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Reminder: The deadline for copy for Issue no. 121 is 31st May 2026.

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Editorial

We at the *Palaeontology Newsletter* hope all members had a restful break over Christmas and the New Year. We also hope that those who attended it enjoyed the Annual Meeting in Portsmouth as much as we did, featuring lots of fantastic presentations and an amazing nautical dinner. This year's meeting in Oxford, UK (8–11 December 2026) will (presumably) involve fewer sea shanties but we are looking forward to it already.

In this issue of the *Newsletter* you'll find palaeontological news, book reviews and an insight from **Joe Keating**, our Education Officer, on some of the exciting things he's been working on. We also have a number of longer reads. Excitingly we have the first of our contributions from our new correspondents: a piece from the University of Bristol's **Hady George** about new Permian fauna from Tanzania and Zambia. We also have an essay marking the centenary of Elsa Warburg, Sweden's first female palaeontologist, as well as a thought-provoking piece on the rarity of fossils from our regular and indefatigable contributor **Jan Zalasiewicz**. For those of a computational persuasion we have a new Palaeoverse instalment from **Will Gearty**, looking at fossils' temporal and geographic ranges. Finally, If you turn to the back, you'll find our third PalAss puzzle, this time with an EXCITING PRIZE thanks to Bloomsbury, who have generously given us five copies of *Spinosaur Tales: the Biology and Ecology of the Spinosaurs* to give away to members. For those who miss out (or hate puzzles), Bloomsbury have also given PalAss members an exclusive 25 % discount on this book, as you can discover in the Member News section. You can also read a review of the book by **Eric Buffetaut** in this issue's Reviews section.

I am currently covering for Harriet Drage as Interim Newsletter Editor and would like to flag the contribution of **Tahlia Pollock**, who is kindly covering my duties as Deputy Newsletter Editor for this and the next *Newsletter* while I swan around with the top job. Huge thanks also as always to all *Newsletter* contributors; if you'd like to contribute anything to the *Newsletter*, particularly if you are inspired by Hady's correspondent piece to write something you think PalAss members would like to read, please do drop us an e-mail.

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Postcards from the President

Phil Donoghue highlights issues of particular topical relevance.

I hope the new year is treating you well. We celebrated the end of 2025 with our Annual Meeting in Portsmouth. The highlight for me was the Annual Dinner on *HMS Warrior* which made PalAss 2025 all the more memorable (happily the president didn't need to make his speech twice, like in 1998!).

2026 begins with big changes on Council, as several officers completed their terms. These include Orla Bath Enright who transformed our support for ECRs, Liz Dowding who delivered innovative outreach, Rob Sansom who helped make our scientific meetings so successful, Manabu Sakamoto who ensured that Council's enthusiasm for promoting palaeontology did not bankrupt us, Susie Maidment who helped initiate, develop and deliver so many activities, and Russell Garwood who finally retired after two tours of duty as Internet Officer, culminating in our smart new website.

It is sobering to remember that these people gave their time, knowledge and experience to the Association voluntarily. I hope you join me in thanking them and their employers for their gift. I look forward to working with the new and continuing members of Council over the coming year as we work on the continuing evolution of the Association.

Phil Donoghue

The Cambrian Explosion: *Paradoxides davidis*, *Protocystites menevensis* et al.
Image: James McKay, © The Palaeontological Association

Internal news

Association News

- The Palaeontological Association Council has undergone a big turnover with the New Year; you can find out more in the 'What's Happening in Council' section. Keep an eye out later in the year for open positions if you'd like to become involved in PalAss Council.

- The Palaeontological Association is pleased to have become a supporter of a new GCSE in Natural History in the UK. You can read more about what this means in Education Officer Joe Keating's piece in the 'What's Happening in Council' section of the *Newsletter*.

- Council has decided to open up the reviewing of PalAss grants to the membership. Thanks to everyone who has already volunteered, and if you would like to contribute your time and expertise, as well as get an insight into how our grants are awarded, you can do so on the PalAss website at <**https://palass.org/awards-grants/grants**.

Richard Dearden
Interim Newsletter Editor

Association News bites

Tiny skull, big shake-up: Spain's smallest ornithopod rewrites the family tree
A tiny dinosaur from Early Cretaceous Spain has finally stepped into the spotlight. New CT-scanned skull material reveals that the long-mysterious 'Vegagete ornithopod' is a new genus and species, *Foskeia pelendonum*, distinguished by unusual forward-leaning teeth, a unique jaw structure and specialized chewing muscles.

DIEUDONNÉ, P.-E., BECERRA, M.G., ZANESCO, T., TORTOSA, T., CRUZADO-CABALLERO, P., STEIN, K. and TORCIDA FERNÁNDEZ-BALDOR, F. 2026, *Foskeia pelendonum*, a new rhabdodontomorph from the Lower Cretaceous of Salas de los Infantes (Burgos Province, Spain), and a new phylogeny of ornithischian dinosaurs. *Papers in Palaeontology*, **12**, e70057. <**https://doi.org/10.1002/spp2.70057**>.

A lost gateway in time: Villeveyrac's amphibians and reptiles reveal early European arrivals

Fossils from the lower Campanian site of Villeveyrac in southern France are shedding new light on how animals moved across Europe during a time of rising seas, shifting plates and global cooling. This richly fossiliferous floodplain – formed under warm, humid subtropical conditions – has now revealed a surprisingly diverse community of amphibians and squamates.

JANSEN, O., GARCIA, G., OTERO, O., AUGÉ, M., GOMEZ, B. and VALENTIN, X. 2026. Freshwater amphibians and squamates from Villeveyrac (lower Campanian; Hérault, France): palaeodiversity, palaeoenvironment and implications for the Late Cretaceous palaeobiogeography of the European herpetofauna. *Papers in Palaeontology*, **12**, e70055. <**https://doi.org/10.1002/spp2.70055**>.

Cambrian worms reveal evolutionary secrets

Guanshan fossils are exceptionally-preserved early animals from the Cambrian of Yunnan Province, China. Shi and colleagues describe ancient carnivorous worms called palaeoscolecids from a new site and compare new species with others that lived at a similar time in what would have been nearby localities; they highlight differences, suggesting a possible faunal turnover. Some of the new groups proved to be highly successful, later being found all over the world and surviving for tens of millions of years.

SHI, X., HOWARD, R. J., ZHANG, G. and MA, X. 2026. Palaeoscolecids from the early Cambrian Guanshan biota, Yunnan Province, China. *Papers in Palaeontology*, **12**, e70058. <**https://doi.org/10.1002/spp2.70058**>.

Darja Dankina
Publicity Officer

Is there news that you'd like to see included in the Newsletter*? Let us know by e-mailing Darja at* <**publicity@palass.org**>*, sending a link to the news and explaining its significance.*

What's happening in Council

New Council Members for 2026

At the AGM the following individuals took up roles on Council:

President-Elect: **Paul Barrett**

Vice-President: **Crispin Little**

Treasurer: **Paul Winrow**

Internet Officer: **Luke Parry***

Meeting Coordinator: **Imhan Rahman**

Outreach Officer: **Thomas Clements**

Publicity Officer: **Darja Dankina**

Early Research Career Officer: **Miriam Slodownik**

Editor Trustee: **Michelle Stocker****

*Council nominee.
**candidate nominated by the Editorial Board as one of two Editor Trustees.

The Association is run by members for members. Without these dedicated and selfless individuals putting themselves forward for Council roles we would not be able to continue our work to promote and support the palaeontological community.

Paul Barrett: President Elect

Paul is a UKRI Individual Merit Researcher based at the Natural History Museum, London. He is a dinosaur specialist, with interests ranging from taxonomy and systematics through to functional morphology and macroevolution. In addition, he is currently the lead scientist on all the Museum's major gallery redevelopments. He joins Council as the President-Elect, in preparation for becoming President next year.

Photo courtesy of P. Barrett.

Cris Little: Vice-President

Photo courtesy of C. Little.

Cris is a palaeontologist at the University of Leeds with research interests in macroevolutionary questions relating to chemosynthetic communities (hydrothermal vents, hydrocarbon seeps and whale-falls) across four billion years from the recent to the Archaean, and mass extinction events (principally the early Toarcian event in the Lower Jurassic). His main areas of expertise are in palaeoecological and palaeoenvironmental analysis, and also fossil systematics, mostly molluscs. Cris sits on Council to provide independent input on all matters, based on his previous experience of Council membership.

Paul Winrow: Treasurer

Paul is a professional accountant and Partner in an audit firm and was previously Palass Treasurer from 2010 to 2020. He completed a part-time PhD in 2015 at Imperial College on Cambrian Lingulate brachiopods, more than 20 years after his Palynology MSc. As Treasurer, Paul's role on Council is to oversee the financial management of the Association, providing an independent sounding board for financial matters and being the link between the Executive Officer and the Trustees on finance.

Photo courtesy of P. Winrow.

Luke Parry: Internet Officer

Photo courtesy of L. Parry.

Luke is a palaeobiologist at the University of Oxford, UK. His research focuses on understanding the early evolution of animals, especially lophotrochozoans, based on evidence from exceptionally preserved early Palaeozoic fossils. He is the Association's Internet Officer, overseeing the PalAss website and online presence.

Thomas Clements: Outreach Officer

Photo courtesy of T. Clements.

Thomas Clements is the incoming Outreach Officer. He is an experimental taphonomist and lecturer at the University of Reading in the UK. Thomas enjoys making models, photography, and talking at great lengths about the best animals on the planet, the cephalopods. He devises new content and works closely with the other members of the Council's Public Engagement Group.

Darja Dankina: Publicity Officer

Darja is a researcher, palaeobiologist, and curator of the palaeontological collection at the Nature Research Centre in Vilnius, Lithuania. As Publicity Officer, Darja drives the Association's social media, raising awareness of the Association's events and initiatives, promoting the Association and palaeontology among experts and the general public, and working closely with the other members of the Council's Public Engagement Group.

Photo courtesy of D. Dankina.

Imran Rahman: Meetings Coordinator

Photo courtesy of I. Rahman.

Imran is a Principal Researcher at the Natural History Museum, London, UK, whose research focuses on the origin and early evolution of animals. In his role as Meetings Coordinator, Imran interacts with the organizers of Progressive Palaeontology and the Annual Meeting, as well as other meetings sponsored by the Association. He also oversees the Association's Postgraduate Travel Fund.

Miriam Slodownik: Early Career Research Officer

Miriam is based in the Botany Department at Trinity College Dublin, Ireland, where she is a Marie Skłodowska-Curie Fellow working primarily in the fields of palaeobotany and palaeoclimatology. Her research focuses on Southern Hemisphere polar forests during Cenozoic greenhouse periods. As Early Research Career Officer she represents the early career community at Council meetings and serves as a point of contact for postgraduate students and postdoctoral researchers. She also organizes online career development workshops.

Photo courtesy of M. Slodownik.

Michelle Stocker: Editor Trustee

Photo courtesy of M. Stocker.

Michelle's research is centred on the macroevolutionary patterns and processes of biodiversity. She is particularly interested in the anatomical evolution of amphibians and reptiles with respect to convergent evolution, ecosystem change and clade diversification. Her work incorporates fossils and extant taxa through fieldwork, museum collections, dissection and CT data to explore regional and chronologic differences among vertebrate assemblages over deep time. Michelle joins Council as a representative of the Palass Editorial Board.

We are grateful that so many members of the Association are willing to step forward. Elections to many of these positions on Council were contested and we are thankful to Francesca Bulian (Groningen), Frankie Dunn (Oxford), Ed Thomas (Leicester) and Natalia Jagielska (Hong Kong) for offering their time and experience.

Meet your Council members: Joe Keating

Photo courtesy of Joe Keating.

I am a Lecturer in the School of Biological Sciences and co-director of the Bioinformatics MSc programme at the University of Bristol, UK. My research spans early vertebrate evolution, vertebrate skeletal histology, morphological phylogenetics and phylogenetic comparative methods. I serve as the Education Officer on the Palaeontological Association Council, and I'd like to take this opportunity to tell you about the projects I have been working on.

When I began my position in 2023, I had the opportunity to develop new projects from the ground up. A key priority was to strengthen links between palaeontological research and secondary school science curricula. Our community has a great deal to offer: palaeontology is inherently multidisciplinary, drawing on expertise in anatomy, climate science, geology, genomics, ecology, evolution and more. As a result, we are uniquely well placed to contribute across a broad range of scientific topics, arguably more so than any other discipline. I chose to focus initially on the UK GCSE curricula, primarily because the Association is UK-based, while recognizing that there is substantial overlap with curricula in other countries. Targeting GCSE level also allows for the inclusion of sufficient detail to meaningfully expand on curriculum content where it intersects with the research interests of our members.

The primary goal of this project is to produce a series of YouTube videos aligned with key areas of the GCSE curriculum. Beyond offering high-quality educational and revision resources for students, the videos aim to highlight palaeontology as a dynamic, research-led discipline (far more than just fossil collecting or dinosaurs!). The project also seeks to promote palaeontology as a diverse and inclusive field by featuring early-career researchers from a wide range of backgrounds. Finally, it aims to broaden the reach of the Palaeontological Association by growing its YouTube audience and potentially attracting new members. I have already produced a pilot video aligned with the AQA GCSE Biology curriculum (4.6.3.5 Fossils). This pilot demonstrates the talking-head documentary style envisaged for future videos. It can be viewed at <**https://www.youtube.com/watch?v=LwF7qnYFde8**>, or scan the QR code.

I have identified a number of priority topics for future videos, including:

- Domains of Life (Edexcel Biology 1B; AQA Biology 4.1): prokaryotes and eukaryotes; fungi, animals, plants and viruses; differences in cell size and structure; and cell differentiation.
- Flowering Plants (Edexcel Biology 2E, 2G, 2H; AQA Biology 4.2, 4.4): photosynthesis; leaf structure and adaptations; ion uptake; water transport; root adaptations; and the use of glucose in plants.

- DNA and Inheritance (Edexcel Biology 3B; AQA Biology 4.6): DNA location and organization; DNA and RNA structure; transcription and translation; alleles, dominance and recessiveness; genotype and phenotype.
- Ecology (Edexcel Biology 4A, 4B; AQA Biology 4.7): populations, communities, habitats and ecosystems; biotic and abiotic factors; food webs; pyramids of biomass, number, and energy; biodiversity and conservation.
- Climate Change (Edexcel Biology 4D; AQA Chemistry 4.9): greenhouse gases and the greenhouse effect; natural and anthropogenic sources of emissions; and personal carbon footprints.
- Evolution (AQA Biology 4.6): natural selection; species and speciation; the history and evidence for evolution; biological classification; and interpreting evolutionary trees.

If your research overlaps with any of these areas and you would be interested in contributing to the video series, I would be delighted to hear from you.

One important lesson from producing the pilot video was just how time-intensive it is to create and edit high-quality documentary-style content. Fortunately, I have found some help. The School of Biological Sciences runs an MSc programme in Science Communication, which trains students in a wide range of communication approaches, including natural history film-making, podcasting, social media content creation and schools outreach. This programme is an excellent fit for the PalAss video project. Consequently, I will be supervising an MSc student research project this summer to produce the educational video content outlined above.

Related to this, I have been liaising with Cambridge OCR exam board regarding its forthcoming GCSE qualification in Natural History. The qualification was launched in 2020 with the aim of empowering students to understand and protect the natural world, with a particular emphasis on local environments. The UK government recently (March 2025) reconfirmed its commitment to proceed with the new qualification, which has now entered the consultation phase as the content is being finalized. I am delighted to confirm that the Palaeontological Association is now a key supporter of this initiative (<**https://teach.ocr.org.uk/naturalhistory**>). In the near future, I will be writing a viewpoint article for stakeholders to outline how PalAss can contribute to the qualification, and to highlight the most important perspectives and insights from palaeontology that we believe should be included. If you have ideas on what these should be, please do get in touch.

Finally, I have been spearheading an outreach project to establish 'county fossils' in the UK, inspired by the state fossils of the USA. As a (sometimes) proud Brit, I would note that the British Isles contain geological diversity comparable to that of the USA, compressed into a fraction of the land area. As a result, the UK can boast an extraordinary diversity of fossils from regions that are geographically very close to one another. More seriously, promoting county fossils offers a powerful way to engage the public with the UK's geological heritage. Fossils also provide accessible entry points for discussing broader issues such as biodiversity loss and climate change. I hope this initiative will also attract media attention and help to raise the profile of the Association and its work. I must admit though that I had not anticipated quite how contentious this project would be. Interestingly, the controversy has centred not on which fossils should be assigned, but on where county boundaries should be drawn. To be absolutely clear, there are many ways of defining UK counties; for this project I am using the historic counties as defined by <**https://abcounties.com/**>. I cannot emphasize enough how little interest I have in debating county boundaries: if your preferred county isn't included, then

I'm afraid to say it's tough luck. The project is still in its early stages, but I aim to launch a website later this year featuring shortlists of candidate fossils for each county. From there, I hope to work with local museums to promote awareness of local geological heritage and to spark wider public engagement with fossils and the Palaeontological Association.

It has been a real privilege to work on these projects, and I hope they will make meaningful progress toward fulfilling the Association's charitable mission. I look forward to continuing this work and warmly invite anyone interested to get involved!

Joe Keating
Education Officer
<education@palass.org>

Annual General Meeting (AGM) 2025 – Awards and Grants announced

The following awards and grants were announced and summarized at the 2025 AGM held at the University of Portsmouth, UK.

Lapworth Medal: Prof. David A.T. Harper

The Lapworth Medal is the most prestigious honour bestowed by the Association, awarded to a palaeontologist who has made a highly significant contribution to the science of palaeontology by means of a substantial body of research and service to the scientific community. It is not normally awarded on the basis of a few good papers, and Council looks for breadth as well as depth of the contributions in choosing suitable candidates. The medal is named for Charles Lapworth FRS (1842–1920), Professor of Geology at the University of Birmingham, UK who pioneered the application of biostratigraphy and established the Ordovician System of geological time.

Photo courtesy of David Harper.

In 2025 the Lapworth Medal was awarded to Prof. David A. T. Harper, in recognition of a career that has profoundly shaped modern palaeobiology through research, synthesis and international leadership. In nominating him, Mike Benton and Derek Briggs describe David as "*an internationally recognized palaeobiologist who has significantly furthered our understanding of the origins and diversification of communities during the Cambrian Explosion, Great Ordovician Biodiversification Event and end-Ordovician extinction, in terms of climatic and environmental change*". They emphasize that his work has had "*significant, international impact across systematics, biostratigraphy, palaeogeography and analytical palaeobiology*".

A central thread of David's career has been his outstanding taxonomic and systematic work on brachiopods. He has produced numerous major monographs and was a key contributor to the

Treatise on Invertebrate Paleontology, where he generated "*new and cladistically-based classifications of four major groups and [revised] all their known genera (c. 500)*". This foundational scholarship underpins much of his later work on Early Palaeozoic faunas and large-scale evolutionary patterns.

David has also played a defining role in establishing robust global chronostratigraphic and palaeogeographic frameworks. His long leadership in the Subcommission on Ordovician Stratigraphy helped to "*define a global chronostratigraphy for that system and accurate palaeogeographic base maps through wide collaboration with large international networks*". This work ultimately led to his election as Chair of the International Commission on Stratigraphy, overseeing the chronostratigraphic framework of the entire rock record.

Among his many scientific contributions, David is particularly associated with research on Early Palaeozoic biodiversification. His work was instrumental in establishing the Great Ordovician Biodiversification Event (GOBE) as "*the largest marine biodiversification of all time*", stimulating decades of subsequent research into its causes and consequences. His integrative approach – combining palaeontology, palaeomagnetism, geochemistry and climate modelling – has reshaped understanding of how plate tectonics, island arcs, climate change, and even meteorite bombardment influenced early marine ecosystems. Equally influential has been David's work on the end-Ordovician mass extinction, which his nominators describe as "*the first test of the resilience of a marine animal-based ecosystem after the origin and diversification of animals in the sea*". His research moved the field beyond simple taxonomic loss to explore phylogenetic structure, ecological selectivity and post-extinction recovery using advanced quantitative methods.

Beyond his research papers, David's impact is magnified through teaching, synthesis and software development. He is the author of widely used undergraduate textbooks, and – with collaborators – developed the statistical software PALSTAT and its successor PAST, which has become an "*industry standard*" cited tens of thousands of times across the sciences, "*driving and encouraging numeracy in the framing and testing of scientific hypotheses*".

HIs nominators conclude that "*David Harper has made a deep and lasting impact on palaeontology internationally through his research and his leadership*". Through scholarship, mentorship, service to professional societies (including the Association), and an exceptional record of synthesis, his career exemplifies the spirit and distinction of the Lapworth Medal. David's accomplishments therefore make him a truly worthy recipient of the 2025 Palaeontological Association's Lapworth Medal.

President's Medal: Prof. Stephen L. Brusatte

The President's Medal is a mid-career award given by Council to a palaeontologist who has had 10–20 years of full-time experience after their PhD, in recognition of outstanding contributions in their earlier career coupled with an expectation that they will continue to contribute significantly to the subject in their further work.

The President's Medal in 2025 was presented to Prof. Stephen L. Brusatte, in recognition of his outstanding contributions to vertebrate palaeontology, scientific leadership, teaching and public engagement. In their nomination, Rachel Wood and Mike Benton describe Stephen as "*a globally recognized palaeontologist who heads the Vertebrate Palaeontology Research Group at the University of Edinburgh*". They emphasize his breadth as a researcher who combines "*fieldwork, anatomical*

Photo courtesy of Stephen Brusatte.

studies, phylogenetic analyses and statistics to study large-scale patterns of evolution over deep time and major evolutionary transitions".

Stephen's research has transformed understanding of dinosaur and vertebrate evolution. Much of his work focuses on how dinosaurs rose to dominance, diversified, and ultimately went extinct, as well as how mammals survived and radiated in the aftermath. High-profile studies have shown that dinosaurs "*gradually rose to prominence*" rather than explosively replacing competitors, that tyrannosaurs evolved large brains and refined sensory systems before attaining gigantic size, and that the end-Cretaceous extinction was "*rapid and caused by the impact of an asteroid*". His more recent work has revealed how mammals survived this extinction by rapidly increasing body size and changing life histories.

Alongside these headline discoveries, Stephen has been a pioneer in developing new quantitative methods to study rates of anatomical evolution and morphological disparity, and in applying techniques from other disciplines – including stable isotope geochemistry and modern ecological modelling – to long-standing palaeontological problems. This interdisciplinary approach has helped open new windows onto ancient ecosystems and evolutionary processes. Stephen is also the leading authority on Scottish dinosaurs. Since his arrival in Edinburgh in 2013, his fieldwork on Skye – carried out with strong student involvement – has transformed Scotland's fossil record. These efforts have revealed "*Scotland's largest dinosaur fossil site*" and led to the naming of new Middle Jurassic species, helping establish Skye as "*Scotland's 'Dinosaur Island' and one of the world's premier fossil sites of Middle Jurassic age*".

Beyond academia, Stephen is an exceptional communicator of palaeontology to the public. He is a prolific and widely-read science writer, with his book *The Rise and Fall of the Dinosaurs* becoming an international bestseller, translated into more than 20 languages and named Science Book of the Year by *The Times*. He is also a consultant for the Jurassic World film franchise and a long-standing contributor to the BBC's *Walking With Dinosaurs*, helping to bring up-to-date palaeontology to global audiences.

Stephen's commitment to education and service is equally notable. He teaches across undergraduate and postgraduate programmes at Edinburgh, co-founded the Palaeontology and Geobiology MScR, and has supervised a large and diverse research group. He has also served the wider discipline through professional societies, editorial boards, and by co-founding the PalAlba consortium to discover, conserve and communicate Scotland's fossil heritage.

His nominators conclude with their "*strongest support*" for Stephen's award, recognizing a palaeontologist whose research excellence, leadership and public engagement exemplify the values of the Palaeontological Association. Stephen's accomplishments to date make him a deserving recipient of the 2025 Palaeontological Association's President's Medal.

Hodson Medal: Prof. Daniel J. Field


Photo courtesy of Daniel Field.

The Hodson Medal in 2025 was awarded to a palaeontologist who has had not more than 5–10 years of full-time experience after their PhD and who has made a notable contribution to the science of palaeontology. The medal is named for Frank Hodson (1921–2002), Professor of Geology at the University of Southampton, UK, founding member of the Palaeontological Association and expert in goniatite biostratigraphy.

The 2025 Hodson Medal was presented to Prof. Daniel J. Field in recognition of his exceptional early-career contributions to vertebrate palaeontology, particularly to understanding the origin, survival and early diversification of modern birds. His nominators, Erin Saupe and Paul Barrett, describe Daniel as "*a world-leading expert on early bird evolution*" whose work has made "*pivotal contributions to understanding the most diverse terrestrial vertebrate group on Earth*". His research is notable for its breadth, combining field palaeontology, high-resolution 3D anatomical imaging, palaeoclimate modelling, isotope geochemistry, comparative morphology, embryology and molecular evolution to address major evolutionary questions.

Since completing his PhD at Yale University in 2017, Daniel's career trajectory has been remarkable. He rapidly established an internationally recognized research programme, first as a Prize Fellow at the University of Bath and then at the University of Cambridge, where he was appointed Assistant Professor in 2018 and recently promoted to full Professor. Alongside this, he serves as Strickland Curator at the University of Cambridge Museum of Zoology and holds research affiliations with major natural history museums in the UK and USA.

A central focus of Daniel's work has been uncovering the mechanisms by which modern bird diversity arose. His research has clarified avian evolutionary relationships, provided a temporal framework for major episodes in bird evolution, and revealed how key anatomical transitions occurred. Among his most influential discoveries is the identification of "*the earliest glimpse of a modern bird ever found*", a Late Cretaceous fossil that sheds light on the common ancestry of major living bird groups. More recently, his work on *Janavis finalidens* overturned a 150-year-old assumption about the evolution of the modern bird skull, revealing an advanced palate in a toothed stem bird.

Daniel has also made fundamental contributions to understanding extinction selectivity at the end-Cretaceous mass extinction. His innovative analyses showed that all tree-dwelling bird lineages went extinct, while surviving lineages were ground-dwelling, providing "*the first compelling explanation for why modern birds survived this mass extinction event when their close relatives did not*". This work further demonstrated how rapid ecological and morphological diversification followed the recovery of global forests.

Beyond research, Daniel is deeply committed to teaching, mentorship and public engagement. At Cambridge he teaches across all undergraduate years, has received multiple student-led teaching

award nominations, and has supervised a growing cohort of PhD students, postdoctoral researchers and early-career scientists. His outreach ranges from museum exhibitions and science festivals to international media coverage, with his research featured by outlets including the BBC, *National Geographic*, *The New York Times* and *Science*.

His nominators conclude that Daniel is "*a leading vertebrate palaeontologist whose early contributions … have substantially advanced our understanding of early bird evolution*", noting that his career remains "*on a strong upward curve*". Innovative research, combined with exemplary teaching and scientific citizenship, make him a highly deserving recipient of the 2025 Palaeontological Association's Hodson Medal.

Dorothea Bate Medal: Dr Emma M. Dunne

Photo courtesy of Emma Dunne.

The Bate Medal is an early career award named for Dorothea Bate FGS (1878–1951), Research Scientist at the Natural History Museum, London, UK and expert in Pleistocene mammals. This award is conferred on a palaeontologist with up to five years of full-time experience post-PhD and who has made a notable early contribution to the field through published research.

The 2025 Dorothea Bate Medal was presented to Dr Emma M. Dunne, in recognition of her outstanding early-career contributions to palaeontology, spanning quantitative palaeobiology, macroevolution, and ethical research practice. In nominating her, Stephan Lautenschlager and Emily Rayfield describe Emma as "*a world-class palaeontologist*" and "*a rising star in palaeontology*" who, despite her early career stage, has already made "*an impressive number of important and influential contributions*" to both science and the wider palaeontological community.

Emma's research has transformed our understanding of the environmental drivers of vertebrate macroevolution. Her PhD work at the University of Birmingham focused on the controls on tetrapod diversity through the Palaeozoic and Mesozoic and produced a series of high-impact publications in leading journals, including *Nature Ecology & Evolution*, *Nature Communications* and *Proceedings of the Royal Society B*. Standout among these was her development of novel approaches to sampling standardization and network biogeography to examine the impact of the Carboniferous Rainforest Collapse on early tetrapod diversity – work that was recognized with the Michael K. O'Rourke Prize for the best PhD student publication.

Following her PhD, Emma pioneered a new integrative framework for analysing the role of climate in deep-time biodiversity change. During a Leverhulme-funded postdoctoral position, she developed methods that, "*for the very first time, integrated fossil occurrence data with palaeoclimate reconstructions from general circulation models and simulations based on ecological neutral theory*". This work demonstrated that climate change was a key driver of early dinosaur evolution and has since been widely adopted by other researchers to study biodiversity dynamics across a wide range of vertebrate groups.

Alongside these scientific advances, Emma has played a leading role in establishing palaeoethics as a quantitative research field. Her work examining the ethical, equitable and legal dimensions of

palaeontological research – including the impacts of colonial histories and extractive practices – has had direct real-world consequences. Through her co-founding of the Palaeoscientometrics Research Collective and her work on issues such as Myanmar amber, her research has prompted "*publishers, government entities and museums [to change] their publishing practices and protocols*", including editorial policy changes at *Nature Ecology & Evolution*.

In 2022, just two years after completing her PhD, Emma was appointed Assistant Professor (Akademische Rätin) at Friedrich-Alexander-Universität Erlangen–Nürnberg. In this highly competitive academic environment, she has balanced major teaching and leadership responsibilities with a rapidly expanding research programme, most recently supported by a Volkswagen Foundation Junior Professorship in Earth System Sciences.

Emma is also widely recognized as an outstanding teacher, mentor and communicator. She leads courses across undergraduate and postgraduate programmes – including teaching in German – and has supported students in publishing their research and in securing PalAss bursaries. Her commitment to outreach and inclusion is exemplified by her co-receipt of the Gertrude Elles Award for work with the education charity The Brilliant Club, alongside extensive public engagement and science communication activities.

Her nominators conclude that Emma is "*an exceptional researcher with an impressive publication record for her early career stage*", combining methodological innovation, major grant success, and an "*impeccable international research reputation*". Her scientific achievements, ethical leadership and commitment to community make her a highly fitting – and inaugural – recipient of the Dorothea Bate Medal 2025.

Mary Anning Medal: Dr Rok Gašparič

The Mary Anning Award, named for the pioneering fossil collector and dealer (1799–1847) of Lyme Regis, UK, is open to all those who are not professionally employed in palaeontology but who have made an outstanding contribution to the subject. Such contributions may range from the compilation of fossil collections and their care and conservation, to published studies in recognized journals. The 2025 Mary Anning Award is awarded to Dr Rok Gašparič, in recognition of his outstanding and sustained contributions to palaeontology made outside traditional professional employment in the discipline.

Photo courtesy of Rok Gašparič.

In endorsing his nomination, the proposers – Javier Luque and John Jagt – emphasize that Rok "*embodies the spirit of the Mary Anning Award, which celebrates individuals who have made outstanding contributions to palaeontology outside of traditional professional roles*". His lifelong engagement with palaeontology began in childhood and developed into a serious scholarly pursuit, pursued alongside a full-time career in the private sector.

Despite working for over two decades as a General Manager for an international corporation in eastern Europe, Rok has maintained an exceptional level of academic output. He has published 29 scientific papers, including 19 in high-ranking international journals, establishing himself as a recognized expert in fossil decapod crustaceans. His doctoral research, completed with *cum laude* honours, on the "*taxonomy, palaeoecology and palaeobiogeography of fossil decapod crustaceans of Slovenia and neighbouring regions*" has significantly advanced our understanding of this group, particularly in eastern Europe.

Rok's contributions extend well beyond publication. He has demonstrated outstanding leadership and service to the palaeontological community, most notably as organizer of the 7th International Symposium on Mesozoic and Cenozoic Decapod Crustaceans, which brought together researchers from around the world. He also founded the non-profit Institute for Palaeobiology and Evolution in Slovenia, providing a platform for research, collaboration and the dissemination of palaeontological knowledge. A committed advocate for public engagement and heritage preservation, Rok has run workshops for schools, delivered fossil classes for children, and worked extensively with collectors. Since 2010, he has served as President of the Slovenian Association of Minerals and Fossil Collectors, where he has played a "*pivotal role in fostering a spirit of cooperation within the collectors' community and in promoting the preservation of natural heritage*".

His nominators stress that Rok's achievements are all the more remarkable given that his palaeontological research is conducted on a voluntary basis, driven by passion rather than professional obligation. His unwavering dedication, rigorous scholarship, and commitment to outreach and collaboration make him an exemplary recipient of the 2025 Mary Anning Medal and a powerful modern expression of the award's founding ideals.

Gertrude Elles Award: Dr Elena Ghezzo

The Gertrude Elles Award is awarded for amateur or institutional public engagement projects that promote palaeontology. The award is named for Dr Gertrude Elles MBE (1872–1960), Vice Principal of Newnham College and Reader at the University of Cambridge, UK, who made seminal contributions to the taxonomy and biostratigraphy of graptolites of the British Isles. The award recognizes high-quality public engagement in the field of palaeontology. Nominated projects can include museum displays and exhibitions, outreach programmes to schools and/or communities, art/science collaborations, digital initiatives, or any other programme that falls broadly under the heading of public engagement with palaeontology.

The 2025 Gertrude Elles Award was presented to Dr Elena Ghezzo, in recognition of her outstanding contribution to public engagement in palaeontology through the creation of *Paleo Stories*, an innovative comic-book series designed to make palaeontological science accessible, inclusive and engaging for young audiences.

Paleo Stories was developed in response to the combined challenges of early-career research, maternity responsibilities, and the constraints of the Covid-19 pandemic. As outlined in her nomination, the project was conceived "*to explain palaeontological insights and details of fossil discoveries to the general public*" through a narrative format that blends storytelling, scientific explanation and visual art. The series follows a group of pre-teens – the Paleo Hunters – who confront scientific problems and personal challenges while learning about evolution, extinction and deep time.

A defining strength of *Paleo Stories* is its thoughtful approach to representation and inclusivity. The narrative foregrounds gender and ethnic diversity, features girls as the STEM experts in the group, and openly addresses themes of disability, social dependence and difference. Scientific accuracy is carefully maintained, with extinct species intentionally mixed across time periods but accompanied by "*clear explanation of their chronological and taxonomic differences*". Each volume integrates palaeontological insights – such as how excavations work or how baleen whales evolved – alongside interviews with practising Italian palaeontologists, adding depth and authenticity to the storytelling.

Photo courtesy of Elena Ghezzo.

Since the release of the first volume in 2023, *Paleo Stories* has demonstrated exceptional reach and impact. The project has been presented at 47 venues across 22 Italian cities, including schools, museums, book fairs and bookshops, reaching more than 2,000 children through structured workshops and events. The first two volumes sold out rapidly, each requiring multiple reprints, with several thousand copies sold, and a third volume was released in March 2025. The books are deliberately priced to remain accessible and are widely available through public libraries.

The educational value of the project is reflected in its uptake by schools, with teachers reporting that the books have been successfully used to teach "*evolution, ecology, and speciation*", and that associated workshops sparked enthusiasm for science, writing and museum collections. The project has also been presented at major professional meetings, including the Italian Palaeontological Society and SVP 2024, and has attracted interest for international translation.

The nomination highlights that the effectiveness of *Paleo Stories* is measurable not only in sales and attendance figures, but in sustained community engagement and feedback from educators, families and young readers. By combining rigorous science with imaginative storytelling and a strong commitment to diversity and inclusion, Elena has created a model for impactful palaeontological outreach. Through *Paleo Stories*, Elena exemplifies the spirit of the 2025 Gertrude Elles Award: creative, inclusive, and deeply committed to widening access to palaeontology and inspiring the next generation of scientists.

Annual Meeting Council Poster Prizes 2025 awardees

The Council Poster Prizes are awarded for the best posters at the Annual Meeting. The poster prize committee for 2025 was Barry Lomax, Alan Spencer, Orla Bath-Enright, Robert Sansom, Richard Dearden and Tina Woltz.

The prize winners were:

- **Harry Berks** (University of Bristol) for 'High functional optimality in mammalian jaws reflects an evolutionary trade-off between strength and speed';
- **Hollie Bean** (University College Cork) for 'A new model for prediction of fossil feather colour using melanosome geometry, metal chemistry and reflectance spectrophotometry';
- **Philip B. Vixseboxse** (University of Cambridge) for 'Miniaturized experimental taphonomy: tracking decay at micron-to-millimetre scales';
- **Lucy Jackson** (University of Reading) for 'A new phylogeny for ctenocystoid echinoderms';
- **Harry Savage** (The University of Manchester) for 'Quantifying disparity in annelid locomotion using discrete non-morphological characters'.

Annual Meeting President's Prizes 2025 awardees

The President's Prizes are awarded for the best talks at the Annual Meeting. The President's Prizes committee in 2025 was Philip Donoghue, Paul Barrett, Orla Bath Enright, Kirsty Edgar, Alex Liu, Emily Mitchell, Mark Purnell, Daniela Schmidt and Jeff Thompson.

The prize winners were:

- **Daniel Cirtina** (University College Cork) for 'Casting light on melanosome geometry and visual strategies in fishes';
- **Rosa Parkin** (University of Edinburgh) for 'Extinction and survival at the dawn of plant life on land';
- **Edna Rodríguez-Sánchez** (Harvard University) for 'Reevaluating the Cambrian chelicerate *Molaria*'.

Career Development Grants 2025 awardees

The Career Development Grant is to assist talented early-career researchers who have recently completed their PhD to strengthen their CVs, to help them achieve a career in palaeontology. In 2025 the Association awarded a total of £7,500 in Career Development Grants to three individuals:

- **Carla San Román** (£2,500);
- **Adele Pentland** (£2,500);
- **Giovanni Pasinetti** (£2,500).

Small Grants Scheme 2025 awardees

In 2025 the Association awarded £9,934 in Small Grants to the following individuals.

Sylvester-Bradley Awards

- **Lucy Muir**: Exceptionally preserved hemichordates and related deuterostomes of the Middle Ordovician Castle Bank Biota, Wales (£547);
- **Oscar Wilson**: Marsupial dental ecometrics and their utility for palaeoenvironmental reconstruction in Australasia (£1,500);
- **Natalia Jagielska**: Furry dragons: on the properties of pterosaur body and membrane fibres (£492);
- **Sergio Martínez Nebreda**: Delving into avifaunal diversity of the Early Cretaceous of the Iberian Peninsula using digital technologies (£1,500);
- **Dánae Sanz**: Reconstructing the palaeoecology of the Ensenadan fauna from Toscas del Río de la Plata, Argentina through stable isotopes (£1,500).

Whittington Award

- **Petter Nordenhaug**: Expanding the early ichthyosaur dataset: comparative analysis of Middle Triassic specimens from Zurich and Svalbard (£1,395).

Stan Wood Award

- **Edgardo Ignacio Misael Figueroa Jimenez**: Palaeoenvironmental analysis of volcanic and volcaniclastic deposits bearing fossil mammals in the Abanico Formation, Chile (£1,500);
- **Hamzah Imran**: An osteological and systematic review of a thalattosuchian crocodylomorph assemblage from the Middle Jurassic of east Morocco (£1,500).

Association Meetings

70th Annual Meeting of the Palaeontological Association
University of Oxford, UK *8 – 11 December 2026*

The 70th Annual Meeting of the Palaeontological Association will be held at the University of Oxford, UK. The organizing committee brings together colleagues from Oxford's Department of Earth Sciences and Museum of Natural History. It is chaired by Ross Anderson and includes Frankie Dunn, Duncan Murdock, Emma Nicholls, Luke Parry, Ricardo Pérez-de la Fuente and Erin Saupe.

Registration is expected to open in the summer. Enquiries regarding the meeting should be addressed to <**annualmeeting2026@palass.org**>.

Programme outline

The meeting will take place from 8th to 11th December 2026 and will be based primarily at the Mathematical Institute, University of Oxford. An assortment of workshops (including on quantitative approaches to palaeobiology) as well as tours of the Oxford University Museum of Natural History collections and the University's colleges will take place on the morning of 8th December. These will be followed by a themed symposium on 'The deep time record of major evolutionary transitions'. The symposium will include a diverse range of researchers at different career stages and will showcase how fossil specimens reveal major evolutionary transitions. An 'icebreaker' reception will be held that evening at the Museum of Natural History, providing the opportunity for delegates to take in the new re-display project in the main court. The main scientific sessions of talks and posters will be held on 9th and 10th December. The Annual Address will be given in the late afternoon of 9th December and will be followed in the evening by the Annual Dinner at historic Merton College, founded in 1264.

Field-trip

A post-conference field-trip will visit a variety of famous sites across Oxfordshire that reveal Mesozoic fossil assemblages and environments, including Kirtlington Quarry, on 11th December. Further details regarding the field-trip will be made available on the Association's website in due course.

Annual Dinner

The Annual Dinner will be held at Merton College, the first college to have formal governing statutes. During the Annual Dinner, delegates will dine in the main hall, with a pre-dinner reception in the college's chapel. This promises to be an entertaining evening in a unique and atmospheric venue.

The city of Oxford

Oxford is a compact city with excellent transport links and several hotels and areas for eating and drinking within walking distance of the meeting venue. The conference venue, the Mathematical Institute, is on the edge of the vibrant Jericho area of Oxford and neighbours the new Schwartzman Centre for the Humanities. Walton Street and Little Clarendon Street in Jericho host numerous bars, restaurants and eateries. The nexus of Radcliffe Square, Broad Street and High Street is around five minutes' walk away and, during the meeting, Broad Street will host the city's annual

Christmas market. Blackwell's bookshop, with its vast Norrington Room, is well worth a visit, and the University's Ashmolean, History of Science, Natural History and Pitt Rivers museums are all close by and free to enter.

Getting to Oxford

Getting to Oxford by train:
Oxford has a train station with direct links to both London Paddington (Great Western Railway) and London Marylebone (Chiltern Railways) as well as cross-country services.

Getting to Oxford by air:
Oxford is around one hour from London Heathrow with a direct coach service, Oxford Airline, regularly connecting the airport to the city centre. The same coach service also serves London Gatwick.

Getting to Oxford by road:
It is best to use the park-and-ride services to access the city centre if coming by car. Parking is available at the Westgate Centre and other central Oxford car parks but there is now a congestion charge.

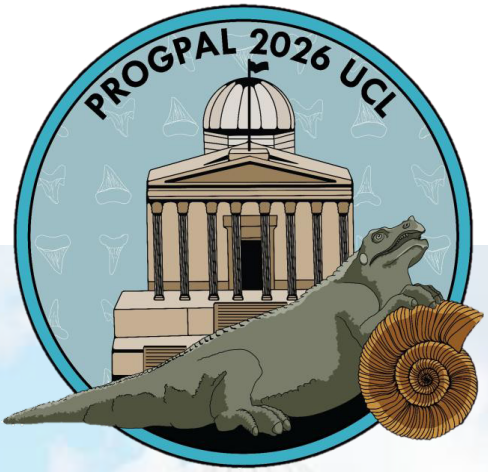
Accommodation

There are numerous options for accommodation in central Oxford, from hotels to college rooms. The organizing committee is currently negotiating the possibility of booking rooms with specific colleges for the conference and will provide details in due course. Accommodation may also be booked through the usual online resources, and delegates are strongly encouraged to book their accommodation as early as possible to avoid disappointment and to get the best rates.

Our logo

Our logo has been designed by students Minxuan Zhu, Lois Houlgate and Lucy Jackson who won a competition organized through the Oxford Palaeobiology Group. The logo uses our iconic specimens of *Megalosaurus*, described over 200 years ago by William Buckland, and the Oxford dodo, alongside the iconic Radcliffe Camera (part of the Bodleian Libraries). It also incorporates dinosaur footprint outlines from the recently discovered site in north Oxfordshire.

The Company of Biologists



The Palaeontological Association

- **Dates: 22nd - 25th June 2026**
- **Registration is open at palass.org**
- **Abstract submission closes 16:00 16th April 2026**
- **Travel grants will be available**
- **Workshops and field-trip details can be found on the PalAss website**

PeerJ

Community news

Updates from members of the PalAss community follow below, while Publicity Officer Darja Dankina has shared some news items from the wider palaeontological world. If you have any news and (especially) palaeontological pictures you would like to share in the next edition of the *Newsletter* please get in touch at <**newsletter@palass.org**>.

Sir David Attenborough backs Charnwood Forest UNESCO status

Leicestershire's Charnwood Forest in England recently took an important step towards gaining a prestigious international designation. Jack Matthews writes:

Charnwood Forest's UNESCO Global Geopark application was submitted to UNESCO HQ in Paris at the end of November. The bid for Geopark status is based on the area's world famous fossils from around 565 Ma. Since the discovery of Charnia by two school children in the 1950s, many other fossils have been described from the Geopark, including Auroralumina attenboroughii, *the oldest known fossil of a predatory animal.*

When people tell the story of the evolution of life on planet Earth, they speak of Charnwood Forest. In 2010 the Discovery Channel, ABC and the BBC joined together to make the Emmy-award winning TV documentary series First Life, *and it was in Charnwood Forest where the programme began. Standing atop the summit of Beacon Hill, Sir David Attenborough welcomed the viewers: "As a school boy, I grew up near here. And in these rocks, a discovery was made that transformed our understanding of that mystery of mysteries: the origin of life". Sir David has now given his endorsement to the UNESCO application.*

The Old Man of Beacon Hill. Photo by Jack Matthews.

Charnwood Forest Geopark has been developed over the past four years as part of a National Lottery Heritage Fund-supported Landscape Partnership Scheme, hosted by the National Forest. The Geopark

includes well-known sites such as Bradgate Park and Beacon Hill, but also hidden gems like Morley Quarry and Markfield's Hill Hole. Charnwood Forest's application for UNESCO Global Geopark status totals more than 140 pages, and outlines details of recent work that has been undertaken in areas such as education, interpretation, conservation and sustainable economic development. The UNESCO bid has been possible thanks to financial commitments made by four local councils: Charnwood Borough Council, Hinckley & Bosworth Borough Council, Leicestershire County Council and North West Leicestershire District Council.

There are currently 229 UNESCO Global Geoparks in 50 countries, each hosting internationally-significant geological features that communities use to support education work and growing the local economy in a sustainable way. In 2026 two international evaluators will visit to judge if the region meets the high standards of a Global Geopark. If all goes well, Charnwood Forest will be awarded the status when the UNESCO Executive Board meets in the spring of 2027.

Jack J. Matthews
Charnwood Forest Geopark, UK

Palaeontology fieldwork survey seeks perspectives from established researchers

The #yourpalaeolife fieldwork survey, being carried out by Harriet Nuttall, is entering its second phase after initially collecting data from early-career researchers. Harriet writes:

Hello once again all fellow palaeontologists! The response to the first #yourpalaeolife *survey over the autumn was fantastic, and we are putting together all the incredible insights we gained as we speak, but now it's time to ask for the other half of the equation.* #yourpalaeolife *is back and this time we need ESTABLISHED RESEARCHERS (that's all of you over five years post-PhD) to tell us about your experiences and views. Do you think fieldwork is important to palaeontology? Do you find it difficult to put together a fieldwork trip, or is it a smooth and simple thing to do? Tell us how you find the whole process –* ***or tell us you don't do it at all****. We need to know!*

As in #yourpalaeolife *part I this is a Google survey, at* <**https://forms.gle/61LiJpD5RfWxVg1U6**> *(or scan the QR code). No names or contact details are requested, and all demographic and location questions are generalized and optional because it is crucial that you are comfortable giving the honest truth of your experiences. Should there be sufficient participants, the results are intended to be published in conference poster and/or journal article format, so if you are interested watch for that via my Bluesky account (*@whosyourmammal.bsky.social*) and the Bluesky hashtag* #yourpalaeolife*. Direct quotations may be included in a results publication if they are particularly impactful or representative.*

Whether or not you choose to participate (and we very much hope you do), please forward the survey to your colleagues and contacts around the world. We've made a cracking start investigating how fieldwork fits into the global palaeontological community and we want to continue to represent as many viewpoints as possible. The world of palaeontological research is changing for everyone and we need to uncover what that looks like, and what it might mean for all of us in the future.

Harriet Nuttall
University of Birmingham, UK

Community News bites

The tiny 'spiny dormice' that keep time in fossils

When it comes to dating Europe's Miocene rocks, some of the smallest mammals turn out to be surprisingly helpful. Enter the fossil 'spiny dormice' of the genus *Neocometes* – tiny creatures with big stories. Despite their modest size, these little rodents have been called 'the most useful and unproblematic' fossils for telling time across Eurasia.

Originally discovered in the 1950s, *Neocometes* fossils reveal a slow but steady evolution: over seven million years, their teeth gradually got bigger. Palaeontologists have tracked this growth across several species – *N. similis* in the Early Miocene, a transitional form in the early Middle Miocene, and *N. brunonis* in the later Middle Miocene.

Now, thanks to a new find at Germany's Hammerschmiede site, the story has become even longer. The youngest known *N. brunonis* extends the lineage almost 1.7 million years into the Late Miocene, proving that these tiny spiny dormice were around – and helping palaeontologists keep track of time – longer than anyone realized. It's a reminder that even the tiniest fossils can leave a big mark on our understanding of the past!

BÖHME, M. and PRIETO, J. 2025. The last European *Neocometes* (Rodentia: Platacanthomyidae) from the early Late Miocene hominid locality of Hammerschmiede (Germany). *Fossil Imprint*, **81**, 91–98.

Source: <**https://phys.org/news/2026-01-spiny-dormouse-europe.html**>, accessed 1st February 2026.

Tiny fossils, big clues: *Spongiophyton* and life's first steps on land

The move from water to land was one of life's biggest evolutionary leaps, shaping soils, oceans and the rise of terrestrial animals. Plants are often credited with kickstarting this transformation, but another group may have quietly joined the party: lichens.

Meet *Spongiophyton*, a tiny, millimetre-wide fossil from 410 million-year-old Brazilian rocks. For decades, scientists debated whether it was an alga, a nonvascular plant or a lichen. Its simple, branching thalli – preserved as carbon-rich 'cuticles' – made it tricky to pin down.

Now, using synchrotron imaging and chemical analyses, researchers are unravelling the mystery of *Spongiophyton*. These fossils offer a rare glimpse into early terrestrial ecosystems, showing that even some of the smallest organisms may have played outsized roles in shaping life on land.

BECKER-KERBER, B., BROCKS, J. J., ARCHILHA, N. L., RODELLA, C. B., PETKOV, V., DEAZEVEDO, E. R. *et al.* 2025. The rise of lichens during the colonization of terrestrial environments. *Science Advances*, **11**, p.eadw7879.

Source: <**https://phys.org/news/2025-10-fossil-lichen-devonian-era-fungi.html**>, accessed 1st February 2026.

How sea turtles lost their scales: clues from a 100-million-year-old fossil

Sea turtles are among the most specialized marine reptiles, with a history stretching back over 100 million years. Today, they fall into two main groups: the familiar loggerheads, greens and hawksbills that have hard, scaly shells, and the leatherback, whose smooth, leathery skin covers its shell. But when and how turtles lost these scales has long puzzled scientists.

Fossil evidence shows that early marine turtles often had clear scutes on their shells, while impressions of soft, scale-less skin are far rarer. Some of the oldest known examples include Jurassic and Cretaceous turtles with preserved limb scales or soft tissue traces, hinting that scale loss occurred gradually as turtles adapted to life in open oceans.

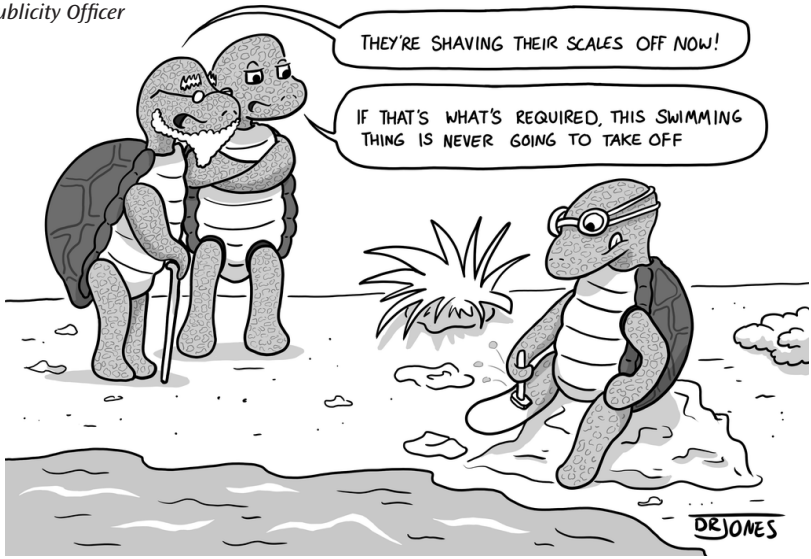
One fossil stands out: *Rhinochelys nammourensis*, a mid-Cretaceous protostegid from Lebanon, lived around 105 Ma and swam across the ancient Tethys Ocean. This specimen preserves impressions of solid flipper skin and faint shell scute markings – making it a crucial piece of the puzzle for understanding how sea turtles transitioned from scaly coastal dwellers to the mostly smooth-skinned ocean-going species we know today.

Even with modern imaging, studying these fossils is tricky. But each new insight brings us closer to understanding how these iconic marine reptiles adapted to life at sea – and why some lost their scales along the way.

KEAR, B. P., NOHRA, R., LINDGREN, J., RABI, M. and BAZZI, M. 2025. Cretaceous sea turtle soft tissues clarify ancestry of scale loss in chelonioids. *iScience*, **28**, 113641.

Source: <**https://www.science.org/content/article/ancient-sea-turtle-discovered-lebanon-reveals-surprising-evolutionary-history**>, accessed 1st February 2026.

Darja Dankina
Publicity Officer



<http://www.ratbotcomics.com/>

Medals and awards from other bodies

Recently several palaeontologists from among our membership have been recognized with fellowships, medals and awards from various societies and institutions.

Polar Medal

Photo by Chris Berry.

Prof. **John Marshall** has been awarded the Polar Medal, announced in the UK New Year's Honours list, for outstanding service in the field of polar research. John has made 19 expeditions to East Greenland and Spitsbergen, amassing over a year's worth of time spent in remote camps in extreme conditions in order to further our science in these harsh polar regions. These expeditions have meant travelling via inflatable boats, helicopters and light planes capable of landing on the Arctic tundra, and have involved camping at high altitudes with the added challenges of snow, ice and storms. John has studied the Devonian palynology of East Greenland, discovering with colleagues the earliest known seed plant, as well as the age of the earliest tetrapods. His work informed our understanding of the causes of the end-Devonian mass extinction (ultraviolet burst in the Earth's atmosphere) and the Late Devonian mass extinction (volcanic eruptions). In Spitsbergen he and Dr Chris Berry from Cardiff University recognized a new type of palaeo-equatorial forest from 384 Ma, and also discovered that a 55-million-year-old warming event reached from the equator to the Arctic. John's polar research has been carried out in collaboration with CASP in Cambridge and with many other colleagues from the UK and Sweden.

Göttingen Academy of Sciences and Humanities Adolf Seilacher Medal

To mark what would have been the 100th birthday of Adolf 'Dolf' Seilacher in 2025, the Göttingen Academy has instituted a new award in his honour: the Adolf Seilacher Medal. Dolf (1925–2014) was a distinguished and respected palaeontologist whose work particularly advanced our understanding of trace fossils, fossil Lagerstätten, and constructional morphology and morphodynamics, including the Ediacara fauna. In 1992 Dolf won the Crafoord Prize, one of the most coveted awards in science, on a par with a Nobel Prize, and, among other honours, was recognized with our Lapworth Medal in 2006. The inaugural Adolf Seilacher Medal, for 'outstanding and pioneering contributions to palaeontology, geobiology, or the geosciences more broadly' has been awarded to **Derek Briggs**.

Photo courtesy of D. Briggs.

Derek is the G. Evelyn Hutchinson Professor of Earth and Planetary Sciences at Yale University, USA, and Curator of Invertebrate Paleontology and former Director of the Yale Peabody Museum. His research focuses on the preservation and evolutionary significance of exceptionally preserved fossils, using a range of approaches from experimental work on decay and fossilization to studies of early diagenetic mineralization and organic preservation, and research in the field and lab on Konservat-Lagerstätten including the Burgess Shale. Derek has served the Palaeontological Association in various ways, as both editor and president. He is a Fellow of the Royal

Society (1999), a member of the American Academy of Arts and Sciences (2019) and was awarded the Lapworth Medal in 2019.

The Paleontological Society medal and Society of Vertebrate Paleontology medal

Photo © University of Bristol.

Prof. **Michael Benton** OBE FRS received the 2025 Paleontological Society Medal at the annual meeting of the Geological Society of America in San Antonio in October and the 2025 Romer-Simpson Medal from the Society of Vertebrate Paleontology at their annual meeting in Birmingham in November 2025. Mike previously received the Association's Lapworth Medal in Erlangen in December 2024, meaning that he has been awarded three lifetime achievement medals from palaeontological organizations in just 12 months! We believe he is the first palaeontologist to be awarded all three of these medals. Mike is a palaeobiologist at the University of Bristol in the UK, where his work focuses on large-scale evolution of major groups such as dinosaurs, and explores the effects of mass extinctions, environmental change, and biological innovation on the evolution of reptiles, birds and mammals. He is a prolific author, having published more than 700 scientific papers, several well-known textbooks, and more than 50 books on dinosaurs and related topics, the majority of which are aimed at younger readers. Mike established the MSc course in Palaeobiology in Bristol in 1996, from which more than 500 students have graduated so far, and he has supervised more than 80 doctoral students and 25 postdocs who now occupy posts all around the world. Mike's contributions to our science have already been recognized by many other bodies including the Geological Society of London, the Geological Society of Glasgow, the European Geosciences Union and the Royal Society of Edinburgh. We are very pleased to have Mike as Editor-in-Chief for the Association's journals.

The Paleontological Society awards

Philip Mannion, a Professor in Palaeobiology at University College London, has received the 2025 Charles Schuchert Award, given in recognition of excellence and quality in research within 15 years of the completion of a PhD. His research focuses on the evolutionary history and systematics of sauropod dinosaurs and crocodylomorphs, and how terrestrial vertebrate biodiversity has fluctuated through time and space over the last 250 Ma, with implications for the emergence and evolution of the latitudinal diversity gradient, as well as future distributions of species. Phil has already made a significant impact on the field of vertebrate palaeontology through collaborative research and the supervision of students and postdocs, and will undoubtedly continue. Demonstrating his excellent scientific citizenship, he has been one of the driving forces helping to administer the Paleobiology Database and is one of its major contributors, as well as being a handling editor for *Palaeontology*.

Photo by Laura Mannion.

The Diversity Engagement and Enhancement in Paleontology (DEEP) Award recognizes ECRs who have made significant contributions to advancing diversity, equity and inclusion within the palaeontological community. In 2025 two awards were made, both to PalAss members. Dr **Sanaa El-Sayed**, Assistant Lecturer in the Geology Department at Mansoura University and PhD candidate at the University of Michigan, received a DEEP Award for her transformative leadership

in building the first vertebrate palaeontology community in Egypt – and helping expand it across the Middle East and North Africa – through the Mansoura University Vertebrate Paleontology Center, together with her advisor Prof. Hesham Sallam. Sanaa has created opportunities for under-represented students, especially women, through long-term mentorship and hands-on training in both field and laboratory settings, encouraging a supportive culture that helps young scientists thrive. Her outreach includes organizing workshops and public lectures across Egypt and collaborating with the Egyptian Environmental Affairs Agency at major palaeontological heritage sites such as Wadi El-Hitan to engage and train students, alongside initiatives that bring pre-university students into real excavation experiences.

Photo © Mansoura University Vertebrate Paleontology Center.

Photo courtesy of D. Sanz-Pérez.

Dr **Dánae Sanz-Pérez**, a postdoc at Universidad Complutense de Madrid, received a DEEP Award in recognition of her sustained leadership in promoting gender equality in the geosciences. She is President of the association Mujeres con los Pies en la Tierra and of the Women and Geology Commission of the Sociedad Geológica de España. Dánae also coordinates the Geólogas en Red mentoring programme, connecting women students and ECRs with established women scientists across Spanish-speaking countries. In addition, she has developed innovative and accessible outreach initiatives, including educational video games and adapted field activities that contribute to building a more diverse and inclusive palaeontological community.

The Winifred Goldring Award, jointly presented by the Paleontological Society and the Association for Women Geoscientists, recognizes emerging women palaeontologists for their academic excellence and commitment to the scientific community. Dr **Dánae Sanz-Pérez** was selected as one of three awardees in 2025 in recognition of her research achievements and her active engagement in initiatives that strengthen and support the paleontological community. Incidentally, **Dr Sanaa El-Sayed** received a Winifred Goldring Award in 2024, recognizing her excellence in creating community in vertebrate palaeontology.

The Micropalaeontological Society Brady Medal

Dr **Jeremy Young** has been awarded the Brady Medal, the highest honour given by The Micropalaeontological Society (TMS). The medal is awarded for sustained excellence in micropalaeontology and is named after naturalists George Stewardson Brady and Henry Bowman Brady in recognition of their outstanding pioneering studies in micropalaeontology and natural history. Jeremy is a world-leading expert on calcareous nannofossils and extant coccolithophores, whose four-decade-long career includes over 150 papers, 20,000 citations, and major advances in taxonomy, biostratigraphy and nannoplankton evolution. Alongside impactful roles at the Natural History Museum, London and University College London, he has held community

Photo courtesy of J. Young.

leadership roles with TMS and the International Nannoplankton Association. His creation of the open-access Nannotax and Mikrotax databases has transformed global research and teaching worldwide, making Jeremy a very worthy recipient of the 2025 Brady Medal.

Ussher Society Honorary Membership

Photo courtesy of G. Warrington.

The Ussher Society, an organization for geoscientists working in southwest England, has made Dr **Geoff Warrington** an Honorary Member for 'services to advancing geological knowledge in the Southwest of England'. His DSc was from the University of London for published work on the palaeontology and stratigraphy of Permian to Early Jurassic successions in the UK and its Continental Shelf. Work in southwest England included the discovery of the first biostratigraphical (palynological) evidence of a Permian age in a Devon succession and an integrated palaeontological and magnetostratigraphical study of the latest Triassic to earliest Jurassic in west Somerset. Geoff contributed to the nomination of the Dorset and East Devon coast for inclusion in the UNESCO World Heritage List and to the British Geological Survey Special Memoir *Geology of south Dorset and south-east Devon and its World Heritage Coast*. Geoff was in the Institute of Geological Sciences, later the British Geological Survey, from 1967 until 2003 when he became an Honorary Visiting Fellow in what is now the School of Geography, Geology and the Environment at the University of Leicester.

Jo Hellawell
Executive Officer

Please let us know of any other recent medal and award recipients that should be featured – by contacting <**newsletter@palass.org**>. Don't forget to nominate your colleagues for these and for the Association's own medals and awards. The deadline for nominations for our medals and awards is 31st March each year and you can find details towards the end of this *Newsletter* and online at (<**https://palass.org/awards-grants/awards**>).

Palaeontological Congress – IPC7

The 7th International Palaeontological Congress takes place in Cape Town, South Africa from 30th November to 3rd December this year (see next page). When registering make sure you take advantage of your PalAss member discount from PalAss's corporate membership of IPA (the International Palaeontological Association). Also note that the PalAss Annual Meeting is immediately after IPC so happily you can make it to both!

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Correspondents

New vertebrate discoveries from the late Permian of Zambia and Tanzania

The Permian was a hugely eventful period of deep time, featuring a global shift from rainforests to drier biomes, the emergence of terrestrial ecosystems dominated by ancient relatives of reptiles and mammals, and several extinction events including the cataclysmic Great Dying. These episodes and events of the Permian have inspired scientists across the planet to study this period further to unearth, often literally, new insight into what our planet was like over 252 million years ago. Among these scientists are the international team of palaeontologists led by Christian Sidor of the University of Washington, USA and Kenneth Angielczyk of the Field Museum in Chicago, USA, who recently published a comprehensive memoir in the *Journal of Vertebrate Paleontology* on vertebrate evolution in late Permian-aged strata from basins in Zambia and Tanzania[1]. This memoir describes a great deal of geological data on key stratigraphic units of these rift basins and an abundance of anatomical information on a wide variety of Permian taxa, considerably expanding our knowledge of late Permian ecosystems.

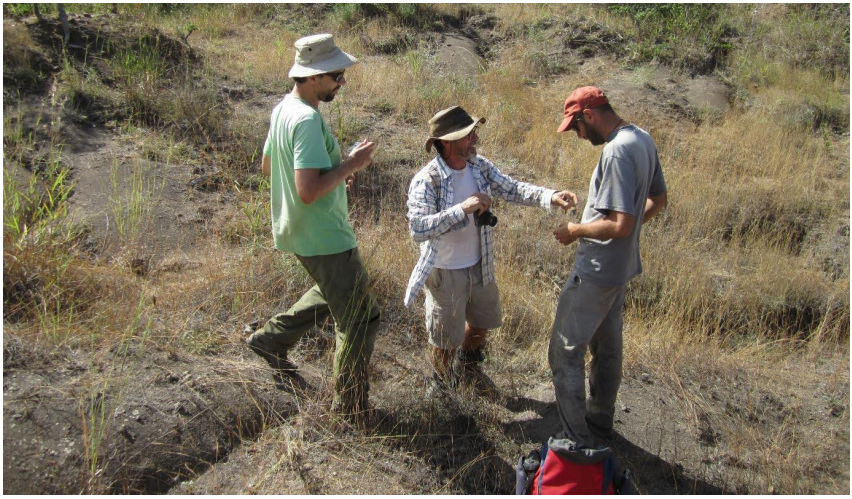
These rift basins of Tanzania and Zambia have an almost century-long history of scientific discovery. Despite this, the information on the ecosystems represented in these basins is far more limited than that of similarly-aged units from South Africa's iconic and fossil-rich Karoo. The team behind the memoir, convinced that the Tanzanian and Zambian basins had much more to offer, set out over the course of a decade to map localities, collect geological samples and prospect for fossils. By the time of writing the memoir, approximately 2,800 fossils had been collected, with about 1,800 from late Permian outcrops, and all of which were accessioned in local and national museums from their countries of origin. The memoir not only covers some of the team's most thought-provoking discoveries but also incorporates scientific study of important, previously discovered material, making it the most exhaustive dive into the late Permian of Zambia and Tanzania yet.

As is standard for late Permian deposits, the majority of the studied fossils were of dicynodonts, ancient relatives of mammals that resembled pigs but with beaks and tusks. They were ubiquitous across Pangea for the few million years leading up to the Great Dying, and afterwards persisted until the very end of the Triassic. With their long-lasting success of about 60 Ma,

[1] JVP Memoir 23. Vertebrate evolution in the Permian rift basins of Tanzania and Zambia: <**https://www.tandfonline.com/toc/ujvp20/45/sup1?nav=tocList**>.

dicynodonts diversified into a variety of forms that collectively occupied numerous ecological niches. Taxa pertaining to several dicynodont subgroups are the subject of multiple studies in the memoir. One of these subgroups is the Emydopoidea, a clade mainly comprising small dicynodonts. However, if there is any rule that truly applies in biology, it is that there is always an exception to the rule. In this case, one of the emydopoids described in the memoir by Brenlee Shipps and colleagues, the novel species *Dicynodontoides kubwa*, is almost twice the size of the type species *Dicynodontoides nowacki*. The new species is closer in size to dicynodonts of other subgroups and rivals a wild boar in size. It does retain the shovel-shaped lower jaw anatomy characteristic of *Dicynodontoides* though, indicative of a possible durophagous diet.

"We don't have direct evidence of small dicynodonts from the fossil assemblage we find D. kubwa *in, but I'd be surprised if the basal conglomerate was truly lacking in little guys. This puts* D. kubwa *somewhere in the middle as far as Usili herbivores go."* **Brenlee Shipps**.



Christian Sidor (left), Roger Smith (centre), and Jean-Sébastien Steyer (right) excited by the discovery of a bone-bearing coprolite from the Permian of Tanzania. Photo courtesy of Kenneth Angielczyk.

Another publication in the memoir concerns a very different emydopoid. *Kembawacela kitchingi* is a small dicynodont that shares with other members of Cistecephalidae a number of adaptations for burrowing. Caroline Abbott and colleagues described the specialized postcranial anatomy of this species in detail, and quantitatively analysed variation in forelimb shape of cistecephalids and extant burrowers. Fascinatingly, cistecephalids were found to exhibit a considerable amount of variation in forelimb shape, lending weight to arguments for different species in this subclade achieving fossoriality through the acquisition of different suites of adaptations.

Other dicynodonts featuring in the memoir include cryptodonts, one of which belongs to a subgroup (Geikiidae) distinguished by bizarre head ornamentation comprising numerous bosses. This is the new species *Aulacephalodon kapoliwacela*, the first of its kind from Zambia, and is represented by numerous skulls described by Henry Thomas and colleagues. The ample number of skulls allows for comparisons between individuals of the same species, and in this case has shown how *A. kapoliwacela* develops from a juvenile with relatively wide interorbital regions and

small tusks to an adult with narrower interorbital regions, larger tusks and an overall less gracile skull. Additionally, the anatomical variation between the skulls seems linked to dimorphism between sexes, with putative males possessing much more strongly developed bosses. This lines up with what has been hypothesized to represent sexual dimorphism in other dicynodont species, showing that across much of the evolutionary history of this cosmopolitan and successful lineage there were apparent differences in facial ornamentation between sexes.

> *"The robust bosses on the skull combined with possible lesions on some specimens suggests that some dicynodonts may have used their bosses in intraspecific combat, for example shoving matches like rutting musk oxen. Visual display is another viable hypothesis."* **Henry Thomas**.

A skull of the new species Madumabisa opainon, *one of the few definitive close relatives of* Lystrosaurus. *Photo courtesy of C. Kammerer.*

The memoir also features critical new information related to the origins of the most well-known and arguably most important dicynodont: *Lystrosaurus*. The closest relatives of this 'disaster taxon', together comprising the lystrosaurids, have long been enigmatic, but the new fossils described by Christian Kammerer and colleagues have totally changed that. With two new genera (*Lystrosauravus* and *Madumabisa*) containing a species each and a new species of *Euptychognathus* featuring in their publication, we now have a substantially clearer idea of what the closest relatives of *Lystrosaurus* looked like as well as some insight into how signature characteristics of the anatomy of *Lystrosaurus*, such as the elongate, strongly downturned snout, evolved. The researchers suggest that the unique skull anatomy of lystrosaurids may have been a specialization for consuming plant material that only became more widespread after the end-Permian mass extinction, explaining why lystrosaurid success did not outdo that of other dicynodonts and reach its zenith before the Great Dying.

> *"As P–Tr workers increase the amount of fieldwork done outside of the traditional basins, a lot of surprises are turning up: a few years ago, I was shocked when the Mallorca gorgonopsian showed up, but today if you told me that a lystrosaurid had been found in somewhere like Spain or Brazil I would say, 'yeah, that makes sense'."* Christian Kammerer.

Of course, there is more to the memoir than dicynodonts. Fans of the Permian will be well acquainted with gorgonopsians, small- to large-sized protomammals that somewhat resemble canids (if they had sabre-teeth), and two new gorgons from a late Permian outcrop of Zambia are reported. One is an indeterminate species of the small gorgonopsian *Cyonosaurus* and the other is a larger new species, *Arctops umulunshi*. We now have five different gorgons from the Late Permian of Zambia including the large and formidable *Rubidgea*, and these predators could probably only coexist through hunting different prey and having differences in lifestyle (*e.g.* most active time of day). Importantly, the description of the Zambian *Cyonosaurus* material by Alex Acker and colleagues is based on micro-CT data that have revealed new information on the internal anatomy of the skull, while the description of *A. umulunshi* by Arjann Mann and Christian Sidor features much needed data on the postcranial skeleton of gorgonopsians. On

a final note regarding gorgons, there is also a study by Zoe Kulik in the memoir detailing the histology of a Zambian gorgonopsian skeleton. Unlike their South African counterparts, this Zambian specimen grew noticeably more slowly, elucidating how variable growth rates were between different populations and species of these predators.

"There is an idea circulating in the literature that gorgonopsians may have had similar ecological guild structures to those seen in modern carnivore clades such as Felidae. While gorgonopsian cranial morphology does show some variation indicating different feeding regimes (Singh et al. *2024), we would also expect this variation to be largely captured in gorgonopsian postcrania. In our recent paper on* Arctops umulunshi *(Mann and Sidor 2025) we described one such well-preserved specimen that shows robust forelimbs, including robust manual elements. Alone, we cannot contextualize this fully yet, but it is one piece of the puzzle…"* **Arjann Mann**.

The in-depth anatomical descriptions featured in the memoir are not restricted to therapsids though, as a couple of the studies focus on other tetrapod material from late Permian Zambia. Jean-Sébastien Steyer and Christian Sidor describe the first Permian temnospondyl from Zambia. As is common across southern and eastern Africa, this Permian species belongs to the Rhinesuchidae branch of the temnospondyl radiation. Possessing a flat, subtriangular shaped head and coming in at about a metre in length, this amphibious predator represents a new species of the otherwise Malawian genus *Rhineceps*. The other non-therapsid featuring in the memoir is a new captorhinid reptile described by Xavier Jenkins and colleagues. Captorhinids superficially resembled lizards with wide heads and narrow snouts, and what grants them scientific importance is that they are among the very first amniotes (or close relatives of amniotes) to give herbivory a try. After sorting through numerous records of early amniotes, the new genus and species *Amenoyengi npunduensis* was found to be one of the last captorhinids, implying that these bizarre ancient herbivores were not victims of the Great Dying, but disappeared from our planet probably around a few million years prior.

"The specialized adaptations that underpinned captorhinid's earlier evolutionary success may have become a liability as wetter early Permian ecosystems gave way to increasingly arid conditions and xerophytic plant communities, potentially contributing to their apparent decline and extinction by the end of the Wuchiapingian (~254 Ma). That said, the scarcity of late Permian equatorial assemblages complicates this narrative, and it is possible that captorhinids persisted in undersampled regions, and that their ultimate disappearance was caused by a combination of other factors." **Xavier Jenkins**.

While studies of the anatomy and systematics of certain taxa comprise most of the text of the memoir, its value is not limited to such work. Arriving at a detailed understanding of the ages, depositional settings and environmental conditions of the late Permian outcrops that the team prospected was one of their core objectives. Adam Huttenlocker and colleagues documented occurrences of the therocephalian therapsid *Theriognathus* across basins in South Africa, Tanzania and Zambia and showed that this taxon, that looks somewhat like a small, gracile gorgonopsian, could serve as a reliable index fossil for correlating across these Africa basins. Indeed, it is now evident that there is an equivalency between the upper *Cistecephalus* to lower *Daptocephalus* Assemblage Zone of South Africa and the two late Permian geological units that outcrop in Zambia and Tanzania, placing all the *Theriognathus*-yielding outcrops at about 254 Ma. These two units are the Zambian Madumabisa Mudstone Formation and the Tanzanian Usili Formation.

It is from these formations that the bulk of the tetrapod material described in the memoir has been collected. Each of these units receives a comprehensive treatment as well. Roger Smith and colleagues describe the geology of the Usili formation and taphonomy of the fossils it has yielded. Their sedimentary logs capture a striking change in environment at the base of the Usili Formation. In the columns below the Usili Formation, there is evidence for an environment that was once lacustrine, somewhat reminiscent of today's Lake Malawi, but the environment represented at the base of the formation is instead alluvial. Furthermore, the fossils collected from this formation are often coated in red or black hematite, evidencing the wet conditions of this past environment. Regarding the other focus unit of the memoir, Brandon Peecook and colleagues carefully itemized the sedimentology and fossil occurrences of all outcrops of the Zambian Madumabisa Mudstone Formation that they prospected. They identified that palaeoenvironments varied across localities including floodplains and lacustrine environments, and it is now much clearer regarding which taxa are found in which divisions of the formation. As it stands, there are two established divisions: an upper and a lower member. However, new species described in this memoir might up-end this. The new *Aulacephalodon* species suggests a possible middle member, while the new lystrosaurid dicynodonts might be from a division even younger than the upper member, possibly from the very close of the Permian.

Collecting fossils from the Usili Formation in Tanzania with the Chingole Mountain in the background. Photo courtesy of Kenneth Angielczyk.

> *"Two things especially surprised me from our work in the late Permian of Zambia: 1) how it can now be demonstrated that the Luangwa Basin captures a good deal of the temporal signal of the late Permian Karoo Basin despite much less exposure and much less time in the field; 2) how diverse and abundant Lystrosauridae was in the Permian of Zambia well before the extinction, again compared to the much better sampled Karoo."* **Brandon Peecook**.

The sheer amount of work that has gone into the memoir is remarkable. Coordinating an international research team, carrying out fieldwork in the wilderness, mapping out localities and

their geology, sinking hundreds of hours into preparing a collection of fossils that would make most museums jealous, and rigorously studying the material is a feat many palaeontologists will find inspiring. Writing as a postgraduate student myself, it is encouraging to see so many others at a similar academic stage contributing to the memoir, which will no doubt steer them towards further career success. The value of this memoir is greater than the sum of its parts too, as it not only is a source of information on select species and localities, but also lays a foundation for future research. We can now use these Zambian and Tanzanian rift basins and the fossils they yield as a study system to shed new light onto what exactly was happening in the lead up to the end of the Permian. Are ecosystem changes in South Africa reflected in the late Permian outcrops of Zambia too? Are the factors behind speciation in the Karoo different to those of late Permian Tanzania? Why did some tetrapod lineages disappear shortly before the Great Dying while others persisted until it, and some even survived it? Attempts at answering all these questions and more can now be reached with more certainty thanks to the discoveries presented in this memoir.

"We encountered challenging hurdles to organising this memoir from fieldwork to publication. In terms of the actual research, I think maybe the thing that has surprised me the most is how hard it can be to locate old localities and/or get to them. For getting the memoir together specifically, I would say it's the usual mundane things that people always complain about when doing edited volumes: my advice to anyone doing them is to make sure you essentially have all the completed manuscripts in hand when you propose the memoir; trying to write them/finish them after the proposal is accepted is just too much!" **Kenneth Angielczyk**.

Hady George
University of Bristol, UK

Legends of Rock

Elsa Warburg, Sweden's first female palaeontologist

2025 marked the 100-year anniversary of Elsa Warburg's dissertation on Late Ordovician trilobites from the Siljan district of central Sweden. With this she became the first Swedish female Doctor of Philosophy and Associate Professor of palaeontology. Female graduates in academia at Swedish universities during Elsa's time did not have the same rights and opportunities as their male counterparts, and despite a heavy administrative workload and teaching over the years, Elsa was never granted her own professorship. A century later we can reflect on Elsa's situation as a woman, a Jewish person, and an academic in Uppsala and Sweden at that time.

Early career

Elsa belonged to the German Warburg family and was born into the Jewish merchant family in Stockholm as the youngest of four daughters. It was likely a family that not only allowed but also encouraged higher education, as Elsa was not the only one of her sisters with a university degree. In September of 1904, the eighteen-year-old Elsa moved to Uppsala and, according to Carl Wiman,

Left: Elsa Warburg, possibly around 1904. The Royal Library, Stockholm, public domain. Right: Elsa at her graduation with the laurel wreath on her head. Reproduced with the kind permission of Museum of Evolution, Uppsala University.

professor of Palaeontology and Historical Geology at the University, "she attracted a certain attention due to her intelligence". Elsa participated in Wiman's course on Swedish fossiliferous deposits, and in 1906 took part in an excursion to the Siljan district of Dalarna, central Sweden. At Wiman's suggestion she stayed on to collect trilobites from the Late Ordovician Boda Limestone and proved herself as both an enthusiastic and an outstanding collector. Elsa then had many collecting trips to Dalarna, Öland and Västergötland. The fossils were donated to Wiman's institution, or in many cases purchased by Wiman, which was a way for Elsa to finance further trips. Elsa was also awarded 2,000 SEK from the 'Liljewalchska Foundation' for studies in England[1], and the fossils from this trip were also given to Wiman. At the same time as her collecting trips, Elsa had begun her doctoral dissertation on the trilobites from the Boda Limestone.

During this time, Elsa was invited to give a lecture as part of the Geology seminar series at Uppsala University by Arvid G. Högbom, a professor of Mineralogy and Geology. The lecture entitled 'Relics in the Swedish flora' was not intended to present anything new on the subject; however, it was such a success that Högbom arranged for it to be printed in 1908. Following this success, Elsa also wrote the guide and led the excursion in the Siljan district in connection with the 11th International Geological Congress in 1910. Besides working on her dissertation, Elsa worked as an assistant at the Institute of Mineralogy and Geology.

Elsa presented and successfully defended her doctoral thesis on 25th May 1925 with her dissertation 'The Trilobites of the Leptæna Limestone in Dalarne – with a discussion of the zoological position and classification of the Trilobita'. More than 100 species of trilobite from the Late Ordovician carbonate mudmounds of the Siljan district, now known as the Kullsberg

[1] *Uppsala Nya Tidning* newspaper report 24/02/1920.

and Boda limestone (previously the Leptaena limestone), are described and trilobite systematics discussed in detail along with the stratigraphy of the deposits. It was a monumental work and was awarded with the highest grades. Even a hundred years later the scientific conclusions remain strong, and the systematics have only needed minor updates through the years, something that reflects the solid scientific legacy of Elsa. In 1926 she was awarded the Linnaeus Prize from the Royal Society of Sciences in Uppsala for her thesis work[2]. Later, in 1936 and 1939, she published two additional major works on trilobites within the order Lichida.

Life as a student

During her student years, Elsa was given a desk at Wiman's small institution – nicknamed 'Sandgropen' (the Sandpit) – in the University's former main administration building (konsistoriehuset) by Uppsala Cathedral. Working together with Elsa and Wiman in the Sandgropen was Erik Stensiö studying early tetrapods and fish, the Austrian Otto Zdansky who collected and studied Chinese fossil mammals, and the illustrator Maria Söderquist. The conditions were primitive and the rooms cold. As a result, Elsa experienced health problems with back pain and headaches. Because the premises were usually warmer towards the evening, Elsa started working late, often after Wiman himself had gone home, and it was well known that she would turn day into night. Elsa was seen as intelligent, highly gifted, friendly and kind-hearted, and engaged well with her fellow humans. However, despite her palaeontological achievements, her approach to the academic world was seen as somewhat passive. This seems to have been a family trait as noted by her friend, the historian Beth Hennings. Wiman noted that Elsa took an uncommonly long time to complete her university education, her bachelor's degree (*filosofie kandidat*) and licentiate degree (*filosofie licentiat*) totalled 12 years, with another five needed to complete her doctoral dissertation. Elsa was a member of Stockholm Student Society ('nation') and became deeply involved in the Uppsala Female Student Association. The society's songbook from 1917 mentions Elsa Warburg in several lyrics, *e.g.*

Elsa Warburg går och petar
Och i jordelagren letar
Och i bergenas struktur
Någon hednahös silur [3]

(These lyrics describe Elsa searching through earth and rock for Silurian fossils – Silurian at that time encompassing the Ordovician.)

In 1915 she was elected to the board of the 'Uppsala Association for Women's political suffrage' and at the time of her dissertation she was elected to the cultural association 'Nya Idun' in Stockholm, which served as an important meeting place for female doctoral students. Elsa also served as the treasurer for the 'Geographical Society' in 1919[4]. At the referendum on prohibition of the sale of alcoholic beverages in 1922, Elsa was engaged in the debate[5]; however, we do not know what her position was.

[2] *Uppsala Nya Tidning* newspaper report 06/03/1926.
[3] From *Idealvisan*, Uppsala Female Student Association songbook, p. 30.
[4] *Uppsala Nya Tidning* newspaper report 13/10/1919.
[5] *Uppsala Nya Tidning* newspaper report 17/03/1922.

Student life: a) photo from Wiman's institute in the 'Sandpit' towards the end of 1920. At the back, from left to right: Elsa Warburg, Maria Söderquist, Otto Zdansky and Erik Stensiö, with Carl Wiman seated in the foreground. Beneath the photo, it says 'The Family'; b) Elsa Warburg, towards the end of 1920; c) Warburg's 1925 thesis, with some of the trilobites in Uppsala's collections. Reproduced with the kind permission of Museum of Evolution, Uppsala University.

Woman in academia

Although several women successfully defended doctoral dissertations at Swedish universities from 1909 and onwards, initially they were not allowed to apply for higher positions, such as professorships. The so-called eligibility-law of 1925 changed this but did not necessarily change the reality. It was not a given that Elsa could stay in academia following her dissertation; however, she worked actively at the institution until her retirement in 1951. For ten continuous years, from 1928, she was awarded the docent scholarship of the natural sciences section and between 1933 and 1939 she was appointed adjunct professor after Carl Wiman to ensure continuation of teaching, and served as the departmental head. It has been suggested that the reason she remained at the university for so long was the excellent grade of her thesis, but the continuous support by Professor Wiman was most certainly of great importance in the male-dominated academic world. Elsa was one of five applicants to the professorship in palaeontology and historical geology after Wiman, a position that was given to another of Wiman's students, Erik Stensiö. After her large monograph in 1939, Elsa never published again.

Antisemitism

Strong antisemitic ideologies with deep historical roots were prevalent in Sweden during the 1930s. The Warburg family had lived in Sweden since the 1790s but, like other Jewish families, they had to follow the 'Jewish Regulations' laid down by the Swedish parliament in 1882, regulating immigration and settlement of Jews in Sweden. Oscar Landahl, member and head of propaganda for the Nazi National Socialist workers Party (NSAP), treated the 'Jewish question' in 1936 and listed Elsa and other Jews at Uppsala University, noting that others, like Carl Wiman, had Jewish family ties. Landahl wrote: "This is not to question their professional competence, but rather to prove that Sweden is ruled by a foreign people" [translated from Swedish].

Elsa also had an academic battle, reflecting the attitude towards Swedish Jews, fought with the nomenclature of fossils. In her dissertation she names the trilobites *Isbergia planifrons* and *Isbergia parvula* for the palaeontologist Orvar Isberg from Scania (subsequently a lecturer in Bromma). Translated from Latin the names mean 'the low browed Isberg' and 'the insignificant Isberg'. Isberg was far right-wing politically and a member of the pro-Nazi party 'Swedish Opposition'. In 1934 Isberg defended his dissertation at Stockholm University on bivalves from the same deposits as Elsas's trilobites. Isberg shot back at Elsa and named species after Warburg: *Warburgia crassa*, *Warburgia lata* and *Warburgia*? *oviformis*, where the names meant 'the broad/fat/round' Warburg, all jibes at Elsa's appearance. A fourth was *Warburgia iniqua*, meaning 'the hostile Warburg'.

The fact that Elsa was Jewish may have played a role in the evaluation of applicants for the professorship after Wiman. One committee member was Othenio Abel (Professor of Palaeontology in Vienna), a well-known antisemite, and his harsh statements judging Elsa Warburg's scientific work as merely mediocre seem to be coloured by his hostile attitude towards Jews. Both Elsa Warburg and Carl Wiman deemed the criticism as unjustified (Uppsala universitet 1932).

Later years and legacy

During the Second World War, Elsa was active in the Uppsala Student Union's Women's Emergency Committee[6], contributing towards Christmas relief presents for Norwegian children. From the 1930s onwards, Elsa was responsible for teaching and served as the head of department in several stints up until 1950. The first instance was when Erik Stensiö, professor after Wiman (1933–1935), resigned to take a post at the Natural History Museum in Stockholm. Following Stensiö, Gunnar Säve-Söderbergh was awarded the professorship in 1937, he too being a student of Wiman's. Tragically, he fell ill with tuberculosis and died in 1948. Elsa acted as head of department until Per Thorslund became professor in 1950 (he too had been one of Wiman's students).

Elsa during fieldwork in Närke, central Sweden, with the geologist Anton Westergård(?), autumn 1940. Reproduced with the kind permission of Museum of Evolution, Uppsala University.

Elsa did, however, receive recognition for her efforts within and outside of academia. She became an honorary member of the Natural Science Student Society in Uppsala[7], and in 1951, two years before her death, she was awarded the Swedish Royal Gold Medal *Ilis quorum* for her substantial contributions to cultural, scientific and other welfare causes[8]. 'Elsa Valley' in East Greenland was named after her by Säve-Söderbergh.

[6] *Uppsala Nya Tidning* newspaper report 22/02/1940.
[7] *Uppsala Nya Tidning* newspaper report 24/04/1948.
[8] *Uppsala Nya Tidning* newspaper report 06/06/1951.

Elsa's fossil collections remain in Uppsala, managed by the Museum of Evolution at Uppsala University, and are a vital scientific legacy. Another part of her legacy lies in her work as an academic during a time when the expectations on women were very different compared to today. However, Elsa's ambition and drive are most likely something many can recognize, at the same time as conflict between career and family persists, as it did then. Elsa never started a family of her own but was an important role model for many young women in Uppsala's academic sphere. She was part of a group of progressive female academics who, among other things, worked for women´s political suffrage. Elsa may have had a limited impact on the scientific sphere of the day but, without doubt, played a significant role in the female academic world, where she and other eminent women of her day paved the way for today's women in research and academia.

Anette E. S. Högström and **Jan Ove R. Ebbestad**
Museum of Evolution, Uppsala University, Sweden

FURTHER READING

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Introducing the Palaeoverse IV: temporal and geographic ranges

Welcome back to our series 'Introducing the Palaeoverse'. Last time, we covered how to efficiently, and reproducibly, estimate the *in vivo* geographic location of extinct organisms (*i.e.* palaeorotation) and spatially bin their distribution using functions from the *palaeoverse* R package. In this article, we'll look at how to quantify the temporal and geographic ranges of fossil taxa.

Setting the stage

Now that we've learned how to estimate the palaeogeography and chronology of individual fossil occurrences, we can combine available occurrences for individual taxa to estimate their temporal and/or geographic range. For this tutorial, we'll continue using the tetrapods dataset that is included with the *palaeoverse* package. We'll use this dataset to study two questions: 'Which tetrapods survived across the Carboniferous–Permian boundary?' and 'How did the geographic range size of tetrapods shift across the Carboniferous and Permian?'

Temporal ranges

The temporal range of a taxon is the stretch of time from when it first originated to when it finally went extinct. However, given the incompleteness of the fossil record, it is very improbable that we will ever find the first or last individual that ever existed (Strauss and Sadler 1989). Therefore, in practice, the temporal range of a taxon stretches from the oldest fossil (termed the FAD, or First Appearance Datum) to the youngest fossil (termed the LAD, or Last Appearance Datum). There are various ways to estimate the true origination and extinction ages of a taxon (and to use those estimates to determine whether a set of taxa originated or went extinct at roughly the same time), but we'll have to save that topic for a future tutorial (Wang and Marshall 2016).

Given a dataframe of occurrences (like in the `tetrapods` dataset), you can calculate the temporal ranges of all taxa in the dataframe with the `tax_range_time()` function of palaeoverse. Here the dataframe columns match the column names that are expected by the function, so we don't need to do anything other than supply the dataframe and specify which column represents the taxonomic resolution that we want to use (in this case we'll use genera).

```
library(palaeoverse)
# Filter out occurrences without an assigned genus
occdf <- subset(tetrapods, !is.na(genus) & genus != "NO_GENUS_SPEC'D")
# Calculate temporal ranges of genera
ranges <- tax_range_time(occdf = occdf, name = "genus")
# Get number of genera
nrow(ranges)
[1] 1005
# Print out the first 6 genera
head(ranges)
           taxon taxon_id max_ma min_ma range_myr n_occ
1    Aetosauripus        1  251.2  247.2         4     1
2 Augustaburiania        2  251.2  247.2         4     2
3    Bathignathus        3  251.2  247.2         4     1
4     Beishanodon        4  251.2  247.2         4     1
5      Boreopelta        5  251.2  247.2         4     1
6     Boreopricea        6  251.2  247.2         4     2
```

Here we've printed out the first six genera alphabetically (of 1,005 total genera) and their calculated FADs (`max_ma`), LADs (`min_ma`), temporal range (*i.e.* duration) in millions of years (`range_myr`), and the number of occurrences that were in the original dataframe and contributed to these calculations (`n_occ`). In this case, the first six genera all have the same temporal range size, but note that many of them are only represented by a single occurrence, so these ranges may be unreliable.

Now that we understand how temporal ranges are calculated, we can move on to answering our question at hand: which tetrapods survived across the Carboniferous–Permian boundary? For this question we will switch to using tetrapod orders. First, we'll remove occurrences without a specified order. Then, we'll convert our `class` column to a factor so we can order the classes in the plot. Finally, we'll use the same `tax_range_time()` function to calculate the ranges; this time we'll also plot (`plot = TRUE`) the ranges to visualize which orders cross the Carboniferous–Permian boundary (Figure 1).

```
# Filter out occurrences without an assigned order
occdf <- subset(tetrapods, !is.na(order) & order != "NO_ORDER_SPEC'D")
# Control plotting order of groups
occdf$class <- factor(x = occdf$class,
                      levels = c("Reptilia", "Osteichthyes"))
# Make plot of order ranges (grouped by tax.classes) with custom title
ranges <- tax_range_time(occdf = occdf, name = "order",
                         group = "class", plot = TRUE,
                         plot_args = list(
                           main = "Temporal ranges of tetrapod orders"
                         ))
```

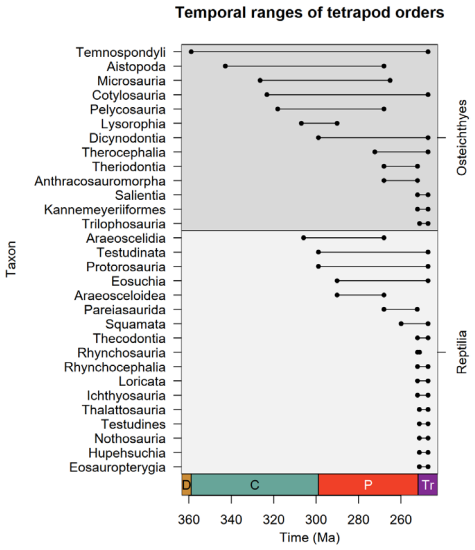

Figure 1. The temporal ranges of various tetrapod orders across the late Devonian, Carboniferous, Permian, and early Triassic.

Here we can see that according to our dataset, six orders assigned to the Osteichthyes class cross the Carboniferous–Permian boundary: Temnospondyli (primitive amphibians such as *Eryops*), Aistopoda, Microsauria, Cotylosauria (*e.g. Dimetrodon*), Pelycosauria and Lysorophia. For Reptilia, only three orders evolved prior to the Permian and crossed the Carboniferous–Permian boundary: Araeoscelidia, Testudinata (turtles and relatives) and Protorosauria. It should be noted that the taxonomy and phylogeny of these groups is constantly in flux (Jenkins *et al.* 2025), but this gives us an idea of the biological diversity and turnover across the Carboniferous–Permian boundary.

A note on 'ghost ranges'

As noted above, we almost never have the first and last occurrences of a taxon (in time or space). However, the same premise leads to having gaps between LADs and FADs for most taxa (often termed 'ghost ranges', coined by Norell in 1992). The tetrapod fossil record is notably sparse in the Palaeozoic (*e.g.* Romer's Gap; Coates and Clack 1995). Taxa with large gaps in their fossil record are termed 'Lazarus taxa' for their apparent extinctions and 'resurrections' (Wignall and Benton 1999). A well known Lazarus taxon is the coelacanth, which was thought to have gone extinct at the K–Pg boundary but was then discovered in the deep sea in 1938. However, we know that such taxa must have persisted somewhere on Earth from their FAD to their LAD. The *palaeoverse* package has the `tax_expand_time()` function for generating a dataset consisting of interval-level pseudo-occurrences where an occurrence is created for each interval between the FAD and LAD (also known as 'range-through').

We can take our output from the above `tax_range_time()` call and pass it through `tax_expand_time()` to get pseudo-occurrences for our orders across the Carboniferous and Permian. We can then use these pseudo-occurrences to calculate the order-level taxonomic richness through time (Figure 2).

```
pseudos <- tax_expand_time(ranges)
order_rich <- group_apply(pseudos, c("mid_ma"), nrow)
plot(order_rich$mid_ma, order_rich$nrow, xaxt="n", type="b", pch=20,
     xlim = c(358.90, 251.902), xlab = "Time (Ma)",
     ylab = "Tetrapod order rangethrough richness")
axis_geo(side = 1, intervals = "periods")
```

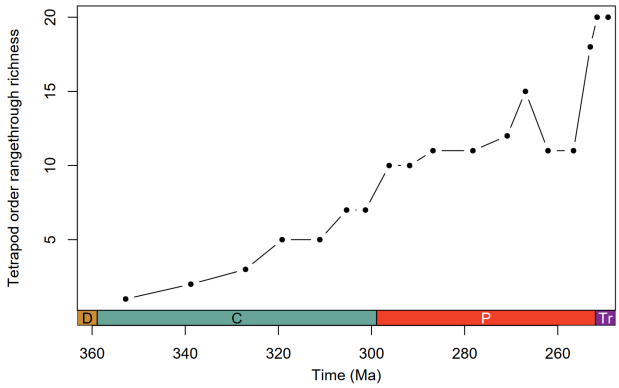

Figure 2. Tetrapod order richness across the Carboniferous and Permian using the range-through method. Richness is calculated at the stage level.

Geographic ranges

The geographic range of a taxon is its spatial extent during a particular time interval. Like temporal ranges, geographic ranges are notoriously fragmentary, which has led to many different ways to estimate them to address different research questions (Darroch *et al.* 2020; Antell *et al.* 2024). Here we'll use the method 'con', which calculates the convex hull of the occurrences in km^2. Let's take a look at how the geographic ranges of our two major classes of tetrapods changed across the Carboniferous and Permian. We'll first need to bin our occurrences in time and then palaeorotate them (see the previous tutorials on Time and Spatial Binning). Then we'll calculate the geographic ranges and plot them through time (Figure 3).

```
bins <- time_bins()
maj_tetrapods <- bin_time(occdf = tetrapods, bins = bins, method = 'majority')
maj_tetrapods <- palaeorotate(occdf = maj_tetrapods, age = "bin_midpoint",
                              method = "point", model = "PALEOMAP")
space_tetrapods <- subset(maj_tetrapods, !is.na(genus) & !is.na(p_lat))

# Find temporal range of each class for each interval
space_tetrapods <- group_apply(occdf = space_tetrapods,
                               group = c("bin_midpoint"),
                               fun = tax_range_space, name = "class",
                               lng = "p_lng", lat = "p_lat", method = "con")
space_ost <- subset(space_tetrapods, taxon == "Osteichthyes")
space_rep <- subset(space_tetrapods, taxon == "Reptilia")
plot(space_ost$bin_midpoint, space_ost$area, col = "#1B9E77", xaxt = "n",
     type = "b", pch = 20, xlim = c(358.90, 251.902), xlab = "Time (Ma)",
     ylab = expression("Range size of tetrapod classes (km"^2*")"))
points(space_rep$bin_midpoint, space_rep$area, col = "#D95F02", xaxt = "n",
       type = "b", pch = 20)
axis_geo(side = 1, intervals = "periods")
legend("topleft", legend = c("Osteichthyes", "Reptilia"),
       col = c("#1B9E77", "#D95F02"), pch = 20, bty = "n")
```

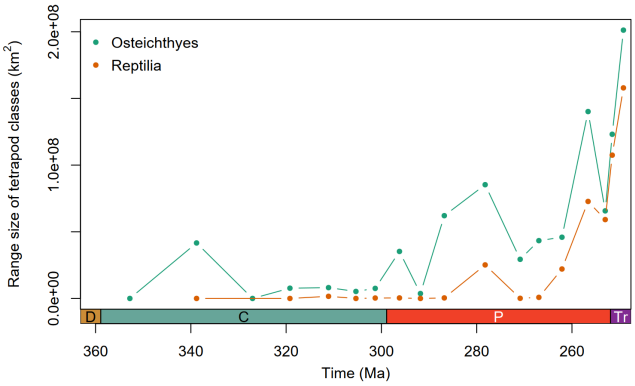

Figure 3. The range sizes of Osteichthyes (green) and Reptilia (orange) through the Carboniferous and Permian. The range sizes are calculated based on the occurrences that exist from each stage.

You can see that the geographic ranges of these two classes were fairly limited for most of the Carboniferous (including many cases where the range size is at or near zero due to there being only one or a small number of occurrences), but they both increased in range size quite dramatically over the course of the Permian. This trend partly mirrors the increase in taxonomic richness that we found above (Figure 2), but the increase in geographic range in the Permian is greater than the taxonomic increase. Perhaps analyzing the range sizes or taxonomic richness of lower taxonomic levels would provide further insight, but we'll leave that for you to investigate.

Also, we've used the 'con' method here, but `tax_range_space()` also supports three other commonly applied approaches (Darroch *et al.* 2020). The 'lat' method calculates the palaeolatitudinal range (in degrees) of a taxon, as the difference between the maximum and minimum latitudinal occurrence. The 'gcd' method calculates the maximum Great Circle Distance (the shortest distance between two points on the surface of a sphere) between pairwise occurrences for each taxon. Finally, the 'occ' method calculates the number and proportion of occupied equal-area grid cells using Uber's H3 library, a geospatial indexing system that partitions the world into hexagonal cells of a user-specified size. Other approaches that can be applied in palaeontology include subsampling and minimum-spanning trees, which are implemented in the *divvy* R package (Antell *et al.* 2024).

Wrap up

That's it for this issue's article, but if you want a more complete guide to running these analyses, the Palaeoverse team have written several vignettes, available on the package website (at <**https://palaeoverse.palaeoverse.org**>), that cover ranges and other functionalities. There's also detailed information about all the functions included here in their documentation, which can be accessed in R by including a '?' before the function name (*e.g.*, `?tax_range_time()`. That's all for now on temporal and geographic ranges. See you next time!

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On behalf of the Palaeoverse Team

Details of the Palaeoverse, the R packages we maintain, resources, and our other activities are available at <**palaeoverse.org**>. Our Github can be found at <**github.com/palaeoverse**> and the CRAN Task View for Palaeontology at <**cran.r-project.org/web/views/Paleontology.html**>.

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Behind the Scenes at the Museum

DIY Devonian Diorama: behind the scenes of a new temporary exhibition

In the 1930s, Leonard Wills (1884–1979) pioneered the study of Palaeozoic fossil fish in the Midlands of England and the Welsh borders. His treasure trove of specimens, as well as detailed archives of his research, are held in the Lapworth Museum of Geology, University of Birmingham, UK. Almost 100 years later, the next generation of palaeontologists at the University of Birmingham are re-examining these strange jawless fish and – now aided by computed tomography (CT) – have been able to learn so much more about jawless fish anatomy and ecology. This project inspired the latest temporary exhibition at the Lapworth Museum and it has gone down as one of the Museum's most successful installations. First debuted at the Society of Vertebrate Palaeontology's 2025 Annual Meeting at the University of Birmingham and now coming to a close, we bring you a little insight into how it was made.

The *Feeding without Jaws* temporary exhibition is a traditional diorama but features some models designed using information from CT imaging of fossils. With it we aimed to popularize the research of a team from the University of Birmingham and the Natural History Museum, London, including Ivan Sansom, Sam Giles, Stephan Lautenschlager, Zerina Johanson, Andy Jones, Emma Randle and postdocs Richard Dearden, Agnese Lanzetti and Lisa Schnetz, funded by a Leverhulme Trust Research Project Grant.

The diorama depicts a generalized Devonian near-shore environment inhabited by a cast of colourful Palaeozoic fish from different places and times, focusing on the jawless heterostracans. In the foreground, striking blue *Pterapis* patrol close to the ground, weaving between simple plants. Above them, *Doryaspis* and *Rhinopteraspis* gather in the open water. In the background, *Tiktaalik* – a jawed invader – has burst into this peaceful scene, sending a shoal of tiny *Anglaspis*

scattering in panic! All the while the docile gentle giant, *Drepanaspis*, rests nearby. Each model heterostracan has a matching fossil specimen in the glass cabinets that surround the display, as well as a small 'aquarium-style' information panel. The exhibit also features some modern specimens; an enormous preserved American paddlefish, the fearsome jaw bones of a tigerfish, a taxidermied piranha and a pickled lamprey give some context for the diversity of feeding methods in modern jawed and jawless fish. Opposite the diorama is a wall of panels detailing the rise and eventual decline of jawless fish, as well as the different feeding methods that have been hypothesized for them over the years.

Figure 1. The diorama in its final form. Photo courtesy of Jake Atterby/Lapworth Museum of Geology.

Of the five heterostracan species featured in the diorama, we created the models of *Anglaspis*, *Rhinopteraspis* and *Doryaspis*, directly informed by new CT data. With each fossil coming from a different locality with a unique preservation, each of these fish posed individual challenges to get them exhibition-ready, with CT data having to be retrodeformed (*i.e.* digitally uncrushed and re-assembled) to create representative 3D models.

- At no more than 5 cm in length, *Anglaspis* is the smallest heterostracan on display. It began its retrodeformation journey as a dorso-ventrally flattened specimen preserving the head region only. Although crushed, the deformation was limited to brittle fractures and mild disarticulation which, though fragmented, retained the specimen's original morphology. Combining these data with a second specimen which preserved the tail and some mirrored elements, *Anglaspis* could be pieced together as a full reconstruction. More than 60 *Anglaspis* models live in the diorama, in reference to Wills' theory that they lived in large shoals.

- *Rhinopteraspis*, a larger pteraspid cruiser hailing from Odenspiel in Germany, was also severely crushed with a dose of mediolateral shear and some ductile folding to the ventral

shield. While it can be difficult to objectively gauge the degree to which ductile deformation has affected morphology, there was enough non-deformed material to correct the distorted elements. As a pteraspid, the retrodeformed head was digitally grafted to a 3D scanned plaster *Pteraspis* model made by Vernon Edwards in the 1930s. This model was then digitally sculpted with reference to fossil material to reflect the unique features of *Rhinopteraspis*, like the extreme elongation of its body, dorsal spine and tail.

Figure 2. Piscine protagonists: from left to right, models of heterostracans Pteraspis*,* Anglaspis*, and* Rhinopteraspis*. Photo courtesy of Jake Atterby/Lapworth Museum of Geology.*

- *Doryaspis* makes up for its small size with an excess of bizarre features: a funnel-shaped oral aperture, a long sword-like under-'bite' and rigid downturned 'wings'. Being heavily ventrally abraded and slightly dorsoventrally crushed, this specimen required careful rearticulation. The missing morphology was substituted with a simplified fluid dynamic model from Botella *et al.* (2024). This model was then digitally sculpted to add plates, scales and branchial openings *etc*., based on images of articulated fossils and resulting in a unique life reconstruction.

- The large, frying pan-shaped *Drepanaspis* was not CT-scanned; however its respective Vernon Edwards plaster model was 3D light-scanned and also digitally sculpted to reflect an updated understanding of its oral anatomy and general body-shape. While the other heterostracans were 3D printed with a resin printer, the hefty *Drepanaspis* was so big it had to be printed in five sections on a more specialized fused deposition modelling printer by the engineering college!

- *Pteraspis*, the classic heterostracan poster child, was the easiest reconstruction of all. This was simply the 3D scanned Edwards model reposed and repainted. We took advantage of some 3D printing errors on one specimen to give it damage to its bony carapace for which there is evidence from the fossil record, perhaps from a hungry eurypterid!

- Finally, the ever-adorable *Tiktaalik* and largest model in the exhibition was built in 2024 and was the Museum's first major foray into 3D-printed replicas. *Tiktaalik* had already entertained tens of thousands of guests as a 'roaming' exhibit before finally finding a home in the diorama.

Each model was hand-painted by a production line of PhD students and postdocs in the department at Birmingham, following colour schemes designed by palaeoartist and illustrator Andy Frazer (<**https://www.andyfrazer.com/**>) and using a combination of aerosols, acrylic paints and even Warhammer paint. Delightfully, this means some of the fish are painted in such diverse colours as 'Skavenblight Dinge', 'Flayed One Flesh' and 'Blood for the Blood God'.

The diorama sits on a large custom-built table. The landscape comprises some surprising stratigraphy; we used mounds of excess recycling, chicken-wire, *papier-mâché* and drywall plaster

to form the undulating terrain. Before the whole scene was buried in sand, small blocks of floral foam were added to hold the stands and wire for the model fish, as well as a few pebbles and cardboard stems of generic plants. The best dioramas also feature a painted backdrop, extending the scene into the far distance. Fortunately, the Museum has a long history of collaboration with the art department of our neighbour, the King Edward VI High School for Girls. Ten incredibly talented year 11-12 pupils produced the enormous backdrop as part of their final year projects. Finally, the diorama is held in place by a retaining wall of display cabinets and plinths, featuring specimens of fossil fish seen in the diorama. Also on display are Wills' original notes and plates alongside modern interpretations, including from recent work led by Lisa Schnetz and the rest of the team at Birmingham.

Figure 3. Building the diorama: left, constructing the seafloor from papier-mâché and sand; right, putting up the diorama backdrop. Photos courtesy of Jake Atterby/Richard Dearden/Lapworth Museum of Geology.

This is the Lapworth Museum's first venture in diorama building, and is hopefully not the last! The *Feeding without Jaws* diorama has proven to be an excellent means of engaging the public in a relatively obscure topic. We found that a diorama offers the chance for instantaneous storytelling. Without reading a single panel, visitors are immediately aware they're visiting a world inhabited by creatures that are unlike anything around today. This prompts the audience to begin exploring the exhibition more thoroughly, as they seek an explanation to these bizarre creatures. Most importantly, the exhibition not only explains what scientists now know about jawless fish, but how scientists have come to make these realizations and who was responsible, both in years gone by and at the present day. The exhibition was only possible thanks to the department's combined talents in tomography, virtual sculpting, exhibition design, writing, painting and construction, of which this exhibition is an excellent showcase. *Feeding without Jaws* will be wrapping up in March; however, a virtual version of the exhibition accessible from anywhere in the world is in the works, so stay tuned!

Jake Atterby and **Andy Jones**
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Careers Q & A

Professional palaeontologists in the wider world: David Nicholson

Dr David Nicholson was born in Taiwan in the 1980s and moved to Scotland when he was eight years old, giving him a unique accent. He studied Palaeobiology and Evolution at the University of Portsmouth in England, then began a PhD on the deep time biodiversity of insects at the University of York in partnership with the Natural History Museum, London (NHM; via a nine-month stint in the NHM giftshop). He went on to a postdoc project on palaeodiversity of turtles at the NHM before leaving academia for a career as a government statistician. He has so far worked for the Home Office on fire statistics, the Department for Education on COVID-19 in the university sector during the worst of the pandemic, then on to the Scottish Government for a less stressful position working with the schools census.

Photo courtesy of David Nicholson (the hairy beast on the right).

When you were a child, what did you want to become when you grew up?

A palaeontologist, of course! Actually I was highly fixated on volcanoes for a long time. I must've drawn hundreds of them. One time, I taped together about 20 sheets of paper so I could draw a vertical pillar of lava coming out of a volcano that reached across the whole room. My mother was mortified as she was convinced volcanology was a very dangerous career choice!

How did you first get interested in palaeontology?

Two of my favourite memories from Taiwan are of all the incredible insects I would see in the garden (huge butterflies, mantids, incredible beetles *etc.*) and visiting large ornamental lakes absolutely stuffed full of terrapins that would gather near the edges and under footbridges to be fed. So it's a nice echo that I was able to work on both of those groups during my time as an academic. After we moved back to the UK, it's pretty standard stuff. David Attenborough documentaries kept me excited about nature generally and *Jurassic Park* got me thinking about fossils. I think those two things would turn up in the answers from most of my generation of palaeontologists!

What was the biggest highlight of your work as a palaeontologist?

The opportunities for travel were amazing. Particular highlights were doing fieldwork with Andy Ross and Nick Fraser at the Triassic Solite Quarry in Virginia, USA, a visit to the University of California Museum of Paleontology, USA, to work with Pat Holroyd, and going to a conference in Beijing in China. Closer to home, getting to spend so much time at the NHM in London was such a privilege. I never let myself take that magnificent building for granted each time I walked into it. It's where I met my wife and made life-long friends. Handing in my pass on my final day and walking away forever felt like a bereavement.

How did you make the transition from a PhD to your career outside academia?
I was exceptionally lucky to get a postdoc position with Paul Barrett at the NHM after my PhD. Most people at that career stage have to move city or even country to chase the few available contracts, so I'm forever grateful to Paul that I was able to stay in my settled life in London with my fiancée. By the time that contract ended, I was married with a second child on the way. I applied for a few grants but didn't get anywhere and the financial realities of life meant that I had to give up and look for permanent employment elsewhere in London. I got in touch with Mark Bell, who I knew had moved from doing very similar work to me and gone into the civil service, in the Government Statistical Service. He helped guide me through the application process and I was successful at interview. I was placed in the Home Office as part of the team producing national fire statistics. It's now a pretty well-worn career path as I can think of at least four other palaeontologists who have moved into civil service analyst jobs just from my narrow circle of contacts!

What does your job involve on a daily basis?
It can be highly variable and reactive, just depending on what's going on at that moment. There's our usual statistical publication schedule, so there's always work going on with that but at any moment you might have to drop everything and help write an answer to an urgent question for parliament, or contribute to briefing for politicians, or answer media queries. Sometimes you've got your work week all planned out and the whole thing gets derailed by a Freedom of Information request that lands on your desk.

Can you tell me more about your current role, and what its significance is?
I'm part of the team responsible for the school, staff and pupil census in the Scottish Government. I lead on the gathering, quality assurance and publication of the teacher data, as well as teacher workforce planning modelling. It sounds like it should be simple enough to just count the teachers but there's a lot of nuance to how it's done. It's important to have accurate information on pupil and teacher numbers for funding allocations and long-term planning of public services.

What gives you the most satisfaction in your current work, and what do you not enjoy so much?
My education was funded by the public and now I return that favour through working for the public. It can be exciting (erm…to a given definition of 'exciting') to hear things I've written being read out in Parliament. For anyone who enjoys politics, it can be fun (again, to a given definition) to see the inner workings of government. However, there is a level of mundanity that I suppose comes with all jobs. Sometimes it can feel like you're just turning the crank and producing a straight update of what came before and nothing much changes. If I feel like that, I remind myself that it doesn't have to be exciting; the service exists to provide the factual basis on which our national services and public debate operate. That's a great thing to be contributing to on any given day.

Do you have any opportunity to still work in research areas of interest to you, or if not do you miss the 'hands on' aspect of being a palaeontologist?
Between a full-time job and raising three children, I don't have the time or energy to be even peripherally involved in research. (I barely found time to write this, with apologies to the editors for all the chasing up!) I follow a few scientists on BlueSky and enjoy hearing about new research but I never get much past reading an occasional abstract. I'd love to go to a PalAss conference again some time just for the fun of it, although I worry that I wouldn't know that many people there anymore!

Do you have any tips for anyone wishing to transition into a role like yours?
I remember being really afraid that I would fail, that I didn't have any of the skills needed. Mark helped me to see that academics have loads of skills that are in high demand: communicating to different audiences, giving presentations, complex analysis, managing projects and self-directed working. It was just a matter of seeing how to translate all of that in an application. So don't assume that your skills are too subject-specific.

If you could take a workplace habit from one field to the other, what would it be?
In academia, you generally get your name put on the work you produce. In the civil service, you're generally an anonymous government official by the time the public see anything you've produced. That's actually a good thing, of course, but it took a little getting used to at first. Another big difference is that academics have a duty to speak out publicly on their respective areas of expertise, while the civil service necessarily *must* be politically neutral. This doesn't actually answer the question and is just a long-winded way of saying that I miss being able to mouth off online.

Is there a skill you wish you had been taught at university that would be useful in industry? What turned out to not be useful at all?
PhD programmes these days (OK it's been a while but still modern times) are really good at making sure their candidates develop a range of transferable skills, so I have no complaints there. Perhaps the most striking difference between academia and the civil service is the speed of turnaround. In palaeontology we tend to work on larger projects that take time. We think big thoughts about big subjects, spanning hundreds of millions of years and applying an architecture of knowledge around geological time scales and the phylogenetic relationships of life without even really thinking about it. When I first started at the Home Office I became really aware of it – this framework which just sat there uselessly in my head while I had to divert thoughts around it (I realise how silly that looks now that I've written it, but it's how I felt at the time). I still have larger projects I work on over the course of months but a typical week will include several smaller pieces of work which have to be turned around very quickly.

What are your future ambitions?
Sorry to be dull but I don't really have any. I have my family, a decent income and a secure home. I'm happy. I suppose if I ever end up with more leisure time I would quite enjoy going down a 'prepper' rabbit hole, making sure that we're ready for the upcoming collapse of society[1]. Perhaps.

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[1] Ed: Always reassuring to hear from someone working for the government…

The rarity of fossils

Fossils are rare. It's what gives our profession its cachet and film-star glow. Our trade is in those few mortal remains that have made a singular escape from the planet's inexorable mill of decay and destruction. We raid the lost ark of primaeval life to find yet one more specimen for the museum, each one a near-miracle, a survivor against all the odds. The idea's widespread, as in that oft-quoted estimate that of all of the species that have ever lived, less than one-tenth of one percent has left even a single fossil[1].

When one comes to specifics, and grinds out the numbers on what is arguably the world's most avidly sought-after fossil – and moreover one with ever-so-fossilizeable large bones and sharp teeth, and preserved in superbly exposed near-horizontal strata in the badland terrain of the Hell Creek Formation, to boot – the impression persists of rarity, and just-occasional skeletal survival against the odds. Charles Marshall and colleagues published such an exercise in 2021 on *Tyrannosaurus rex*, extrapolating from the remains (mostly incomplete) of the 100 or so *T. rex* individuals clutched protectively in the hands of museums and private collectors.

How many of these eye-catching dinosaurs were there, they asked? Well, altogether in their modest patch of North America, a couple of million square kilometres or so, they calculated that perhaps two and a half billion individuals existed over the ~0.2 million years that they lived. Using that as a starting point they focused on the outcrop of the Hell Creek Formation, and there followed a great deal of numerical to-ing and fro-ing. The upshot was what they called a 'median per-individual preservation rate', there, of 1 in 16,000, with admittedly wide error bars (from 1 in 1,100 to 1 in 260,000).

Not much chance, then, for any immortality-seeking *T. rex* individual that might have wished to ultimately wind up in a museum, or gracing some Silicon Valley trillionaire's patio. For most similarly impressive terrestrial animals throughout geological time, similar statistics likely apply. But had our philosophically inclined *T. rex* thought this conundrum through, and looked more widely across the tree of life and its palaeontological possibilities, it might have wished to be reincarnated – as a coccolithophore.

This might result in a certain loss of status, if one takes personally one's position in the pecking order on the food chain. There is some distance, to be sure, between a five-ton reptilian carnivore and a microscopic marine alga. But ignoring mere size and trophic level, then a coccolithophore skeleton as revealed by a scanning electron microscope is not one whit less magnificent than a reassembled dinosaur[2] and, crucially, its component skeletal parts, the coccoliths – works of art in themselves – have found a mass-market route to palaeontological immortality. Mass? That of a single coccolith has been measured. The kitchen scales won't quite do, of course, so Celina Valença *et al.* (2024) tried no less than three methods: using an electron microscope to chart the volume of a single coccolith and combining that with its specific gravity to work out its weight; using a 'Coulter micro-sizer' which hinges on the way that water-suspended coccoliths disrupt electrical fields; and using a light-based 'bi-directional circular polarization' technique. Thankfully, all three gave much the same answer, which for the super-

[1] <**https://www.bbc.co.uk/future/article/20180215-how-does-fossilisation-happen**>.

[2] Those revealed by the photographic skill of Jeremy Young and colleagues (2005), for instance, could take a starring role in any surreal sci-fi fantasy.

abundant *Emiliana huxleyi* – a coccolith icon – usually turns out to be between two and three trillionths of a gram.

As classical chalk is generally made very largely of coccoliths, that suggests that a gram of it will contain tens of billions of individual fossil coccoliths – a very large mass by any measure. In standard chalk, hard and cemented, it's tricky to test this out by counting, though back in 1971 Donald Hattin and David Darko disaggregated some Cretaceous 'shaley chalk' and from the resultant muddy sludge calculated counts of up to 9 billion coccoliths per cm^3. Either way, it's enough to make a posterity-conscious *T. rex* gnash its considerable teeth and turn green with envy. The Cretaceous Chalk strata being both world-spanning and often reaching half a kilometre thick or more, that is an unconscionable amount of fossils. A coccolithophore living and dying in the Cretaceous seas clearly had a better than one in sixteen thousand chance of leaving its remains in the strata.

How much better? Our *T. rex*, rendered picky by sheer jealousy, might wish to point out that not *all* coccolithophores would be fossilized. It can be a long way from the sea surface to the sea floor and, for a finely bio-engineered assembly of calcite plates weighing two trillionths of a gram, a lot can happen on the way. Finding out quite what that might be has become something of a minor industry.

The most obvious hazard here is the water itself, to dissolve the coccolith into its component ions, as it begins to sink ever deeper. Olivier Sulpis and colleagues (2021) have investigated this trajectory at the present day, for all calcitic plankton, of which coccolithophores still form a large part. How big are the losses, and where do they occur? Their starting point was some 76 terramoles per year of calcite production by oceanic plankton, worldwide, each year. Innumerate as I am, I had to look up what terramoles were, scribbling some old-school sums with pencil on paper. A terramole is a trillion moles, or a trillion times the molecular weight, in grams, of some compound. Calcium carbonate – bless it! – has a molecular weight of almost exactly a hundred, so those terramoles translate into about 7.6 billion tons of this stuff, biologically crystallized. Hence the scientific industry around this question, because here we depart from amusing but inconsequential disputations about who wins the fossilization stakes, to try to get a handle on one of Earth's major chemical cycles. Our *T. rex* may at this stage be a little more miffed still, because this annual production sum exceeds, roughly five-fold, the biomass of all of the *T. rex* that ever lived… Size does turn out to be everything, but there's more than one way to measure it.

Of those 7.6 billion tons, about half dissolves in the water column, and part of the remainder then dissolves on the sea floor. Sulpis & co estimated a little over 1 billion tons gets finally buried each year, to start its long underground sojourn in the fossil realm. That suggests a survival rate better than one in ten for each individual coccolith – and, as there are quite a number of coccoliths on each organism, the chances of an individual coccolithophore being represented are better still. Fossilization has become almost the norm here, rather than a rare exception.

That happy state is despite the complicated – and frankly, undignified – journey that many coccoliths take to get to the sea floor. It's a journey, moreover, that explains a paradox, in which coccoliths begin to dissolve in the upper levels of the ocean waters, that are supersaturated in

calcite[3], even before they reach the deep, CO_2-charged corrosive waters where such dissolution is the norm. The answer to this paradox lies in the guts of the copepods and other zooplankton which graze mightily on the coccolithophores. These form tiny micro-environments that are acidic as well as digestive, so while the algal tissues are dismantled to be converted into copepod flesh, their calcitic skeletons also begin to be attacked in these low-pH stomach juices. Quite how this works was elegantly unpicked by Meredith White and colleagues (2021). Creating a microcosm of the ocean in their laboratory, they fed their captive copepods upon specially cultured coccolithophores: radiocarbon-rich, enabling the researchers to track what happens when the coccoliths come out the other end, in the copepods' faecal pellets. Keep a copepod hungry before it's fed, they found, and its juices will attack the coccoliths more fiercely, so that less emerges within the faecal pellets. A well-fed copepod's stomach, though, has its acid juices buffered by a surfeit of calcite, so the pellets come out richer in these nano-skeletons – and therefore heavier too, so that they sink through the seawater about twice as quickly. It's a nice insight into the intricacies governing the 'faecal express' by which most coccoliths arrive to the sea floor, to start their enviably successful journey into the fossil realm.

They're not alone, of course. The image of the young, athletic Charles Darwin of 1836 using a wooden 'leaping pole' to reach the sea-facing parts of the Cocos-Keeling atoll, one of his stopovers during the *Beagle* voyage, comes to mind here. His subsequent puzzling over these curiously ring-shaped coral structures led to his realization, described in his first book, *The Structure and Distribution of Coral Reefs* – that caused, incidentally, Charles Lyell to dance with delight – that these were the circular, living tips of mountains of coral, continuously subsiding as the island volcanoes on which they were anchored sank into the depths. The individual coral colonies on these fossil atoll-mountains have, like the coccoliths and unlike our poor *T. rex*, been dealt a very good hand.

Not a perfect hand, though, as with the coccoliths. Darwin's atoll hypothesis may have been celebrated most exuberantly by Lyell, but it wasn't welcomed everywhere. There was some heavyweight opposition. John Murray of the *Challenger* expedition, no less, argued for atolls having grown up from the sea floor, atop carbonate sandbanks. Likewise Alexander Agassiz – who, unlike his more famous father Louis, accepted Darwin's evolution theory – spent much time trying to demolish the atoll-as-subsiding-volcano model. It took more than a century for the truth to emerge, when the US military, mainly concerned with detonating 43 nuclear test bombs on Eniwetok atoll, nevertheless took the time to drill down through what was left, to test Darwin's then-still-controversial idea. It was an emphatic vindication[4]. They finally reached the volcano 1.2 kilometres down, representing 30 million years' worth of fossil coral accumulation. That's a lot of corals but, constrained by the rate of subsidence, these accumulated overall at less than half a centimetre a century. Corals unhindered by such constraints can grow several centimetres a year. This seems to result in the same kind of ballpark as the one-in-ten coccoliths.

Of more ancient fossils, I sometimes wonder, too, about the graptolites that I have struggled with, especially in the 'graptolite shales' in which the remains of these colonial zooplankton can abound. Are we seeing just a minuscule fraction, *à la T. rex*, of the original populations, as we collect those fossil-bearing slabs? Or, as with coccoliths, a goodly proportion of what was living

[3] Still, it seems, even despite the best efforts of the fossil fuel industries to change that state.

[4] The whole story, and more like it, are related by Mark Williams and me in the book *Skeletons* (OUP, 2018).

in that graptolite ecosystem? I cautiously suspect the latter. In those alien oceans with their widespread and prolonged bottom-water anoxia, just where else was there for a dead graptolite to go?

For the graptolite animals themselves, the tiny soft-bodied zooids, their fate was to be dissolved back into the ocean in a day or two, with a little help from decay-inducing bacteria. But the 'skeleton' – in reality, the collectively constructed colonial homes woven from the tough-as-old-boots scleroproteinaceous material that is the graptolite's 'periderm' – was harder to digest and dissolve. The mind's eye sees stages to its journey. Firstly sinking through the upper, sunlit ocean waters, inhabited by other zooplankton that might be tempted to have a nibble at these lumps of tough but presumably nutritious protein as they sink, although I'm not aware of much in the way of fossil nibble-marks on dead graptolites[5]. Then they would fall through deeper, anoxic waters, where there were no nibblers to pose any such threat. Next they would lie on a similarly anoxic, nibbler-free sea floor for what may have been decades, centuries or even longer (some graptolite shales accumulated *exceedingly* slowly), likely shrouded in marine snow and/or anaerobic microbial mats (Jones *et al.* 2002). This rather *grand guignol* setting seems not to have done the graptolites much, if any, damage. Finally there would follow slow burial, once enough sediment had drifted down to cover them. The graptolites we see in settings like this don't seem to be just the lucky few that hit the preservational jackpot. As with the coccoliths, it's more like a mass production line to taphonomic immortality.

It's another demonstration of how easy it is to become a fossil, if you're the right kind of animal in the right kind of place. It's something more for our rare celebrity, *T. rex*, to brood enviously on. What price posterity? Evolve to reach the top of the tree, and your mighty reputation can later be so easily scattered, Ozymandias-like, by those ever-shifting sands. But live a modest life among your modest neighbours on the lower branches of the tree of life, and there's hope of an eternal future. Not quite in heaven, perhaps – but not at all bad, as epitaphs in stone go.

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5 Rarely, fossil graptolites are found that have been folded, or crumpled into balls (Loydell *et al.* 1998), but not obviously partly digested; here the likely target for this rough treatment was the soft zooids and not the periderm.

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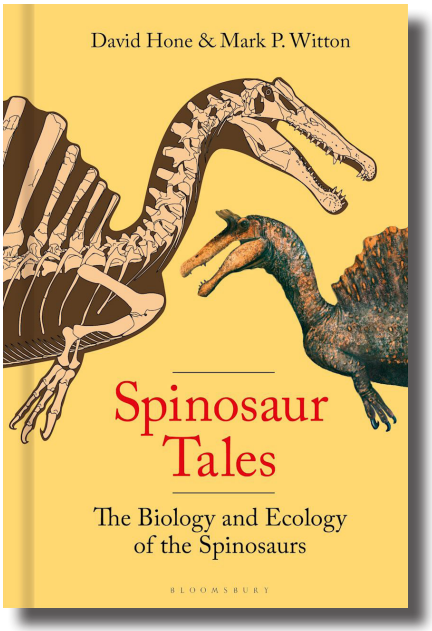
Ed: anyone wishing to celebrate a love of coccoliths, look no further than this wonderful coccolith costume! <**https://pml.ac.uk/news/ocean-warming-in-focus-at-royal-society-summer-sci/**>.

Reviews

Spinosaur Tales. The Biology and Ecology of the Spinosaurs [1]

David Hone and Mark P. Witton, 2025. 320 pp., Bloomsbury, ISBN 978-1-39941-2- 469.



Spinosaurid teeth were discovered in England, by Gideon Mantell, as early as the 1820s, but they (and similar ones from other parts of the world) were generally assigned to crocodiles. It was in 1915 that Ernst Stromer described the dinosaur *Spinosaurus aegyptiacus*, on the basis of a partial skeleton discovered during his expeditions to Egypt, and erected for it the family Spinosauridae. However, for most of the twentieth century, spinosaurs did not attract much attention among palaeontologists, let alone the general public. *Spinosaurus* was seen as a slightly odd dinosaur because of the tall sail along its back, formed by the elongate neural spines of the dorsal vertebrae, but otherwise it seemed to conform more or less to the traditional theropod body plan. This changed in the 1980s, when more spinosaurid material began to be discovered. The description of *Baryonyx walkeri*, from the Wealden of England, by Alan Charig and Angela Milner in 1986 (followed by their 1997 monograph) was a turning point because it revealed that spinosaurs, with their rather crocodile-like snouts, were indeed very unusual theropods. As new specimens kept turning up in various parts of the world, a flurry of scientific publications ensued, and eventually the media became aware of the fact that spinosaurs were a potential 'hot' topic that could generate considerable interest beyond scientific circles. This culminated in the appearance of *Spinosaurus* in the film *Jurassic Park III* in 2001. From then on, spinosaurs could rival tyrannosaurs as the most impressive and fascinating of all large carnivorous dinosaurs, at least in the eyes of dinosaur enthusiasts.

In that context, *Spinosaur Tales* by David Hone and Mark Witton is definitely timely. It is thankfully free from the hype and superlatives that mar too many publications about dinosaurs (including some research papers). Rather, it is a sober and well-researched review of our current knowledge of spinosaurs, covering practically all aspects of their evolutionary history, distribution in time and space, anatomy, palaeobiology and palaeoecology. The chapters about the adaptations and life habits of spinosaurs are especially valuable. There is little doubt that these dinosaurs fed largely (but not exclusively) on fish, as shown by their long and narrow jaws and crocodile-like teeth. In

[1] Ed: win a copy on page 110!

this context, it could have been mentioned that the first to argue that spinosaurs were fish-eating dinosaurs was the late Philippe Taquet in a 1984 paper that did not get the notice it deserved. He based his rather prescient conclusion on fragmentary elongate premaxillae (initially misidentified as dentaries) from Niger, two years before the description of *Baryonyx walkeri* eventually provided reliable information about spinosaurid cranial anatomy and dietary preferences. Taquet's interpretation of spinosaurs as foraging heron-like along streams is essentially that favoured by Hone and Witton, who reject recent reconstructions of *Spinosaurus* as a good swimmer spending a large part of its time pursuing its prey immersed in water. The anatomical and biomechanical reasons for that rejection are clearly put forward and convincing – and the warnings about putting too much faith in some specimens purchased from fossil dealers should be heeded.

Not surprisingly for a book co-authored by Mark Witton, *Spinosaur Tales* is well illustrated, with clear anatomical diagrams, line drawings and colour plates. Thankfully, unlike quite a few recent reconstructions by over-imaginative palaeoartists, Mark Witton's dinosaurs look like real animals, not like weird creatures out of a science-fiction pulp magazine. Spinosaurs were odd in some respects, but there is no point in making them look like aliens.

The book is generally well-written (despite the occasional 'large-bodied' where 'large' would be amply sufficient) and avoids technical jargon (or explains it when necessary), being aimed at the general public rather than experts. This does not mean that professional palaeontologists will not find it useful. It contains a wealth of up-to-date information about spinosaurids and for that reason it will serve experts as well as dinosaur fans as a valuable resource. One can only regret that the list of references, despite the fact that it takes up 16 pages, misses quite a few important papers (editorial restrictions on the number of pages may explain that). Curiously enough, although the names of authors who have contributed significantly to spinosaur research are mentioned in the historical chapter on the discovery of this group of dinosaurs, the protagonists of the recent controversies about spinosaur biology and especially their purported aquatic adaptations are not identified. This will not make it easy for the interested reader to look up the relevant papers, whether they are listed in the bibliography or not.

Although the information provided is generally up to date and reliable, a few inaccuracies can be detected, notably in the chapter about spinosaurid distribution. It is surprising, for instance, to read (p. 102) that France "has lots of teeth, jaws and other bits that have been referred to *Baryonyx*", when, to my knowledge, the only spinosaurid specimen hitherto reported from France is the single *Ostafrikasaurus*-like tooth from the latest Jurassic of Chassiron. As to Asia, the Chinese spinosaurid record is definitely better than what the book suggests: spinosaur teeth are quite abundant in the Lower Cretaceous Xinlong Formation of Guangxi Zhuang Autonomous Region, in southern China, as described in several papers.

Despite these minor criticisms, *Spinosaur Tales* successfully reviews our present knowledge of this unusual group of theropods and does so in a matter-of-fact way that pleasantly contrasts with the somewhat ebullient treatment of dinosaurs that too many books seem to favour. It will appeal to all readers who consider that dinosaurs, despite all their perceived oddities, should be taken seriously. The authors have clearly realized that unbridled enthusiasm does not combine well with good science and for that we can be grateful to them. They repeatedly emphasize that our knowledge of spinosaurs is still far from complete, because even the best available specimens are rather fragmentary, and they are well aware of the fact that new discoveries may well force

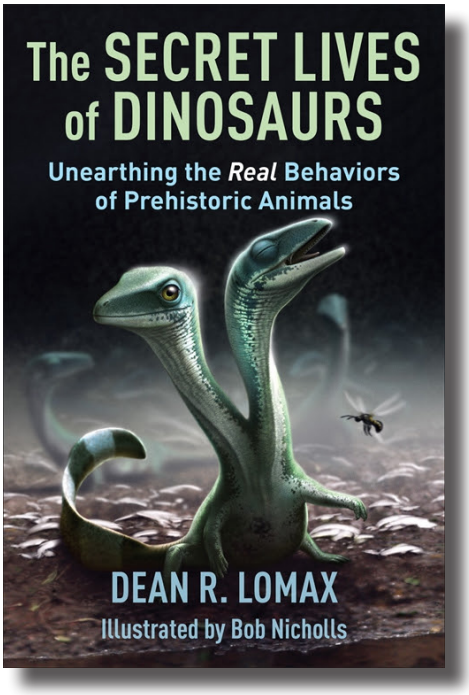
us to reconsider, perhaps rather profoundly, some of the conclusions presented in their book. This, however, applies to most palaeontology books, and *Spinosaur Tales* is a highly readable book summing up our present knowledge of this peculiar dinosaur group.

Eric Buffetaut

After retiring from the French National Centre for Scientific Research, Eric is now associated with the Paléospace museum in Villers-sur-mer, on the coast of his native Normandy. His main research interests are dinosaurs (both avian and non-avian) and the history of palaeontology.

The Secret Lives of Dinosaurs: Unearthing the *Real* Behaviors of Prehistoric Animals

Dean R. Lomax (illustrated by Robert Nicholls), 2025. 340 pp, Columbia University Press, ISBN 9780231558846.



In this book, the author successfully strikes a thoughtful balance between narrative storytelling and scientific content that is particularly appealing to readers interested in palaeontology. Opening with a childhood memory of the author's, the text gradually transitions into scientific detail. This narrative technique enhances the book's appeal while guiding the reader smoothly into more specialized concepts. The chapter structure is well organized, leading the reader step by step toward the scientific themes explored throughout the work.

The book consists of eleven chapters. The first chapter begins with a discussion of reproduction in various organisms, including millipedes and giant creatures such as *T. rex*. Chapter two examines the eggs of ammonites and *Diplocynodon*, a crocodilian species where mothers are thought to guard their nest and eggs until the very last moment. Chapters three and four focus on different forms of parental care in animals, based on fossil evidence ranging from prolonged post-birth care to hiding offspring in protective shelters. The narrative then turns to the world's largest dinosaur bonebeds, formed as the result of a catastrophic flood, and continues with discussions of swimming dinosaurs and crinoids.

Chapters five and six address wide-ranging topics such as autotomy (tail-shedding) in reptiles, nesting behaviours in crustaceans and amphibians, feeding strategies among members of the tyrannosauroid family, and the behaviour of killer whales. Chapter seven explores battles among dinosaurs and the more ancient and diverse group known as 'crocodyliforms', which includes

modern crocodiles along with remarkable and unusual ancient species dating back to the Late Triassic. This chapter also discusses the massive tail club of ankylosaurs, one of the most striking defensive weapons among armoured tetrapods, as well as combat in giant marine lizards. Chapter eight focuses on the epic confrontations between *Mosasaurus* and *Ichthyosaurus*, the so-called 'sea dragons.'

Chapter nine covers coprolites, tapeworms, beetles and herbivorous dinosaurs. Chapter ten turns to injury and pathology in dinosaurs, especially theropods, and compares them to birds and crocodiles. It also addresses tail-loss and regeneration in lizards, bite marks in vertebrates, and the structure of the vertebral column. Finally, Chapter eleven concludes with discussions of the 'death trace' of the horseshoe crab, Ice Age regeneration, and the search for two-headed fossils.

Taken together, these topics show how skilfully the author weaves precise scientific information into an engaging narrative, creating a rich and compelling reading experience for anyone fascinated by the world of palaeontology. The book offers remarkably comprehensive scientific coverage of behaviour in prehistoric animals, presenting topics such as fossils, reproductive stages, historical discoveries, and modern examples with well-documented references. The author enriches the narrative with unexpected and engaging examples, such as the weasel riding a woodpecker or the naming of the fossil (*Obamus*) which introduce a subtle layer of humour and playfulness, enhancing readability. The blend of science and wit, particularly in sections discussing crocodile coprolites and the analysis of a supposed fingerprint on one, not only adds to the scientific depth of the text but also sparks the reader's curiosity. The book's attention to dates, individuals and locations lends it an authoritative and reliable tone, while its ability to link fossil evidence to animal behaviour effectively illustrates how traits such as hunting, overfeeding or intraspecific combat can be reconstructed. Additionally, human-centred and emotionally resonant narratives such as crocodiles rescuing a puppy add warmth and appeal, elevating the work beyond a purely scientific account.

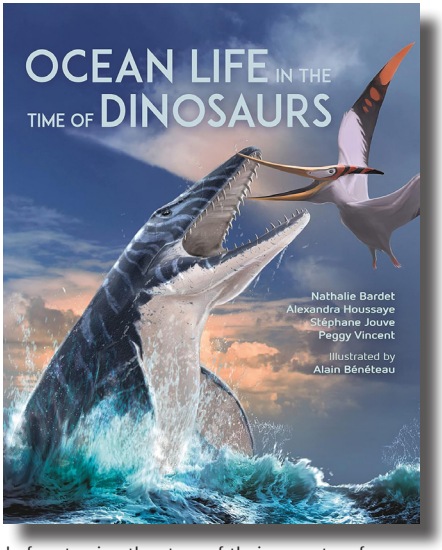
Despite the book's strong scientific value, the structure of some sections requires clarification. The boundary between the author's personal narratives and the scientific content is sometimes unclear, and the long paragraphs and complex sentences can exhaust the reader. Extended explanations of topics such as *Diplocynodon darwini* or ammonites, along with shifts in narrative tense, reduce the text's cohesion, and the repetition of certain information blurs the lines between evidence and hypothesis. In addition, the connections between sections are occasionally weak, and the use of humorous headings, the lack of precise citations and the introduction of technical terms without definition impact readability.

In conclusion, despite certain structural weaknesses, this book offers an engaging blend of personal narrative and scientific content that showcases the author's palaeontological expertise. While improvements in tone, section cohesion and scientific clarity could enhance the smoothness and consistency of the reading experience, the book's scholarly value and the author's narrative skill still make it a compelling and worthwhile read.

Kiana Kiarostami
Kiana has a PhD in stratigraphy and palaeontology, with a specialization in microfossils (foraminifera), and is active in both academic and petroleum industry sectors with a focus on fossil events of the Cretaceous period.

Ocean Life in the Time of Dinosaurs

Nathalie Bardet, Alexandra Houssaye, Stéphane Jouve and Peggy Vincent (illustrated by Alain Bénéteau), 2023. 208 pp, Princeton University Press, ISBN 0691243948.



When I first opened *Ocean Life in the Time of Dinosaurs*, I expected a beautifully illustrated popular science book – something light that offered a broad overview of Mesozoic marine reptiles. What I found instead was far more substantial. First published in French in 2021 as *La Mer au Temps des Dinosaures* by Belin/Humensis and translated into English by Mark Epstein for Princeton University Press in 2023, the book manages to combine real scientific depth with clear, engaging storytelling. Its greatest strength lies not only in its striking visuals but in how it traces the evolution of marine reptiles across geological time while keeping a strong narrative thread – something that will appeal to students, enthusiasts and professionals alike.

This book is organized chronologically, beginning with a concise overview of modern marine reptiles before tracing the story of their ancestors from the late Palaeozoic through the Triassic, Jurassic and Cretaceous to the early Cenozoic. Each period is explored through its characteristic fauna, key fossil localities and major environmental changes, leading readers through the ecological recovery that followed the end-Permian mass extinction, the rapid diversification of the Triassic seas, and the later evolutionary specializations that shaped the ocean ecosystems of the Jurassic and Cretaceous. The story is framed around a series of remarkable fossil sites, including Monte San Giorgio, Holzmaden and the Oxford Clay. Each one represents a distinct stage in the evolution of marine reptiles. This site-based approach gives the book a strong geological rhythm and ties the wider story of oceanic life to real places and discoveries.

Some of the most engaging chapters focus on these exceptional fossil localities. The Holzmaden deposits of southern Germany, for instance, are beautifully presented, not only for their exquisite preservation but also for what they reveal about ichthyosaur reproduction with a female *Stenopterygius* preserved with multiple embryos, one in the process of birth, used by the authors to demonstrate how viviparity evolved as a key adaptation for a fully aquatic life. The Monte San Giorgio section is equally strong, showing how the Anisian–Ladinian deposits capture the early Triassic recovery and diversification of marine reptiles. The Oxford Clay is treated as a window into the complex ecosystems of the Jurassic seas, with its wealth of invertebrates, ammonites and rare soft-tissue preservation of belemnites that hint at predator–prey relationships. In the Guanling deposits in China, the reader encounters the extraordinary *Atopodentatus unicus*, a Triassic marine reptile with a hammerhead-like skull and unusual herbivorous dentition, that is used to show how early reconstructions were corrected as new fossils came to light. For students like me, this emphasis on how scientific ideas evolve through evidence is one of the book's valuable lessons.

One of the book's greatest strengths is the way it combines text and imagery. Alain Bénéteau's palaeoart is both scientifically precise and visually immersive, avoiding the speculative excesses that sometimes appear in popular palaeoart, favouring anatomical realism, convincing musculature, and lighting that captures the sense of depth and motion in ancient seas. The pages are richly illustrated, with maps, fossil photographs, cladograms and anatomical diagrams. Far from feeling cluttered, these visuals reinforce the explanations in the text and make complex ideas easier to follow. Throughout the book, the main text is interspersed with thematic sections that act like short lectures on key topics in palaeobiology. Some are brief summaries, while others span several pages and combine clear diagrams with explanatory text. For instance, *Secrets of the Bone* explains how microanatomy and vascularization reveal patterns of growth, buoyancy and diving behaviour, while *Show Me Your Teeth* explores diet through enamel wear and jaw morphology. I found these inserts especially engaging because they connect the spectacular fossils to the analytical science behind their interpretation. Diagrams showing changes in tail and limb anatomy and bone density give an accessible introduction to functional morphological adaptation, with visuals that genuinely clarify the science rather than simply illustrating it. The inclusion of short contextual features on figures such as Georges Cuvier, Mary Anning and Alfred Wegener give the reader a sense of the historical development of palaeontological ideas, from the foundations of comparative anatomy to the exceptions of continental drift showing that the study of ancient life is as much about evolving ideas as about the fossils themselves.

The English edition reads smoothly and clearly throughout. Technical terms are used carefully and usually explained in context, making the text accessible to non-specialists while still precise enough for students and researchers. I was impressed by how well it balances scientific accuracy with readability, with the prose being engaging without ever becoming superficial.

If I have any criticisms, they are structural rather than scientific. The interspersed feature boxes can occasionally interrupt the flow of reading, but they also provide some of the book's most informative content. For instance, the section on the Chinese Guanling fossils is intercut with extended text boxes explaining swimming mechanics and underwater vision. However, these transitions also provide welcome pauses to absorb the underlying science, and for non-specialists they probably make the material more accessible. From an academic standpoint, the book's main limitation lies in its referencing. The bibliography, though substantial, leans heavily on sources from 2006 to 2019, with relatively little from the last few years. For a book translated into English in 2023, it would have been valuable to include references to more recent isotopic and modelling studies. More frustrating, particularly for students, is the lack of in-text citations. The narrative frequently mentions intriguing hypotheses but following up on these points requires independent searching; even a short list of key papers per chapter would have made this a much more valuable academic resource.

Despite these reservations, *Ocean Life in the Time of Dinosaurs* stands out as a superb synthesis that bridges palaeobiology and palaeoecology with clarity and imagination. As a palaeobiology student, I found *Ocean Life in the Time of Dinosaurs* both inspiring and academically relevant, capturing the dynamic interplay of adaptation, extinction and recovery that defined life in the oceans throughout the Mesozoic. In sum, this is an elegant and intellectually satisfying book: part atlas, part narrative, and part celebration of scientific discovery. Its blend of palaeontology and visual art is genuinely impressive, and its clarity of writing makes complex topics easy to follow without oversimplifying them. For students, educators and enthusiasts alike, it offers both inspiration and insight into life in the prehistoric seas.

Thomas Fox
Thomas is a third-year Ecology and Conservation undergraduate at the University of Reading, UK, specializing in vertebrate palaeobiology and palaeopathology. He recently worked as a research assistant at Dinosaur Provincial Park, Alberta, Canada, and is actively seeking an MRes in dinosaur palaeobiology with a future aim of a PhD in palaeontology.

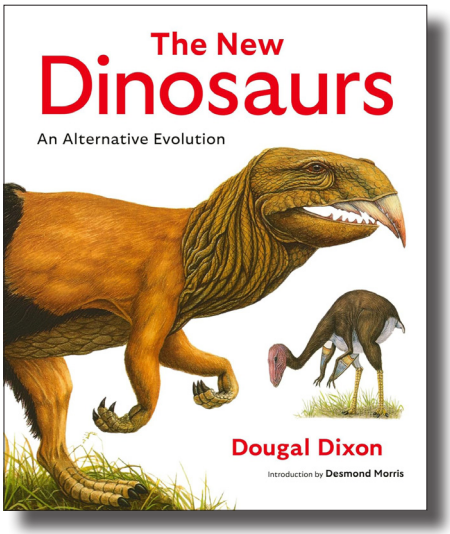
The New Dinosaurs: An Alternative Evolution

Dougal Dixon, 2025 edition. 128 pp., Breakdown Press. ISBN: 9781911081210.

Dougal Dixon may not be a familiar name to you, but for some readers around the age of 50 his work will need no introduction, and it may even be seared into your imagination. His hit book *After Man: A Zoology of the Future* was published in 1981. That lavishly illustrated book had a simple premise: if (when) humans go extinct, how do animals evolve over the next 50 million years? A new edition of that cult classic book was published in 2018, shortly followed by an updated fortieth anniversary edition. This is not a review of that book, but of the follow-up *The New Dinosaurs: An Alternative Evolution*, which has been updated and republished by Breakdown Press.

The New Dinosaurs was originally published in 1988, and was soon followed by *Man after Man: An Anthropology of the Future* in 1990. The three books are regarded as foundational within the field of speculative biology (a subgenre of science fiction employing the ideas of evolutionary biology and frequently involving the same principles used in palaeoart). Of the three books, *After Man* is the most well known. *Man After Man* is arguably the one which has spawned the most memes recognizable by the terminally online, even if their source is not. *The New Dinosaurs* is thus the least well known of the trilogy, although it's the one that on the face of it would seem to be the easiest sell to a mainstream audience: what if more dinosaurs had evolved?

The central idea of *The New Dinosaurs* is that the K–Pg meteorite did not hit the Earth, so the mass extinction event did not happen. It is life on Earth today that is presented, but from a different trouser-leg of time. In this new edition, Dixon has firmed up this notion with a new introduction, in which the book is presented as the report from a 1988 expedition to a parallel universe, and therefore primarily based on the knowledge available to them at that time. Another, more recent, expedition then indicated that the information presented about theropods needed revising. The updated sections throughout the book have been printed in an ever-so-slightly different font. Almost all of the beautiful illustrations are unaltered.



In line with the framing of a new expedition update, the scene-setting sections at the start of the book have been substantially rewritten. Where the old edition gave a range of possible extinction mechanisms for the K/Pg extinction event, the new version gives a good summary of our current understanding of the meteorite strike

and its global effects. Similarly, the section summarizing dinosaur evolution and phylogenetics has been given a thorough update, with a significant re-jigging of the theropod branch of the tree. The broad-brush 'carnosaurs' of the 1980s edition are now distinct groupings of coelurosaurs, carnosaurs *sensu stricto*, and with ceratosaurs giving rise to abelisaurs. Where the 1988 edition lacked any discussion of how birds fit into any of this (despite two bird species being described in the book), the new edition acknowledges their dinosaur ancestry and explains that the term 'dinosaur' is used as shorthand for 'non-avian dinosaur' throughout.

The principle driving the main body of the book is biogeography. The Earth is divided into 'realms', which map onto our modern continents, and which are subdivided into familiar biomes (after all, this is our Earth, just without the last major mass extinction). The (mostly) tetrapods of the Mesozoic era have evolved to inhabit our modern world, having adapted to the constraints of the different habitats in each biogeographic realm. As in *After Man*, the descriptions of these animals are presented in the style of a detailed naturalist's notebook. So, for example, in the Nearctic (North American) realm, we meet prairie sprintosaurs, evolved from hadrosaurs, which are prey to the northclaw, retro-engineered to be a therizinosaur in this new edition. Similarly, the mountain leaper *Montanus saltus* is now a shaggy-looking alvarezsaur, the forelimbs of which are no longer visible (and have been excised from the illustration in the 1988 edition – one of very few changes to artwork between editions). There are many tree-living arbrosaurs, descended from coelurosaurs, across the continents – and in the Nearctic woodlands the nauger has arrived at a very woodpecker-like way of being. In order to hammer home the point about ecology moulding adaptations, resulting in convergent evolution, Dixon adds: "If there were no dinosaurs living, it is possible their ecological niches would have been occupied by birds". Even with the substantial revisions, there are still reminders that the book was written in the 1980s and that conceptually, birds were much more distinct from dinosaurs than now.

It's not all dinosaurs. There's a plankton-sieving giant pliosaur, and flightless aquatic pterosaurs. There's even the lank, a four-metre-tall savannah-grazing pterosaur resembling a giraffe. I was vaguely surprised that there was no update to the text to make it into an azhdarchid descendant. I must admit to having a soft spot for the two invertebrates in the book: both ammonites, one a giant of the oceans, and the other undergoing the process of terrestrialization.

The afterword discusses the survival of the dinosaurs in popular culture, and features an essential *Jurassic Park* update. I was pleased to see that Dale Russell's dinosauroid still gets a shout-out and that the Silurians and Sea Devils of Doctor Who get a mention, if not by name.

This book will be of interest to different folks for different reasons. For fans of Dougal Dixon and speculative biology, it's great to revisit this work, and the retro-fitting of some of the theropods given progress in the field is pleasing. If speculative biology is not your thing, it will give you a snapshot of informed but popular vertebrate palaeobiology thinking in the 1980s. For anyone, I would argue that this book is tremendous fun, and does a great job of contriving a situation in order to make you think about evolution, biogeography and contingency in deep time.

Susannah Lydon
Susie is Associate Professor in Plant Science at the University of Nottingham, UK, where she teaches about plants, rocks, ecology and science communication. Her background is in Mesozoic palaeobotany. The overlap between palaeontology and science fiction interests her greatly. On Bluesky she is `@susieoftraken.bsky.social`.

Books available to review

We are commonly approached by publishers with books to review, and we are always looking for new reviewers. Any member of the Association is welcome to contribute a review, and our reviewers come from all career stages from students to emeritus professors. If you are interested in reviewing a specific book from the list below, have an idea for another book you would like to review, or would be interested in reviewing something but you don't know what, please drop an e-mail to Interim Newsletter Editor Richard Dearden at <**bookreview@palass.org**>.

Here are some suggestions for books we'd like to commission reviews for:

- **Journey through the Cenozoic: Tetrapod faunas 66 million years in the making** by William J Toosey.
  A beautifully illustrated guide to Cenozoic tetrapods, from gomphotheres to glyptodonts, and the environments and ecosystems they lived in.
- **The Oldest Rocks on Earth: A Search for the Origins of Our World**, by Simon Lamb.
  Find out how and when Earth became the blue planet it is today in this book delving back into our planet's 4.6 billion year history.
- **Discarded: How Technofossils Will Be Our Ultimate Legacy**, by Sarah Gabbott and Jan Zalasiewicz.
  You saw it in the PalAss Erlangen Annual Address, now read about it in this book applying a palaeontological eye to humankind's waste.
- **The Palaeontology and Geology of Shepherd's Gutter near Bramshaw in the New Forest**, by David C. Taylor
  The author's own collection of Middle Eocene fossils illustrate this book, great for anyone who fancies a spot of fossiling in southern England's beautiful New Forest.

We don't just publish book reviews! If there is something else that you think would be of interest to PalAss members and that you would like to review we would love to include it in the *Newsletter*. This could be a film, a podcast, a video game, an exhibition, or something else that Richard is insufficiently imaginative to think of. As above, please just get in touch at <**bookreview@palass.org**> where he is very happy to discuss ideas.

Richard P. Dearden
Interim Newsletter Editor

Reports

OBITUARIES

Yngve Grahn
1945 – 2025

Photo courtesy of P. Ahlberg.

Yngve Grahn, a distinguished micropalaeontologist and stratigrapher, passed away unexpectedly on 16th July 2025 at his home in Estepona, Spain, where he had resided for the past fifteen years. He was internationally recognized as a leading authority on chitinozoans and chitinozoan biostratigraphy. His prolific scientific output – comprising approximately 95 peer-reviewed papers, along with numerous abstracts, reports and other publications – reflects both the depth and breadth of his geological scholarship.

Born in Malmö, southern Sweden, Yngve spent his early years and completed his primary and secondary education there. After working for about twelve years in Malmö (1960–1972), primarily as a postal sorting clerk and newspaper distributor, he pursued supplementary studies before enrolling in geology at Lund University in 1972. He obtained his BSc degree from Lund University in 1976 and earned his PhD from Uppsala University in 1982. His doctoral research on the palaeobiology and biostratigraphy of Ordovician chitinozoans laid the foundation for a lifelong research focus that he would continue to expand on throughout his career. From the mid-1980s onwards, Yngve broadened his research to include Silurian and Devonian chitinozoans and their applications in biostratigraphy and stratigraphic correlation. Following completion of his PhD, he undertook a one-year post-doctoral fellowship at The Ohio State University, USA (1983–1984), where he conducted pioneering research on Ordovician and Silurian chitinozoans from the Appalachian region and the Cincinnati Region of Ohio and Kentucky.

In 1993, Yngve was appointed docent (Reader) in geology at Stockholm University. His trial lecture, entitled 'Ordovician and Silurian glaciations in northwest Gondwana', exemplified his ability to synthesize palaeontological, stratigraphic and palaeoclimatic data – an integrative perspective that characterized much of his scientific legacy. Yngve was employed by the Swedish Geological Survey (SGU) in Uppsala, first as Geologist (1977–1984), then as Senior Geologist (1984–1985), and subsequently as Principal State Geologist (1985–1989). During his tenure at SGU, he carried out palaeontological and stratigraphic research, managed the fossil collections, and contributed to the development of exhibitions. Although his years at SGU were productive, he eventually felt his work was not fully appreciated, and in 1988 he accepted a position in Rio de Janeiro, Brazil, as a consultant for Petrobras, the national oil company.

Yngve returned to Petrobras on several occasions, working there during four extended periods up to 2016. His work with the company included teaching specialized courses on organic-walled microfossils, conducting research on the pre-Carboniferous stratigraphy of Brazil, and developing considerable expertise in petroleum geology. Between 1997 and 2004, he also served as Visiting Professor at Universidade do Estado do Rio de Janeiro. During an extended interval between his appointments in Brazil, he returned to Sweden to work as a visiting researcher at Stockholm University and at the Swedish Museum of Natural History (1991–1992, 1995–1997). Between 1992 and 1995, he held the position of temporary curator at the Swedish Museum of Natural History, where he continued his palaeontological research and contributed to the study and curation of the Museum's extensive fossil collections.

Yngve's first scientific paper, published in 1978, dealt with chitinozoan stratigraphy and palaeoecology of the Ordovician–Silurian boundary beds of Scania (Skåne), southern Sweden. This study marked the beginning of a distinguished research career devoted largely to the study of Ordovician–Devonian chitinozoans. Over the following decades, he produced a substantial body of work on these microfossils from a wide range of regions across the globe, with publications on the subject continuing until 2011. The majority of these studies focused on the systematics, taxonomy and stratigraphic applications of chitinozoans, but Yngve also made notable contributions to understanding their ultrastructure, biological affinity, and palaeoecology – research that significantly advanced knowledge of this important group of organic-walled microfossils.

Following his relocation to Rio de Janeiro in 1988, Yngve became deeply engaged in research on the geology and stratigraphy of the Amazonas, Parnaíba and Paraná basins of Brazil, as well as the Tarija Basin in northwestern Argentina. His investigations in these regions yielded numerous publications addressing the Ordovician–Devonian miospore and chitinozoan stratigraphy of these intracratonic basins, on the regional palaeographic evolution of northwest Gondwana, and on evidence for early Silurian glaciations in Brazil.

As a person, Yngve was an independent and distinctive character. Unconcerned with outward appearances, he pursued his own path with quiet determination and intellectual integrity. He had a deep appreciation for literature, classical music – particularly opera – and travel, frequently to Asia and always undertaken alone, reflecting his introspective nature. After retiring from Petrobras, Yngve settled permanently in Estepona, southern Spain, where he enjoyed a peaceful and contemplative life until his passing. He leaves behind an enduring legacy of scholarly publications and fond memories among his colleagues and friends. It was both a privilege and a pleasure to have known him.

Per Ahlberg
Lund University, Sweden

Robert Lilljequist
Estepona, Spain

Louis Liljedahl
Storuman, Sweden

Yngve Grahn (left) and the graptolite specialist Ragnar Nilsson (1903–2000) in the late 1970s. Photo: Louis Liljedahl.

W. D. Ian Rolfe FRSE
1936 – 2025

Photo courtesy of Victoria Fairnie.

Dr William David Ian Rolfe, known as Ian, was a distinguished UK palaeontologist, museum curator and historian of science, whose career spanned more than five decades and left a lasting imprint on arthropod palaeobiology, Scottish geology, and the stewardship of national collections. Renowned for his meticulous scholarship, breadth of knowledge and generosity to colleagues, he published nearly 200 papers and played a central role in shaping modern understanding of fossil Crustacea, among other arthropod groups. His influence extended across multiple scientific societies, where his energy, humour and commitment to service were widely appreciated.

Born in humble beginnings in Hornchurch, Essex in 1936, Ian's early fascination with the natural world was nurtured at the Royal Liberty Grammar School where he gained a scholarship. Plants, animals and the outdoors were lifelong passions. He wrote his first 'scientific paper' as a child on ivy-leaved toadflax and enjoyed Outward Bound activities as a Queen's Scout. An organic gardener since the 1980s, he remained a dedicated member of the Soil Association, being particularly enthusiastic about composting. After retirement he worked in his garden alongside his wife, Julia, who created a remarkable oasis of calm and beauty in the heart of the city.

Ian studied geology, and met his wife while they both studied at the University of Birmingham, graduating BSc and later PhD in 1960. Julia supported them both while he wrote his doctoral thesis on the Silurian inliers of the Midland Valley of Scotland. He provided a rigorous re-examination of the large pod-shrimp *Ceratiocaris*, work that would underpin part of his authoritative contribution to the 1969 *Treatise on Invertebrate Paleontology Part R*. His early promise was quickly recognized. In 1961 he was recruited by Harry Whittington FRS to Harvard University's Museum of Comparative Zoology, where he curated non-trilobite arthropods and published on the Burgess Shale fossil *Proboscicaris*, now recognized to be part of the anomalocaridid *Hurdia*. Ian revised the Carboniferous myriapod *Arthropleura* and wrote several papers including on its trackways (*Diplichnites*) on Arran and elsewhere. The whole family took part in moulding and casting the *Arthropleura* tracks on the Isle of Arran as part of their 'summer holidays' in the 1970s.

In 1962 Ian returned to Britain to take up lecturing Geology and a curatorship at the Hunterian Museum, University of Glasgow, beginning a long association with Scottish geology and museum practice. At that time, the Hunterian Museum was a scattered group of departmental collections being looked after by appointed curators. With Ian's advice and persistence, the Museum became a separate university department and its first director (Prof. Frank Willet) was soon in place. Ian rose to Deputy Director (1981–1986) and became a central figure in the intellectual life of the institution. His curatorial work was complemented by field research, most notably his participation in the six-month-long, 1967 joint expedition to the celebrated Devonian locality of Gogo in Western Australia, where he helped collect more than 1,000 fish and some 2,000 pod-shrimps. Colleagues

later recalled his ability to synthesize field observations, historical context and taxonomic detail with unusual clarity. Following damage by over-collecting at some key Silurian localities in the 1970s, Ian helped change laws to help protect UK geological sites of special scientific interest.

Following years of mentorship, and the availability of grants and government programmes, Ian was able to employ the brilliant Scottish fossil collector, Stan Wood, to undertake an excavation at a site in Bearsden near Glasgow in the early 1980s. This resulted in the discovery of the important 'Bearsden Shark' and its associated fauna. A travelling exhibition, conceived by Ian and designed at The Hunterian, celebrated Mr Wood's fossicking prowess and was opened by Sir David Attenborough. Ian and Stan continued to have strong links throughout their careers. In 1986 Ian was appointed Keeper of Geology at the National Museum of Scotland (NMS), a post he held until 1996. His tenure coincided with a period of major palaeontological discoveries being made in Scotland. Recognizing the significance of the early terrestrial vertebrate assemblage being uncovered at Bathgate and the Scottish Borders by Stan Wood, Ian established a major acquisition and documentation project to ensure that these globally-important fossils were properly recorded and secured for the national collection. His colleagues at NMS remember him as a curator of rare diligence, with a deep commitment to public engagement and the long-term care of collections.

Ian's service to learned societies was exemplary. He served on the Council of the Palaeontological Association from 1965 to 1976 and again from 1992 to 1994, holding roles including Assistant Secretary, Secretary, Vice-President and President, and was later elected an Honorary Life Member. Ian also edited the early PalAss Circulars and, between 1971 and 1978, produced an annual supplement listing palaeontological theses and postgraduate research topics – an invaluable resource in the pre-digital era. He also became president of the Geological Society of Glasgow (1973–1976), the Edinburgh Geological Society (1989–1991) and the Society for the History of Natural History (1996–1999). He enjoyed a prominent role as a Fellow of the Royal Society of Edinburgh. Ian was also involved with many different choirs, reflecting his life-long love of music and singing.

Retirement did not diminish Ian's intellectual curiosity. He devoted 20 years to researching and writing on the Paper Museum of Cassiano dal Pozzo (Royal Collection), a project that absorbed him deeply. When this work was completed with the publication of the volumes on *Birds, other Animals and Natural Curiosities*, he seemed to lose a sense of purpose, and it was around this time that the first signs of Alzheimer's disease appeared. Yet his love of geology endured. During the Covid-19 lockdown he would still mention what rocks flagstones and buildings on daily walks were made of, explaining their features to passers-by. In a care home from 2024, geology remained the subject he could discuss with clarity and enthusiasm even when other memories faded.

Ian's research legacy is preserved not only in his extensive publications but also in the taxa named in his honour, including *Eldeceeon rolfei*, *Dithyrocaris rolfei*, *Microdecemplex rolfei* and *Actinodesma rolfei*. His achievements were recognized by several major awards, including the Murchison Fund (1978), the Coke Medal (1984) and the Clough Medal (1997). He was elected a Fellow of the Geological Society (1960), the Museums Association (1972), and the Royal Society of Edinburgh (1983).

Colleagues remember Ian as a scholar of immense range, a curator of rare diligence, and a generous mentor. His work strengthened collections, advanced research, and enriched the historical and scientific record; the field is markedly better for his contributions. Ian is survived by his daughters Victoria and Sara and two grandchildren; his wife Julia pre-deceased him in 2023.

Neil D. L. Clark
The Hunterian Museum, University of Glasgow, UK

Dugald Ross
1957 – 2025

Photo by S. Brusatte.

Many palaeontologists work in museums. During the history of our field, various palaeontologists have founded museums. But there is only one palaeontologist we know of who literally built his own museum with his own two hands: our friend Dugald 'Dugie' Ross of the Isle of Skye, who passed away in October 2025 at the age of 68.

Dugie was an exceptional man who devoted his life to understanding the prehistory and human history of his native island, and to communicating this information to the public and studying it scientifically with academic colleagues, particularly with us and our students at the University of Edinburgh and the Hunterian Museum in Glasgow. The Association recognized him in 2016 with the Mary Anning Award, the prize for palaeontologists not professionally employed in the discipline, and in 2024 he was awarded an honorary doctorate by the University of Edinburgh – a much deserved achievement for a man who never had the opportunity to attend university.

Dugie grew up a native Gaelic speaker in Ellishadder, a small hamlet on Skye, the largest of the Inner Hebrides islands off the west coast of Scotland. One of the most charming and natural raconteurs we've ever known, Dugie liked to recount how his interest in collecting began with a chance encounter when he was a teenager. As he and his father were cutting peat, he noticed a large stone emanating from the ground. His father told him, in Gaelic, "Sin agad Clach an Airgid!" (Behold, the Money Stone!). Dugie returned the following day to explore further, and found a handful of Neolithic arrowheads, which sparked an enthusiasm that would never abate. He began scouring Skye for artefacts like arrow points, Roman coins and crofting implements, and started to organize these into a small museum. He was forced to leave school early to manage his family's croft, and settled into a career in farming and building. But before turning 20, he established the Staffin Museum, and he later repurposed the ruins of a nineteenth century one-room schoolhouse to make into a museum attraction that could be visited by locals and tourists. Each year, thousands of tourists visit his museum, contributing immensely to the culture and economy of the Isle of Skye.

As his museum grew, Dugie became interested in fossils and rocks, in addition to archaeological artefacts. As a young man, he collected what he thought might be a dinosaur footprint, but nobody believed him because, at that time, dinosaurs had never been found in Scotland. It wasn't until decades later, in 1984, that scientists described what they thought was Scotland's first dinosaur footprint. This encouraged Dugie to explore the Jurassic-aged rocks of Skye, and he soon began finding a wealth of fossils, including a substantial piece of a sauropod limb bone hailed, at the time, as Scotland's first dinosaur bone[1]. Dugie's museum grew to contain many dinosaur remains as well as ammonites, marine reptiles and fishes.

[1] Clark *et al.* 1995: <**https://doi.org/10.1144/sjg31020171**>.

Over the past 30 years, Dugie's discoveries established Skye as 'Scotland's Dinosaur Island', and led to the creation of a tourist trail, and ultimately to the protection of several fossil sites along the coast by the Scottish Government. Dugie further ventured into scientific research, and through his own self-taught work and collaboration with scientists such as ourselves, Dugie became a world expert on Scottish dinosaurs. He published over a dozen peer-reviewed papers in leading academic journals, and named new species of ancient animals from Skye. For these, he created technical scientific names based on Gaelic, among the only such fossils to ever earn Gaelic epithets. These include the pterosaur *Dearc*[2] and the ocean-living reptile *Dearcmhara*, both of which lived ~170 million years ago when Skye was a subtropical island. Dugie collected hundreds of dinosaur footprints, and helped describe the largest dinosaur tracksite ever found in Scotland[3], where there are over 100 prints left by long-necked sauropods. He was still working with us up until his death, and just a month before he passed away he published an open-access catalogue with us of the hundreds of dinosaur footprints in the Staffin Museum collection[4].

Dugie at his museum on Skye with his Mary Anning Award certificate. Photo by Steve Brusatte.

Dugie frequently worked with the media to publicize his discoveries, and appeared often on television, speaking in both English and Gaelic; he was a particularly popular guest on BBC Alba documentaries. He acted as the 'eyes and ears' for the Scottish government, making sure that new fossils found by tourists were conserved properly and not illegally collected. He regularly took

2 Jagielska *et al.* 2022: <**https://doi.org/10.1016/j.cub.2022.01.073**>.
3 Brusatte *et al.* 2015: <**https://doi.org/10.1144/sjg2015-005**>.
4 Blakesley *et al.* 2025: <**https://doi.org/10.1098/rsos.251016**>.

school and community groups on fossil hunting tours, and more than anything, enjoyed holding court in the Staffin Museum, where he enchanted tourists with stories of his discoveries and his beloved island.

For the two of us, Dugie was one of the most treasured and supportive friends in our academic lives. He welcomed us both to Skye, and eagerly championed our fieldwork and helped train our students in field techniques. Our families became friends. Through Dugie, we felt part of the Isle of Skye community, and always will. Dugie was a pillar of that community. He served as one of the directors of the Staffin Community Trust, was instrumental in the creation of the Skye Ecomuseum outdoor tourist trail, taught students Gaelic, helped run archaeological digs on Skye with the University of the Highlands and Islands, and used his building skills to survey land for new affordable housing developments for local families.

He was, above all, a wonderful man. Quiet, unassuming and humble; tenacious, hard-working and incredibly loyal; kind, generous, patient and always enthusiastic to anybody he crossed paths with. Through his discoveries, he brought Jurassic Skye to the world and the Jurassic world to Skye. He had a profound and far-reaching impact on Middle Jurassic terrestrial palaeoecology and Jurassic Skye continues to proffer new research and discoveries. We will end with a quote from the Staffin Community Trust, in their touching obituary: "Dugie read our landscape like no other. He understood his landscape like no other. And nobody loved this landscape as Dugie did. It's what we call in Gaelic dùthchas – the coupling of people and place over generations and throughout time. Not only did he read the landscape on multiple levels, but he read people and saw what others didn't. He treasured people whom society had overlooked."

Dugie is survived by his wife Debbie and his three children and each of their partners: Caroline and James, Catriona and Jamie, and Cameron and Emma – who will carry on the family legacy and continue to run the Staffin Museum. Two weeks before he passed, Dugie welcomed his first grandchild, which ensures the Ross clan will carry on, as they have for generations on Skye.

Stephen L. Brusatte
University of Edinburgh, UK

Neil D. L. Clark
The Hunterian Museum, University of Glasgow, UK

Michael Waldman
1941 – 2025

Photo by Ben Waldman.

My friend Dr Michael 'Mike' Waldman died peacefully at home from cancer on the 27th July 2025. He was an expert palaeontologist and inspiring teacher, but most of all a wonderful person who was always generous with his time and knowledge. A researcher turned schoolteacher, Mike carried out studies in Australia and Canada before settling back in England at Stowe School. It was during this time he led a school trip to the Isle of Skye and discovered one of the most productive and important fossil sites in Scotland, near the village of Elgol.

Mike was born in Bearstead maternity hospital, Hampton Court on 28th December 1941. He was an only child, and his mother, Rose (née Pushkin), was a secretary. His father Max was in banking, and sadly died when Mike was only eight years old. Mike attended Haberdashers' Aske's Hampstead School, in London. After school, he studied geology and zoology at the University of Bristol, working on the iconic British dinosaur *Megalosaurus*. This was the first scientifically named dinosaur in the world, named over 200 years ago. Mike added to this incredible legacy by naming a new species, *M. hesperis*, from the Greek hesperos, meaning 'from the West' (Waldman 1974). Later, it turned out not only to be a new species, but a new genus (*Duriavenator hesperis*), proving that Mike's powers of observation were acute even as a student.

It was during his student days that Mike met his future wife, Hazel Mills. She was holding a party with friends at Newton Park College in Bath (now Bath Spa University), and they invited a few men to attend; Mike was among them. He and Hazel proved a perfect match, they married in 1965, the day before the couple set sail for Australia. Mike took up a PhD at Monash University in Melbourne, receiving his doctorate in 1968. His dissertation was on Cretaceous fish fossils from Koonwarra, Victoria, and he named several new genera and species including *Koonwarria manfifrons* and *Wadeichthys oxyops* (Waldman 1968; 1971). The couple then moved to Canada where Mike worked in a museum in Ottowa and studied fossils from the Badlands. He published a scientific description of a coprolite containing a fossilized fish that had been eaten and excreted over 100 million years ago by a crocodile (Waldman 1970). He X-rayed this fossil to study it; a cutting-edge approach at the time.

In the 1970s Mike and Hazel returned to Britain, where he worked briefly as a research assistant at the University of Bristol with the world famous mammalogist, Robert Savage. He then switched to teaching, becoming a geology teacher at Stowe School in Buckinghamshire. He was clearly very popular with the pupils, known affectionately as 'Doc Pot'. He was renowned for his enormous rock collection, which he donated to the school to help with teaching. His contagious enthusiasm

led many to pursue careers in geology, and he continued to receive postcards of rock formations and volcanoes from former pupils for years after they'd left. Mike continued his research alongside teaching, making his most important scientific discovery during a Duke of Edinburgh trip he co-led to Camasunary in Skye. After researching the geology of the area, Mike located a promising shoreline and took the class on a hunt for ancient bones. He found the first Mesozoic mammal fossil from Scotland, a 166 million-year-old jaw, which was named *Borealestes serendipitus*, 'the northern rogue found through serendipity' (Waldman and Savage 1972). The name is beautiful, but the discovery was no 'happy accident'; it was his scientific training and diligent research into the historical literature about Skye's geology that led him to it.

In subsequent fieldwork during the 1970s and 80s, Mike and his colleagues discovered fossil skeletons of fish, salamanders, lizards, turtles and mammals from the Middle Jurassic, including some of the most complete examples of their kind in the world. Working with fellow palaeontologist Professor Susan Evans, Mike published several papers in the 1990s on small herps from Skye such as *Cteniogenys* and *Marmoretta* (Waldman and Evans 1994; Evans and Waldman 1996). The first fossil to be named using Scottish Gaelic was named in his honour: *Eileanchelys waldmani*, meaning 'Waldman's island turtle' (Anquetin *et al.* 2009).

Mike's discoveries on Skye have sparked decades of research, which continues to this day. Although he retired from teaching in 2002, Mike continued to support young academics. I met him in 2016 during my PhD at National Museums Scotland, when I began work on his mammal fossils from Skye. I was delighted to invite him to visit our collections at the Museum in Edinburgh, where he was reunited with his namesake turtle! We kept in touch ever since. I found him to be one of the most open and welcoming people I've ever met, and I was invited to visit him and Hazel in their beautiful home in Yorkshire in 2018. I came with the BBC in tow, who interviewed the veteran palaeontologist about his Skye discoveries. They raved about him the whole way back to the train station, such was the impression he made in just one afternoon.

The author with Mike at his home in Yorkshire in 2018. Photo by Elsa Panciroli.

Mike's important role in the history of Scottish palaeontology deserves to be more widely known. His encouragement spurred on many in their studies and in life, and he will be dearly missed, most especially by his wife Hazel, his children Penny, Amanda and Ben, and grandchildren Phoebe, Isaac, Henry and Gracie.

Elsa Panciroli
National Museums Scotland, UK

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Meeting REPORTS

69th Annual Meeting of the Palaeontological Association
University of Portsmouth, UK *11 – 15 December 2025*

PalAss at Portsmouth. Photo by Anthony Butcher.

In writing this report, I have tried to give a flavour of not only the amazing science presented, but also my observations and experiences from attending such a multifaceted and international gathering, in the hope that it inspires those who may be wary of stepping into this world. I have nothing but praise for how welcoming PalAss has been since my first Annual Meeting in Bristol in 2018 as an undergrad, and it has continued to be so. Last December we gathered for the PalAss Annual Meeting in the historic naval city of Portsmouth on the south coast of England.

Thursday 11th December was just for the early-career researchers, commencing with the workshop 'Learning from experience: publishing, grants and jobs', which provided sessions on academic publishing, applying for grants and permanent positions, and included a panel discussion. This was followed by a social event to help get to know others at a similar early-career stage before the main conference started.

Friday 12th December began with four workshops available to pre-book; I cannot recommend these enough, especially sessions that may be out of your comfort zone! I attended **Nizar Ibrahim**'s workshop on 'Capacity building in palaeontology: an African perspective to a global challenge', which was eye-opening and thought-provoking. He showcased case studies from Morocco, Egypt and Niger, as well as illustrating some of the logistical and local obstacles presented when obtaining fossil materials across the continent. Nizar brought both African and European perspectives to the discussion from his own experiences, highlighting that we must critically consider and evaluate the nuanced interactions with each collector, locality and region, emphasizing the importance of these considerations within the global palaeontological community.

After lunch we were warmly welcomed to the main event by Organizing Committee Chair **Nicholas Minter**, then Friday's Symposium 'Experimental Palaeontology' commenced. First up was **Claire Belcher** presenting a blazing talk on palaeo wildfires and their long-term contribution to Earth system processes, the evidence they leave behind in both plant fossils and soil profiles, and setting modern vegetation on fire in experimental burns in the wildfire lab. Next **Thomas Clements** presented on the paradox of exceptional preservation and his use of decay experiments on fish, identifying how phosphatization yields exceptional preservation of soft tissues. **Harriet Drage** introduced computational fluid dynamics experiments in validating palaeoecological simulations, focusing on Palaeozoic arthropods. After a coffee break we returned to hear **Jelena Godrijan** talk

about coccolithophores and their persistence when photosynthesis fails (as in the K–Pg extinction) through osmotrophy. **Barry Lomax** then presented experimental work on malformations in pollen and their connection to mass extinction events. **Erik Sperling** concluded the afternoon discussing physiological insights as a bridge between palaeontological and geochemical records, concluding that physiology and environment control Palaeozoic fossil trends. We then headed to the atrium for the 'icebreaker' reception with our engraved commemorative PalAss glass beakers ready to be filled with beer from local brewer Staggeringly Good, catching up with old friends and making new ones.

Saturday 13th and Sunday 14th included 107 talks and 69 posters across parallel sessions in two adjacent buildings. This presented the unenviable choice of deciding which talks I was going to attend … and the abstract volume proved very useful! Session 1 on Saturday, chaired by PalAss President **Philip Donoghue**, comprised six talks, with **Arindam Roy** looking at fully automating CT-segmentation using deep learning with examples from Skye, followed by **Zixiao Yang** using ultrastructural preservation of fossilized dinosaur skin in the transition from scales to feathers. **Emily Mitchell** then used metabolic theory of ecology to constrain lifespans of Ediacaran animals, finding higher evolutionary rates for smaller organisms, while those in colder water increased their lifespans. **Benjamin Griffin** used a tridactyl foot model to test foot motions in sediments illustrating how curved tracks are made from straight toes. Jumping back to the Chengjiang biota of China, **Yu Liu** presented new 3D renderings and micro-CT analysis of early Cambrian arthropods. The final presentation of this session by **Joseph Keating** demonstrated the value of palaeoproteomics for phylogenetic inference using 'big birds' (elephant birds and moas).

Posters in the Portland Building. Photo by Nic Minter.

After morning tea the concurrent sessions commenced and I headed to Session 2C chaired by **Sarah Losso**. In this session **Adam Murphy** showcased changes in metazoan functional diversity across the Cambrian Sinsk Event, **Yarong Liu** presented multi-scale community dynamics in the Ediacaran Shibantan Biota, while **Mingyang Qiu** presented work on macroscopic carbonaceous compression fossils from the Changlingzi Formation. **Blanca Martínez-Benítez** looked at the Porma Biota from the Cambrian of Gondwana in Spain, **Martina Aubrechtová** talked about Late Ordovician cephalopod assemblages of Estonia, and **Jared Richards** discussed the community ecology of the Early Ordovician Moroccan Fezouata Shale. The session was wrapped up with **Matěj Šilinger** discussing the microanatomy and functional morphology of the trilobite *Morocops? degener*.

HMS Warrior. *Photo by Sherri Donaldson.*

Session 3B chaired by **Luke Meade** took us from polar adaptations in Australia's earliest mammals with **Andre Rowe**, to **Mary Kate Branigan** reconciling molecular clocks in placental mammals, then **Nicholas Hadjigavriel** presenting work on the Early Cenozoic mammal radiation and increased terrestrial habitability. **Paul Barrett** showed new data on Zimbabwean Late Triassic/Early Jurassic vertebrate faunas, and **Cassius Morrison** looked at Late Cretaceous regional variation as a driver of

The Annual Dinner venue, HMS Warrior*'s gun deck. Photo by Sherri Donaldson.*

functional diversity and ecosystem structure. The session ended with palaeoecological insights from palynological and mesofossil analyses of an Edmontosaurus bonebed from the Late Cretaceous from **Nicolas Stagg**.

The first poster session of the event was held across both atriums, and these didn't disappoint! I'm always amazed at how much work goes into creating a poster and how they enable you to digest the science and quiz the author too! This was followed by the Annual General Meeting. We then headed into the Annual Address by **Jennifer McElwain** titled 'Exploring Earth's dynamic atmospheres and ecosystems'. Jennifer highlighted how broad and powerful the application of fossil plant functional traits can be in modelling terrestrial palaeoecosystem processes. From my personal perspective and ongoing work, it was a really inspiring and thought-provoking talk.

Arriving on board *HMS Warrior* in Portsmouth's Historic Dockyard for the Annual Dinner on the Saturday evening, we were greeted by our period-dressed Quartermaster and guided below deck to be seated at the mess tables, suspended amongst the cannons on the main gun deck and lit by candlelight. Our three-course meal was fabulous. The now-traditional PalAss quiz carried on valiantly until the more formal medal presentations began. Our Quartermaster then turned into the evening's MC and sea shanty singer, leading us to sing along late into the evening. Thankfully no-one was required to walk the plank.

Concurrent sessions kicked-off Sunday morning, so I headed across to Session 4A chaired by **Anthony Butcher** and sponsored by the Palaeontographical Society. **Luke Meade** introduced us to a climbing carnivorous mammal from the Middle Jurassic of Skye, **Neil Gostling** reviewed a decade of spinosaurids in the UK, and **Jack Lovegrove** presented a redescription of the sauropod *Camelotia* and highlighted its importance for understanding sauropod origins. **John Cope** presented possibly the world's most diverse Early Ordovician fauna from South Wales, followed by high-resolution µCT-scans of beautifully 3D-preserved *Leiodendron* specimens from Brymbo Fossil Forrest in Wales by **Ewan Titcombe**. The session wrapped up with **James Witts**' talk on the benthic palaeoecological response to environmental changes across the Cenomanian–Turonian interval in the UK Chalk Sea.

During Session 5 I headed from 5B to see **James Craig**'s talk on vegetation-induced sedimentary structures, a lightning talk by **Rosa Parkin** on the extinction and survival at the dawn of plant life on land, then to 5C to catch **Thomas Smith** talking about the complex relationship between brachiopods, bivalves and their environment, **Ninon Allaire** presenting on biodiversity dynamics during the initial Devonian radiation of ammonoids, and **Sarah Gale** exploring the climatic and environmental controls of bivalve biogeography, before **Venu Gopal Kella** rounded off the session looking at Cenozoic marine biodiversity hotspots and their evolutionary dynamics and environmental controls.

Following the post-lunch poster session and field-trip briefing, I took some time to really go through the posters I hadn't seen, then headed into Session 6B chaired by **James Witts** to catch **Miriam Slodownik**'s talk on the Austral Antarctic Forest during the Early Eocene Climatic Optimum where she presented case studies on the biogeography, diversity and fate of polar lineages. Session 7 was a single session chaired by **Emma Dunne**, containing the final four talks! **Philip Novack-Gottshall** discussed clade-level constraints to ecological diversification of marine animals in the Phanerozoic, **Peiyun Cong** explored the transition from lower to upper stem groups of arthropods, **Rebecca Koll** presented evolutionary perspectives on flammability and functional

traits in conifers, and **Allison Daley** (on behalf of Farid Saleh) closed the session updating the progress on the exceptionally-preserved Early Ordovician Cabrières Biota of France.

During closing business, postgraduate students at University College London were announced as the hosts of the ProgPal postgrad conference in 2026, and Oxford Palaeobiology Group were announced as hosts of PalAss 2026 at the Oxford University Museum of Natural History! Mark your diaries for Tuesday 8th to Friday 11th December, including a field-trip to the Mesozoic of Oxfordshire which looks amazing! Poster prizes and concluding remarks from the President wrapped up a fabulous 69th PalAss in Portsmouth.

About to float to the field-trip on a hovercraft. Photo by Nic Minter.

However, for some delegates, Monday 15th brought the field-trip to the Isle of Wight – by hovercraft! We assembled at 8am at Southsea Hoverport to watch our vessel arrive from across the water, then float up over the shingle beach and land on the concrete pad with ease. The excitement level at this stage in the morning was high as most of us had never seen nor flown on a hovercraft before! Arriving on the island only ten minutes after we set off, we then boarded the coach and headed off to our first stop at Whitecliff Bay, which features an unconformable contact between Cretaceous–Eocene successions. Exploring the coastline for a couple of hours we worked our way through the Headon Hill Formation, Barton Group, Bracklesham Group and the London Clay Formation, seeing changes in palaeoenvironment represented in the beds and fossils found in the exposures.


Field-trip attendees at Compton Bay. Photo by Sherri Donaldson.

We then headed to the Wight Mouse Inn, a delightful seventeenth century pub where the food was fabulous, fast and very filling, particularly welcome on a somewhat gloomy December day. We

then headed to the southwest of the island to see excellent exposures of the Lower Cretaceous Wessex Formation, seeing huge dinosaur footprints and keeping a weather eye on the tide. Finally it was time to return to Ryde for our return trip across the Solent, and dispersal into the evening. Huge thanks to **Nic Minter** and **Tony Butcher** for a grand day out among stunning outcrops and to **Simon Penn** and **Martin Munt** for their bonus local insights.

A final thanks to the entire organizing committee and their armada of student volunteers who created such an engaging event, and avoided a mutiny on *HMS Warrior*. Looking forward to #PalAss26 in Oxford!

Sherri Donaldson
University of New England, Australia

The meeting organizer, Nic Minter, with a dinosaur footprint at Hanover Point. Photo by Sonia Camina.

3rd International Geobiology Conference
Banff, Canada *20th – 24th May 2025*

In May 2025, the 3rd Geobiology Society Conference, Geobiology 2025, was held in the picturesque town of Banff, nestled in the heart of the Rocky Mountains of Alberta, Canada. Over four days, Professor **Kurt Konhauser** (Chair of the Geobiology Society) and his research group hosted an international gathering of both established and emerging scientists spanning the broad and interdisciplinary field of geobiology. Participants included micro-, molecular and evolutionary biologists, alongside geochemists, palaeontologists and palaeoclimate modellers. The conference theme, 'Tracing the Biosphere through Time', captured the co-evolution of life and Earth across 4.5 billion years, while highlighting modern analytical approaches and conceptual advances that are reshaping our understanding of how ancient life persisted under deep-time environmental conditions.

Following an opening evening of bowling, networking and reconnecting with colleagues, the scientific programme embarked on a chronological journey through Earth's history. Each day featured thematic research talks led by early-career scientists, followed by Medallist Lectures, professional development sessions and dynamic lightning talks presented by graduate and undergraduate students. Day one focused on the early Archean eon, exploring prokaryotic evolution and the emergence of microbial metabolisms on an environmentally challenging young Earth. Day two moved into the Proterozoic eon, examining its dynamic redox landscape and the evolutionary trajectory of eukaryotic life. The conference culminated on day three with the rise of a more familiar biosphere, spanning the origin of animals in the Ediacaran to the development of complex Phanerozoic ecosystems.

At each conference, the scientific and organizing committees recognize outstanding researchers at the senior, mid-career and early-career levels. These awards honour three pioneers whose work helped shape modern geobiology across geomicrobiology, geochemistry, sedimentology

and ichnology: Robert M. Garrels, Terry J. Beveridge and S. George Pemberton. The 2025 award recipients were **Andrew Knoll** (Harvard University, USA), **Timothy Lyons** (University of California, Riverside, USA), **David Johnston** (Harvard University, USA), **Tanja Bosak** (Massachusetts Institute of Technology, USA), **Eva Stüeken** (University of St Andrews, UK) and **Benjamin Mills** (University of Leeds, UK). In keeping with the Geobiology Society's commitment to amplifying the voices of early-career researchers, the meeting featured daily professional development sessions. Over the lunch hour, **Tiffany Lancaster** (NSERC, Canada) led practical discussions on the 'do's and 'don't's of academic funding. A lively Q&A with *Nature Geoscience* editor **James Super** and *Nature Communications* editor **Joy Buongiorno** offered valuable insights into what makes a strong manuscript and how editorial and peer-review processes differ among journals. **Frank Corsetti** (USC Dornsife, USA) gave an engaging talk on 'How not to blow the most important talk of your life', providing practical guidance on effective scientific communication – from crafting compelling figures to using body language and even mastering the laser pointer. To conclude the professional development programme, **Erik Sperling** (Stanford University, USA) introduced the Sedimentary Geochemistry and Paleoenvironments Project (SGP), encouraging participants to contribute to this expanding community database, which has the potential to support a wide range of emerging research questions in geobiology.

The Geobiology conference sessions under way at Banff Park Lodge. Photo by Sanaa Mughal.

At this conference, we introduced three-minute lightning talks as an eco-friendly and engaging alternative to traditional poster sessions. Each rapid-fire presentation block was followed by a two-hour, discussion-focused networking session, providing presenters with the opportunity to expand on their research in an informal and collegial setting. This new format proved highly effective in fostering interdisciplinary dialogue and meaningful scientific exchange among participants. We are pleased to congratulate the recipients of the Graduate Student Awards from each lightning talk session:

Day 1. The archaeal and bacterial biosphere

Holly Rucker (University of Wisconsin-Madison, USA) for 'Continuity of nitrogenase isotope signatures over 3 billion years of evolution' and **Stacey Edmonsond** (University of Victoria, Canada) for 'Timing and magnitude of the Lomagundi excursion and its relationship with Earth's Great Oxidation'.

Day 2. The origin & flourishing of nucleated cells

Princess Aira Buma-at (University of Cambridge, UK) for 'Morphometric and spatial analyses of Charniodiscus from the Ediacaran of Newfoundland, Canada' and **Andrea Halling** (University of Utah, USA) for 'Viscosity-driven shifts in microbial competition and community structure'.

Day 3. The rise of complex life

Harpreet Batther (University of Colorado Boulder, USA) for 'Stable carbon isotope fractionation during steady-state methanogenesis as a function of DIC concentration' and **Isabel Baker** (Johns Hopkins University, USA) for 'Deciphering the geobiological formation of isotopically superheavy pyrites in the modern era to understand their environmental relevance in oceans past'.

Each day concluded with evening socials hosted by the organizing committee, showcasing the best of Banff. These included guided walks to Vermilion Lake and Bow Falls, where participants explored the cultural and geological history of the town.

Socializing in the beautiful settings of Banff National Park. Photo by Sanaa Mughal.

Banff National Park has proven to be an ideal setting for the Geobiology Society Conferences (2017, 2019 and 2025), renowned not only for its spectacular scenery but also for its exceptional stratigraphic record. The region spans Neoproterozoic rocks of the Miette Group, which preserve evidence of some of the earliest shelly animals, through to the Late Cretaceous 'dinosaur highways' associated with *Albertosaurus* and *Edmontosaurus*. In this way, Banff's geological history mirrors the breadth and temporal scope of the research themes discussed throughout the conference.

Geobiology 2025 would not be possible without the Geobiology Society scientific committee: **Marc Laflamme** (University of Toronto, Canada), **Benjamin Mills** (University of Leeds, UK), **Katie Maloney** (Royal Ontario Museum, Canada), **Nagissa Mahmoudi** (McGill University, Canada), Daniel Mills (University of Düsseldorf, Germany) and **Victoria Petryshyn** (USC Dornsife, USA) and the

organizing committee at the University of Alberta in Canada: **Sanaa Mughal**, **Yuhao Li**, **Jenifer Spence**, **Kelly Rozanitis**, **Daniela Gutierrez Rueda** and **Baptiste Coutret**. We especially give thanks to our sponsors: the Paleontological Association (grant number PA-GA202402), Thermo Scientific, Agilent, Geological Society of America, Paleontological Society, Agouron Institute, Gordon Research Conferences, Timothy Lyons (UC Riverside), University of Alberta Faculty of Science, and University of Alberta Earth & Atmospheric Sciences.

After another successful Geobiology Society conference, we are excited to invite both old and new friends of the Geobiology Society to Geobiology 2027 in spring next year!

Sanaa Mughal and **Kurt O. Konhauser**
University of Alberta, Canada

A deer in downtown Banff. Photo by Yuhao Li.

4th Crossing the Palaeontological–Ecological Gap meeting and 3rd Conservation Paleobiology Symposium
University of Zurich, Switzerland *27 July – 1 August 2025*

The biennial Crossing the Palaeontological–Ecological Gap (CPEG) meeting aims to bring together researchers in palaeontology and ecology. While they often address overlapping research areas, such as biogeography, community and population ecology, food web dynamics, or extinction mechanisms and conservation, they do so on different temporal scales. CPEG provides a platform for sharing ideas, data and methods across these fields. Following previous meetings in Leeds, UK (2018), Berin, Germany (2021) and Vilnius, Lithuania (2023), the most recent edition of this meeting took place in Zurich, Switzerland, convened by **Catalina Pimiento** and myself. On this occasion, we have merged the meeting with the 3rd Conservation Paleobiology Symposium (CPB), a meeting for researchers focusing on the application of the knowledge gained from palaeobiology and historical biology to inform current conservation practices.

From the outset, our goal was to make the meeting accessible and affordable to all participants, whilst also implementing and encouraging practices reducing its carbon footprint. With the generous support of many sponsors, we were able to offer free registration to students, postdoctoral researchers and all residents of low-income countries. In addition, we awarded competitive grants to cover the travel and accommodation costs for three students from low-income countries: congratulations to **Fernanda Dias Paes Landim**, **Samuel Augusto Aguiar dos Anjos** and **Avinash Dahakey**! We are grateful to the Palaeontological Association for Grant-in-aid to cover refreshments (grant number PA-GA202403). Field-trip costs were also fully covered for all participants from low-income countries. To further reduce barriers to participation and limit travel-related emissions, the meeting was held in a hybrid format. Presenters were able to give talks virtually, and all participants could attend sessions via livestream, or access recordings afterwards. As such, we further reduced the need and cost of travel for a number of participants. Invited

keynote speakers were encouraged to travel by train wherever feasible; if this was not possible, they participated virtually.

In total the CPEG & CBP 2025 meeting brought together 301 participants from six continents, with 194 attending in person and 107 virtually. Notably, 82.7 % of participants attended the meeting for free. Over the course of six days, we enjoyed a programme filled with oral and poster presentations, workshops and networking activities. The scientific sessions featured seven keynote presentations, 58 standard talks, 44 lightning talks and 57 poster presentations. All abstracts are openly accessible via Zenodo (DOI: **10.5281/zenodo.16443649**).

CPEG & CPB 2025 participants. Photograph by Morgane Brosse.

Ahead of the in-person meeting, participants could join two online workshops organized by **Transmitting Science**. One focused on science communication through storytelling, while the other addressed building a career fitting different lifestyles. The in-person meeting was then opened with two full-day workshops, one organized by the **Palaeoverse** team, focusing on open data science skills, and the other led by the **Silvestro** research group, introducing the use of deep-learning methods in macroevolutionary research.

The following four days comprised of eight thematic sessions, each opening or closing with a keynote presentation. The Monday morning session focused on evolutionary dynamics and diversification patterns and opened with a talk by **Daniele Silvestro** (ETH Zurich, Switzerland) who addressed the timely topic of the use of AI in the understanding of past and present biodiversity dynamics. The afternoon session explored trophic ecology and ecological interactions and concluded with a virtual presentation by **Julia Tejada** (California Institute of Technology, USA), who invited us into the world of molecules, and how those preserved in the fossil record can provide insights into the evolution of dietary adaptations. The poster sessions were also held on Monday, in the Natural History Museum of the University of Zurich. The participants could browse posters during the coffee and lunch breaks, as well as during the evening 'icebreaker' event.

Poster session and the icebreaker event under the watchful eye of Diplodocus. *Photograph by Morgane Brosse.*

Tuesday opened with a session dedicated to extinctions and subsequent recoveries. **Emily Mitchell** (University of Cambridge, UK) started the day off by taking us to the Ediacaran to explore the eco-evolutionary dynamics which shaped its communities. At lunchtime, early-career researchers had the opportunity to network with more senior participants during a 'speed-dating' style roundtable lunch event, organized by **Lucia Snyderman** from the Conservation Paleobiology Network (CPN) student panel. The afternoon session focused on biodiversity and biogeography patterns and began with **Emma Dunne** (Trinity College Dublin, Ireland) talking about the impacts of climate on the diversity of terrestrial tetrapods. The day concluded with an optional guided walking tour of Zurich.

Wednesday was devoted to conservation palaeobiology and historical ecology. **Ruth Thurstan** (University of Exeter, UK) opened the day with a talk on the use of historical sources in reconstructing past transformations of marine systems. The afternoon session began with **Oskar Hagen** (Goethe University Frankfurt, Germany) walking us through the ways biodiversity models can help breach the gap between past environments, ecology and evolution. The day ended with an informal gathering at the terrace of the Federal Technical Institute, neighbouring the University of Zurich, overlooking the city. Even several waves of rain could not disturb the participants, and the lively conversations continued well into the evening.

The final day of talks began with a session on biotic responses to environmental change, opened with a virtual talk by **Mónica Carvalho** (University of Michigan, USA) on evolutionary and ecological dynamics of Neotropical forests in deep and recent time. The final session addressed biases in the fossil record and advances in methodologies. It ended with the closing remarks and award announcements, delivered by **Catalina Pimiento**.

As the meeting was filled with presentations of excellent quality, the scientific committee decided to award multiple prizes in each category. The best standard talk was awarded to **Fernanda Dias Paes Landim**, followed by **Sachin Bhardwaj**. Best lightning talk was delivered by **Michael G. Hynes**, while **Kateryn Pino** and **Coraline Montariol** shared the second place. The award for the best poster was shared by **Iris Menédez González** and me. The final award recognized the commitment to sustainable travelling and was awarded to **Abigail Parker**, who travelled from Helsinki to Zurich and

back via train, ferry and bicycle, covering an impressive 6,100 km without flying. The second place was given to **Tom Pavey**, who travelled roughly 2,200 km between Oxford and Zurich by train. We congratulate all the awardees again!

The meeting concluded with a full-day field-trip led by **Christian Klug** to the decommissioned Holderbank quarry which is famous for its rich Jurassic deposits. We spent the morning digging and sifting through the loose deposits on the steep slopes of the quarry, finding many beautiful fossils. After enjoying some Swiss cuisine for lunch, we wrapped up the day by visiting Lenzburg Castle, one of the oldest castles in Switzerland.

Fossil hunting at the Holderbank quarry. Photograph by Saurav Dutta.

Overall, I consider the meeting a great success, based on my own experience and on the participant feedback. We could not achieve this without our project managers, **Morgane Brosse** and **Taylor Norris**, the scientific committee, and the incredible team of volunteers. The next CPEG meeting, once again jointly held with the CPB symposium, will take place in summer 2027 at University College London in the UK. See you all there!

Kristína Kocáková
University of Zurich, Switzerland

Research Grant REPORT

Re-tracing arthropod ichnology: ichnotaxonomy of arthropod trackways, trails and imprints

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The main aim of this project was to make first-hand observations of type and referred specimens of arthropod trackways, trails and imprints in museum collections in the USA and Europe in order to review their ichnotaxonomy. There has been a surge in recent years in the number of high-profile papers using trace fossils in meta-analyses for understanding major evolutionary events by using them to investigate patterns of ecospace occupation and ecosystem engineering (Minter *et al.* 2017; Buatois *et al.* 2020, 2025; Feng *et al.* 2022). However, macroevolutionary and macroecological analyses utilizing trace fossils need to be underpinned by robust ichnotaxonomy to provide reliable units of measurement and frameworks for analysis. It is nearly 50 years since the last publication of the synoptic, 'Part W: Trace Fossils and Problematica', of the *Treatise on Invertebrate Paleontology* (Häntzschel, 1975) and, in that time, over 70 new arthropod trackway, trail and imprint ichnogenera (almost two-thirds of the present total) have been named. Evaluation and revision of these ichnogenera is therefore timely if we are to have a firm foundation for the future study of trace fossils.

The ability to make first-hand observations of type and referred material is important to enable comparisons with the original diagnoses of ichnotaxa and any proposed subsequent emendments and revisions. Also, some of these ichnotaxa were poorly described and figured, and idealized 'search images' may have diverged from the original concepts over time. Identifying junior synonyms is important because over a third of the total number of these ichnogenera were named in isolation in the late nineteenth or early twentieth centuries so names may have been erected independently for the same morphologies, and also may have been based on fragmentary or partially-preserved material. As a further goal, creating open-access resources of images and 3D reconstructions is important for future trace fossil researchers and trace fossil meta-analyses.

During this project, I spent one month in the USA visiting collections at the Museum of Comparative Zoology, Beneski Museum of Natural History, Springfield Science Museum, New York State Museum, Yale Peabody Museum, the Smithsonian Institute and the University of Colorado Museum. The funding also enabled me to spend two weeks in total in the Czech Republic at the Czech Geological Survey and in Germany at the BGR Spandau, Museum für Naturkunde, Senckenberg Museum and Stuttgart Natural History Museum. In the UK, I also visited the Natural History Museum in London, Warwick Museum and the British Geological Survey (Figure 1). Across these visits, I was able to make first-hand observations of type and referred material of 119 ichnospecies across 77 ichnogenera (Figure 2). This is being added to data that I previously collected from the New Mexico Museum of

Natural History and Science as well as the Museum of Northern Arizona in the USA, New Brunswick Museum in Canada and Bergakademie Freiberg in Germany.

Figure 1. Museum collections visited during this research project. Clockwise from top left: Museum of Comparative Zoology (Harvard University, USA), Beneski Museum of Natural History (Amherst College, USA), Yale Peabody Museum (Yale University, USA), Czech Geological Survey (Czech Republic), Naturmuseum Senckenberg (Frankfurt am Main, Germany), BGR Spandau (Berlin, Germany), British Geological Survey (Nottingham, UK), Smithsonian Institute (Washington, DC, USA) and Beneski Museum of Natural History. Photos by Nicholas Minter.

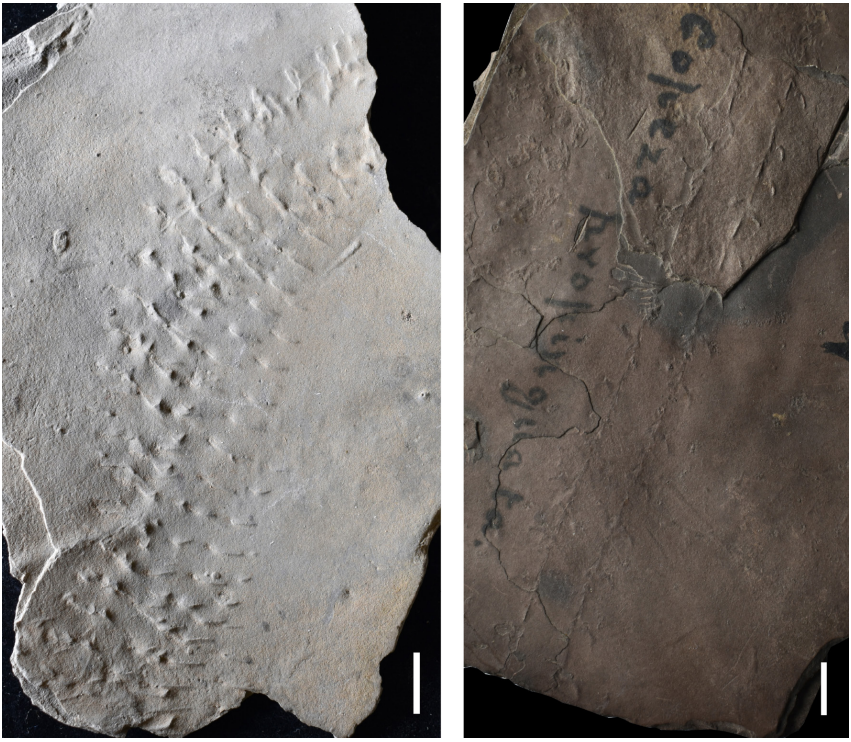

Figure 2. Example type arthropod trackway material. Left, Museum of Comparative Zoology (Harvard University, USA) MCZ 114301 Petalichnus multipartitus *(holotype). Right, Beneski Museum of Natural History (Amherst College, USA) ACM.ICH 36/26* Lithographus hieroglyphicus *(lectotype). Scale bars are 10 mm.*

Work is ongoing to analyse this material, starting with critiquing previous ichnotaxonomic revisions, testing if the commonly-held features of a particular ichnotaxon are in fact represented by their holotype, and identifying *nomen dubium*. Preliminary observations have identified that *Trachomatichnus permultus* and *Trachomatichnus cincinnatiensis*, which were synonymized with *Petalichnus multipartitus* by Osgood (1970), bear little resemblance to the type specimen of *P. multipartitus*; however, due to the specimen originally named as *T. permultus* being illustrated by Häntzschel (1975), this is generally considered as the 'search image' for *Petalichnus* as opposed to that represented by the holotype. Visiting these collections has also enabled the identification of inadequate type material and that, in some instances, type material has sadly been lost to science and that these names should be *nomen dubium*. Following this, junior synonyms are being identified through the principle of 'smoking guns' (Minter *et al.* 2007) that show intergradation between ichnotaxa within single specimens so that they can be demonstrated to be minor morphological variants. This is especially the case for the collection of Hitchcock (1858, 1865) because there are multiple ichnogenera and ichnospecies that are likely to be minor morphological variants of one another, and the large number of specimens held across the Beneski Museum of Natural History, Museum of Comparative Zoology and Yale Peabody Museum permit this analysis.

Images of have also been collected to enable the production of 3D photogrammetic reconstructions.

Other ongoing research using this material involves the use of morphometrics to provide more objective means of delineating ichnotaxa and, from this, using subsets of these specimens as training datasets for machine learning. The ultimate plan is to have an AI model that can be used to help with identification of arthropod trackway, trail and imprint ichnotaxa, thereby making it more accessible and opening up this source of palaeontological data more broadly. A pilot study on the application of AI in trace fossil identification has yielded promising results.

Acknowledgements
This work has been made possible by Palaeontological Association Research Grant number PA-RG202302, and through the generous help of the curators and collections managers at the museum collections visited during this research project.

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Small Grant REPORTS

Dental microwear of South American theropods: testing ecological niche partitioning among Cretaceous carnivores

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Introduction

Theropod dinosaurs exhibit significant variation in tooth shape, skull shape and estimates of bite force, with this disparity associated with dietary differences, thus enabling ecological niche partitioning. Analyses of modern mammalian sympatric predators from the African savannah illustrate predator partitioning such as differences in the prey acquired and hunting strategies. Sympatry of medium- to-large-sized predatory theropods is known in many Mesozoic terrestrial ecosystems, raising the question of how they partitioned their diets and food sources due to their large mass (greater than 500 kg). This has not been quantified in Mesozoic ecosystems, outside of the sub-aquatic spinosaurids, with at least some species being facultative piscivores. Allosauroid theropods were the top apex predators in most terrestrial Mesozoic ecosystems from the Middle Jurassic to the onset of the Late Cretaceous, although they were sympatric with several other medium-to-large predatory theropods such as megalosauroids, ceratosaurids and megaraptorids during this time, most famously in the Late Jurassic Morrison Formation of the USA. However, their extinction at the end of the Cenomanian dramatically reduced sympatric predator diversity, with tyrannosaurids dominating Laurasia with abelisaurids and megaraptorids having spatial partitioning of Gondwana. This dramatic shift in ecosystem composition raises the questions of how and why such diverse predatory taxa co-existed for so long and what changed after the allosauroid extinction. Patagonia in Argentina is an ideal study area to investigate these fauna and ecosystems changes due to the fossils recovered that span before, during and after the Cenomanian extinction (Figure 1).

Methods

Dental microwear texture analysis (DMTA) provides a means to quantify feeding differences that can indicate potential niche partitioning, because microwear leaves distinct patterns based on different diets ranging from carnivory, piscivory and herbivory (Bestwick *et al.* 2019). DMTA was used to analyse the diets of sympatric theropods throughout the Cretaceous of Patagonia. Dental moulds were made following the procedures described in Bestwick *et al.* 2019. All specimens were cleaned before sampling using an ethaline-based solvent. High fidelity models of the teeth were made using the President Jet Regular Body polyvinylsiloxane. The initial mould per tooth was disregarded to remove any remaining dirt and all analyses were performed on the second moulds. Data were captured using an Alicona InfiniteFocus G5+. The 3D digital models were analysed using MeasurementSuite 5.3.6 that calculated the surface texture parameters such as the percentage of peaks and valleys. Principal Component Analysis was carried out to quantify the DMTAs that belong to different dietary categories such as piscivory and carnivory as seen in other archosaurs.

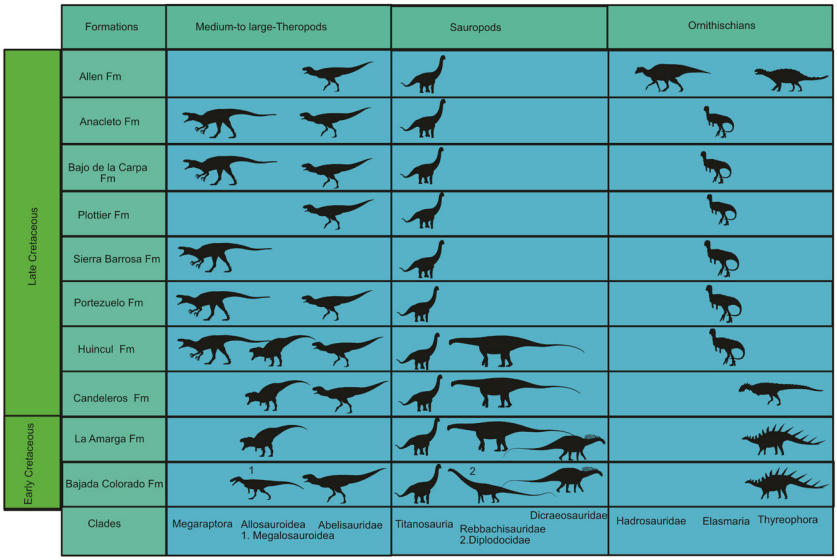

Figure 1. Temporal changes in the dinosaurian fauna during the Cretaceous of Patagonia (after Leanza et al. *2004).*

Due to advancement in the methodology and support from collaborators in Argentina, I was able to extend the scope of the project and not just assess the diet of sympatric medium-to-large theropods but additionally small theropods such as the potentially piscivorous unenlagiine and insectivorous alvarezsaurids, alongside crocodilians. Equally exciting are the diets of herbivorous clades such as sauropods, hadrosaurids and ornithischian dinosaurs, which are also being tested. Over 400 microwear samples will be collected in total. An ecological functional diversity analysis was carried out based on Blanco *et al.* 2025 on the dinosaurian fauna for the Cretaceous of Patagonia, to determine the extent of functional diversity changes through time.

Preliminary results and discussion

There are several manuscripts currently in preparation/submission including my detailed findings, so the results herein are an overview. The DMTAs show that there are distinct dietary groupings among the different theropod clades (for example Figure 2), and these do vary temporally and have implications for the ecological mechanisms enabling the ecosystem compositions of sympatric medium-to-large theropods. This likely contributed to variation in diet and food resource utilization, enabling sympatry without competitive exclusion. It should be noted that specialization in diet may not be a widespread phenomenon in megatheropods. Distinct functional diversity changes and assemblages emerge related to temporal changes that are potentially correlated to the evolution and dispersal of new taxa, alongside environmental changes in Patagonia impacting all dinosaurian guilds.

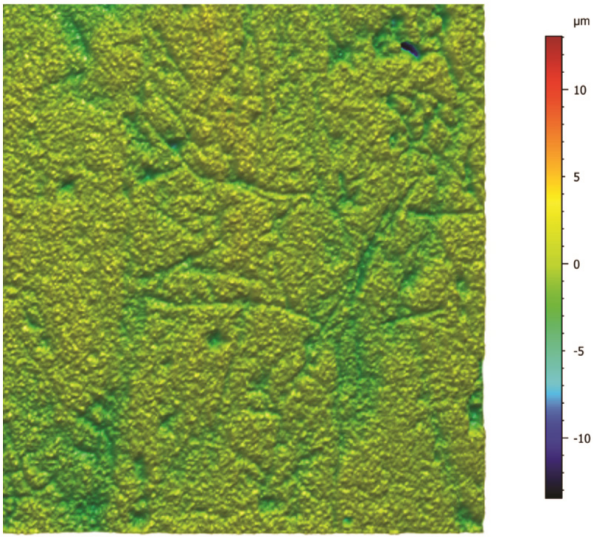

Figure 2. Microwear texture of a Gondwanan averostran theropod. Vertical scale bar is the topographical scale of the microwear. The field of view is 1 mm by 1 mm.

Conclusions

DMTA has shown the potential to reveal dietary disparity in theropod dinosaurs, while assessing temporal and spatial changes within different faunal assemblages. Further, the ecological mechanisms for sympatry can be elucidated amongst dinosaurian faunal assemblages, as well as why competitive exclusion did not occur in certain ecosystems. Applying modern ecological techniques to the fossil record has revealed new and exciting results, alongside the importance of using multiple metrics to assess long-term macroecological and evolutionary trends. Additionally, there are multiple benefits of mutual collaborations between the Global North and South that can dramatically enhance palaeontology and address the historical under-representation of peoples and data.

Acknowledgements

I would like to thank my collaborators in Argentina, alongside curators and museum professionals who have allowed access to specimens and the creation of the dental moulds. A special thanks to the Palaeontological Association for the Sylvester-Bradley Award, grant reference number PA-SB202304, which facilitated this research and supported such productive international collaborations between multiple early-career researchers.

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Bovid taxonomy and palaeoecology of the Upper Miocene locality of Pikermi (Greece) through osteometric and mesowear analysis

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Introduction

The Upper Miocene locality of Pikermi (Attica, Greece) is one of the most important vertebrate fossil sites in Europe and a reference locality for the Turolian of Eurasia. Its rich macromammalian fauna has been studied since the mid-nineteenth century (*e.g.* Wagner 1839; Gaudry 1862–67) and continues to yield new material through systematic excavations conducted over the past decades. Recent fieldwork in the Pikermi Valley (PV1–PV4) has recovered more than 3,000 specimens, highlighting the continued scientific potential of the area. Bovidae represent the most diverse and ecologically informative herbivore group at Pikermi. The Greek fossil record of bovids is exceptionally rich, and a substantial portion of known taxa occur at Pikermi alone (Kostopoulos 2021). Ten bovid species are currently recognized from the locality, encompassing a wide spectrum of body sizes, cranial morphologies and inferred feeding strategies. Previous studies have documented the complex taxonomy and phylogenetic relationships of these taxa, as well as their broader biogeographical significance in the eastern Mediterranean. Recent palaeoenvironmental reconstructions based on sedimentology, palynology, magnetostratigraphy and isotope data suggest that the Pikermian biome represented a heterogeneous environment intermediate between woodland and grassland, broadly comparable to, but not identical with, modern savanna-type ecosystems (Böhme *et al.* 2017).

This project aimed to assess the taxonomic diversity of the bovid fauna of the new Greek material by comparing data from the new localities to that of specimens in a historic collection in the Muséum national d'Histoire naturelle (MNHN), Paris, France, as well as performing mesowear analysis of the cheek teeth of Pikermian bovids of the MNHN collections. The results of this will contribute to a better understanding of the adaptive radiations of bovids in the Balkan Peninsula in parallel with the spread of grasslands during the climatic cooling of the Late Miocene.

Materials and methods

The grant funded a research visit to the MNHN in Paris, which houses one of the largest collections of Pikermi fossils, assembled by Albert Gaudry during historical excavations in the mid-nineteenth century. During this visit, craniodental specimens of bovids from the Gaudry collection were examined and compared with material recovered from recent excavations in Pikermi (Roussiakis *et al.* 2019). Approximately 120 specimens were studied, with a focus on representative taxa such as *Tragoportax*, *Miotragocerus*, *Gazella*, *Palaeoreas* and *Oioceros*. The historical and newly excavated assemblages are separated by an estimated temporal interval of approximately 40,000 years (Böhme *et al.* 2017), providing an opportunity to investigate potential short-term changes in community composition.

Taxonomic assessment was carried out using classical palaeontological methods, including detailed morphological observations and osteometric measurements of cranial and mandibular elements.

Measurements followed established protocols (Roussiakis 1996; Kostopoulos 2009), allowing direct comparison with published datasets from Pikermi and other Turolian localities. Palaeoecological inferences were based on mesowear analysis of bovid cheek teeth. Mesowear analysis examines the balance between abrasion and attrition during feeding and provides insights into long-term dietary preferences. Specimens were scored following the method of Fortelius and Solounias (2000), which distinguishes browsing, mixed-feeding and grazing adaptations.

Preliminary results and discussion

Preliminary taxonomic assessment of the studied material supports the attribution of the examined specimens to the currently recognized bovid taxa from Pikermi, with no substantial deviations from previously established systematic frameworks (Figure 1). Preliminary mesowear observations suggest that the majority of Pikermian bovid taxa exhibit mixed-feeding adaptations, accompanied by very limited evidence of obligate grazers or browsers. This overall dietary pattern appears broadly consistent, with only minor variation in the presence of specialist feeders. The observed mesowear signal does not conflict with existing palaeoenvironmental reconstructions for Pikermi and is consistent with interpretations of a predominantly open and heterogeneous Late Miocene landscape.

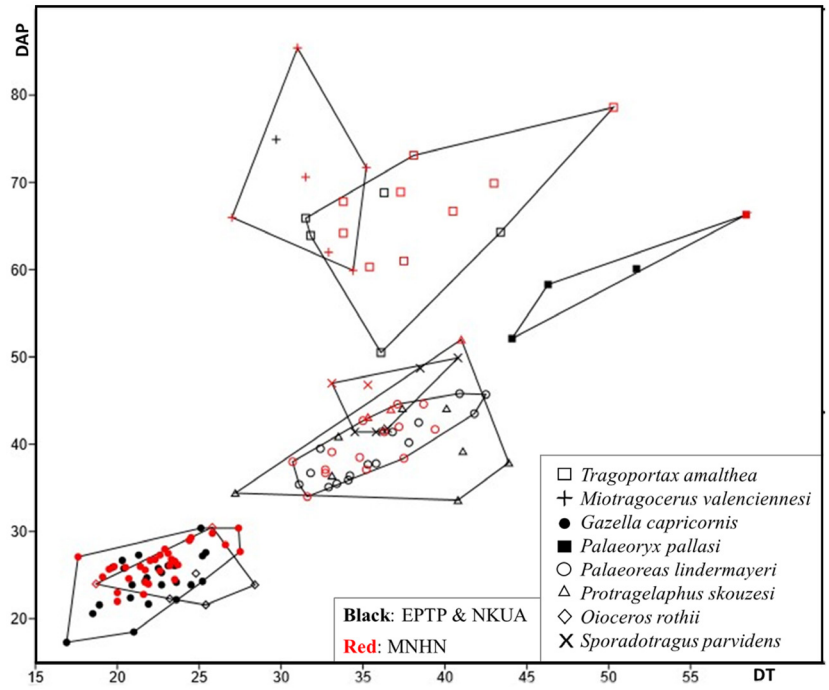

Figure 1. Bivariate plot of transverse diameter (DT) versus anteroposterior diameter (DAP) measured at the horn-core base along its minor and major axes, respectively, for bovid cranial specimens from the Upper Miocene locality of Pikermi (Greece). Symbols denote different bovid taxa as indicated in the legend. Black symbols represent specimens from the Exhibition of Palaeontological Treasures of Pikermi (EPTP) and the National and Kapodistrian University of Athens (NKUA), while red symbols correspond to material housed at the Muséum national d'Histoire naturelle (MNHN), Paris. Convex hulls outline the observed morphometric range of each taxon.

The ongoing comparison with material from recent excavations will further clarify temporal and spatial patterns in bovid palaeoecology within the Pikermi locality. This project contributes to the integration of historical museum collections with newly-excavated material and demonstrates the continued relevance of nineteenth-century assemblages for addressing modern palaeobiological questions. The results will form part of a peer-reviewed publication on the palaeoecology of Pikermian bovids and will be incorporated into my PhD thesis.

Acknowledgements

I warmly thank Professors Efterpi Koskeridou, Socrates Roussiakis and Dimitris Kostopoulos for their continued support, constructive guidance and insightful discussions, which were instrumental to the development of this project. I am sincerely grateful to the Palaeontological Association for selecting me as the recipient of a Whittington Award (PA-WA202201), which enabled a research visit to the Muséum national d'Histoire naturelle in Paris. I also thank the curator, Dr Christine Argot, for facilitating access to the MNHN collections and for her kind assistance during my study visit.

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Association Business

New Council Members for 2026

At the AGM the following individuals took up roles on Council:

President-Elect:	**Paul Barrett***
Vice-President:	**Crispin Little**
Treasurer:	**Paul Winrow**
Internet Officer:	**Luke Parry***
Meeting Coordinator:	**Imhan Rahman**
Outreach Officer:	**Thomas Clements**
Publicity Officer:	**Darja Dankina**
Early Research Career Officer:	**Miriam Slodownik**
Editor Trustee:	**Michelle Stocker****

*Council nominee.

**Candidate nominated by the Editorial Board as one of two Editor Trustees.

The Association is run by members for members. Without these dedicated and selfless individuals putting themselves forward for Council roles we would not be able to continue our work to promote and support the palaeontological community.

The following Council position become vacant at the end of 2026:

- Vice-President (2-year term)
- Secretary (5-year term)*
- Newsletter Editor (3-year term)
- Deputy Newsletter Editor (3-year term)
- Education Officer (3-year term)
- Diversity Officer (3-year term)
- Ordinary Members (x2; 3-year term)

*Council nomination proposed.

If you wish to stand for Council in 2026 please contact the current holder of the role for more information and see <**https://www.palass.org/association/how-stand-election-council**>.

The deadline for nominations is **1st September**.

Association Awards and Prizes in 2026

The Palaeontological Association recognizes excellence in our profession by the award of medals and other prizes. The Association sees its lists of medals and award winners as a record of the very best palaeontologists worldwide, at different career stages, and offering different kinds of contributions to the field. The Association stresses the importance of nominations and encourages all members to make nominations.

Summary of all our Awards

Association professional awards

Award	Who is it aimed at?	Who can nominate?	Deadline	More information…
Lapworth Medal	Someone who has made a highly significant contribution to palaeontology. Has a substantial body of research and service to the scientific community.	Requires nomination by two members of the Association.	**31st March**	
President's Medal	Mid-career award. 10–20 years of full-time experience after their PhD. In recognition of outstanding contributions in their earlier career, coupled with an expectation that they will continue to contribute significantly to the subject in their future work.	Requires nomination by two members of the Association.	**31st March**	
Hodson Medal	Early-career award. Between 5 and 10 years of full-time experience after their PhD. Has made a significant contribution to palaeontology.	Requires nomination by two members of the Association.	**31st March**	
Dorothea Bate Medal	Early-career award. Up to five years of full-time experience after their PhD. Has made a notable contribution to the field during and immediately after their PhD.	Requires nomination by two members of the Association.	**31st March**	

Association community awards

Award	Who is it aimed at?	Who can nominate?	Deadline	More information…
Mary Anning Medal	Open to all those who are not professionally employed in palaeontology but who have made an outstanding contribution to the subject.	Requires nomination by two members of the Association.	**31st March**	
Gertrude Elles Award	For high quality, amateur or institutional, public engagement projects that promote the discipline.	Nomination by one or more individuals. Individuals do not need to be members of the Association. Can self-nominate.	**31st March**	

Association membership awards and prizes

Award	Who is it aimed at?	Who can nominate?	Deadline	More
Honorary Life Membership	Recognizes individuals deemed to have been significant benefactors and/ or supporters of the Association.	Requires nomination by two members of the Association.	**31st March**	
Undergraduate Prize Scheme	Talented undergraduates.	Any university departments where a palaeontology course or module is taught after the first year as part of a degree programme.	**No deadline.** Applications accepted throughout the year.	

Association Annual Meeting prizes

Award	Who is it aimed at?	Who qualifies?	Deadline	More information…
Annual Meeting Council Poster Prize	Awarded for the best poster(s) at the Annual Meeting.	All student members of the Association, and all members of the Association who are early-career researchers within one year of the award of a higher degree (PhD or MSc).	N/A	
Annual Meeting President's Prize	Awarded for the best talk(s) at the Annual Meeting.	All student members of the Association, and all members of the Association who are early-career researchers within one year of the award of a higher degree (PhD or MSc).	N/A	

Association publication prizes

Award	Who is it aimed at?	Who qualifies?	Deadline	More information…
Best Paper Awards	To recognize papers published in either *Palaeontology* or *Papers in Palaeontology* and reward excellence in our field.	Open to all authors irrespective of age and nationality; membership of the Association is not required.	N/A	

Upcoming grants in 2026

Palaeontological Association grants are offered to encourage research, education and outreach through different means. Undergraduates, early-stage researchers, and otherwise unfunded persons are particularly encouraged to apply. All of these awards and grants are core to the charitable aims of the Palaeontological Association. A full list of the Association's grants can be found on the Association's website at <**https://www.palass.org/awards-grants**>. A summary of our grants throughout the year is given below.

Summary of all our Grants

Association Grants

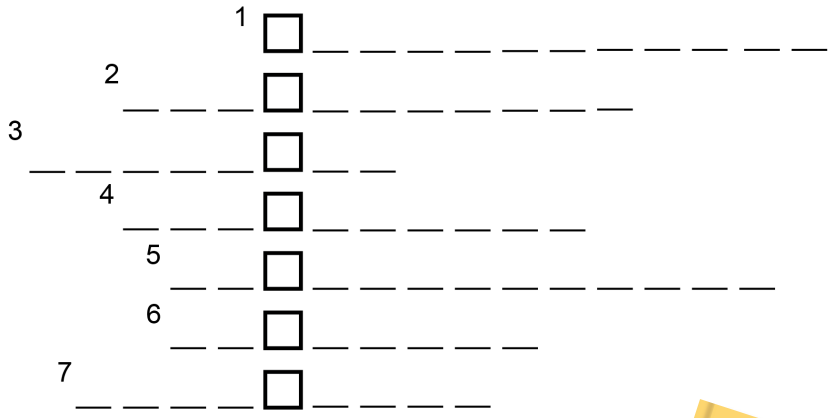
Grant Name	Who is it aimed at?	Who can apply?	Maximum Funded	Deadline	More info…
Undergraduate Research Bursaries (URB)	Aimed at giving undergraduate students the opportunity to acquire research skills and experience.	Applications must be submitted by the principal supervisor. Principal supervisor must be a member of the Association.	£444.85 per week. Maximum of 8 weeks.	**1st February**	
Grant-in-aid	Aimed at organisers of scientific meetings, workshops and short courses.	Organisers of scientific meetings, workshops and short courses.	Up to £2,000.	**1st March** and **1st September**	
Research Grants	To support a single research project, or a 'proof of concept' proposal.	Principal applicant must be a member of the Association.	Up to £10,000.	**1st March**	
Small Grants Scheme	To fund palaeontological research, travel and fieldwork.	Applicant must be a member of the Association. Preference is given to students, ECRs, and retired members.	Up to £1,500.	**30th September**	

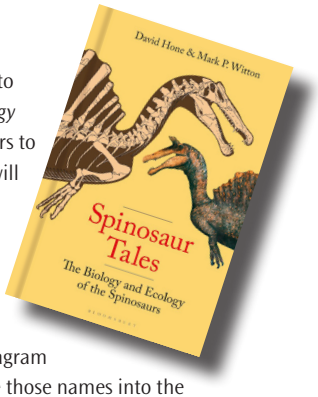
Postgraduate Travel Fund	To support attendance of international meetings.	Postgraduate students who are members of the Association.	Up to £300.	**No deadline.** Applications accepted throughout the year.	
Engagement Grants	To encourage educational outreach, public engagement, and related initiatives with palaeontological themes.	Open to all.	Normally up to £5,000. Up to £8,000 under exceptional circumstances.	**1st September**	
Career Development Grant	To assist talented early career researchers who have recently completed their PhD to strengthen their CVs.	Postgraduate students who are members of the Association, about to submit a PhD thesis or within one year of submission.	Up to £2,500.	**7th October**	
Carer's Bursary	To support attendance at Association meetings by researchers with caring responsibilities.	All members of the Association.	Up to £250.	**Normally a few weeks before ProgPal and the Annual Meeting each year.**	

PalAss Puzzle #3

Set by Barbarossa

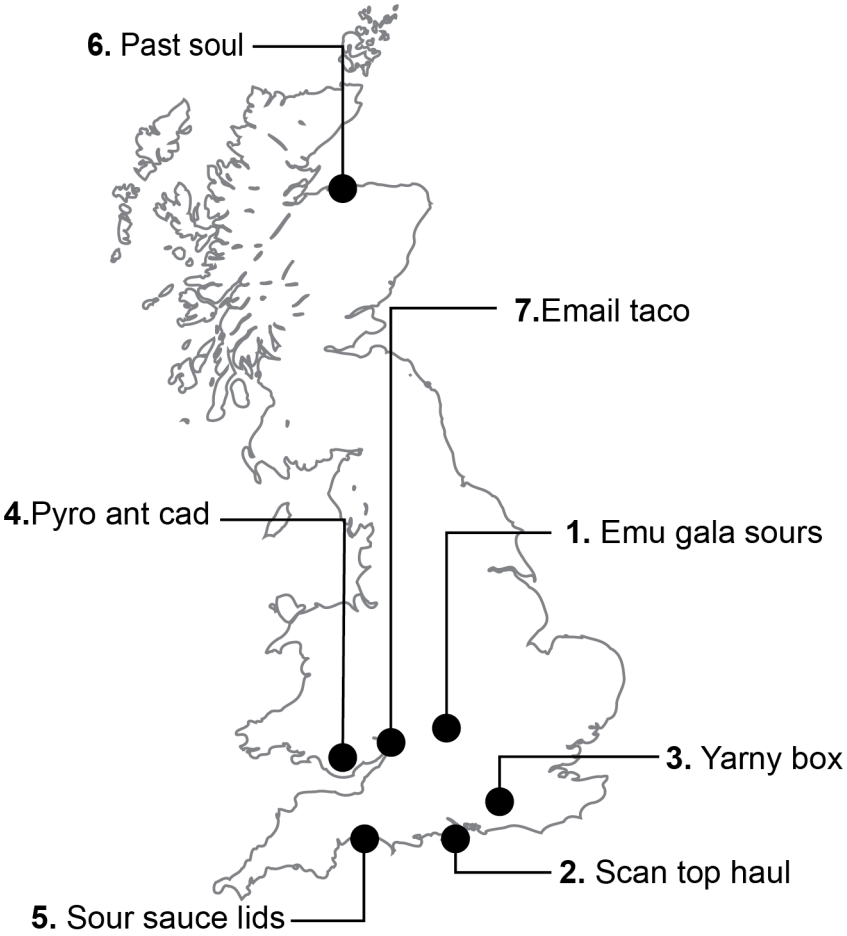
Welcome to this edition of the PalAss Puzzle!





Excitingly for this issue we are able to provide a *bona fide* prize, thanks to Bloomsbury, who have given us five copies of *Spinosaur Tales: the Biology and Ecology of the Spinosaurs* to give away. The first five PalAss members to e-mail <**bookreview@palass.org**> with a correctly solved puzzle grid will get a free copy of the book posted to them, along with their name (and photograph if desired) printed on the next puzzle page, to be admired and envied by *Newsletter* readers the world over.

The theme of this puzzle is dinosaurs of Great Britain. Seven localities are marked on the map opposite, each linked to an anagram. Each anagram when solved will give you a dinosaur genus found at that locality. Place those names into the corresponding numbered row of the grid, and the bold square boxes will spell the name of a prominent British dinosaur palaeontologist, most famous for describing a British dinosaur which does not feature among the anagrams.


6. Past soul
7.Email taco
4.Pyro ant cad
1. Emu gala sours
3. Yarny box
2. Scan top haul
5. Sour sauce lids

Solution to PalAss puzzle #2:

1 T R I A S S I C

2 L O C H K O V I A N

3 P E N N S Y L V A N I A N

4 O R D O V I C I A N

5 G U A D A L U P I A N

6 L U D L O W

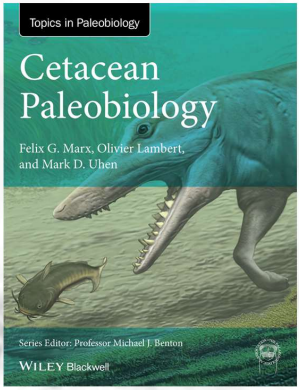
7 C A M B R I A N

8 R H A E T I A N

9 D E V O N I A N

Congratulations to the winner of PalAss Puzzle #2, Benjamin Weston, who was the first to e-mail with the correct solution to the last puzzle!

Image courtesy of Benjamin Weston.



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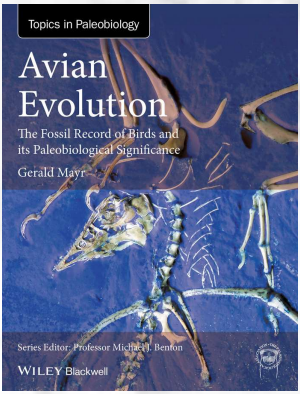
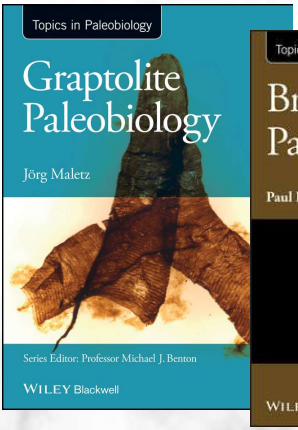
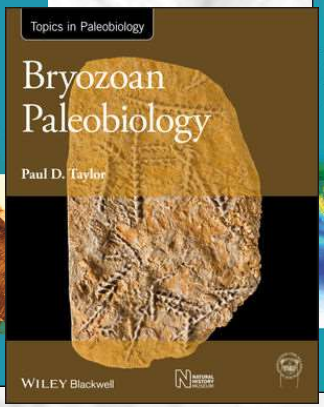


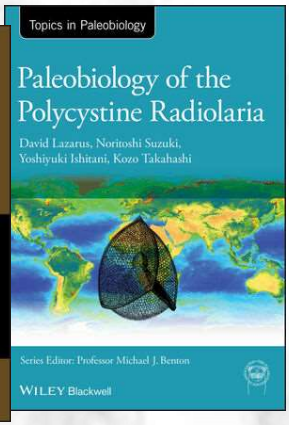
TOPA Topics in Paleobiology

All titles are available via the Wiley website with 30% discount for PalAss members. Log in to your PalAss account at www.palass.org for the discount code.

New titles now available!







Newsletter copy

Information – whether copy as such or Newsletter messages, review material, news, emergencies and advertising suggestions – can be sent to Newsletter Editor Harriet Drage via e-mail to <**newsletter@palass.org**>).
The *Newsletter* is prepared by Nick Stroud, and printed by Y Lolfa, Talybont, Ceredigion.

Deadline for copy for Issue No. 122 is 1st June 2026.

Palaeontological Association on the Internet

The Palaeontological Association website can be found at <**http://www.palass.org/**> and includes information about the Association, and PDF copies of the *Newsletter*. Internet Officer Russell Garwood can be reached by e-mail at <**webmaster@palass.org**>.

Advertising in the Newsletter

Advertising space in the *Newsletter* will be made available at the rates given below to any organization or individual provided the content is appropriate to the aims of the Palaeontological Association. Association Members receive a 30% discount on the rates listed. All copy will be subjected to editorial control. Although every effort will be made to ensure the *bona fide* nature of advertisements in the *Newsletter*, the Palaeontological Association cannot accept any responsibility for their content.

£200 for half a page £300 for a full page

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