Evolution*. Dover Publications, New York, 604 pp.

# Book Review: *Birds of Stone: Chinese Avian Fossils from the Age of Dinosaurs*




**Chiappe, L.M. and M. Qingjin. 2016. *Birds of Stone: Chinese Avian Fossils from the Age of Dinosaurs*. Johns Hopkins Univ. Press, Baltimore, MD, 304 pp. ($85.00 cloth, $85 e-book.)**

*Reviewed by Ashley W. Poust (University of California, Berkeley, Berkeley, CA & San Diego Natural History Museum, San Diego, CA)*

"For these dead birds sigh a prayer."—Shakespeare "The Phoenix and the Turtle"

In little under a quarter century, our knowledge of the evolution of birds has transformed from an empty field with the figure of *Archaeopteryx* perching nearly alone, into a crowded, raucous aviary. This change has been global, but at its core has been the discovery of exquisitely preserved Jurassic and Cretaceous birds in a set of lakebed deposits in Liaoning, China. These feathered fossils have allowed scientific discoveries in an abundance that threatens to be overwhelming. Amid this noisy confusion, *Birds of Stone* provides welcome clarity. While it is not a technical text, authors Chiappe and Meng are major players in the research on Chinese fossil birds. They know the subject intimately and give the reader both an excellent summary of current avian paleontology and a loving introduction to some of the world's most beautiful fossils.

The book is divided into two parts: the first two-thirds cover the birds themselves and the remainder provides a background for their scientific importance. Conveniently, the transition is distinguishable by merely glancing at the edge while the book is closed: the first section is so densely packed with color photographs that it stands in contrast to the white second section with its traditional margins. Considering this density of photographs, the book is well-priced. It is also well-bound with a spine that can take some abuse—important because you will want to open the book widely to view the many full-spread photos. In the first section, two-page spreads alternate with one-page photographs facing text. The short, relevant, punchy writing and the excited, clear style make reading these passages like eating little chocolates: each one makes you wonder what's in the next and only the most disciplined will be able to stick to consuming one at a sitting.

The second section combines denser text with diagrams and additional photos placing the birds in the context of their early evolution. For anyone less grounded in vertebrates this is an excellent quick introduction to an elegant animal class, and it will be guaranteed to occupy those already versed in vertebrate paleontology. The text goes on to introduce additional players in the diverse ecosystems that filled and surrounded the Liaoning lakes, and many of the plates feature beautiful invertebrate fossils nestled among the feathers. But the primary focus remains on the birds.

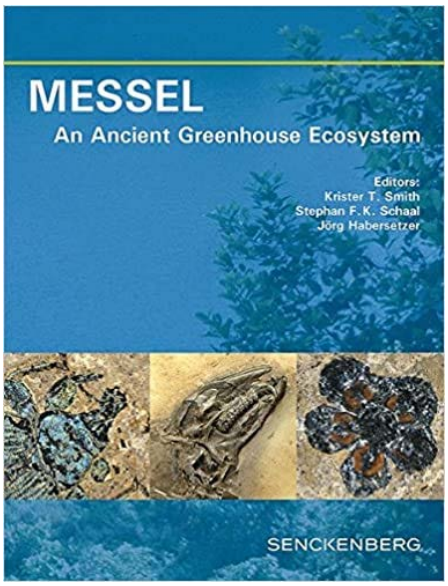
The book's greatest success is visual. One of the hardest things about major scientific advances is the difficulty of accepting them, not only with the logical mind, but unconsciously, automatically. Perhaps this is why there was initial resistance to the acceptance of fossil feathers and the revelation of the dinosaurian origin of birds. By laying out the diversity of fossil birds and the hugely numerous, detailed, and beautiful specimens with feathers, this book becomes convincing at that fundamental level. The quantity of fossil birds in Chinese museums is so great that many are unpublished and unlikely to ever be figured. Even as a morphologist who has seen many of these fossils, the images are exciting in both their quality and sheer diversity. For that reason alone, this is an exciting document, and one that is persuasive, not just about avian topics, but about the power of the fossil record to document the pathways of evolution.

Some brilliant designer had the clever idea of printing the front and back covers with the slab and counterslab of an avian fossil (*Protopteryx fengningensis*). The subtle differences jump out once you realize the photographs differ. The cleverness continues inside, with the application throughout the book of relatively new methods for studying Mesozoic birds such as histology and UV light adding scientific interest and variety to the illustrations. Striking images stand out: the intact sclerotic ring (eye bones) detached from a bird's skull like a dropped monocle (p. 54 and 131); the campfire oranges of *Confuciusornis* bone tissue along the black hollows of its blood vessels (p. 119); the plump fat pads on the feet preserved in *Sapeornis* reminiscent of the chicken feet in Chinese cuisine (p. 55); tiny toolmarks, evidence of the skill with which the stone has been peeled away to show one more feather, one more barb.

Ultimately, any quibbles with the book fade in the light of its overall quality and the power of the images. The book could have benefitted from a greater sense of scale: even understanding the artistic reasons the authors chose to omit scale bars, in several cases it is hard to intuit the size of the animals confined to the page. Some early birds, such as *Sapeornis*, were larger than their photographs. But even here the images ameliorate the problem somewhat. One beautiful spread addresses the scale of enantiornithines by showing a particularly small specimen life size, its slab held between two outstretched human hands.

Chiappe and Meng's book bridges the gap between popular and scholarly audiences, using the gorgeous fossils to instruct and the scientific context to expose the depth hidden in the beautiful images. The book's ability to touch both science and art recalls the famous avian poem quoted at the top. In the end of Shakespeare's tragic *The Phoenix and the Turtle*, "Truth and beauty buried be." *Birds of Stone* unearths both.

# Book Review: *Messel: an Ancient Greenhouse Ecosystem*




**Smith, K.T., S.F.K. Schaal, and J. Habersetzer, eds. 2018 (English Edition). *Messel: An Ancient Greenhouse Ecosystem*. Senckenbergbuch 80. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 355 pp. (Hardback € 54.90.)**

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

This multi-authored book gives an extremely well-illustrated update of our knowledge of this fantastic *Lagerstätten*, the Messel pit. In this pit, oil shales are excavated, lake deposits formed in a crater lake. It is the second book by Senckenberg on the Messel fossils, 30 years after the first by Schaal and Ziegler's (1988) also well prepared 'Schaufenster'. This second book shows the large increase in knowledge due to more research, in which amateurs were very helpful, new preparation methods and a larger group of paleontologists also from outside Germany involved. The oil shale was discovered in the 18th century; in 1875 the first fossil crocodylian was found and in 1898 a first overview of the fossil site's geology and paleontology appeared. The oil shales were mined up to 1971, when a pyrolization plant was operated for the production of mineral oil and paraffin. The initial plan to fill the Messel pit with garbage, approved in 1981, was cancelled in 1991 after a 10-year-long legal battle. The extraction of fossils now takes priority. In 1995 the "Messel Pit Fossil Site" was selected as one of the UNESCO World Heritage sites.

The volcano that caused the lake, as explained in this book, erupted 48.2 million years ago. The lake was gradually filled with clay deposits that became oil shales and as such at the end of the 19th century mined for crude oil production. By means of surface mining, 55m of the black pelites were removed. Drilling down to 433 m depth showed still more pelites and basal deposits of sand, volcanic ash and lapilli. These lake deposits were formed over a period of about 1 million years in the Eocene, when the earth was dominated for the last time by a greenhouse climate not caused by man. As the IPPC (2014) predicts a near-future $CO_2$ level comparable to the Eocene levels, it is well-suited as a reference period. Algal remains (in particular of *Tetraedron minimum*), pollen and spores in the seasonally laminated shales document annual algal blooms. Whether the best-preserved alga *Tetraedron* was also the most important bloom former (as suggested by the authors) could be questioned. Other non-skeletal algae may also be involved. I myself have studied algal blooms in the North- and Wadden Sea that were dominated by *Phaeocystis,* an alga that leaves no skeletal remains in the sediment. The seasonally laminated shales clearly document cyclic and periodic climate fluctuations. Interestingly, these cycles can be interpreted as El Niño Southern Oscillations (ENSO). This answers an important and controversial question in climate research: are these events only occurring in Recent times? Messel pit excavations show that such ENSO events also occurred in the geological past and in a warmer world.

The burial community in the lake deposits includes animals and plants that lived in the lake as well as those living on its banks. Sometimes even a food-chain could be reconstructed: a snake was found with a lizard in its gut tract, which in turn had consumed an insect! All this could only be preserved under special environmental conditions. The most interesting mystery is that so many bats are fossilized. It is suggested that dead bats initially floated on the water surface: they have, like all mammals, a specific weight higher than water but the amount of air trapped in the hair and the air-filled lungs kept the bats longer afloat at the lake surface. The unique preservation in Messel of fossilized soft tissues gave new insights into decoding fossil color patterns.

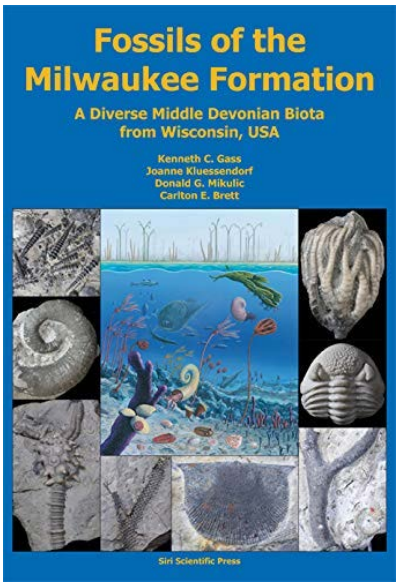
The cause of death of the terrestrial Messel vertebrates is still in discussion: did they drown after being rendered unconscious by toxic gases or after consuming cyanobacteria floating on the water surface, or still some unknown cause? Moreover, the natural course of microbial breakdown of tissues in carcasses was prevented, specific environmental conditions must have been present in the water. The taphocoenosis found documents an almost complete biocoenosis. Questions still remain how this was possible!

Special methods had to be invented to collect the fossils: moist oil shale is subject to rapid drying and subsequent disintegration. Blocks of shale were rapidly after collecting finely split with knives in the laboratory. Vertebrate fossils found had to be kept moist by wrapping them in wet paper and plastic bags. In winter, when excavations are not possible, the specimens are prepared. Insects, invertebrates and plants are exposed under the binocular. For permanent storage they need to be kept in glycerin. Vertebrate fossils are preserved using a special synthetic resin transfer method invented in 1961. Non-invasive methods, some recently developed such as micro-X-ray and micro-computed tomography (µCT) are used for further study. This results in excellent material for fabulous pictures, of which the book presents a large collection.

Compared with the first Messel book (1988) it shows how much more animal and plant groups have now been discovered, making the picture of the original biocoenosis more complete. In 1988 the lake was thought to be due to a series of faults around the Messel area. Now its formation is explained, thanks to the deep core taken, by a volcanic explosion resulting in a crater lake.

The book is written for paleontologist but in a style that makes it also easy to read by a broader public. The >400 well-chosen pictures make it very attractive. Highly recommended by your reviewer.

# Book Review: *Fossils of the Milwaukee Formation*




**Gass, K.C., J. Kluessendorf, D.G. Mikulic, and C.E. Brett. 2019. *Fossils of the Milwaukee Formation: A Diverse Middle Devonian Biota from Wisconsin, USA*. Siri Scientific Press, Manchester, UK, 222 pp. (£24.99 paper from http://www.siriscientificpress.co.uk)**

*Reviewed by Thomas A. Hegna (SUNY Fredonia, Fredonia, NY)*

The Milwaukee Formation has little reputation outside of Wisconsin. Indeed, some might be surprised to learn that Wisconsin has any Devonian rocks at all. It has limited exposure; and as a result, it is not a magnet for modern collectors. Few modern papers have been written on the fossils from the Milwaukee Formation. This raises a good question: why devote an entire book to it?

The Milwaukee Formation during the 1800s and early 1900s was different. Open cement quarries in the growing Milwaukee area meant that the strata were exposed more easily at the surface. A series of paleontologists and collectors made significant collections during this heyday that are deposited in regional institutions. Thus, this book is a window into the past in two ways: a window into a rich Devonian ecosystem, and a window into paleontology at the turn of the last century.

The book itself is richly illustrated (over 350 figures) with color photographs of all of the groups of macrofossils present in the formation (invertebrate microfossils are the only exception to this). Each fossil group (foraminifers, ostracods, conulariids, rugose corals, tabulate corals, tentaculitoids, bryozoans, hederelloids, brachiopods, hyoliths, mollusks, annelid worms, arthropods, echinoderms, graptolites, conodonts, fish, fungi, land plants, trace fossils) has its own section of text, with an additional section devoted to unidentified body fossils. Both the paleoecology and taphonomy are covered in significant detail. A chapter explores fossil collecting in the Milwaukee Formation—something that is difficult today given the dearth of modern exposures. Further chapters discuss fossil preparation, the location of major collections of fossils from the Milwaukee Formation, and the history of the cement industry which helped expose the rocks of the Milwaukee Formation.

No book, to my knowledge, explores a complete fauna from North America in this detail. The only comparable book is Karl A. Wilson's 2014 *Field Guide to the Devonian Fossils of New York*. The differences are several—Wilson's guide relies on copies of old Hall and Clarke era illustrations rather than photographs. The other major difference is that the fossils of the Devonian of New York is still accessible to collectors over a wide area, meaning that new discoveries are continually being made. The story of the Milwaukee Formation told in this new book is not as likely to change with new additions owing to the lack of collectable exposures in the area. Thus, Gass *et al.*'s book is likely to be the final word on the Milwaukee Formation for the conceivable future. The book will be useful to collectors and professional paleontologists alike.

I would love to see other authors take this approach and produce similar volumes on other well-known, and not-so-well-known formations around the world.

# Books available for review

The following volumes are available to Paleontological Society members in exchange for writing a review in *Priscum*, the PS newsletter. Reviews should be informative, engaging, and 400–800 words long. The tone can be informal and casual, appropriate to recommending or critiquing a book to friendly colleagues. (Longer reviews are allowed, but please request ahead of time.) Past book reviews can be found in past issues of *Priscum* at https://www.paleosoc.org/priscum-newsletter. Reviews should be submitted by May 1 for inclusion in the Summer issue or Dec. 1 for inclusion in the Winter issue.

**Reviewers must be a current member of the Paleontological Society before beginning review.** If you are interested in reviewing one of these texts, please contact Book Reviews Editor Phil Novack-Gottshall (pnovack-gottshall@ben.edu)

**Book publishers:** Please contact Book Reviews Editor Phil Novack-Gottshall (pnovack-gottshall@ben.edu) if you are interested in providing review copies for inclusion in *Priscum*, which has a readership of more than 1,100 professional and avocational paleontologists.

Al Kindi, M. 2018. *Evolution of Land and Life in Oman: an 800 Million Year Story*. Springer. (Review copy is digital e-book.)

Alperson-Afil, N.; G. Herzlinger, and N. Goren-Inbar. 2018. *The Acheulian Site of Gesher Benot Ya'aqov Volume IV*. Vertebrate Paleobiology and Paleoanthropology Series. Springer. (Review copy is digital e-book.)

Basilone, L. 2018. *Lithostratigraphy of Sicily*. Springer. (Review copy is digital e-book.)

Beck, L. A. and U. Joger. 2018. *Paleontological Collections of Germany, Austria and Switzerland*. Springer. (Review copy is digital e-book.)

Berta, A. 2017. *The Rise of Marine Mammals: 50 Million Years of Evolution.* Johns Hopkins Univ. Press.

Bjornerud, B. 2021. *Timefulness: How Thinking Like a Geologist Can Help Save the World*. Princeton Univ. Press.

Carroll, S.B. 2021. *A Series of Fortunate Events: Chance and the Making of the Planet, Life, and You*. Princeton Univ. Press.

Carlton, R. L. 2018. *A Concise Dictionary of Paleontology*. Springer. (Review copy is digital e-book.)

Croft, D. A., D. Su, and S. W. Simpson. 2018. *Methods in Paleoecology*. Vertebrate Paleobiology and Paleoanthropology Series. Springer.

De, C. 2019. *Mangrove Ichnology of the Bay of Bengal Coast, Eastern India*. Springer. (Review copy is digital e-book.)

Defler, T. 2019. *History of Terrestrial Mammals in South America*. Topics in Geobiology 42. Springer. (Review copy is digital e-book.)

Diston, K. and Z. Simmons. 2018. *Rare and Wonderful: Treasures from Oxford University Museum of Natural History*. Bodleian Library, University of Oxford, and Museum of Natural History.

Everhart, M. 2017. *Oceans of Kansas: A Natural History of the Western Interior Sea*. 2nd ed. Indiana Univ. Press.

Farlow, J. O., with contributions from D. Coroian and P. J. Currie. 2018. *Noah's Ravens: Interpreting the Makers of Tridactyl Dinosaur Footprints.* Indiana Univ. Press.

Gass, K. C., J. Kluessendorf, D. G. Mikulic, and C. E. Brett. 2019. *Fossils of the Milwaukee Formation: A Diverse Middle Devonian Biota from Wisconsin, USA.* Siri Scientific Press.

Gee, H. 2018. *Across the Bridge: Understanding the Origin of the Vertebrates*. Univ. of Chicago Press.

Gee, C.T., V.E. McCoy, and P. Martin Sander. 2021. *Fossilization: Understanding the Material Nature of Ancient Plants and Animals*. Johns Hopkins Univ. Press.

Gerlach, J., ed. 2014. *Western Indian Ocean Tortoises: Ecology, Diversity, Evolution, Conservation, Palaeontology*. Siri Scientific Press.

Hallett, M. and M.J. Wedel. 2016. *The Sauropod Dinosaurs: Life in the Age of Giants*. Johns Hopkins Univ. Press.

He, W.-H., Y. Zhang, G. R. Shi, T. Yang, S. Shen, and K. Zhang. 2019. *Brachiopods around the Permian-Triassic Boundary of South China*. Springer. (Review copy is digital e-book.)

Holman, J.A. 2018. *Fossil Frogs and Toads of North America*. Indiana Univ. Press.

Huh, M. and J. Y. Kim. 2018. *Dinosaurs, Birds, and Pterosaurs of Korea*. Springer. (Review copy is digital e-book.)

Jackson, P.N.W. 2019. *Introducing Palaeontology—A Guide to Ancient Life*. 2nd ed. Dunedin Academic Press.

Kendrick, P. 2020. *A History of Plants in Fifty Fossils*. Smithsonian Books.

Lister, A. 2018. *Darwin's Fossils: The Collection That Shaped the Theory of Evolution*. Smithsonian Books.

Lucas, S. 2016. *Dinosaurs*. 6th ed. textbook. Columbia Univ. Press.

Lyons, S.K., A.K. Behrensmeyer, and P.J. Wagner, eds. 2019. *Foundations of Paleoecology: Classic Papers with Commentaries.* Univ. Chicago Press.

Marshall, M. 2020. *The Genesis Quest: The Geniuses and Eccentrics on a Journey to Uncover the Origin of Life on Earth.* Univ. Chicago Press.

Martinetto, E., E. Tschopp, and R. Gastaldo, eds. 2021. *Nature Through Time: Virtual Field Trips Through the Nature of the Past*. Springer. (Review copy is digital e-book.)

McNamara, Ken. 2020. *Dragons' Teeth and Thunderstones: The Quest for the Meaning of Fossils*. Reaktion Press.

Molina-Pérez, R. and A. Larramendi. 2019. *Dinosaur Facts and Figures: The Theropods and Other Dinosauriformes.* Princeton Univ. Press.

Norell, M. A. 2019. *The World of Dinosaurs: An Illustrated Tour*. Univ. Chicago. Press.

Oxford University Museum of Natural History, editor. 2020. *Strata: William Smith's Geological Maps.* Univ. Chicago Press.

Pérez-Lorente, F. 2015. *Dinosaur Footprints and Trackways of La Rioja*. Indiana Univ. Press.

Tyler, C.L. and C.L. Schneider. 2018. *Marine Conservation Paleobiology*. Springer. (Review copy is digital e-book.)

Prothero, Donald R. 2018. *When Humans Nearly Vanished*. Smithsonian Books.

Prothero, Donald R. 2019. *The Story of the Dinosaurs in 25 Discoveries: Amazing Fossils and the People Who Found Them*. Columbia Univ. Press.

Rieppel, O. 2019. *Mesozoic Sea Dragons: Triassic Marine Life from the Ancient Tropical Lagoon of Monte San Giorgio*. Indiana Univ. Press.

Selden, P., M. Boughdiri, B. R. C. Granier; P. Bengtson; B. Bádenas, and E. Jaillard. 2019. *Paleobiodiversity and Tectono-Sedimentary Records in the Mediterranean Tethys and Related Eastern Areas*. Springer. (Review copy is digital e-book.)

Sepkoski, D. 2020. *Catastrophic Thinking: Extinction and the Value of Diversity from Darwin to the Anthropocene.* Univ. Chicago Press.

Swaby, A., J. R. Hendricks, and A. McGillis (illustrator). 2021. *Into the Ordovician: Adventures in a Prehistoric World.* An Illustrated Children's Book. Paleontological Research Institute.

Tyler, C.L. and C.L. Schneider. 2018. *Marine Conservation Paleobiology*. Springer. (Review copy is digital e-book.)

Wood, R., T. Lenton, S. Poulton, A. Liu, and P. Donoghue, eds. 2020. The Origin and Rise of Complex Life: Integrating Models, Geochemical and Palaeontological Data. A special topics issue of the Royal Society's Interface Focus. All articles available for free at https://royalsocietypublishing.org/toc/rsfs/2020/10/4

Ziermann, J. M., R. Diogo, and R. E. Diaz, Jr. 2019. *Heads, Jaws, and Muscles*. Springer. (Review copy is digital e-book.)

## Ideas for *Priscum* Content or Book Reviews?

Do you have any ideas for content for the *Priscum* newsletter? We are interested in including a wide range of content of possible interest to members of our Society. Consider anything from a short description of a future GSA symposium or field trip you are planning to an op-ed sharing a cantankerous viewpoint on a topical issue, an idea for a regular *Priscum* feature, or memorable photos of fossils or fieldwork. Submission deadline for the next issue is December 1st, 2021

For *Priscum* Content: Alycia L. Stigall, Editor
E-mail: stigall@ohio.edu

For Book Reviews: Phil Novack-Gottshall, Book Reviews Editor
E-mail: pnovack-gottshall@ben.edu

The Paleontological Society
7918 Jones Branch Drive, Suite 300
McLean VA 22102-3345, USA

TEL: +1-301-634-7231
Email: membership@paleosoc.org