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The Palaeontology Newsletter

Contents

Reminder: The deadline for copy for Issue no. 106 is 8th February 2021.

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Editorial

The *Newsletter* continues to survive the pandemic unscathed, with a full slate of contributions once again. There are a lot of Association updates in this issue. Our promised statement on the Black Lives Matter movement appears and includes many ways in which we can work to improve our poor racial diversity. Other areas for improvement are also identified in a summary of the results from our anonymous survey following last year's Annual Meeting. **Uwe Balthasar** gives an update on an extension to our Exceptional Lecturer scheme (do consider applying, or pass the advert on to your favourite speaker(s)). At the back of this Newsletter we have the tables of contents of the final print issues of the Association's journals, before we move to online-only publishing as detailed by Sally Thomas in *Newsletter* **103**; a significant change after 63 years of printing. This issue also includes some updates on our upcoming Virtual Annual Meeting, but to keep as up-to-date as possible keep an eye on our online outlets, such as the webpage (<**https://www.palass.org/meetings-events/annual-meeting/2020/annual-meeting-2020-virtual-meeting-overview**>) or our Twitter account (@ThePalAss). Finally, one way you can directly contribute to the future of the Association is through voting for new Council members. We have an unusually large number of Council openings for 2021 and many of them have multiple candidates standing, so do read their personal statements (see pages 5–9) so you can make an informed choice when asked to vote online later this year.

Elsewhere, the Association has already hosted a virtual meeting in 2020, after the Leeds Progressive Palaeontology crew impressively switched to, and delivered, a virtual meeting in just three months – effectively organizing two different meetings, one at very short notice! Part of the organizing committee (**Bethany Allen**, **Owain Fletcher Williams**, **Frances Procter** and **Ailsa Roper**) give a frank account of their experiences, including results from their own post-meeting survey. It is worth noting that attendance was the highest ever for the meeting – indicating how such meetings can increase inclusivity – and I would especially highlight their concluding sentence: "While virtual conferences have risen in popularity during the COVID-19 pandemic, we believe that they represent an opportunity rather than a compromise, and hope to see them diversify and thrive in the years to come". In their own report of the meeting, **Miranta Kouvari** and **Cecily Nichols** – who will organize next year's meeting – were clearly impressed. If you are looking for somewhere to divert funds you have saved from missing out on in-person meetings in 2020 there are a couple of palaeontological causes looking for donations in this issue: **Sarah Slaughter** gives an update on recent damage to the famous Crystal Palace dinosaurs, and for Behind The Scenes At The Museum **Alexander Kellner** gives an update on the recovery efforts from the 2018 Museu Nacional fire.

The many regular contributions are also here. **Susie Lydon**'s news column has a more "adult" theme than normal – covering both ostracod sperm and the origin story of North America's newest rock unit, the "Heck Creek Formation" – and includes the usual **Ellis Jones** cartoon. Ellis' artwork also appears in this issue's Greatest Ever Graphs, where **David Černý** discusses how Tanja Stadler's work unlocked the historically problematic issue of how we recognize ancestors in the fossil record. Aspects of Tanja's work may eventually appear in **April Wright**'s Bayesian phylogenetics column, where the focus this time is the Mk model and MCMC analysis. **Tasnuva Ferdous Ming Khan**, **Nuria Melisa Morales Garcia** and **Vishruth Venkat** are this issue's

palaeontologists abroad, giving their accounts of life in Germany/USA, the UK and the UK/USA, respectively, and **Paul Barrett** tells the movie-worthy story of Franz, Baron Nopcsa von Felso-Szilvás for this issue's Legends of Rock. **Jan Zalasiewicz** discusses the surprising fossil record of the humble earthworm, and **Shaena Montari** is the subject of the Careers Q&A – discussing how she has translated her palaeontological skills into a career in journalism. After an absence last time, the Book Reviews (managed by **Tom Challands**) return with three titles, and our Spotlight on Diversity is a double bill, with pieces by **Orla Bath Enright** and **Farid Saleh** on managing diabetes in palaeontology and the experience of being Lebanese in a dominantly European field, respectively.

Finally, as this is my last issue as Editor I would like to say some quick thank yous. Firstly, to the many contributors who have given up their time for free to produce the many articles that have appeared across my nine issues, but also to our Executive Officer (**Jo Hellawell**) and Typesetter (**Nick Stroud**), whose work largely goes unrecognized, but is essential to the appearance of every issue. I am sure they will be just as supportive to my successor.

Graeme Lloyd
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Association Business

Annual Meeting 2020

Notification is given of the 64th Annual General Meeting

The Annual General Meeting (AGM) will be held on Thursday 17th December 2020. COVID-19 continues to have a major impact on all events and, as a Charitable Incorporated Organisation, we are now able to hold our AGM and other members' meetings online; this has been made possible by the Corporate Insolvency and Governance Act 2020. This temporary amendment allows the AGM to be conducted via electronic means, and although members still have the right to vote, the Association can now require this to be done electronically, or by other means (such as by post). Council will inform the membership of the exact format of the AGM and voting procedures via e-mail, or by post for those members with no access to e-mail.

AGENDA

1. Apologies for absence
2. Minutes of the 63rd AGM, University of Valencia
3. Trustees Annual Report for 2019
4. Accounts and Balance Sheet for 2019 and election of financial examiner*
5. Election of Council and vote of thanks to retiring members
6. Resolution to amend the Constitution
7. Report on Council Awards

* Papers pertaining to these agenda items were published in the previous Newsletter, available online at <**www.palass.org**>, and will be included in full in the Programme and Abstracts of the Annual Meeting.

Nominations for Council

At the AGM in December 2020, the following vacancies will occur on Council:

- Vice President
- Treasurer
- Newsletter Editor
- Book Review Editor
- Education Officer
- Meetings Coordinator
- Diversity Officer
- Ordinary Member (up to one vacancy) *

* This positions is dependent on a Council member currently holding this post moving to another Council post.

Nominations received thus far are as follows:

- Vice-President: Richard Butler
- Treasurer: Manabu Sakamoto, Paul Varotsis
- Newsletter Editor: Emilia Jarochowska
- Book Review Editor: Karen Bacon, Thomas Clements, Thomas Hegna
- Education Officer: Elspeth Wallace
- Meetings Coordinator: Konstantina Agiadi, Uwe Balthasar
- Diversity Officer: Farid Saleh
- Ordinary Member (0-1 position): Tracy Aze, Borja Cascales-Miñana, Sherri Donaldson, Christine Strullu-Derrien, Robert Theodore, Thomas Wong Hearing,

As there are multiple nominations for the Treasurer, Book Review Editor, Meetings Coordinator and Ordinary Member posts there will be an election conducted prior to the Annual General Meeting. This will take place electronically (or by post for those without electronic access) as per Schedule 14 clause 3(4) of the Corporate Insolvency and Governance Act 2020. Voting instructions will be sent via e-mail (or post) to all voting members in late November, to allow for all votes to be cast and then counted in time for election results to be announced at the AGM. The statements of interest for the posts by the nominated persons are as follows.

Nominations for Treasurer:

Manabu Sakamoto

I am standing for the PalAss Council office of Treasurer. For years, I have enjoyed the privileges of being a member of PalAss, and I feel it is a good time to offer up my services to the palaeontological community that has helped me throughout my academic career. As a palaeontologist, I have a varied background, having had my undergrad education in Japan, MSc and PhD at Bristol, three postdocs in the UK as well as industry experience as a data scientist, and finally a permanent position as Senior Lecturer at Lincoln. Therefore, I bring to the Council a unique perspective – that of an international student and researcher and the experiences involved. I am passionate about diversity, equity and inclusion, and have a keen interest in making the palaeontological community accessible to under-represented and marginalized groups. Having a seat on the Council, I would have the opportunity to partake in meaningful decisions and impactful actions that lead to real changes for the betterment of the community and for society at large. As Treasurer, I hope to steer the Association's financial investments towards causes that lead to social justice and diversity, equity and inclusion.

Paul Varotsis

I have been a member of PalAss for about a decade and regularly attend the Annual Meeting. I am an amateur geologist and palaeontologist, graduated with a BSc in Geology from Birkbeck in 2014; I then started a part-time PhD at UCL/NHM on *Dorsetisaurus*, a Mesozoic lizard. Unfortunately, I had to drop out as a result of family obligations. I have had a career in banking and asset-management and am familiar with the financial needs of a scientific charity as I have been trustee and portfolio manager of the Friends of the Muséum national d'Histoire naturelle in Paris, a charity with about

4,000 members that organizes lectures, field-trips, distributes grants and purchases items for the museum collections. After a decade I have informed the board that I plan to resign in 2021. My CV can be found on my LinkedIn page: <**https://www.linkedin.com/in/paul-varotsis-2473926/**>.

Nominations for Book Review Editor:

Karen Bacon

I wish to be considered for the vacant Council position of Book Review Editor. I have been a member of PalAss for over ten years and am interested in becoming more actively involved in the society. I hold a PhD in palaeobotany and have over ten years' experience in palaeobotany and general palaeontology/palaeoecology research and teaching. My research background is focused on palaeobotany and my teaching experience includes a wide range of palaeontological topics, *e.g.* palaeoecology, taphonomy and evolution of both plants and animals. I also have two years' experience acting as a scientific writer and editor for HW Wilson abstracting service so understand how to edit other people's writing without removing their style or voice. I feel that my broad interests and experience would allow me to contribute effectively to this role.

Thomas Clements

I am running for the role of Book Review Editor as I thoroughly enjoyed taking on the role this year for the period that Dr Challands was on sabbatical. I have forged great contacts with publishers, authors and reviewers during my short stint. If elected I would substantially modernize the role: 1) Historically this role has been passive; waiting for interested parties to contact us to review books. I will take a more proactive role so we can review more books while better utilizing the experience and knowledge of the PalAss membership; 2) We should embrace online formats (*e.g.* videos, docuseries, games *etc*.) related to palaeontology. By including more 'non-traditional' material, we will move into the 21st century and set up a way of communicating brilliant online palaeontological outreach to the membership; 3) Palaeontological books are currently very popular. The PalAss is in a unique position to help fledgling authors, so I propose to set up workshops/virtual meetups with publishers to help talented writers find ways to get their ideas out there; 4) I will facilitate creative writing competitions to encourage members (particularly early-career researchers) to flex their science communication muscles.

Thomas Hegna

I am an Assistant Professor of Palaeontology at the State University of New York at Fredonia (SUNY Fredonia), USA. I grew up in the Midwest of the USA and did my BS (2004) and MS (2006) at the University of Iowa. I then did my PhD at Yale University on the fossil record of branchiopod crustaceans (completed 2012). I began teaching at Western Illinois University in 2011, and made the jump from there to SUNY Fredonia in 2019. I spend my free time researching the arthropod fossil record, in particular branchiopod crustaceans and trilobites. I have authored 36 peer-reviewed papers, 76 conference presentations, and ten book reviews. I have served as an associate editor for the *Journal of Paleontology* for four years and co-edited a special issue of *Zoological Studies*. More relevant to the job at hand, I am a bibliophile who tries hard to keep his finger on the pulse of published palaeontological work. I would relish the chance to see new books as they come in, and then get them into the hands of the most appropriate reviewers.

Nominations for Meetings Coordinator:

Konstantina Agiadi

I hereby would like to express my interest to be part of the Association's Council as the Meetings Coordinator (three-year term). I have been an undergraduate and postgraduate student, a PhD Fellow and a Postdoctoral Researcher at the Department of Historical Geology and Palaeontology of the National and Kapodistrian University of Athens for my entire adult life of 14 years. Next month, I will start working as a Lise Meitner Postdoctoral Fellow at the Department of Palaeontology of the University of Vienna. My long experience in a country with very limited funding for participating in networking activities has taught me the great value of such opportunities especially for early-career researchers. Personally, I gained tremendously from my membership in the COST Action MedSalt (<**www.medsalt.eu**>) management committee, as well as through my often self-funded participation in scientific conferences. However, not everyone is as lucky. For these reasons, I believe I can contribute to the goals of the Association and the improvement of the academic environment particularly for young researchers.

Uwe Balthasar

I am a lecturer of palaeontology at the University of Plymouth with a broad research interest including brachiopods, taphonomy and the evolution of biomineralization. Before starting my lectureship in Plymouth in 2014, I had a string of postdocs at the universities of Cambridge, Uppsala and Glasgow, and since 2017 I have served on the Council of the Palaeontological Association as Meetings Coordinator. Throughout my career, PalAss has been invaluable to keep me rooted in the palaeontology community while moving from job to job and I feel a strong sense of responsibility to return the support I have received. Furthermore, I am keen to ensure that palaeontology as a subject is promoted as a relevant cutting-edge interdisciplinary science. Towards this end, I instigated the Exceptional Lecturer series, which is now in its second year. Having studied in Germany and Canada, and having had a postdoc in Sweden, I also bring an international perspective to the Council. I would be honoured to have a second term as Meetings Coordinator.

Nominations for Ordinary Member:

Tracy Aze

I am Associate Professor of Marine Micropaleontology at the University of Leeds and have nearly ten years of professional experience as a palaeontologist. I have served on the committee of the Micropalaeontological Society as both Foraminifera Group Secretary (2015–2017) and Events Secretary (2017–2020). These roles required attendance of the four committee meetings per year, voting on awards, prizes and funding applications and the general running of the society, group meetings and outreach activities. I liaised with all Sub-Group Chairs and Secretaries to support meeting activities and to promote and advertise meetings of interest to the society members. I proposed and devised the Code of Conduct for meetings, which also included a social media Code of Conduct, in order to make our society meetings supportive, inclusive and of the highest professional standard. I also produced the first society Risk Assessment Strategy for fieldwork associated with our Society Meetings, again ensuring inclusivity and high professional standards. I believe this experience would make me a useful addition to the PalAss Council.

Borja Cascales-Miñana

As a Spanish citizen with international experience, I am currently working as a research scientist of the CNRS at the University of Lille, France. My research interests cover the early evolution of vascular plant and Palaeozoic floras, with special interest in the study of the first terrestrial ecosystems. Overall, my activity involves the use of data analysis and regular fieldwork for the study of plant macrofossils and spore diversity. In parallel, I have always been interested in participating in promoting science, in particular palaeobotany (currently as Vice-President of Agora Paleobotanica <**https://agorapaleobotanica.wordpress.com**>). The PalAss is one of the most reputed palaeontological associations around the world, and it would be an honour for me to serve as an Ordinary Member of Council.

Sherri Donaldson

Fossils and geology excite me! For the past three years I have been a Palaeobiology Volunteer at National Museums Scotland in Edinburgh, helping to curate the fossils and extract data from the associated hand-written registers belonging to the historically important Hugh Miller Collection. I also volunteer with the Australian Opal Centre on their fossil collection. As a mature Geology graduate from the COVID-Class of 2020, University of Aberdeen, I've a particular interest in the palaeoecology of mid-Cretaceous Griman Creek Formation in Australia. I've enjoyed a successful 30+ year career in learning design and development, delivering projects across the globe, in a variety of industries. My skills encompass working collaboratively with multi-national teams; organizing exhibitions; managing projects, budgets and tenders; fieldwork logistics planning; and technical writing for regulatory compliance. I love presenting; communicating clearly and without ambiguity is one of my biggest strengths. As a PalAss member, I've attended the last two Annual Meetings and their field-trips, and absolutely loved being immersed in new science and being a part of the global palaeontological community. I'm excited to be considered as an Ordinary Member of the PalAss Council, as I feel my experience coupled with academic enthusiasm will be an asset to the Association. I appreciate serving on the Council is a privilege and look forward to doing so with pride.

Christine Strullu-Derrien

I am an independent researcher, a Scientific Associate at the Natural History Museum, London, based in France. I work on the origin and evolution of fungi and on their relationships with plants, with interests in the anatomy of fossil plants. I really appreciate the crucial role that PalAss plays in promoting all of palaeontology. The Association has been incredibly supportive to my research in the past, having previously received a Research Grant that allowed me to study important fungi and associated organisms in early freshwater environments. Because I consider that science needs to be explained to a wide audience, I am keen to organize or participate in outreach activities. As such I would like to volunteer for the role of Ordinary Member. I think this is a role in which I can help the Association, for example supporting the Meeting Coordinator or the Newsletter Editor. I have experience in the role of editor, being a new member of the editorial board of *Botany Letters*. In addition, I'm keen to help promote the PalAss' outreach efforts. Being part of Council will be a way of giving back to the palaeontology community for the support PalAss has shown me.

Robert Theodore

My role at the Sedgwick Museum supports the promotion of Earth sciences at the University of Cambridge through physical and digital exhibitions. I am confident I can bring valuable science communication experience to support the Association's aim of promoting research in palaeontology

to a broader public. I am interested in how palaeontology can be a powerful, reliable source of information around global issues such as climate change and biodiversity. Palaeontological collections are a valuable resource for research into slavery and colonialism and I have an active lead role in undertaking and facilitating this research at the Sedgwick, including research into the Bernissart Iguanodon cast donated by King Leopold II of Belgium. As a Black British palaeontologist, I am under-represented in the PalAss membership and in Earth sciences more generally. However, I interact face-to-face with museum audiences daily, challenging stereotypes of what a palaeontologist looks like and the work they do. The Association's aims to address the lack of racial diversity in its membership and broaden its appeal aligns with my own values. I gave constructive consultation on the PalAss Black Lives Matter statement and wish to support the actions detailed within it.

Thomas Wong Hearing

I am a Doctor-Assistant and Research Fellow at Ghent University, Belgium. In my short career in academic palaeontology I have greatly benefited from membership of the Palaeontological Association, especially getting to know an enthusiastic and supportive group of professional and amateur palaeontologists. I now feel that I am in a position to help develop the community as a member of Council. During my PhD I represented the interests of research students on department-level committees and was a lead organizer of *Progressive Palaeontology*. As an Ordinary Member I will continue to be an advocate for early-career members of the Association. I have been an ambassador for geology and palaeontology throughout my career, mainly working with secondary school pupils. I know the importance of integrating the experiences and expertise of diverse stakeholders when organizing effective outreach work, and I will encourage this integration across the Association's activities. Finally, I am particularly keen on encouraging equity and transparency in decision-making. As an Ordinary Member, I will focus my efforts on increasing the transparency of decision-making within the Association, and on improving the reality and perception of equity, diversity and inclusion at all levels within the Association, including in the grants and prizes.

Awards and Prizes

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. Members considering making nominations should first read the Palaeontological Association 'Statement of Diversity' below.

Statement of Diversity

The Palaeontological Association has an Unconscious Bias document (available on the Association website), the recommendations of which will be adhered to at all times. All decision-making for Palaeontological Association awards and prizes will be carried out objectively and professionally. The Association is committed to making award and prize decisions purely on the basis of the merit of the individual(s). No nominee for awards or prizes will receive less favourable treatment on the grounds of: gender, marital status, sexual orientation, gender re-assignment, race, colour, nationality, ethnicity or national origins, religion or similar philosophical belief, spent criminal conviction, age or disability. Equally, all nominations will be assessed on equal terms, regardless of the sex, age and/or ethnicity of the nominee. Nominations will therefore be assessed and graded on their merits, in accordance with the criteria and the aims and objectives set for each award or medal. Due consideration will be given to any period away from science due to parental leave, illness or any other such career break. Nominators are reminded that neutral language (*e.g.* gender neutral) should be used in all nominations.

Palaeontological Association Awards/Medals selection procedures

The Palaeontological Association Council discusses Awards and Medals at the May Council meeting and votes to select awardees. The benefit of using Council to select awardees, rather than a dedicated awards committee, is that it draws on the wider experience of the entire Council. Voting is preceded by an introduction from the President that: (i) includes a diversity statement to remind Council of their responsibility in terms of fairness and diversity issues (including impact of non-standard careers *etc.*); (ii) outlines the remit and selection criteria for each award; (iii) considers the impact of awardees in terms of increasing the diversity of recipients. Each award is considered in turn with every application considered except those that clearly fall outside of the remit. Each Council Member will vote by listing their three preferred candidates in rank order. The candidate with the most votes as preferred candidate will be awarded the award/medal. If there are only two candidates and they are tied the President shall have the casting vote. If there are three or more candidates and there is a tie the vote will be recounted including the second ranked candidate for all of the votes. If the vote remains a draw after second and third ranked candidates are considered the President will cast the deciding vote.

Lapworth Medal

The Lapworth Medal is the most prestigious honour bestowed by the Association 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, but Council will look for breadth as well as depth in the contributions in choosing suitable candidates.

The candidate must be nominated by two members of the Association (proposer and seconder; names and contact details required). The nomination must consist of: (i) a two-page career summary (font-size 12); (ii) a list of ten papers that demonstrate significance and breadth of research. The two-page career summary should outline the significant contribution to the science in terms of research and also other activities such as outreach, teaching, mentoring and administration (including that relevant to palaeontology at their home institutions, scientific societies and at higher levels, such as funding bodies and government advisory panels). We are looking for evidence of both depth and breadth in research with clearly identified achievements and breakthroughs. Relevant honours and awards may be mentioned. If a candidate has taken time out from their professional career for family or other purposes this should be highlighted. Nominations must be compiled into a PDF file of less than 10 MB and uploaded to the Association website by the deadline.

The award will be considered by Council at its May meeting and awardees will be invited to a ceremony at the Annual Meeting in December. Awards will also be announced in the *Newsletter*, on the Association website and through social media. Council reserves the right not to make an award in any particular year.

Nominations are invited by **31st March** each year.

President's Medal

The President's Medal is a mid-career award given by Council to a palaeontologist who has had between 15 and 25 years of full-time experience after their PhD (excluding periods of parental or other leave, but not excluding periods spent working in industry) in recognition of outstanding contributions in his/her earlier career, coupled with an expectation that they will continue to contribute significantly to the subject in their further work.

The candidate must be nominated by two members of the Association (proposer and seconder; names and contacts details required). The nomination must consist of: (i) a statement of when the PhD was awarded; (ii) a two-page career summary (font-size 12); (iii) a list of ten papers that demonstrate significance and breadth of research. The two-page career summary should outline the significant contribution to the science in terms of research and also other activities such as outreach, teaching, mentoring and administration. We are looking for evidence of significance of research with clearly identified achievements and breakthroughs. If a candidate has taken time out from their professional career for family or other purposes this should be highlighted. Nominations must be compiled into a PDF file of less than 10 MB and uploaded to the Association website by the deadline.

The award will be considered by Council at its May meeting and awardees will be invited to a ceremony at the Annual Meeting in December. Awards will also be announced in the *Newsletter*, on the Association website and through social media. Council reserves the right not to make an award in any particular year.

Nominations are invited by **31st March** each year.

Hodson Award

The Hodson Award is conferred on a palaeontologist who has had no more than ten years of full-time experience after their PhD (excluding periods of parental or other leave, but not excluding periods spent working in industry) and who has made a notable contribution to the science.

The candidate must be nominated by two members of the Association (proposer and seconder; names and contacts details required). The nomination must consist of: (i) a statement of when the PhD was awarded; (ii) a two-page career summary (font-size 12); (iii) a list of ten papers that demonstrate significance and breadth of research. The two-page career summary should provide evidence of outstanding contribution in career so far. If a candidate has taken time out from their professional career for family or other purposes this should be highlighted. Nominations must be compiled into a PDF file of less than 10 MB and uploaded to the Association website by the deadline.

Nominations will be considered by Council at its May meeting and awardees will be invited to a ceremony at the Annual Meeting in December. Awards will also be announced in the *Newsletter*, on the Association website and through social media. Council reserves the right not to make an award in any particular year.

Nominations are invited by **31st March** each year.

Mary Anning Award

The Mary Anning award 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 candidate must be nominated by two members of the Association (proposer and seconder; names and contacts details required). The nomination must consist of: (i) a statement confirming that the nominee is NOT professionally employed in palaeontology; (ii) a one-page career summary (font-size 12). The one-page career summary should outline the nominee's contribution to palaeontology. This should include details of the sorts of activities pertaining to development of fossil collections, curation, care and maintenance of fossil collections, publications relating to these fossil collections, evidence for outreach activities associated with these fossil collections. Nominations must be compiled into a PDF file of less than 10 MB and uploaded to the Association website by the deadline.

Nominations will be considered by Council at its May meeting. Awardees will be invited to a ceremony at the Annual Meeting in December, although the award may be presented at another time and place on request of the awardee. Awards will be announced in the *Newsletter*, on the Association website and through social media. Council reserves the right not to make an award in any particular year.

Nominations are invited by **31st March** each year.

Gertrude Elles Award

The Gertrude Elles Award is to promote high-quality public engagement in the field of palaeontology. The award is made by Council for high-quality, amateur or institutional, public engagement projects that promote the discipline. 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.

Nominations must consist of a one-page supporting case (font-size 12) and a portfolio of up to four images. The supporting case must outline:

- the aims of the project
- the nature of the target audience
- the available budget and funding sources
- visitor/audience members
- the results of project evaluation to demonstrate the quality and effectiveness of the project
- links to any digital components
- mechanisms for obtaining feedback

Self-nominations are permitted, and the nominators (names and contacts details required) and proposed recipients do not need to be members of the Association. Nominations will be considered relative to the scale of the institution and the available project budget. The supporting case and the portfolio of images must be compiled into a PDF file of less than 10 MB and uploaded to the Association website by the deadline.

The award will be considered by Council at its May meeting and winners will be invited to the award ceremony at the Annual Meeting in December. Awards will also be announced in the *Newsletter*, on the Association website and through social media. Council reserves the right not to make an award in any particular year.

Nominations are invited by **31st March** each year.

Honorary Life Membership

Honorary Life Membership recognizes individuals whom Council deem to have been significant benefactors and/or supporters of the Association. Recipients will receive free membership for life.

The candidate must be nominated by two members of the Association (proposer and seconder; names and contact details required). The nomination must consist of a one-page statement (font-size 12) outlining nature of support for the Palaeontological Association. This should be uploaded to the Association website by the deadline.

The award will be considered by Council at its May meeting and announced at the AGM. The award will also be announced in the *Newsletter*, on the Association website and through social media.

Nominations are invited by **31st March** each year.

Annual Meeting President's Prize and Council Poster Prize

These prizes are awarded for the best talk and best poster at the Annual Meeting. All student members of the Palaeontological 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), excluding periods of parental or other leave, are eligible for consideration for these awards. Individuals may nominate themselves for consideration when submitting abstracts for the meeting. Each prize consists of a cash award of £200, and is announced immediately after the oral sessions at the end of the Annual Meeting.

Best Paper Awards

The aim of this award is to recognize papers published in either *Palaeontology* or *Papers in Palaeontology* and reward excellence in our field of science. The selection criteria are as follows: scientific breadth and impact; novelty of approach; and quality of writing and illustration. The awards are open to all authors irrespective of age and nationality; membership of the Association is not required. Frontiers reviews, rapid communications and regular research articles are all eligible. The selection procedure is that a list of all papers published in the year will be drawn up in October (when papers for final parts are allocated) and circulated around the science editors. The science editors are asked to nominate any papers that stand out, providing 2–3 sentences explaining why they are deserving. The Editor-in-chief will draw up a shortlist of no more than five papers with supporting statements to circulate to the Editorial Board. The Editorial Board will then select winners by vote. Corresponding authors of winning papers will be offered 'Gold open access' paid for by the Association for one nominated paper submitted to *Palaeontology/Papers in Palaeontology* within the following 18 months (and subsequently accepted). In the case of joint authorship papers, corresponding authors can, by agreement, transfer the prize to one of the co-authors. The Editor-in-chief will contact the winning authors and write short synopses for the *Newsletter*. An announcement of the awards will also be made at the AGM.

Undergraduate Prize Scheme

The Undergraduate Prize Scheme annually invites all university departments where a palaeontology course or module is taught after the first year as part of a degree programme to recommend one of their undergraduate students to receive this award. The award consists of a certificate and free membership of the Association for the rest of the year in question, plus the following calendar year. It provides electronic access to both of our journals, postal copies of the *Newsletter*, and all the other advantages of membership. Receipt of the award also looks good on a recipient's CV.

Departments may use any criterion for selection, though most prefer to use the scheme as an acknowledgement of best performance in a relevant exam or project. Only one nomination will be accepted from any one institution in each calendar year. The nominee must be an undergraduate student, not a postgraduate, when they are selected. Normally the award is made to a student in the penultimate year of study, but a final-year candidate may be chosen if this is deemed more appropriate for the department in question.

Contact <**executive@palass.org**> with the nomination (name and e-mail address) and we will arrange to sign up the student as a member and send them a certificate. There is no deadline for this award.

Innovations in Palaeontology Lecture Series and the PalAss Exceptional Lecturer

The Innovations in Palaeontology Lecture Series, to be given by the PalAss Exceptional Lecturer, aims to promote palaeontology to the wider academic community and to recognize excellence in research among palaeontologists. The PalAss Exceptional Lecturer is selected in a competitive process. This scheme aims to:

- improve the dissemination of cutting-edge palaeontological research to the broader academic community;
- raise the profile of palaeontology within the Earth sciences and related fields;
- recognize outstanding research and science communication in palaeontology among members of the Association.

Format of the scheme:

- One PalAss Exceptional Lecturer will be selected each year in a competitive process.
- The PalAss Exceptional Lecturer will be expected to give five lectures at five different institutions over a nine-month period.
- The successful applicant will receive the Innovations in Palaeontology Lecture Series Grant, which will be administered by the home institution of the PalAss Exceptional Lecturer.
- The Innovations in Palaeontology Lecture Series Grant may only be used to pay the reasonable travel costs incurred by the PalAss Exceptional Lecturer to visit each of the host institutions (up to £2,000 for the total Innovations in Palaeontology Lecture Series with a maximum of £500 for any individual lecture). The host institutions will cover costs for accommodation (where necessary) and hospitality.
- Any academic institution (universities and/or museums) from any country can apply to participate in the Innovations in Palaeontology Lecture Series as a host institution.
- Any unused funds must be returned to PalAss after delivery of the final lecture. Should the PalAss Exceptional Lecturer move institutions within the timeframe of the lecture series, any unspent funds must remain available to the PalAss Exceptional Lecturer.
- Applications to be a PalAss Exceptional Lecturer will be strengthened if the applicant agrees to submit a paper as a review article for possible publication in *Palaeontology*.

Eligibility and selection process of the PalAss Exceptional Lecturer:

- Eligible candidates will have a PhD in palaeontology or a related field.
- Applicants can reside in any country, but must be members of the Association.

- Candidates must self-nominate.
- To self-nominate, a two-page CV, full list of publications, and statement of motivation (max. 300 words) must be submitted via the Association's webpage as a single PDF format file (max. 8 MB). In addition, a 60 second video summary (in MP4 format; max. size 30 MB) of a proposed seminar topic must be submitted via the Association's webpage.
- The PalAss Exceptional Lecturer will be chosen based on the career track record, including research impact (relative to their career stage) and oratorical skills.

Selection of host institutions:

- Institutions interested in participating in the Innovations in Palaeontology Lecture Series should apply via the PalAss webpage and suggest a timeframe within which the lecture should be given.
- The PalAss Exceptional Lecturer will receive the list of potential host institutions after the 1st May deadline, and will choose their preferred hosts and liaise directly with them. Applications after the 1st of May will be considered depending on the remaining availability.

Expectations for host institutions:

- Each lecture must be widely advertised across the host institution. We particularly encourage advertisement of the Innovations in Palaeontology Lecture Series on social media.
- Host institutions are expected to pay for hospitality and offer a meal in a social environment to the PalAss Exceptional Lecturer.
- If the PalAss Exceptional Lecturer has to travel more than three hours to the host institution or cannot return home at a reasonable time, the host institution must offer at least one night of accommodation.

Deadlines each year:

- 1st September: Deadline for nominations for the PalAss Exceptional Lecturer. **NB:** for 2020 the deadline has been extended to 30th November.
- December: The PalAss Exceptional Lecturer will be announced at the Annual Meeting.
- February: The call for host institutions to participate in the Innovations in Palaeontology Lecture Series will be published in the spring *Newsletter*.
- 1st May: Deadline for applications from host institutions.
- September – May: delivery of lectures.

GRANTS

Palaeontological Association grants are offered to encourage research, education and outreach through different means. Undergraduates, early-stage researchers, and otherwise unfunded persons are given special encouragement 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 may be found on the Association's website (<**www.palass.org**>). Those with deadlines in the next six months are detailed below.

Undergraduate Research Bursaries

The Palaeontological Association Undergraduate Research Bursaries are aimed at giving undergraduate students the opportunity to acquire research skills and experience that will significantly transform their academic career. The bursaries will support projects co-designed by students and their supervisor(s) that give students registered for an undergraduate degree their first experience of undertaking a palaeontological research project; students and supervisors from all countries are encouraged to apply. The bursaries provide a stipend for the student for up to eight weeks. The scheme is not intended to fund students to undertake routine work for the supervisor(s) and the Association expects the supervisor(s) to provide significant personal mentoring of successful student applicants. Students from under-represented groups will be given priority.

Applications should be made by the principal supervisor through online submission via the appropriate page on the Association's website, and will include:

- Details of the principal supervisor making the application, and other members of the supervisory team
- Details of the named student
- An account of the project aims, methods and expected outcomes
- A project plan including details of supervision
- Ethics statement
- A referee statement in support of the named student

After completion of the work, successful **students** are required to produce a short report of the findings suitable for publication in the *Newsletter*. This report should be submitted by e-mail to <**palass@palass.org**> within eight weeks of the stated end date of the project. Successful candidates are requested to prioritize the Association's meetings and publications as media for conveying the research results.

Further details, including eligibility criteria for supervisors and students, and a full list of terms and conditions for the Undergraduate Research Bursaries scheme, can be found on the appropriate page of the Association's website. Enquiries may be made to the Secretary (<**secretary@palass.org**>).

The deadline is **1st February** each year. Successful applicants will be notified by the end of March and funds will normally be available from 1st June. A full list of awards will be announced at the Annual General Meeting.

Research Grants

Awards are made to assist palaeontological research up to a maximum value of £10,000 GBP per award. Normally, grants must support a single research project, or a 'proof of concept' proposal with an aim of supporting future applications to national research funding bodies. Field-based projects are also eligible, but the scientific objectives and outcomes of the research must be made clear.

Applications for investigators' salary costs will only be considered in exceptional circumstances and if awarded all legal and financial liability will lie with the applicant (see: Categories of expenditure for which the Palaeontological Association does not provide support, below).

Other conditions

Preference is given to applications for a single purpose (rather than top-ups of other grant applications). Applicants must be members of the Association and will normally have a PhD and a successful track record as an independent scientific investigator. Current PhD students (*i.e.* those who have not yet been awarded a PhD by the application deadline) are not eligible for this scheme and instead should consider the Small Grants Scheme.

Preference will normally be given to candidates who have not previously won an award. Proposals must fit with the charitable aims of the Association.

Proposals will be ranked on the following criteria:

- Scientific quality of research, novelty and timeliness, likely outputs
- Feasibility, value for money and cost effectiveness
- The scientific track record of the investigator

At the end of the award period a final report (including receipted accounts) will be submitted for review by the Trustees or, where appropriate, external referees. This final report will also be printed in the *Newsletter*. Awardees are asked to prioritise the Association's meetings and publications as media for conveying the research results.

Applications must be submitted electronically through the PalAss website (see below for details of the Required Supporting Information), with a deadline of **1st March**. Successful applications will be reported at the May Council meeting, and funds will normally be available from 1st June. The awards will be announced at the AGM.

Categories of expenditure for which the Palaeontological Association does not provide support

Applicants are advised that the Association does not offer funding for the following costs, and hence none of these items may be included in any budget proposal submitted to the Association.

- Core funding or overheads for institutions. The Association will fund the directly incurred costs of research on awards but, as a charity, we expect the general running costs (*e.g.* indirect costs, estate costs, support services, directly allocated staff costs) to be provided by the host research institution. We will therefore not fund on a proportion of full economic costs (fEC) basis. Attention is drawn to paragraphs 3.31 to 3.37 of the Science and Innovation Investment Framework 2004–2014, HM Treasury (July 2004), which explains arrangements for the provision of overheads linked to charity funding to academic institutions.

- Individual items of equipment over £1,000 GBP, sites, buildings or other capital expenditure.
- Support for attendance at, or organization of, conferences, workshops or exhibitions.
- A shortfall resulting from a withdrawal of or deficiency in public finance.
- Student tuition fees and summer research bursaries.

Further details and a full list of terms and conditions for the Research Grant scheme can be found on the appropriate page of the Association's website. Enquiries may be made to the Secretary (<**secretary@palass.org**>).

The deadline is **1st March** each year. Successful applicants will be notified by mid-May. A full list of awards will be announced at the AGM.

Grants-in-aid: meetings, workshops and short courses

The Association is happy to receive applications for grants from the organizers of scientific meetings, workshops and short courses that lie conformably with its charitable purpose, which is to promote research in palaeontology and its allied sciences. The Association will consider applications up to £2,000. Application must be made in good time (at least nine months before the start of the event) by the scientific organizer(s) of the meeting using the online application form. Such requests will be considered by Council at the May and October Council Meetings each year. If the application is successful, we will require that the support of the Association is acknowledged, preferably with reproduction of the Association's logo, in the meeting/workshop/short course literature and other media. Enquiries may be made to the Secretary (<**secretary@palass.org**>).

Applications should be made through online submission via the appropriate page on the Association's website, for which you will need the following information:

- Title of meeting / workshop / short course
- Date and Place proposed
- Name, position, and affiliation of the organizer(s)
- Brief description (not more than ten lines) of the rationale behind the meeting / workshop / short course
- Anticipated number of attendees
- Amount requested (also whether request is for a loan or a grant)
- Other sources of funding applied for
- Specific use to which requested funds will be put

Note: If funds are requested to support one or more keynote speakers, then full details of their names, affiliations and titles of presentations should be included. The application will be strengthened if keynote speakers agree to submit their papers as review articles for possible publication in *Palaeontology*.

The deadlines are **1st March** and **1st September** each year.

#BlackLivesMatter

Following recent events in the USA we are reminded that systematic racism is detrimental to the lives and well-being of Black people everywhere. Racism and prejudice, in any form, are not tolerated by the Palaeontological Association. The Association is committed to providing equality of opportunity and increasing diversity within palaeontology. Equitable practices lead to more productive and innovative organizations. However, if we want science to improve for the benefit of everyone, we have to be more active in supporting activities and behaviours, including anti-racism, that lead to meaningful change.

We stand in solidarity with Black members of the Association, as well as those in the geosciences and the wider scientific community.

The racism and risk of harassment or violence that some people face in their daily lives is not unconnected to diversity and inclusion in the scientific community. As palaeontologists, we see a major lack of diversity in our discipline. In the geosciences, Black people remain under-represented at all academic levels, and palaeontology is no exception: <1 % of respondents to the Association's 2017/2018 Diversity Study identified as Black. The results of our study reveal that the Association and our community have not done the work required to ensure parity in the employment and career progression of people from ethnic minorities in palaeontology, and to eliminate discrimination and harassment based on racial identity. As palaeontologists we should all have the right to feel safe in public spaces, including during conferences, at work and while out in the field.

Historically, as an Association and within our discipline, we have simply not done enough to make palaeontology accessible and inclusive for everyone. We recognize this, and have been taking initial steps to rectify this:

- We began by benchmarking: the Diversity Study served to both highlight and quantify our shortcomings.
- We have since ensured that data collection and monitoring will continue, including providing the opportunity for members to provide feedback and suggestions anonymously.
- We have been actively seeking more diverse voices for our *Newsletter* and website.
- We will continue to host diversity panels and events at our Annual Meeting.
- We have revised our nomination and selection procedures for our annual medals and awards, and will continue to revisit this process.
- Council members are now required to read a statement on subconscious bias before evaluating submissions for grants and awards.
- For our Undergraduate Research Bursaries priority will now be given to students from under-represented groups based on self-declared protected characteristics. Black students will be given top priority, as members of the most under-represented group among Geoscience students.
- We have created a mentoring scheme to provide support for early career palaeontologists, initially focusing on those at the postdoc level and recently extended to include those at PhD level.
- We are developing school programmes with the aim of reaching out to children from under-represented groups.

We acknowledge that this is not enough and that we must do much more towards increasing ethnic diversity. This must include raising awareness and playing an active part in developing anti-racist initiatives.

As a scientific organization with global membership, the majority of whom are white, we have a responsibility to educate ourselves. Why is our discipline not more ethnically diverse? Why are there so few Black members of the Association? What barriers are in place? How can we do better? What can we do to support our Black colleagues and those from other ethnic minorities? How can we make our scientific discipline work for more people? In addition to the work that we must do as an organization, we believe that every member of the Association can also play a role in instigating and sustaining change. Here are several things that most of us can do to help with progress, wherever we are in the world:

- Learn and communicate the history of racism in science and society, in particular anti-Black racism, how it is perpetuated and how it impacts people's lives;
- Recognize your own implicit and subconscious biases;
- Take part in relevant courses (*e.g.* unconscious bias, allyship training) if this is available at your workplace/institution. Learn to actively challenge racism and discrimination in your workplace;
- Recognize that belonging to marginalized groups impacts personal and professional lives in ways that are not always visible;
- Amplify the voices and experiences of colleagues and students from ethnic minorities;
- Actively support organizations that support ethnic minority individuals and communities;
- Recognize and engage with the broader non-academic scientific community, including science communicators and educators, to allow space for more diverse voices;
- Invite and support ethnic minority colleagues in being editors, reviewers and authors of your peer-reviewed papers and grants. Be intentional in broadening your professional circles;
- Recognize the work of your Black and ethnic minority colleagues through co-authorship, citation, promotion and employment opportunities;
- Ensure that conferences, seminars and panels have a diverse range of speakers;
- Actively engage at your workplace/institution to challenge practices and policies that put any ethnic group at a disadvantage;
- Nominate your ethnic minority colleagues for Association medals and awards as well as those of other learned societies and professional bodies;
- Fill out Association diversity surveys to increase the reliability of our data monitoring;
- Encourage your ethnic minority colleagues to stand for PalAss Council (see page 4).

We emphasize that both individuals and organizations, including the Association, have an important role to play in making further progress.

If you have any suggestions or feedback for us please get in touch with the Diversity Officer or Executive Officer via e-mail (<**diversity@palass.org**> or <**executive@palass.org**>, respectively) or contact us on Twitter @ThePalAss.

The Palaeontological Association Council

ASSOCIATION MEETINGS

64th Annual Meeting of the Palaeontological Association
Virtual meeting hosted by
Oxford University Museum of Natural History, UK *16 – 18 December 2020*

The 64th Annual Meeting of the Palaeontological Association will be held online due to the COVID-19 pandemic. The Meeting is being hosted by the Oxford University Museum of Natural History and the organizing committee is chaired by Dr Jack Matthews. The e-mail address for all meeting-related matters is <**annualmeeting2020@palass.org**>.

Information about the meeting is provided on the Association website at <**https://www.palass.org/meetings-events/annual-meeting/2020/annual-meeting-2020-virtual-meeting-overview**> and will be e-mailed to all delegates in due course. Registration remains open until Friday 20th November.

This year's virtual format offers the opportunity for attendees from around the world to watch presentations live and interact, discuss and debate palaeontology in real-time. As well as three styles of presentation (posters, talks and flash talks), the meeting will feature a Symposium, Annual Address, the Annual General Meeting and a number of interactive and engaging social events.

Talks, the AGM and the Annual Address will take place on the Webinarjam platform. Registered attendees will be able to run this in their web browser – we recommend using Chrome. Poster presentations will take place on Discord. Full instructions on how to install and use Discord will be sent to all attendees.

Further information, including the abstract volume and details of other events at the Annual Meeting, will be available on the website soon, and will be e-mailed to all delegates. Delegates will receive an e-mail closer to the event including details of how to access the Annual Meeting sessions. We look forward to seeing you online!

Summary of Schedule

Tuesday 15th December: Pre-conference fringe events and workshops

The Association is hosting an afternoon workshop on Palaeoethics, discussing issues in palaeontology from fieldwork to collections and publication. This is a free event, open to all, regardless of whether you are signed up to the Annual Meeting. More information can be found online, at <**https://event.webinarjam.com/register/109/pyy6xf3y**>. In addition, the Association is planning a diversity event and meet-up; more information will be available soon.

If you would like to host a fringe event at this year's Annual Meeting, please e-mail <**annualmeeting2020@palass.org**> to arrange for details to be advertised to delegates. Fringe events can be hosted on Tuesday 15th December, or at lunchtimes during the Annual Meeting.

Wednesday 16th December: Symposium, conference, welcome social event

Please note that unlike previous Annual Meetings, the first day will begin at 9.00 GMT. Wednesday will comprise conference presentations (talks and posters) and the symposium entitled "New Ideas on Old Fossils: A Symposium of Early Career Palaeontologists from Around the World". The symposium will be timed to best accommodate our international speakers. The evening will include a welcome virtual social event.

Thursday 17th December: Conference, AGM, Annual Address

Presentations will begin at 9.00 GMT and continue throughout the morning and early afternoon. The Association's Annual General Meeting will begin at 16.30 GMT, and will take place online. This will be made accessible to all members of the Association, regardless of Annual Meeting registration. The AGM will feature the presentation of the Association's medals and awards for 2020. This will be followed in the evening by the Annual Address at 19.00 GMT, this year given by Prof. Rachel Wood. The Annual Address is free to attend and will be open to the public. Details for those not registered for the Annual Meeting will be circulated in due course.

Friday 18th December: Conference, future meetings, prizes

Talks will begin at 9.00 GMT and continue through the day. Presentations will end not later than 17.30 GMT, and be followed by announcements by the organizers of future Association meetings, and the announcement of the prizes for talks, flash talks and posters.

The evening will conclude with this year's premier social event – a fun, online, international, interactive competition to decide the Association's favourite fossil for 2020. More details, and how to enter, will follow.

The Palaeovision Fossil Contest

To bring us all together in these difficult times, this year's Annual Meeting will end with The Palaeovision Fossil Contest, an online, interactive, international competition to decide the Annual Meeting's favourite fossil for 2020.

We are seeking entries from groups of palaeontologists to represent their institution and submit a fun engaging video (up to 3 minutes in length) making the case as to why their chosen fossil should be crowned champion for 2020. The event, broadcast live from the OUMNH and beginning at 19.30 GMT, will feature all the video entries, a number of interval 'acts' and will be followed by the voting. Firstly we will go live to each competing institution, to collect the points from their juries, then we will announce the public vote gathered from all those attending that evening, before finally revealing who has won what might be the most important competition of the year.

Competing institutions can be anything from university research groups, to museums, fossil sites or other groups of palaeontologists. All you need is a thirst for your fossil to win! You may choose to fly the flag for a newly named taxon, or celebrate a specimen with longstanding ties to your work – either way, may the best fossil win! Limited spaces are available, so please confirm your group's entry by e-mailing <**annualmeeting2020@palass.org**> with your chosen fossil as soon as possible, and not later than **30th November**. Your video entry should be submitted by **11th December**.

What will be this year's favourite fossil? YOU DECIDE. We look forward to welcoming you online at 19.30 GMT on Friday 18th December.

Virtual field-trips

Throughout the Annual Meeting the Oxford University Museum of Natural History will be running a number of virtual field-trips, using material from our extensive collections to guide delegates around a number of otherwise inaccessible localities from around the world. These events will be advertised to all delegates and will not require separate registration.

Training and guidance

The Organizing Committee is conscious that with this being the first virtual Annual Meeting, many attendees and presenters may not have experience of this format of meeting. Over the coming weeks we will be releasing a number of training and guidance videos and guides to support everyone involved in this year's meeting.

Illustrations

This year the organizers have arranged for a number of illustrators to attend the Annual Meeting. Inspired by the presentations being made, they will be making their illustrations available online, so do keep an eye on social media to catch your favourite talks in artistic form.

Social media

With the Annual Meeting taking place online, social media becomes an even more important way for us to share our experience of the meeting with others. Please be respectful of the wishes of authors if they do not wish their work to be shared online. We look forward to hearing all your thoughts on various social media outlets, and encourage the use of the official hashtag #PalAss20.

Carer's Bursary

For those with caring responsibilities who need paid help to enable their attendance at the meeting, our Carer's Bursary is available and open for applications until 30th November. Please see <**https://www.palass.org/awards-grants/grants/palaeontological-association-carer-s-bursary**>.

Logo

For our Virtual Annual Meeting it seemed appropriate that the logo should feature a virtual fossil. This model of a trilobite, an enrolled *Bailiaspis ? glabrata*, is based on CT scans and 3D reconstructions by Imran Rahman, Deputy Head of Research at the Oxford University Museum of Natural History and member of the Organizing Committee. The model is part of 3D computer simulations associated with a paper in *Palaeontology* by Jorge Esteve and colleagues on modelling enrolment in Cambrian trilobites. The image is used with their permission.

Abstract of Annual Address

The Annual Address will be given on Thursday 17th December at 19.00 GMT. All Annual Meeting delegates will automatically be registered for this event. The event is also open to the public, and we welcome the support of members and attendees in helping advertise this free annual palaeontological outreach event. Sign-up information for those who wish to attend but are not registered for the Annual Meeting will be circulated in due course.

Tales from the Cambrian Explosion

Prof. Rachel Wood
University of Edinburgh

The Cambrian Explosion marks the rise of diverse animal groups *c.* 540 million years ago, but the triggers for this revolution remain poorly understood. I will explore the differing roles of changing climate, oceanic redox, nutrient availability and ecosystem feedbacks across the critical Ediacaran–Cambrian transitional period. The fossil record now reveals that the roots of the Cambrian Explosion are to be found in the Ediacaran. We can now document a series of pulses of enhanced seawater oxygen availability over the Ediacaran to Cambrian interval. These coincide with pulses of diversification and increased body size in animals, but the biological control of carbonate production was driven by ecosystem feedbacks including the rise of predation.

Symposium: New Ideas on Old Fossils: A Symposium of Early Career Palaeontologists from Around the World

The Symposium will take place on Wednesday 16th December

Symposium Abstracts

Growing with dinosaurs: an interdisciplinary approach to getting to know South Africa's iconic *Massospondylus carinatus*

Kimberley E. J. Chapelle[1], Paul M. Barrett[2], Stephan Lautenschlager[3], Jennifer Botha[4,5], Vincent Fernandez[2] and Jonah N. Choiniere[1]
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In the last decade, digital methods for studying fossils have come into their own, allowing for the use of multiple methods to examine the same material in order to test hypotheses previously out of reach. Using an interdisciplinary approach including micro-computed-tomography, synchrotron radiation, digital retrodeformation, geometric morphometrics and osteohistology, we can reassess longstanding hypotheses regarding the identity and growth strategies of *Massospondylus carinatus* and their implications in the macroevolution of dinosaurs. *Massospondylus carinatus* was one of

the first dinosaurs named from southern Africa in 1854 by Sir Richard Owen. Since then, hundreds of specimens have been discovered and referred to the taxon, meaning it is one of the most iconic dinosaurs from South Africa. These abundant fossils range in size from embryo to adult, making it an ideal study system for looking at dinosaur life histories. The phylogenetic position of this Early Jurassic plant-eating dinosaur also entails that understanding its development has inferences for the evolution of sauropodomorphs.

Phytolith analyses from modern Herbivore molars: testing reliability of using phytoliths to reconstruct herbivore diets/habitats in the fossil record

Rahab N. Kinyanjui[1], Doris Barboni[2] and Jean-Philip Brugal[3]
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[2]*CEREGE, Aix-en-Provence, France*
[3]*CNRS, Aix-en-Provence, France*

Phytolith are plant's silica cells formed when silica is deposited within or/and around plants' cells producing cell casts that are taxonomically related to source, hence, if extracted from secondary environments or source, they can be traced back to their primary source. Grass short cell phytoliths (GSCP) are particularly significant and more diagnostic than those associated with woody and herbaceous sources. East African herbivores are specialized grazers/browsers or mixed feeders depending on what is available in their habitats. Specialized grazers are ecologically associated with open grasslands while specialized browsers are ecologically associated with wooded vegetation cover (forests, shrublands, bushlands). In the palaeontological record, preservation of teeth is favoured by all depositional environments, therefore in most cases, it is the only part of the animal that is used to accurately identify the animals' species in the fossil record. Over the years, isotopic analyses have been used to study the teeth to identify animals' diets and, by extension, the environments they interacted with. Here we explore how reliable phytolith analyses can be in reconstructing diets of herbivore species with known feeding behaviour and assess their application in reconstructing herbivore diet in the fossil record. We present the preliminary data analysed from six specialized grazers, six specialized browsers and six mixed feeders collected from different habitats.

The influence of extinction on the rise and fall of trilobite disparity

Diego Balseiro, Arnaud Bignon and Fernanda Serra
CONICET, Universidad Nacional de Córdoba, Argentina

Of the many contributions of palaeontology to evolutionary biology, the analysis of the evolution of morphological diversity – *i.e.* disparity – is probably among the most relevant. In particular, the rise and fall of disparity throughout the evolutionary history of a clade has been a widely studied aspect of the fossil record. The temporal dynamics of morphological disparity are usually studied by comparing the trajectories of taxonomic and morphological diversity. However, comparing trajectories alone is not enough to understand true macroevolutionary dynamics of disparity, because it analyses net diversification but does not individualize extinction and origination rates. In this contribution we analyse trilobite disparity during the Cambrian–Devonian history of the clade, integrating the largest morphometric database to date with stratigraphic ranges obtained from the Paleobiology Database. We generate time series of taxonomic and morphological diversity,

extinction and origination rates, and individualize the selectivity of extinction and origination with respect to morphology using logistic regression. Net diversification is unable to explain the trend in disparity because the largest increases in trilobite morphological diversity occur at intervals of relatively stable taxonomic diversity. However, studying the selectivity of extinction and origination sheds light on the dynamics underlying the trend in disparity. In particular, a modified measure of the macroevolutionary influence of extinction and origination shows how these processes complement each other to generate the observed patterns, underscoring that both extinction and origination can individually produce increases and decreases in disparity. For trilobites in particular, extinction is the main cause of morphospace expansion and contraction, highlighting that the classic idea of extinction as a constraining factor for morphological evolution is a limited view.

Breaking new ground in the study of Egypt's ancient prehistory

Sanaa El-Sayed[1] and Hesham Sallam[1,2]
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[2]*The American University in Cairo, Egypt*

Mansoura University Vertebrate Paleontology center (MUVP) is a research unit within the Department of Geology, created in 2010 to be a pioneer centre in Egyptian universities and institutions. It is the only high-level research unit in the field of vertebrate palaeontology in Egyptian universities, and indeed in the entire Middle East. Since its foundation, MUVP has become a centre for the study of fossil vertebrates where students and researchers can exchange ideas and collaborate on projects that build upon Egypt's fascinating geological past. MUVP is engaged in multiple projects in the Egyptian deserts that are diverse in scope, ranging from Late Cretaceous dinosaurs to Oligocene mammals, with other groups (*e.g.* fishes) or questions (*e.g.* stratigraphy) sprinkled in between. Late Cretaceous projects aim to recover vertebrate fossils, in particular archosaurs and mammals, from the exposures in the Western Desert. Recovery of such fauna from this area will help us to understand the final phase of non-avian dinosaur evolution and the subsequent rise of mammals. In the Cenozoic, MUVP is interested in understanding the possible impacts of hyperthermal events like the Paleocene Eocene Thermal Maximum (PETM) and the Late Danian event (LDE), both of which are represented by fossil-bearing marine beds in the Eastern Desert. MUVP also has active palaeontological fieldwork in the Fayum Depression excavating the micromammal-bearing quarries north of Birket Qarun (late Eocene to early Oligocene in age). Expeditions there have led to the recovery of remarkable and unparalleled collections of fossil mammals, including primates and representatives of many other groups. Fossil whales represent an additional area of interest for MUVP, and are the focus of excavations in the middle to late Eocene deposits south of Birket Qarun. This work has led to a series of remarkable discoveries including the oldest record of Basilosauridae in Africa (early middle Eocene), which will help to fill in an important biogeographic and evolutionary gap in our understanding of the early evolution of whales. The results of these projects have made substantial contributions to scientific understanding of the vertebrate fossil record of Egypt through publications led by Egyptian students. Another critical aspect of the MUVP's work is its public outreach. MUVP has come to play an indispensable role in helping to communicate the new palaeontological discoveries to the general public via accessible social media, presented free of jargon, in Arabic. This endeavour has raised public engagement in science and provided a model that other Middle Eastern institutions seek to apply.

Dickinsonia costata from the Late Precambrian of the White Sea

Maria Zakrevskaya and Andrey Ivantsov
Borissiak Paleontological Institute, RAS, Russia

Dickinsonia costata, one of the most recognizable Ediacaran macrofossils, has been found in abundance in the siliciclastic deposits of the Flinders Ranges (South Australia) and the White Sea coast (northeastern Europe). However, the main information about it is based on the Australian material. In the White Sea Basin, *D. costata* lived in quieter environments. Its remains are found in more fine-grained, slightly altered rocks and, in addition to imprints and feeding traces, are also represented by organic 'compressions'. This allows us to expand the data on age-related changes in *D. costata*, going beyond the documented range of body length (4.1–140.5 mm). The smallest specimens that show the main features of *D. costata* (rounded outline, with length only slightly exceeding width, wide 'half-segments' or isomers) are 1.7 mm long, and the number of visible isomers does not exceed 3-4 pairs. However, in the White Sea localities, there are also similar rounded imprints of smaller size, highlighted by organic matter. Transverse dissection is less noticeable in them, and in the smallest ones (up to 1.2 mm) does not appear at all. This can be explained by the unfavourable ratio of the density of the thin body and the grain size of the surrounding rock. However, based on the trend of a decrease in the number of isomers with a decrease in body size, such *D. costata* specimens could lack transverse dissection, and the putative planktonic Dickinsonia larva could be nonmetameric. The largest *D. costata* specimen is 395 mm in length and has 225 pairs of visible isomers. The White Sea material shows that the appearance of *D. costata* in the benthic community occurred at a body diameter of slightly more than 1 mm, and the addition of isomers occurred during the entire observed interval of a lifetime.

Code of Conduct for Palaeontological Association Meetings

The Palaeontological Association was founded in 1957 and has become one of the world's leading learned societies in this field. The Association is a registered charity that promotes the study of palaeontology and its allied sciences through publication of original research and field guides, sponsorship of meetings and field excursions, provision of web resources and information, and a programme of annual awards.

The Palaeontological Association holds regular meetings and events throughout the year. The two flagship meetings are the Annual Meeting held at a different location each December, and the annual Progressive Palaeontology meeting, run by students for students with the support of the Palaeontological Association. The Association Code of Conduct relates to the behaviour of all participants and attendees at annual events.

Behavioural expectations

It is the expectation of the Palaeontological Association that meeting attendees behave in a courteous, collegial and respectful fashion to each other, volunteers, exhibitors and meeting facility staff. Attendees should respect common sense rules for professional and personal interactions, public behaviour (including behaviour in public electronic communications), common courtesy, respect for private property and respect for intellectual property of presenters. Demeaning, abusive, discriminatory, harassing, or threatening behaviour towards other attendees or towards meeting volunteers, exhibitors or facilities staff and security will not be tolerated, either in personal or electronic interactions.

Digital images and social media

Do not photograph a poster or record a talk without the author's express permission. While the default assumption is to allow open discussion of presentations on social media, attendees are expected to respect any request by an author to not disseminate the contents of their talk or poster.

ProgPal UCL 2021

June 17-19th
University College London

Conference run by students, for students
Registration is free!

Talks, posters, and social events

Workshops on biomechanics, the Paleobiology Database, and palaeobiogeographical methods

Roundtable talks with palaeontologists

@ProgPal2021

Progressive Palaeontology 2021

The Palaeontological Association

UCL

UCL Department of Earth Sciences Vertebrate Palaeontology

A crash course in running online conferences: lessons from Progressive Palaeontology 2020

Introduction

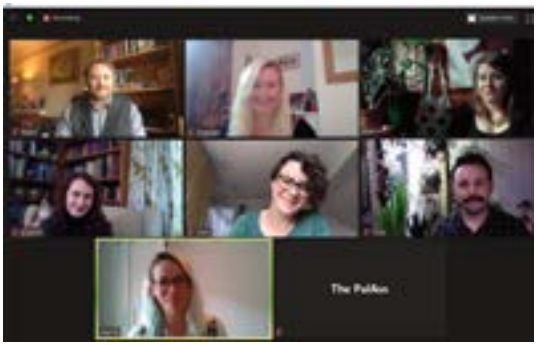
Progressive Palaeontology (ProgPal) is an annual conference for student palaeontologists, enabling them to present their research and network in an inclusive and welcoming environment. A committee of students from the University of Leeds, including ourselves, was chosen to host ProgPal in June 2020. We spent months making plans to hold the conference at the Yorkshire Museum, host an Annual Dinner at a nearby Italian restaurant and run a field-trip to the beautiful Robin Hood's Bay. But in March, as the UK transitioned into a period of lockdown to prevent the spread of the coronavirus, it became clear that we had a stark choice: either postpone or cancel the conference or quickly find a way to hold it online. Despite the many uncertainties we faced, we decided to try and rearrange the conference virtually. Drawing on our experiences and feedback we collected via an anonymous survey of delegates after the conference, we want to illustrate how online platforms hold incredible potential for improving inclusivity and engagement at academic events.

Presenting

Over 80 research presentations were given at ProgPal this year across three formats: full talks (12 minutes), lightning talks (4 minutes) and posters. To help delegates create their presentations, clear instructions were provided, along with links to software instructions for creating videos. An example 'lightning talk' video was shared, which also introduced the organizing committee. Delegates were given as much notice as possible of abstract submission and presentation upload deadlines. All presentations, both talks and posters, were available for the full duration of the conference, via a password-protected link through the PalAss website. Having talks pre-recorded meant that this year they were of a particularly high quality, as they were delivered exactly as intended by presenters, and also enabled delegates to view them at their own pace. Feedback suggested that while many appreciated the flexible nature of viewing the presentations, some would have preferred a more structured viewing order.

To enable discussion around presentations, daily question-and-answer (Q&A) sessions were hosted using Discord. We set up individual 'channels' for each presenter, whereby at their designated Q&A session they would be present to answer questions and interact with other delegates via instant messaging. Previously answered questions remained visible for the benefit of all delegates. We received a lot of positive feedback for these sessions, with 81 % of survey respondents reporting that they liked the Q&A format. Delegates commented that text channels enabled those who may have felt nervous or less comfortable asking questions in person to interact. Presenters also commented that the format of the sessions allowed the articulation of more informed and detailed answers to questions, and more in-depth discussions.

There were several live components of the conference which we held using Zoom, namely a careers panel, quiz and workshop drop-in session. The careers panel was particularly well attended, with over 75 delegates watching live. The panel was also recorded and later made available to all delegates. We represented careers from academia, publishing, educational engagement, museum curation, television research and the civil service, with each panel member having a background in palaeontology. Conference delegates were provided with a short biography for each panellist in the abstract booklet, and were encouraged to submit questions for the panel before the live session. This enabled questions to be asked to the relevant panellists in an efficient, seamless manner.



The Careers Q&A panel conducted over Zoom. Feedback praised the broad range of careers presented, with the panel being described as "positive, encouraging, and friendly", and many attendees reported it was their highlight of the conference.

Interaction between delegates

Interaction between friends, colleagues and new acquaintances is an essential feature of in-person conferences, so finding a way to facilitate such interactions whilst hosting an online conference posed a challenge. In place of the traditional ProgPal Annual Dinner, we organized a 'palaeontology pub quiz', with a mix of cerebral and comedic questions. Delegates could organize their own teams, but those without were put into teams by the committee, grouping people with different research specializations and from different universities together to promote networking. The quiz received excellent feedback, with many appreciating the opportunity to converse via voice chat with their fellow team members and enjoy an event closer to the in-person conference experience.

For the less structured social elements of the conference, we chose to use the platform Discord, as it is free of charge, relatively user-friendly and can host multiple instant messaging threads at once. Alongside the Q&A sessions, we set up several chat rooms (delegate biographies, "Palaeontology", "Anything but palaeontology", an LGBTQ+ meet-up) as well as holding four "tea breaks", timetabled discussions on a mix of serious and frivolous themes. Over 140 delegates joined our Discord server, and engagement via the platform was strong, especially during the tea breaks.

The feedback we received on this aspect of the conference was mixed. 66% of survey respondents enjoyed the instant messaging format, however some stated that dynamic group chats could be difficult to keep up with. This could be remedied in future using a larger number of more specialized chat rooms. 43 % of survey respondents felt they interacted with fewer delegates online than they would have at an in-person conference, however 31 % felt they interacted with more. Some respondents said that they would have preferred voice or video calls, especially for presenter Q&A sessions. Such channels can become chaotic when overpopulated, or dominated by a few individuals; this could be controlled by limiting the number of people who can use a voice channel at any one time. Increasing the number of platforms through which people can interact in turn increases the organizational workload of the organizing committee. Online conference organizers need to carefully consider the balance between the range of social and discussion platforms that delegates want, and the reality of how much the organizing committee can manage and moderate.

Committee communications

We considered social media an important tool, and carefully planned how best to use our Facebook page and Twitter account. They proved useful for advertising the conference to prospective delegates, with a third of survey respondents having discovered ProgPal through Twitter. During the conference, discussion through 'tweets' enabled delegates to connect with and 'follow' each other, and invited others from outside the conference to engage with conference content.

Given the novelty of online conferences back in June, a plan for communicating logistical information was particularly important, and we aimed to strike a balance between ensuring delegates were knowledgeable but not overwhelmed with information. Event formats and instructions for accessing content were added to the conference website and abstract booklet as far in advance as possible, and once the conference had begun, an e-mail was sent each morning with a summary of the day's events. This approach worked well, with 91 % of survey respondents reporting that they felt well informed about conference logistics. We collected information from delegates using Google Forms, a highly flexible platform for submitting questions, conducting surveys and answering quizzes. Some delegates suggested that videos with opening and concluding remarks from the committee would be a simple addition to make proceedings feel friendlier.

A snapshot of the conference Discord.

Inclusivity and accessibility

Running an inclusive, accessible conference for a diverse range of delegates was an important consideration for us throughout planning, particularly given the previous reputation of ProgPal (see the article written by the 2019 organizing committee in *Newsletter* **103**). The overall tone of the conference was very well received, with 93 % percent of survey respondents reporting feeling included, respected and safe, and not a single respondent witnessed any discriminatory or harassing behaviour. Our survey highlighted some potential barriers to conference attendance and engagement relevant to our delegates: nearly a quarter of respondents have a disability or long-term illness, 29 % reported being a first-generation university student and 14 % reported being from a disadvantaged socio-economic background. Moving forwards, we feel that consideration of these particular groups should be a priority for ProgPal and other student-oriented conferences.

Moving the conference online enabled a higher number of delegates to attend, with numbers up from 110 in 2019 to 190 this year. This particularly opened up the conference to a more international audience, including delegates from at least 12 different countries. While ProgPal itself is free to attend, hosting the conference online removed potential travel and accommodation costs. Removing the need for travel also resolved issues for delegates with certain disabilities or caring responsibilities, which could be a barrier to in-person attendance, and was more environmentally

friendly. Over a quarter of survey respondents stated they would not have attended this year's conference if it had taken place in-person, with distance and/or financial constraints being commonly cited reasons.

Using online, pre-recorded materials gave delegates the option to pause or re-watch presentations and consume content at their own pace. This can be particularly helpful for those with translation needs, hearing or visual impediments or learning difficulties, as well as those who are trying to fit in a conference around work or caring responsibilities. Some platforms such as YouTube can also auto-generate subtitles for presentations, further improving their accessibility.

Having highlighted some accessibility improvements resulting from the online format of this year's ProgPal, we must acknowledge that we benefited from our target demographic being students. For other conferences, an online format may provide different challenges, as a broader demographic may include individuals who are less tech-savvy or have limited access to the technology required for participation.

Conclusions

From evaluating our successes and dwelling on the feedback we received on ProgPal 2020, our take-home messages for aspiring conference organizers are:

- Online and in-person events should both have a place in our future academic calendars. They each have pros and cons, but widening the breadth of possible events to attend increases the diversity of scientists who can engage with our research community.
- Broadcasting content and/or uploading presentations to an online repository is the most practical way to bring the accessibility benefits of a virtual conference to an in-person meeting. Social media is also a helpful tool for sharing these materials and facilitating online discussion.
- Many conference-goers have ideas about what their ideal conference would look like. However, these ideas often represent wants, whereas accessibility is a need. If we want to ensure that as many people as possible feel welcomed at and engaged in our events, accessibility should be prioritized in all aspects of conference planning.
- Conference organizers shouldn't be afraid to "think outside of the box". Although it may take a little more time and effort, there are many potential benefits to be reaped in designing a conference to cater to current potential delegates, rather than just by defaulting to tradition.

72 % of our survey respondents reported that they would like to see more palaeontological online events in future. While virtual conferences have risen in popularity during the COVID-19 pandemic, we believe that they represent an opportunity rather than a compromise, and hope to see them diversify and thrive in the years to come.

Bethany Allen, Owain Fletcher Williams, Frances Procter and Ailsa Roper
University of Leeds

A selection of presentations from ProgPal 2020 are freely available to view via the PalAss website: <**https://www.palass.org/meetings-events/progressive-palaeontology/2020/progressive-palaeontology-2020-online-talks-and-posters**>.

The conference workshop, on Sampling Bias in the Fossil Record, is also available via GitHub: <**https://github.com/bethany-j-allen/sampling_bias_workshop**>.

Diversity and Inclusion at PalAss events: Report

The goal of this anonymous questionnaire was to obtain feedback from our membership about diversity and inclusion at the Annual Meeting and other PalAss events, and to identify key areas for improvement.

The survey was open between 20th February 2020 and 31st March 2020, communicated via e-mail to members and advertised on social media. We received 191 responses. For context, 325 people attended the Annual Meeting in 2019 and the Association had 1,149 individual members on 31st December 2019.

Insights

Overall, survey respondents are happy to see our diversity and inclusion initiatives. Respondents were also very positive about last year's Annual Meeting in Valencia.

Demographic data highlight that we have many members who cannot attend the Annual Meetings, due to geography and costs. Virtual meetings create the ideal opportunity to increase participation.

Discrimination/harassment

There were 58 "Yes" responses to questions about direct experiences of harassment/discrimination at PalAss events. 23 people also responded that they had observed discrimination/harassment towards others and 33 reported that they had been informed of incidents (without witnessing or being involved). Two people reported that they chose not to attend PalAss due to discrimination/harassment at previous events (see Results Section 2). In addition, 17 people provided written examples of discrimination/harassment. Examples include sexual harassment, including one incident at the previous Annual Meeting in 2019, in addition to reports of racism, transphobia, and negative comments relating to parental status and career stage during previous years. Despite the high volume of incidents, the Association has never received a formal complaint for any Code of Conduct violations. One respondent remarked that their decision not to report the incident was for fear of retributions, given at the time they were at a junior career stage. Several other respondents expressed a wish to see improved reporting procedures for Code of Conduct violations. Note that although 50 % of survey respondents agreed with the statement "Consequences for breaches of the Code of Conduct were clear" – we do not currently have any.

Recommended actions for Council

- Establish consequences for the Code of Conduct, normalize reporting and broadly promote reporting procedures.
- Use tools that make reporting as straightforward as possible.

Awards, posters and student engagement

12 respondents provided written feedback on the poster sessions, and a further two respondents made related comments about our awards. It was recommended that more time and space should be allocated for posters, so that attendees really benefit from contributing to this part of the meeting, in the same way that speakers do. There was a general sense that posters are not valued to the same extent as talks. The process of awarding medals for posters and talks was also criticized for being non-transparent and unfair. Related to this were suggestions that more experienced conference attendees should make more effort to engage and network with younger or first-time conference attendees.

Recommended actions for Council

- Allocate more time and space for posters and/or decrease the total number.
- Implement an alternative approach for awarding prizes that involves a greater diversity of members.
- Encourage and facilitate engagement between senior and junior conference attendees.

Other recommendations based on member suggestions

- Provide gender neutral toilets, quiet spaces and nursing/breast-feeding facilities.
- Provide (optional) pronoun badges.
- Always create the opportunity for meeting attendees to provide feedback after each event.

Section 1: General Perceptions

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Unsure
Overall, the PalAss diversity and inclusion initiatives are something I am happy to see.	**2 (1%)**	**4 (2.1%)**	**14 (7.3%)**	**45 (23.6%)**	**123 (64.4%)**	**3 (1.6%)**
Overall, PalAss events are becoming more diverse and inclusive.	**0**	**3 (1.6%)**	**37 (19.5%)**	**99 (52.1%)**	**21 (11.1%)**	**30 (15.8%)**
Overall, palaeontology is becoming more diverse and inclusive.	**0**	**10 (5.2%)**	**34 (17.8%)**	**105 (55%)**	**24 (12.6%)**	**18 (9.4%)**

Statement	Yes	No
Are you currently a member of PalAss?	**165 (87.3%)**	**24 (12.7%)**
Did you attend the PalAss Annual Meeting in Valencia 2019?	**119 (62.6%)**	**71 (37.4%)**

Section 2: Annual Meeting Valencia 2019

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Unsure
Overall, I felt included, respected and safe at the meeting.	**0**	**0**	**7 (5.7%)**	**34 (27.9%)**	**79 (64.8%)**	**2 (1.6%)**
I felt comfortable approaching people at different career stages.	**1 (0.8%)**	**7 (5.7%)**	**18 (14.8%)**	**35 (28.7%)**	**59 (48.4%)**	**2 (1.6%)**
I felt comfortable approaching people at more senior career stages than my own.	**4 (3.3%)**	**9 (7.4%)**	**20 (16.5%)**	**39 (32.2%)**	**47 (38.8%)**	**2 (1.7%)**
Information about the code of conduct was readily available.	**1 (0.8%)**	**2 (1.6%)**	**11 (9%)**	**51 (41.8%)**	**46 (37.7%)**	**11 (9%)**
Reporting procedures for code of conduct issues were clear.	**3 (2.5%)**	**5 (4.1%)**	**20 (16.5%)**	**40 (33.1%)**	**33 (27.3%)**	**20 (16.5%)**
Consequences for breaches of the code of conduct were clear.	**3 (2.5%)**	**15 (12.3%)**	**24 (19.7%)**	**37 (30.3%)**	**24 (19.7%)**	**19 (15.6%)**
My concerns, if reported, will be taken seriously by PalAss Council.	**1 (0.8%)**	**1 (0.8%)**	**14 (11.6%)**	**38 (31.4%)**	**45 (37.2%)**	**22 (18.2%)**

Statement	Yes	No
Did you experience or witness any discrimination or harassment during the meeting?	**2 (1.6%)**	**123 (98.4%)**

One of the respondents who answered "Yes" for this question reported an incident of sexual harassment at the conference dinner. The other reported a case of gender identity based discrimination/harassment.

We also asked respondents "How could your experience at the PalAss Annual Meeting be improved?" 34 respondents provided suggestions.

Section 3: Previous PalAss Events

For each statement select the option that best reflects your experience.

Statement	Yes	No
I have experienced discrimination/harassment based on my gender at a PalAss event.	**15** (**8.2%**)	**167** (**91.8%**)
I have experienced discrimination/harassment based on my sexuality at a PalAss event.	**2** (**1.1%**)	**180** (**98.9%**)
I have experienced discrimination/harassment based on my racial/ethnic identity at a PalAss event.	**2** (**1.1%**)	**180** (**98.9%**)
I have experienced discrimination/harassment based on my disability status at a PalAss event.	**3** (**1.7%**)	**176** (**98.3%**)
I have experienced discrimination/harassment based on my nation of origin, citizenship or immigration status at a PalAss event.	**4** (**2.2%**)	**177** (**97.8%**)
I have experienced discrimination/harassment based on my religious identity at a PalAss event.	**2** (**1.1%**)	**176** (**98.9%**)
I have experienced discrimination/harassment based on my career stage at a PalAss event.	**17** (**9.3%**)	**165** (**90.7%**)
I have experienced discrimination/harassment based on my academic status (*e.g.* having/not having a PhD) at a PalAss event.	**10** (**5.6%**)	**170** (**94.4%**)
I have experienced other types of discrimination/harassment at a PalAss event.	**3** (**1.7%**)	**177** (**98.3%**)
I have observed discrimination/harassment towards others at a PalAss event.	**23** (**12.8%**)	**157** (**87.2%**)
I have been informed (without personally witnessing anything) about discrimination/harassment towards others at a PalAss event.	**33** (**18.3%**)	**147** (**81.7%**)
I have chosen not to attend PalAss events due to discrimination/ harassment I experienced at previous events.	**2** (**1.1%**)	**179** (**98.9%**)

Section 4: Demographics

Age

16-18 years	19-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65 + years	Prefer not to say
0	19 (9.9%)	69 (36.1%)	47 (24.6%)	16 (8.4%)	14 (7.3%)	21 (11%)	5 (2.6%)

What best describes your gender?

Male	Female	Non-binary	Prefer not tosay	Other
99 (51.8%)	83 (43.5%)	5 (2.6%)	4 (2.1%)	0

Do you consider yourself to be trans?

Yes	No	Prefer not to say
4 (2.1%)	180 (95.2%)	5 (2.6%)

Are you:

Bisexual	Gay man	Gay woman / lesbian	Heterosexual / straight	Prefer not to say	Other
19 (9.9%)	7 (3.7%)	3 (1.6%)	150 (78.5%)	8 (4.2%)	4 (2.1%)

Do you have a disability, long-term illness or health condition?

Yes	No	Prefer not to say
21 (11%)	162 (84.8%)	8 (4.2%)

What is your ethnic group?

Asian	Black	Hispanic or Latinx	Mixed/multiple ethnic groups	White	Prefer not to say	Other
10 (5.2%)	1 (0.5%)	12 (6.3%)	5 (2.6%)	154 (80.6%)	6 (3.1%)	3 (1.6%)

What is your religion or belief?

Buddhist	Christian	Hindu	Jewish	Muslim	Sikh	No religion or belief	Prefer not to say	Other
0	32 (16.8%)	1 (0.5%)	1 (0.5%)	2 (1%)	0	140 (73.3%)	13 (6.8%)	2 (1%)

Other: Marxism.

Are you married or in a civil partnership?

Yes	No	Prefer not to say
76 (40%)	105 (55.3%)	9 (4.7%)

Do you have any ongoing caring responsibilities? Select all that apply.

Statement	
None	**129 (68.3%)**
Sole primary carer of child/ren under 18	**3 (1.6%)**
Sole primary carer of adult(s) with disability, learning needs or health issues / elderly person/people	**1 (0.5%)**
Primary carer of child/ren under 18	**10 (5.3%)**
Primary carer of adult(s) with disability, learning needs or health issues / elderly person/people	**3 (1.6%)**
Co-carer of child/ren under 18	**29 (15.3%)**
Co-carer of adult(s) with disability, learning needs or health issues / elderly person/people	**6 (3.2%)**
Other caring responsibilities	**8 (4.2%)**
Prefer not to say	**6 (3.2%)**

Multi answer: Percentage of respondents who selected each answer option (*e.g.* 100% would represent that all this question's respondents chose that option).

Select all that apply:

Statement	
Are you pregnant?	**3 (10%)**
Are you currently on maternity leave?	**3 (10%)**
Are you currently taking adoption / paternity / shared parental leave?	**2 (6.7%)**
Have you previously taken maternity / adoption / shared parental / extended paternity leave of three months or more?	**28 (93.3%)**

Multi answer: Percentage of respondents who selected each answer option (*e.g.* 100% would represent that all this question's respondents chose that option).

Do you consider yourself to be from a disadvantaged socio-economic group?

Yes	No	Unsure	Prefer not to say
35 (18.4%)	**130 (68.4%)**	**23 (12.1%)**	**2 (1.1%)**

Are you the first person in your immediate family to go to university?

Yes	No	Unsure	Prefer not to say
94 (49.2%)	**91 (47.6%)**	**3 (1.6%)**	**3 (1.6%)**

In which country are you currently based?

Respondents are based in 23 countries: Argentina 1 (0.5%), Australia 2 (1.1%), Belgium 1 (0.5%), Canada 1 (0.5%), China 4 (2.1%), Congo (Democratic Republic) 1 (0.5%), Czechia 1 (0.5%), France 11 (5.9%), Germany 7 (3.7%), Greece 3 (1.6%), India 1 (0.5%), Ireland 7 (3.7%), Italy 1 (0.5%), Latvia 1 (0.5%), Lithuania 1 (0.5%), Monaco 1 (0.5%), Norway 2 (1.1%), Poland 1 (0.5%), Portugal 1 (0.5%), Spain 19 (10.2%), Sweden 2 (1.1%), Switzerland 6 (3.2%), United Kingdom 92 (49.2%), United States 15 (8%), Prefer not to say 6 (3.2%).

If employed in palaeontology or a related discipline, do you work in:

Museum	University	Industry	Research institute	Other
38 (23.6%)	124 (77%)	2 (1.2%)	17 (10.6%)	7 (4.3%)

Multi answer: Percentage of respondents who selected each answer option (*e.g.* 100% would represent that all this question's respondents chose that option).

Other: University Student, Geological/palaeontological consultant, Education and Public Engagement, Learned Society, Unemployed.

If you currently work/study in palaeontology, which of the following best describes your career stage?

Statement	
High school	1 (0.5%)
Apprentice / post high school technical training	0
Undergraduate student	3 (1.6%)
Masters / postgraduate student	11 (6%)
PhD / research student	40 (22%)
Fixed-term contract researcher, temporary or project worker	38 (20.9%)
Permanent contract – junior or entry level	16 (8.8%)
Permanent contract – mid level (*e.g.* senior lecturer, curator or administrator)	20 (11%)
Permanent contract – senior level (*e.g.* head of division or department)	25 (13.7%)
Self-employed, freelance	8 (4.4%)
Retired/no longer in work	13 (7.1%)
Other	7 (3.8%)

Other: I am working at a small company, Research Technician, unemployed, taking part in research without payment.

The Palaeontological Association Diversity Group

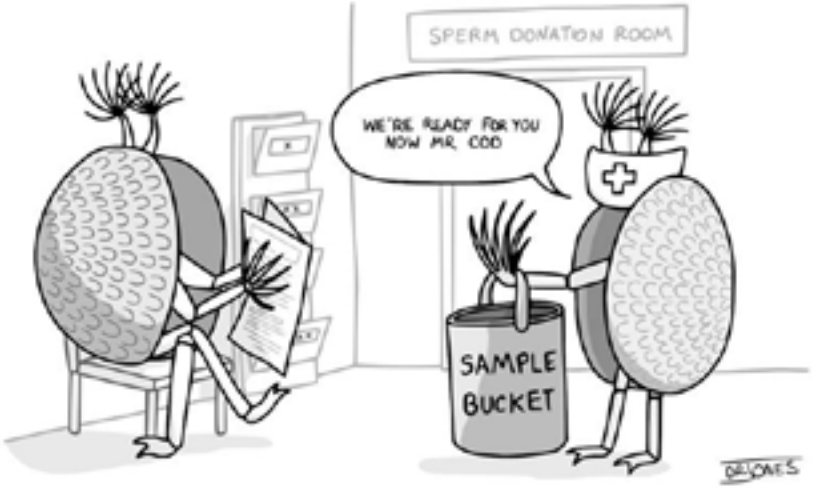
news

Palaeontology in the news — Ostracod sperm hits the headlines

Recent fossil news outside our palaeontological bubble has – for once – not focused entirely around theropod dinosaurs. 'Sex sells' is a truism in the media, and a carefully crafted headline can draw traffic to the most niche palaeontological topics.

On 16th September the *Proceedings of the Royal Society B* published a paper entitled 'Exceptional preservation of reproductive organs and giant sperm in Cretaceous ostracods' (Wang *et al.* 2020), authored by researchers from Nanjing Institute of Geology and Palaeontology and Center for Excellence in Life and Paleoenvironment, Ludwig-Maximilians-Universität München, Queen Mary University of London and the University of Chinese Academy of Sciences, Beijing.

This paper describes ostracods with exquisite soft-tissue preservation. These tiny carapaced crustaceans are preserved in Kachin amber (another name for Burmese amber, from Myanmar, which is itself the subject of ethical controversy and associated media interest) and dated from the mid-Cretaceous, around 100 million years old. Thirty-one specimens of the new taxon *Myanmarcypris hui* were reported in the piece of amber. The giant sperm were found in the seminal receptacle of a female, reconstructed from micro-CT analysis.



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

Giant sperm are well known from modern ostracods, and fossil examples had already hit the news in 2014, with the description of fossilized sperm, a mere 17 million years old, from phosphatized cave deposits in Queensland, Australia. The new discovery, together with detailed descriptions of

male and female reproductive anatomy, suggests that this group of ostracods have been doing it that way for a very long time.

The *Telegraph* ran with "Scientists discover the world's oldest sperm sample" (conveniently failing to mention either the fossiliferous nature of the sperm, or its crustacean origins) while *Sky News* had rather optimistically romantic notions about ostracod sex: "The sperm was found trapped in amber after two ostracods were enveloped by tree resin while in the throes of passion". My own favourite headline was in *TheCut.com*, which said what everyone was really thinking: "Damn, That's a Lot of Giant Sperm for One Tiny Crustacean". And if Unilad are covering your research, you really know you've made it in the 'bants' end of student culture, although the journalist covering the story did not remain impartial: "I'm not sure if we're supposed to be impressed or horrified with this knowledge…".

Meanwhile, back in the world of scholarly palaeontological discussions, the unavoidable move to digital annual conferences has resulted in unexpected publicity for the discipline, although not in the way that many researchers would have wished.

The Society of Vertebrate Paleontology's 80th Annual Meeting was a virtual affair, for which an online conferencing platform was employed, with a helpful in-built feature: a profanity filter for Q&A sessions. Given concerns about abuse both off- and online at major conferences, this would seem to be a sensible generic feature for any online conference platform.

Unfortunately, in scenes reminiscent of a Douglas Adams novel, the overzealous cybernetic puritan enthusiastically redacted any words in the Q&A sessions that could cause offence. Words like 'bone'. Words like 'pubic'. Words like 'hell' – which meant that for a while 'Heck Creek' was a well-known Cretaceous formation under discussion. Words that could be the surnames of researchers were also caught by the filter, such as 'Wang' (although it was pointed out that 'Johnson' was not similarly censored, suggesting an additional problematic, anglocentric bias in the filter). Tom Holtz of the University of Maryland (@TomHoltzPaleo on Twitter) helpfully posted a spreadsheet of all the words known to be caught by the filter, so that they could be unblocked. If you are of a puerile disposition, this makes for a very jolly read.

At the time of writing, this unintended feature of the conference had resulted in coverage in both *The Guardian* and the *Daily Mail*, thus demonstrating that rude words have universal appeal across the political spectrum. Some researchers expressed frustration on social media that of all things that journalists could have reported on from this high-profile meeting, it was the profanity filter which made the cut. I would gently suggest that we cannot change what the media will focus on, and perhaps explaining the reason why not being able to talk about, say, pubic bones from Hell Creek is an interesting outreach opportunity.

Susannah Lydon
Publicity Officer

REFERENCE

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2020 and the Crystal Palace Dinosaurs

The Friends of Crystal Palace Dinosaurs (FCPD) are a volunteer-run charity set up to advocate for the conservation of approximately thirty palaeontological sculptures, five geological displays and related landscaping in Crystal Palace Park, London. The animal sculptures represent the beginning of science communication and outreach: sharing cutting-edge (at the time) knowledge about extinct animals by modelling full-size, three-dimensional creatures from fossil remains. Today, they tell us a story about the development of scientific ideas and how scientists respond to new evidence.

We are all familiar by now with references to 2020 as an eventful year, to say the least. The FCPD have been no exception to this experience and we were happy to accept the invitation of the Palaeontological Association to detail the year so far in the life of the Crystal Palace Dinosaurs.

February 2020 saw the most significant development. Historic England, the public body that champions and protects England's historic places, confirmed that the Crystal Palace Dinosaurs were to be added to the Heritage At Risk register. Many of the sculptures have large cracks in their bodies and limbs, and some are in danger of losing toes, teeth, tails and antlers. By adding the much-loved sculptures to its Heritage at Risk Register, Historic England hopes to raise awareness of their plight and focus attention on their repair and conservation.

The Crystal Palace Dinosaur sculptures are now on the Heritage At Risk Register, February 2020. Photo: Sarah Slaughter.

Unfortunately, a few weeks into lockdown, devastating news came from a member of the public that something terrible had happened to the Megalosaur sculpture. Our beloved Meg, the symbol of our charity, had lost the front of its face and lower jaw. We alerted Historic England, the London Borough of Bromley (owners) and the Metropolitan Police to investigate the cause of this damage. A week later, we also discovered that the antlers of the Irish Elk had been damaged, potentially by strong winds.

After sharing our sad news with the public through our social media channels on Facebook, Twitter and Instagram, we were overwhelmed with the kind response of CP Dinosaur fans from across the world. Fundraisers from distant places such as Texas and Hong Kong as well as people from our local community rallied to support us. Aware of our responsibility for the donations received, we worked hard with Historic England and Bromley Council to find a solution for the Megalosaur. We met with a senior historic architect and a structural engineer from Historic England in mid-June

on the island so they could assess the damage. Shortly after that we guided a specialist sculpture conservation team to assess the damage in greater detail and cost the options. This work included assessment of all the fragments and the standing structure, including material testing, breakage patterns and other critical variables for repairs. The sampling, research and report were contracted by Historic England, as they provide the groundwork for decisions on further works.

The Megalosaur damage to upper and lower jaw, May 2020. Photos: Sarah Slaughter.

The Megaloceros *antlers now both have damage, May 2020.*

Our volunteer photogrammetry team (Rhys Griffin and Anthony Lewis) fully documented all the fragments with 3D data. This will be included in the pending conservation report and has already been invaluable in understanding the breakage patterns and getting perspectives on conservation options. The two areas of the Megalosaur distinctly affected by the damage are the upper jaw and nose, and the lower jaw and mouth plate. There are stress cracks all over the body and we hope to determine the exact causes, which could be rusted iron inside the structure, stress on the joints or poor foundations. We have also had meetings with a hydrology survey contractor to look for solutions to the low water levels, making it harder for people to trespass on the islands. Trespassers climbing on the already weakened structures increase the potential for further damage. Several security professionals have kindly met with us to set up several ways to improve security on the island.

As if there hadn't been enough drama already, at the end of the summer we discovered a large wasp nest in the mouth of the Megalosaur. Responding to concerns regarding the safety of conservators who will hopefully soon be working on the damaged sculpture, FCPD contacted a local friendly pest controller who offered to tackle the nest for free. A wasp-filled dinosaur sounds like a horror film monster but Vicki from Lady Bug Pest Control was not afraid to face it!

Tackling the wasp-filled Dinosaur, August 2020. Photo: Sarah Slaughter.

news

The beginning of the autumn sees us preparing to facilitate future conservation work by building a new bridge, reinstating access for maintenance as well as guided interpretation visits. The bridge project, led by Friends of Crystal Palace Dinosaurs, was crowdfunded by many hundreds of members of the public, businesses, the mayor's office and council, and supported by Historic England. For information about the design and construction of the bridge, see <**https://cpdinosaurs.org/bridge/**>.

Mock-up of the new bridge. Photo courtesy of Tonkin Liu.

Once the bridge is in place we hope to begin making applications for funding to conserve the sculptures and ensure their place in the hearts of members of the local community, scientists, historians and many more for generations to come. We are concerned at the ongoing deterioration of the sculptures, especially those that have not received recent attention. As with the Megalosaur, the mammal sculptures are in particular need of conservation work, along with the early amphibians and therapsids. Our overall aim at this point in time is to ensure the Dinosaurs lead a long and fulfilling life in the public imagination. We want to help them inspire and educate generation after generation of local, national and international fans.

Sarah Slaughter
Trustee, Friends of Crystal Palace Dinosaurs

If you would like to learn more about the work of the Friends of Crystal Palace Dinosaurs, and how to support them, please visit their website (at <**https://cpdinosaurs.org**>) or follow their social media accounts (@cpdinosaurs on Twitter and Instagram, and @cpdinos on Facebook).

PalAss Exceptional Lecturer Scheme – Deadline Extended

The application deadline for the PalAss Exceptional Lecturer scheme has been extended to Monday 30th November 2020 to allow for a broader field of applications. The successful applicant will deliver the Innovations in Palaeontology Lecture Series in 2021/22 on a topic of their own research to promote palaeontology to the wider academic community, and is supported by up to £2,000 (up to £500 per lecture) for travel expenses. Candidates must self-nominate. For more details, please see pages 15–16 in this *Newsletter*, or the Palaeontological Association webpage: <**https://www.palass.org/awards-grants/awards/palass-exceptional-lecturer-application**>.

Uwe Balthasar
Meetings Coordinator

New e-mail service

Earlier this year the Association began using an e-mail service, Mailchimp, to send out notifications to members. It has come to our attention that for some members the e-mails sent using the new service have not been delivered to their inboxes successfully.

If you haven't received any recent communications from the Association please check your junk/spam folder and add palass@palass.org to your list of safe senders. If there is still a problem please contact me via e-mail at <**executive@palass.org**>.

Jo Hellawell
Executive Officer

Mentoring scheme

The Palaeontological Association has established a mentoring scheme to assist palaeontologists throughout their academic careers. We identified priority areas and in the first instance focused on the transition from postdoctoral to permanent job. We are now expanding the scheme to include PhD students, and mid-career to senior leadership roles will be considered later.

The Palaeontological Association mentoring scheme operates through direct mentoring, via e-mail, telephone or video calls, or other forms of communication. Twenty-three palaeontologists in permanent positions are currently acting as mentors and, so far, ten postdoctoral palaeontologists have taken part in the scheme. Feedback from mentors and mentees about the scheme has largely been very positive.

If you are a PhD student or postdoctoral palaeontologist and are interested in having a mentor, or a palaeontologist in a permanent position who would be willing to act as mentor, please e-mail me (<**vicepresident1@palass.org**>) for more information.

Fiona Gill
Vice President

From our Correspondents

A Palaeontologist Abroad

Highlighting early-career researchers who have taken posts outside their home country and the opportunities they used. This issue's palaeontologists are Tasnuva Ferdous Ming Khan, Nuria Melisa Morales Garcia and Vishruth Venkat.

Tasnuva Ferdous Ming Khan is a Bangladeshi who studied in the United States and is currently in Erlangen, Germany. She completed her Bachelor of Science at Cornell University from the Department of Earth and Atmospheric Sciences and the Paleontological Research Institution on a Cornell scholarship, and is presently a Masters student at GeoZentrum Nordbayern, Friedrich-Alexander Universität Erlangen-Nürnberg.

Q1: How did you end up in the United States and Germany?

I always knew I wanted to study abroad after high school, but the costs were going to be prohibitively expensive. The USA was one of the few places in the world where the possibility of a fully funded degree existed, but only a select few institutions extended need-blind and need-aware admissions policies to international students. Through a combination of hard work, determination and some luck I was awarded a four-year scholarship to do my undergraduate degree at Cornell – and so I went. I moved to Germany in October 2019 to start my Masters in Palaeobiology, a highly research and writing oriented programme. I picked FAU because I wanted to work with Professor Wolfgang Kiessling and his team on the TERSANE project (Temperature related stresses as a unifying principle in ancient extinctions).

Q2: How is your position funded?

As an undergraduate student at Cornell all of my tuition, supplementary fees and living expenses were covered by grants from the university through financial aid packages. At FAU in Germany, only a small fee (~€120) is charged every semester. My living costs are funded through a combination of my savings and work as a research assistant (called HiWis in Germany) at the Institute for Palaeontology at FAU.

Q3: What is your project about?

My first year Masters project focuses on extinction selectivity measures on marine invertebrates, *i.e.*, assessing which ecological or physiological traits have historically been more vulnerable to extinction. Present studies of selectivity usually use occurrence-based data from the Paleobiology Database (PBDB), but the stratigraphic ranges are taken at face value. To account for the possible backward smearing of last appearance dates (LADs), I am using simulation-based approaches that quantify sampling completeness in order to reassess extinction selectivity metrics on body size and geographic range.

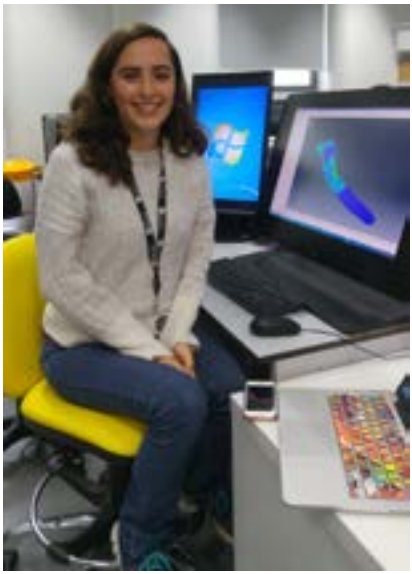
For undergraduate research, I studied turritelline gastropod-dominated assemblages (TDAs) from the La Meseta Formation (Eocene) of Seymour Island, Antarctica. These assemblages occur multiple times throughout the 15 million years encompassed in the Formation. I used a combination of sclerochronology and sedimentology to assess palaeoecological, palaeoenvironmental and taphonomic processes that govern the formation of such gastropod assemblages through the Formation. A manuscript is presently in preparation!

Q4: What surprised you most about living in the United States and Germany?
Moving from the heart of urban Dhaka, Bangladesh to rural Ithaca, New York for the first time was a huge east-meets-west culture shock. America was everything and nothing like how movies and TV portrayed it to be, though I had to keep reminding myself that Ithaca was not representative of America. Ithaca is well known for its two major universities, hundreds of waterfalls, politically charged poetry slams in cafés, a liberal mindset and nonconformity. The first thing I noticed was that it was very common to say hello and engage in conversation with virtually everyone, and how, at least in the Department of Earth and Atmospheric Sciences, barriers of formality between professors and students were very small. It took a little while to be comfortable with this level of friendliness, as urban Dhaka's culture and everyday stressors did not always allow for this sort of interaction. During my time in Ithaca, I also came to appreciate how American history is fraught with structural inequalities, how past injustices have lasting consequences, and how college campuses are at the forefront of civics, organizing and dissent. Ithacans have described the city as "ten square miles, surrounded by reality", and I fully agree!

The move from Ithaca, NY to Erlangen, Germany was not as drastic because my time in America had prepared me for Western culture. Of course, the first thing I noticed was my lack of German skills! Thankfully, Erlangen is also a university city, so not speaking the language was not a serious disadvantage, especially as my coursework is completely in English. I was also surprised at how singularly focused the education system seems to be: if you're a geoscientist, you primarily take geoscience courses with the prerequisite maths, physics, chemistry and biology, which was quite unlike the American curriculum that mandated training in other liberal and social fields of study. I had come to associate college campuses with places of collective action against injustices – social, national and global – and a place to learn about privilege and inequality. Unfortunately, such intersectional dialogue about current events is often absent in Erlangen, perhaps as a result of a university structure that does not integrate critical analyses of history and current events unless you specifically choose to study those fields. I am glad that the Institute of Palaeontology at FAU recognizes this, and is working towards including studies in diversity, equity and inclusion in its curriculum for Masters students.

Q5: Apart from friends and family, what do you miss most about Bangladesh?
I really miss being able to joke in Bangla! I am very comfortable in articulating my thoughts in English, but there are just some instances when life feels incomplete unless I throw some colloquial Bangla in. I also miss simple and hearty home-cooked traditional dishes and the punchy flavors of cheap street food. It does not taste the same when Indian restaurants make the sauce for fuchka and pani puri with clean water, because they're missing out on extra flavour from urban Dhaka's streets. I also miss a lot of entertainment options because most things are produced in German, and when foreign media is originally in other languages, they're often dubbed into German without subtitles, with very limited opportunities to access it in its original language.

Ming tweets at @Ming_tfk27, and her personal/work website can be found at <**https://mingkhan.com**>. Her lightning talk from ProgPal 2020 is on YouTube (see page 34).



Nuria Melisa Morales Garcia is a Mexican in the UK, doing a PhD at the University of Bristol on CONACYT funding.

Q1: How did you end up in the UK?
I was finishing up my undergraduate degree in Pachuca, Mexico. By this time, I had been working in palaeontology for a couple of years; first, on my thesis about mastodons, and then on a side project on canid coprolites. I knew I wanted to keep working on mammalian palaeontology and one of the world-experts on this topic – Christine Janis – was working in Bristol. Plus, I discovered Bristol had an excellent MSc in Palaeobiology course, so it was a match made in heaven!

Q2: How is your position funded?
My MSc and PhD have been funded by CONACYT (National Council of Science and Technology), Mexico. My scholarship has covered my tuition and living expenses, but I've had to seek research and travel funding elsewhere. I've obtained a few grants for these purposes, including the Palaeontological Association's Stan Wood Award, SVP's Jackson School of Geosciences Travel Award and other sources within the University of Bristol.

Q3: What is your project about?
I study the relationship between jaw shape, functional performance and diet in Mesozoic mammals, using small extant mammals as a comparative basis. To do so, I use different biomechanical techniques including Finite Element Analysis (FEA) and beam theory. A very cool part of my project is that I've helped develop a new technique that allows us to build 3D models from scratch (using measurements from photographs) and then analyse them using FEA without having to CT-scan any material. This is really crucial to making biomechanical techniques like FEA more accessible to people with little or no research funding – the costs associated with CT scanning can be prohibitive for many people.

Q4: What surprised you most about living in the UK?
Before moving to the UK, I started watching British shows and movies to get a feel for the culture and the British accent, and I thought it was very peculiar that everything I was watching had this "grey filter". When I finally came to the UK, I realised there was no filter and things really do look like that!

On a more serious note, it really surprised me how expensive everything is compared to Mexico. I was very lucky to have a scholarship to cover my tuition, but international fees for many people coming from abroad are exorbitant. Likewise, costs associated with academic publishing and research are really high – I have been very privileged to work in a UK institution that can cover these costs for me, which has allowed me to publish in high-ranking journals. Sadly, I would never have been able to afford this studying in Mexico.

Q5: Apart from friends and family, what do you miss most about Mexico?
Definitely the food! Sadly "Mexican food" abroad is nowhere near as good as the real thing. Fortunately, I can still get some authentic Mexican supplies here and I get to share a little taste of Mexico with my friends.

Melisa tweets at @NuriaMelisaMor1, she is also a science graphic designer and you can find her work at <**https://www.sciencegraphicdesign.com**>.

Vish Venkat is an Indian American in Chicago, USA, previously a Masters student in Bristol, UK and currently working as a PhD student in the Integrative Biology programme at the University of Chicago, funded by its Biological Sciences Division.

Q1: How did you end up in the UK and USA?
I grew up in India for most of my life, but I knew I wanted to study evolutionary biology, and moving out of the country seemed the most prudent way to go about things. I did my undergraduate work at the University of California Berkeley, where I got hooked on palaeontology, and thanks to the support of one of my undergrad mentors, Seth Finnegan, went on to do a short study abroad stint at the University of Bristol with Phil Donoghue and Jakob Vinther.

I fell in love with the city and the department, and went back to Bristol to get an MSc in Palaeobiology, studying the sarcopterygian dermal skeleton with Phil. Bristol helped me crystallize my interests in evolutionary morphology, development and the philosophy of biology, and UChicago seemed to be the ideal place to develop those further. I finally found myself in UChicago's Organismal Biology and Anatomy department, working with Michael Coates (whose work I had been familiar with as an undergrad at Berkeley) and Vicky Prince. UChicago's close links with the Field Museum and the Marine Biological Laboratory, as well as its traditional appreciation of unusual, integrative projects combined with two advisors working respectively in palaeontology and developmental biology made this the perfect fit for me.

Q2: How is your position funded?
For two years of my time here, I was funded by a National Institute of Health (NIH) Developmental Biology training grant that Vicky had been awarded. The rest of my time has been supported by UChicago's Biological Sciences Divisional (BSD) funding, which covers many students in the Darwinian sciences cluster (which includes the Committee on Evolutionary Biology, and the departments of Organismal Biology and Anatomy and Ecology and Evolution). UChicago's BSD provides very respectable graduate support, especially in departments that may not be directly applicable to grants from the NIH, which often cover other molecular or biomedical research programmes. My time at Bristol was self-funded, and while international

fees in Britain and living costs in Bristol can quickly add up, the intellectual experience easily makes it one of my most worthwhile investments.

Q3: What is your project about?
I'm studying the evolution and development of the cranial lateral line across vertebrates. This is a centuries old area of interest, and palaeoichthyologists have long used the lateral line – a network of mechanosensory cells housed in canals or grooves on the head and trunks of fishes – as an important taxonomic tool. Recently, however, developmental biologists have begun to uncover the morphogenetic underpinnings of how this system is built, thanks to the advent of modern imaging methods and transgenic lines. Much of this new research has been focused on the simpler trunk lateral line and in a few model systems. I am trying to combine palaeontological information with developmental data (from comparative embryology) to understand the more complicated lateral line network in the head, particularly in the context of changing head morphology across disparate lineages – like the transition from jawless to jawed vertebrates. This work is timely given our rapidly changing picture of early vertebrate evolution, concurrent with the advent of new imaging methods (like lightsheet microscopy and synchrotron tomography) which make a wide variety of extant embryos accessible to analysis.

Q4: What surprised you most about living in the UK and USA?
The most surprising (and exciting) thing about Bristol for me was how accessible the entire country was, public transit wise. I could walk up to the station, get on a train and find myself in Bath, Wales or Manchester for the weekend! I had to visit Paris, Estonia and Switzerland for my MSc work, and even the affordability of air travel was fascinating. What surprises me the most about Chicago – and the Midwest in general – is just how much vast, flat, empty space there is. The moment one gets out of the city, it is swathes upon swathes of cornfields, farms and empty grassland – beautiful sky country, aptly named. In both Bristol and Chicago, perhaps another very (pleasantly) surprising thing is professional camaraderie and lack of academic hierarchy – most faculty treat researchers as junior colleagues. I still fondly remember my MSc advisor reminding me that one does not use titles when speaking with faculty in Bristol, and my PhD advisor still reminds all of her students that she's "just Vicky, not Dr Prince".

Q5: Apart from friends and family, what do you miss most about India?
I grew up in a bustling metropolis of seven million people, and both Bristol and Chicago (surprisingly) feel a lot, lot quieter. I'd say I miss the food, but both places are culinary delights (with the sad exception of fresh coconut water), so it really is the hustle and bustle, the people and the noise that I miss these days.
Vish tweets from @vish_venkat and is on Instagram at @venkatvishruth.

Legends of Rock

Franz, Baron Nopcsa von Felso-Szilvás
The great, gay pioneer of palaeobiology

Politician, linguist, spy, pretender to the throne of Albania. These are just a few of the accomplishments of one of the most colourful palaeontologists of all time, Baron Franz Nopcsa von Felso-Szilvás, whose work on fossil reptiles earned him the title 'The Father of Palaeobiology'.

Nopcsa was the scion of a noble family, whose seat was at Szacsal, in Transylvania, then part of the Austro-Hungarian Empire. He was born in 1877 and grew up on the family estate where his sister, Ilona, made a discovery that would come to mould the rest of his life – a series of latest Cretaceous (Maastrichtian) dinosaur bones that would become the basis of an important and impactful career.

Fired by the discovery of this material, Nopcsa went to Vienna to study under the famous Alpine geologist Eduard Suess. Suess was no palaeontologist but encouraged Nopcsa to educate himself in the subject, which he did by corresponding with many of the eminent figures active in Europe at this time. An excellent student, this research led to Nopcsa's descriptions of several dinosaurs from the terminal Cretaceous of the Sânpetru Basin, including *Magyarosaurus*, *Telmatosaurus* and *Struthiosaurus*, which had inhabited a series of islands that once dotted the region.

Unlike the majority of his contemporaries, who were interested solely in taxonomy, Nopcsa was interested in his study organisms as living, breathing animals. With this in mind, he produced a brilliant set of studies in which he argued that his dinosaurs were insular dwarves. This was the first time that this modern phenomenon had been recognized in the fossil record – a conclusion that has since been confirmed and expanded by modern authors. In addition, he was one of the first to apply osteohistology to fossil vertebrates, using it to speculate on the evolution of reptile physiology. Finally, among many other accomplishments, he also suggested that dinosaurs were sexually dimorphic, regarding the crests and horns of many taxa as sexual display structures, a conclusion that's been partially upheld, although his male–female pairs have since been shown to represent different taxa. Despite his palaeobiological interests, he never eschewed detailed taxonomic work and went on to describe many other new fossil reptiles from across the world and opine on their relationships.

Nopcsa in Albanian uniform in 1915. Public domain image.

Alongside his palaeontological work, Nopcsa became fascinated by the people and customs of Albania and developed a strong reputation as an academic ethnographer. His work in this area is still widely respected and cited, with his notes forming the core of Albania's National Library. Indeed, his knowledge of the region made him an effective spy for the Austro-Hungarian army in the Balkans during World War I. There are photos of Nopcsa posing in Albanian national dress and with the local brigands, and he clearly developed a strong attachment to the country, not least when he volunteered (in all sincerity) to become the King of Albania. He aimed to reconstruct post-war Albania by using his title and position to lure an American heiress to be his consort, so that he could use her money to rebuild the country. This plan was turned down by the Allies – much to Nopcsa's disappointment.

Still, attracting an American heiress might have been difficult, as Nopcsa was an openly gay man, whose long-time partner was his younger Albanian secretary Bajazid Elmas Doda, his constant companion for nearly two decades. Indeed, Nopcsa's devotion to Bajazid was recorded not only in his diaries, but also in the fossil turtle named *Kallokibotion bajazidi* in his honour. *Kallokibotion* is commonly translated as 'beautiful box' and it's widely thought that this doesn't refer to the turtle's shell, but to Nopcsa's wholehearted appreciation of one particular part of Bajazid's anatomy. It seems likely that Nopcsa's aristocratic origins enabled him to live openly in this way – at a time when homosexuality would have been criminalized in many European countries. It's difficult to imagine other LGBTQ+ contemporaries being welcomed into the scientific elite in the same way, and he remains the only founding figure of palaeobiology known to have been in a same-sex relationship.

Nopcsa's fortunes were strongly and negatively affected by the war – Transylvania was ceded to Romania and he lost his ancestral lands. Impoverished, he took a position at the Hungarian Geological Institute. However, it's clear that paid work disagreed with Nopcsa's rather haughty temperament and he quit his post to go on a motorcycle tour of European museums, writing copious notes and meeting with many of his contemporaries, with Bajazid ever-present in the sidecar. On returning to Vienna, he sold his beloved fossil collections, including Bajazid's turtle, to the Natural History Museum, London, where they remain today.

Reading through some of Nopcsa's correspondence in the archives of the Natural History Museum, one is struck by the man's brilliance, curiosity and self-regard, but there are also flashes of the depression and melancholy that dominated his later life. In 1933, distressed by his financial ruin and illness, Nopcsa drugged Bajazid and shot him, before turning the gun on himself. He was only 55. His suicide note mentioned his desperation and that he did not want Bajazid to suffer alone and in poverty. Despite this tragic end, Nopcsa made substantial contributions to understanding the geology of the Balkans, the ethnography of Albania and was one of the most brilliant minds in vertebrate palaeontology, as well as stimulating research programmes that continue today. Despite his colourful life, most biographies of Nopcsa are rather dry – but surely he and Bajazid are deserving of a sumptuous Hollywood biopic? Casting suggestions anyone?

Paul M. Barrett
Natural History Museum, London

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Behind the Scenes at the Museum

Rebuilding the Museu Nacional — it's time to move on...

The palace, main headquarters of the Museu Nacional, to be partially reopened in 2022 for the commemoration of 200 years of Brazil´s independence. Photo: Alexander Kellner.

The fire of Sunday night, 2nd September 2018, will hardly be forgotten by anyone who works in science and culture in Brazil and abroad. This is one of those dates that everyone remembers where they were and what they were doing as they got the news that South America's largest natural history museum was engulfed in flames.

The first days and weeks after the tragedy were not only chaotic, but cast serious doubts about the future of the Museu Nacional. Many employees, after having dedicated a large part of their professional lives to the institution, lost everything and were flooded with feelings of perplexity, bitterness and uncertainty. Students lost their dissertation data and theses, and scientists (not only those employed at the Museum) had much of their research ruined. Not to mention the greatest pain for everyone: the partial loss of a collection formed across two centuries of existence, causing both national and international consternation.

Days after the fire, there was a unique discourse shared by everyone: rebuild the palace and the academic structures, as well as to act in the recovery and restoration of the collection. Thus, the project "Museu Nacional Vive" – the Museu Nacional Lives – was established. Two years after the tragedy, the future is clearing up, with greater understanding as to where the Museum is heading.

One of the main sources of support came from UNESCO, our partners from day one. Through them we got the support of the Vale Foundation (Vale Mining Company) and on 3rd March 2020 a technical cooperation agreement was signed. This agreement resulted in the installation of working groups and committees. The Executive Committee, which is responsible for the deliberations of the project, is formed from two representatives from the Federal University of Rio de Janeiro (the University to which the Museum belongs), one from the Museu Nacional, one from UNESCO, two from the Vale Foundation and one from the Civil Society. Meanwhile, the Institutional Committee has an advisory character and monitors the development of the reconstruction of the Museum. The German Government, the Goethe Institute, UNESCO, the Brazilian Academy of Sciences and several other institutions from Brazil and abroad are confirmed or invited. A final committee, named the Post-Inauguration Safety and Sustainability Working Group, will be coordinated by representatives of the The National Bank for Economic and Social Development (BNDES) and includes, amongst others, the Friends of the Museu Nacional Association (SAMN). Nobody wants the tragedy to be repeated.

Sauropod dinosaur still inside the palace. This specimen is one of many that survived the fire of 2nd September 2018. Photo: Alexander Kellner.

One of the most important aspects of this initiative, with several open committees, is to bring transparency about how activities are being carried out and to make actions more agile. It is clear to all that the Museu Nacional will only be rebuilt with support from governmental structures – at the federal, state and municipal levels – from different national and international organizations, including scientific institutions and museums from Brazil and abroad, and, above all, with a wide participation of private initiatives.

One of the results already presented is a preliminary schedule of the different stages to be developed, ending with the delivery of the palace in 2025. But before that, we would like to open at least part of the palace for the bicentennial celebration of Brazil's independence in 2022.

Of course, we cannot be insensitive to what we are experiencing at the moment: the pandemic caused by the SARS-CoV-2 virus. At the time of writing these lines, it is not yet possible to have an exact idea of the magnitude of the damage that this pandemic can still cause in societies around the world. But, even with the social isolation recommended by the health authorities, which we are complying with, we and our partners continue to work on the reconstruction of the institution.

A view from the inside of the palace. Photo: Alexander Kellner.

There is another action that museums and scientific institutions around the globe can help with: the recovery of our collections! We are seeking to receive original material for our new exhibits. Perhaps international societies might get involved and come to our aid. The Universalmuseum Joanneum of the city of Graz (Austria) has already pledged the donation of 196 ethnographic objects. Several German institutions have signed an open letter expressing their willingness to help in this matter. But more is needed.

Lastly, I would emphasize that the Museu Nacional Vive project has ended up becoming an opportunity for people and countries to work together, aiming at the establishment of a modern museum of natural history and anthropology that could become a model for South America. This opportunity cannot be missed.

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For more information about the Museum and how you can help you can visit the website (<**http://www.museunacional.ufrj.br**>*), Facebook page (*<**https://www.facebook.com/MuseuNacionalUFRJ**>*), or donate at* <**https://www.samn.org.br/donate**>*.*

The worm turns

When the young Ralph Vaughan Williams asked his mother about his great-uncle Charles' most scandalous book, she replied that the Bible said that God made life arise in six days, while his great-uncle said it took much longer – but that it was wonderful either way! It was a nicely judged response, as befitted one of the more progressive of late Victorian English households. Whether that musically-talented youngster knew that his notorious relative had once serenaded earthworms in a brief improvisation for bassoon, penny whistle and piano, though, is less clear. This was not for some kind of creative outburst – at least, not in the sense that the young Ralph would have understood. Charles Darwin, in later life, bemoaned his loss of any pleasure from music, his mind having become by then 'a kind of machine for grinding general laws out of large collections of facts'. This particular piece of music-making was aimed at accumulating yet more facts, to better grind those general principles.

The earthworms were to become the focus of Darwin's last, and in some ways most charming of books, *On the Formation of Vegetable Mould through the Action of Worms*. That later Earth-spanning polymath, Vladimir Vernadsky, was once accused of trying to analyse 'the geochemistry of the soul of the mosquito' [1]. Well, here Darwin was overtly seeking to commune with, and understand the thinking of, the common earthworm. Common?… and *thinking*? The great man clearly marvelled at the behaviour of these blind and (almost) brainless invertebrates, watching as they *felt* which end of a leaf (the tip, not the side or stalk) was best to drag down first into their burrow. The music came in the form of a low note on the bassoon, to judge the worms' response (none), a shrill note on the whistle (the same) and a piano played 'as loudly as possible' (ditto). But put a flowerpot with worms *on* the piano, and a single note will cause them to instantly descend into their burrows. Therefore, Darwin surmised that worms are deaf, but sensitive to ground vibrations – as finely ground-out a general worm principle as one could wish for.

It was the worms' activity as engineers of the landscape, though, that absorbed much of Darwin's labours for this book. The story had started long ago, in Darwin's own youth, when 'Uncle Jos' Wedgwood, pottery magnate and future father-in-law, had shown him how cinders spread on the lawn were progressively buried, as they were covered by wormcasts (the 'vegetable leaf-mould' of the book) brought up from below. The curiosity that Uncle Jos showed here for this domestic piece of natural history might, perhaps, have been a factor when he was to argue (successfully) with Darwin's father to allow Charles to sail on *The Beagle*. That decision was to lead to many things – among very many others the impetus for the young Ralph Vaughan Williams' innocent question, and Darwin's own experiments on the impressive rates of soil formation by earthworms.

Earthworms too, would seem to fit in with Darwin's strongly expressed prejudices in another way. Their constant activities leave their mark in soils both modern and ancient, even in the most trying of circumstances. Soils that formed only centimetres above the Cretaceous–Palaeogene asteroid impact layer have shown an abundance of worm burrows looking much like modern ones – and the authors of that paper surmised that the worms' resilience and dedication to their task literally laid the groundwork for the rapid reconstruction of the terrestrial ecosystem above, and sped up the evolution of the new generations of big fierce animals that were to stalk

[1] For more on Vernadsky see 'The Birth of the Biosphere' from issue 84.

it (Chin *et al.* 2013). But as to remains of earthworms themselves? – well, there is almost nothing that meets the naked eye. It seems to be yet another of those gaps in the fossil record which Darwin so bemoaned, as he turned to fancily bred pigeons and the like for physical evidence of biological evolution.

Marine worms, now, can be beautifully fossilized in strata going back half a billion years and more, as those many wonderful examples from the Burgess Shale and other such extraordinary fossil localities show. I've even seen fragments of annelid worm, complete with nicely preserved segmentation, turn up now and again amongst the trilobites and graptolites of the Welsh slates. But standard terrestrial worms of the oligochaete kind look to be genuinely, exceedingly, scarce as body fossils. Small wonder, perhaps, as most soils are nicely aerated (by the worms themselves, of course) and about the ideal medium for the active scavenging/decay of any pieces of recently-deceased worm. *Very* rarely, worms turn up in amber, though even here it is useful to have a helping hand. One such petrified example was described in a paper in the marvellously named journal *Megadrilogica*, which sounds as if it should be a fanzine of Hollywood monster films, but is actually devoted to the science of the oligochaete worms (the website helpfully explains that this is because these organisms 'are commonly referred to as the megadrile oligochaetes', a meaning of the word 'commonly' that is new to me). Here, the unfortunate but immortalized worm seems to have been carried into the amber by a predatory fly – that was entombed, too, before it could enjoy its lunch (Poinar 2007).

Much more recently, humans have given a hand to the fossilization process, not least by producing micro-environments too unappealing even for the standard agents of scavenging and decay. The all-too-directly anthropogenic strata of a 16th-century cesspit in York have been delicately rummaged through, and among the treasures unearthed was an earthworm, mineralized by calcium phosphate, complete with traces of setae, collagen fibres and blood vessels (McCobb *et al.* 2004). It's a distinctive addition to the palaeontological archives, and in so being underlines the rarity of whole-earthworm petrifaction.

Darwin's assessment of the imperfection of the general fossil record was, of course, soon overturned, by the simple expedient of looking more closely at the strata and unearthing many more fossils – not least among them the marvellous evolutionary series of sea urchins from the Chalk strata that lay, *inter alia*, under his own house [2]. Similarly, the story of earthworm palaeontology was not to stop there, but rather to take off into other, much tinier dimensions. Its source did not, though, escape Darwin in his own profound exploration of these organisms, though he could not, in those days (even allowing for his own frustrations with fossils), have gone on to see the remarkable palaeontological possibilities that were on offer.

Darwin indeed saw that worms were doing something strange, and worried away at it, over more than ten pages of his book. Near the front end of the worm are some specialized glands, which he saw were well supplied with blood vessels and so, clearly to him, served some important function for the animal. These 'calciferous glands' secreted tiny granules of calcium carbonate, which were then excreted into the soil, together with the rest of the material in the worm-cast. Why? Darwin mulled over several possibilities. A means to neutralize acid from the digested leaves? A means of helping to grind the leaves down during digestion, like miniaturized gizzard-stones? He left it as an open question, before moving on to other earthworm mysteries.

[2] See 'Darwin's diffidence', issue 86.

Nearly a century and a half on, it still seems to be an open question. Or, as one recent-ish summary carefully put it, 'the biological imperative for calcium carbonate production by worms is not known' (Cantl 2007). So, still something of a mystery, then – and a mystery on a large scale, at that. The standard earthworm of school biology, *Lumbricus terrestris*, can produce a couple of milligrams of such granules a day. Classically soft-bodied perhaps – but it's nevertheless a genuine biomineralizing organism. And so, given the numbers of earthworms working away around us (often a hundred or more in a square metre) and allowing time to unroll as it does, it's a wonder – as one researcher put it – that we're not knee-deep in the stuff.

Perhaps not quite knee-deep – but there's quite enough in soils to work on, if one is ingenious enough. And, of course, it doesn't matter that the function of the worm granules remains an object of bafflement, so long as the objects themselves can last long enough to become fossilized (some can) and therefore become open to the usual forms of enquiry (interrogation has, indeed, begun). What, then, can one do with a calcareous worm granule that is disinterred from a soil or a fossil soil?

One can work out its numerical age, for a start – though so far this trick is possible only on relatively youthful Ice Age worm granules, and not (say) those that lived cheek by jowl (so to speak) with the dinosaurs [3]. The simplest way to do this is by targeting the carbon in the carbonate of the calcium carbonate of these worm products, and radiocarbon dating them. But… *simplest*? Radiocarbon dating may be a standard chronological workhorse for objects going back to the limits of the technique (usually about 60,000 years), but it has its fair share of pitfalls. If the carbon that is incorporated is 'ancient', for instance, and so hasn't picked up the newly minted radiocarbon that's around at the time of incorporation, then the ensuing date will be much older than the object itself, and thus terribly misleading. Soils are full of such ancient 'fossil' carbon, and one would have thought that that would easily find itself into the granules, and so upset the atomic clock. But no – almost all the carbon in the granules turns out to have come from those dragged-down leaves and other contemporary vegetation eaten by the worm, thus with its full complement of radiocarbon, that is then transmuted into the calcium carbonate. This is very well-behaved biomineralization, for sure, and the shade of Darwin would be nodding his head in appreciation at yet another astounding earthworm trick.

But worms, one might protest, can burrow through different soil layers, that would once more result in mixed-up ages? Again, not quite so. As Uncle Jos Wedgewood observed to the young Darwin all those years ago, worm casts are mainly released at one level, the ground surface: the granules naturally come along for the ride, so their precious cargo of time information neatly and conveniently assembles into one layer at any one time. And if one chooses one's fossil soils especially carefully, where successive soil layers formed in temperate and worm-friendly times are separated by wind-blown silt (loess) layers marking harsher climate intervals, then the stage is set for some properly meaningful patterns.

These are exactly what Olivier Moine and his colleagues (Moine *et al.* 2017) found when using what they called their 'earthworm clock' on a succession of ice age loess and fossil soil layers in northern Germany, that ranged from 20,000 to nearly 50,000 years old. These strata thus covered those times of the last ice age when the Dansgaard–Oeschger events were in full cry. The name

[3] The non-avian dinosaurs, that is. Far too many worms get to be terminally cheek by jowl with the avian dinosaurs on the lawn.

of the event may be a mouthful, but the mechanism is dramatic enough, producing a stop-go pattern to the Gulf Stream that, alternately, and every 1,500 years or so, plunged western Europe into bitter, windy, dusty cold on the 'off' setting before this part of world ocean circulation switched back 'on', to bring relatively warm and wet conditions to the land once more, so the earthworms could get to work again.

The earthworm clock worked a treat, picking out a succession of satisfyingly precise ages for carbonate granules extracted from no less than 25 of these vertically superimposed soils, which tied in beautifully with the timing of the Dansgaard–Oeschger events (that had been originally discovered within the chemistry of the 100,000 years-worth of compressed snow layers that cover Greenland). What's more, they showed that earthworms were not the kind of mollycoddled softies that needed thoroughly balmy conditions to be persuaded to function; just as soon as the cold and the wind began to die down a little, they would defy the elements to once more wriggle into active, granule-producing mode.

The granules have other stories to tell, too. One is of climate, where that finely tuned if mysterious worm biochemistry could react to how warm or cold the soils that they lived in were. This earthworm palaeothermometer is based upon another of the simple components of the granules, the oxygen within the carbonate, and to be more precise the ratio of the two main stable isotopes of oxygen, ^{16}O and ^{18}O. It was devised, or perhaps revealed, by taking some captive earthworms, putting them for a few weeks in soils at different temperatures, retrieving the granules that they made, and measuring the oxygen chemistry preserved within them (Versteegh *et al.* 2013). Technologically this was a step up from Darwin's own earthworm experiments, though it seemed to be the same large-spirited kind of enquiry. The results, expressed as some most well-behaved-looking graphs, were fascinating. First, the worms applied their own spin to the oxygen, by preferentially selecting the heavier ^{18}O isotope to the tune of 1.51 parts in a thousand (by comparison with inorganic calcium carbonate precipitated in the same conditions). Then, as temperatures changed, the palaeothermometer itself kicked in on top of this specific earthworm vital effect, to systematically alter the proportions of this heavy isotope within the granules. This is the same kind of now well-nigh classical temperature effect that has been seen in fossil ammonites, belemnites, foraminifera and other organisms, and that has underpinned very many studies of fossil climate. Worms have simply, if perhaps a little surprisingly, joined the club.

As a bonus, these unglamorous but eloquent fossils have encoded within them the patterns of rainfall that the worms lived through. This time it is the pattern of carbon isotopes that tell the story: carbon originally taken up by plants growing at various times of the last Ice Age, then eaten by the industrious worms, and finally converted into the tell-tale granules (Prud'homme *et al.* 2018). The underlying biochemistry here is a little murky, with the logic being what one politely calls 'empirical'. That is, today plants in dry conditions are observed to accumulate fewer of the light ^{12}C than the heavy ^{13}C atoms, everything else being equal (Stewart *et al.* 1995) – and the worms then dutifully petrify those patterns.

They're marvellous and subtle organisms, therefore, both modern and – as we now know – ancient. There seems to be ever more justification for Darwin's fascination – and for ours too. But did this sympathy for wormkind rub off on his illustrious-to-be great-nephew? Well, Vaughan

Williams wrote a good deal of his music around the country life. Here, the creatures that rose high above the soil, like that noisy lark, famously got some very good lines. But were the humble earthbound ones so harmoniously celebrated? The evidence base here is, admittedly, slim, but one might turn to *Windsor Forest*, one of his *Folk Songs of the Four Seasons*, for just the slightest of indications of where his heart lay as regards the less aristocratic branches of the tree of life. Alas, one of the lines here begins '*Vile worm* ….' No justice there, clearly, for the invertebrate sons of toil that live amid all those tons of soil.

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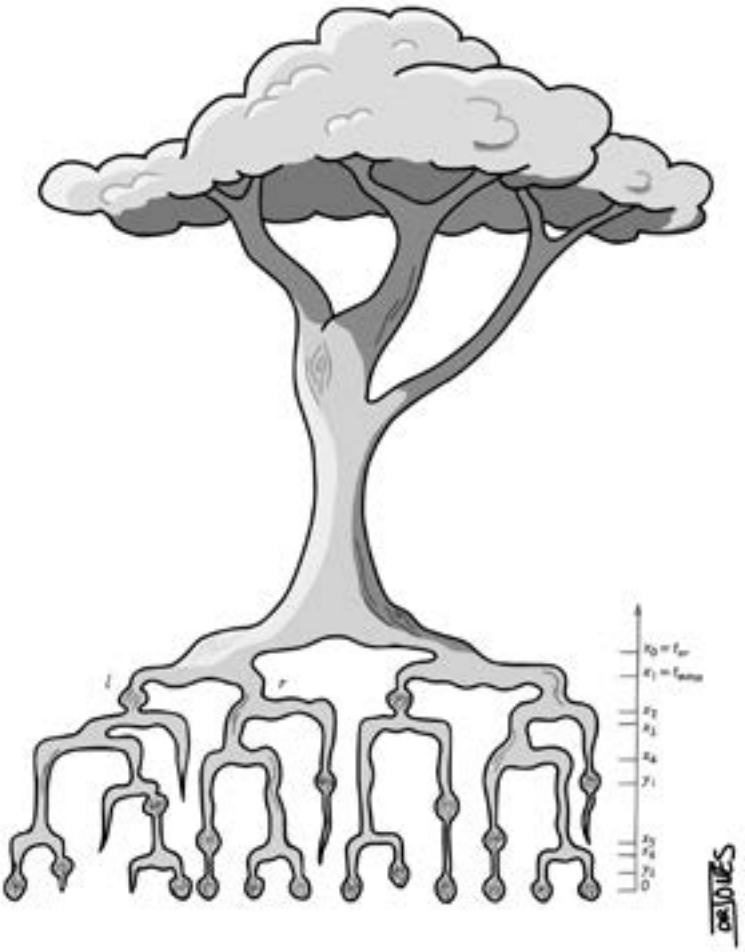
Palaeontology's greatest ever graphs

Stadler's sampled tree



When it comes to diagrams that changed the way we do palaeontology, the sampled tree from Tanja Stadler's seminal 2010 article is rather understated. Buried among lemmas and proofs in a maths-heavy paper that only ever refers to fossils in general, it's almost skeletal in its simplicity. Yet it opened up the way for palaeontologists to infer a whole new category of phylogenetic relationships: those between ancestors and their descendants.

That's not to say that the search for ancestral fossils doesn't have a long and tumultuous history. In the late 19th and early 20th century, phylogenetic thinking could still be a bit muddled, but to the extent that palaeontologists engaged in it, ancestor–descendant relationships were considered to be of prime importance. At the same time, it didn't take much for a fossil to be viewed as a possible ancestor: it was enough if, as Heilmann (1926) put it, "nothing in [its] structure militate[d] against the view" that it might have been one.

All of this changed in the 1960s with the advent of cladistics, which almost erased the word "ancestor" from palaeontologists' dictionaries. The cladists were happy to use shared derived characters to infer sister-group relationships, but had little to say about ancestors, other than what they couldn't be. An ancestral species cannot postdate its descendants, and it can't have any unique derived characters of its own: these would show that it embarked on an evolutionary trajectory separate from that of its supposed offspring. Following these criteria (which are not infallible: Foote, 1996; Wagner, 1998), the argument went, we can rule out potential ancestors; however, just because a fossil didn't fail our test doesn't mean we have found a true ancestor. Unlike the shared derived characters that unite sister groups, there is no positive evidence one could put forward in support of an ancestor–descendant relationship. This claim picked up on a real weakness in previous practice: early 20th century palaeontologists would often postulate ancestor–descendant relationships, but had no way to test them.

Yet it seems like an over-reaction to discard the possibility of finding ancestors altogether. Sometimes, the attitude would be justified by claiming that in the incomplete fossil record, the chances of finding a direct ancestor of a later taxon are minuscule. However, that's more of an appeal to intuition than a rigorous argument – and indeed, Foote (1996) showed the intuition to be wrong.

Many pieces had to fall together to make the estimation of ancestor–descendant relationships possible (Lewis, 2001; Drummond *et al.* 2006), but Stadler's (2010) paper was a key step along the way, and her Figure 1 shows why. A "sampled tree" is obtained from a tree generated under the birth–death process by suppressing all branches without known descendants. Stadler's contribution consisted in calculating the probability of such sampled trees with ancestors conditional on given values of speciation, extinction and sampling, enabling their use with birth–death priors in Bayesian analyses. This didn't make such analyses immediately practical – it was up to Gavryushkina *et al.* (2014) to develop the simulation machinery necessary – but the key ingredients were all there.

The first results were not long in waiting. Bapst *et al.* (2016) found no support for the oft-proposed ancestor–descendant relationship between the "Urvogel" *Archaeopteryx* and modern birds. On the other hand, the oldest known penguin, *Waimanu manneringi* from New Zealand, does seem to be ancestral to all later members of the group (Gavryushkina *et al.* 2016). But besides the cool factor of allowing us to make statements like these, what are sampled-ancestor trees good for?

It turns out that accounting for ancestors is important to get the divergence times right – and divergence times, in their turn, inform our inferences about diversification, trait evolution and biogeography. Incorrect placement of ancestors in sister-group relationships with their descendants amounts to assuming that both evolved from some earlier pseudo-ancestor.

Compared to the true tree, the same amount of character change is now spread over a longer period of time. This decreases the average rate of evolution, which has to be offset by making divergences older. Chang *et al.* (2015) demonstrated this phenomenon in Indo-European linguistics, referring to it as "jogging rootward".

As I write these lines, a pandemic ravages the world, provoking not only concern but also feverish research. Surprisingly enough, epidemiologists analysing serially-sampled viral sequences face similar challenges as palaeontologists analysing fossils: for the former, sampled ancestors refer to patients who continue to transmit the virus after having been diagnosed. Here, too, being able to estimate the frequency of such events matters, as it helps us understand how an epidemic unfolds.

As far as interdisciplinary connections go, the one between palaeontology and epidemiology is pretty neat – and it was inaugurated by Stadler's little tree figure.

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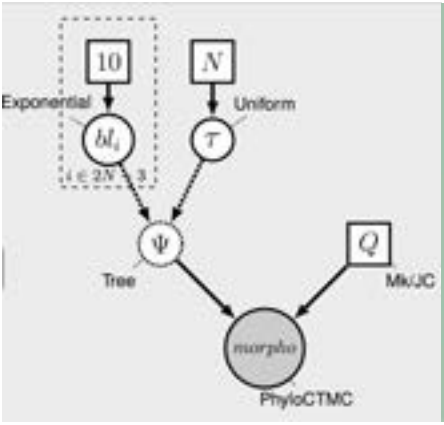
An Introduction to Bayesian Phylogenetics Part 3: Models

[NB: This tutorial, data and other useful files are available at <**https://github.com/wrightaprilm/PA_newsletter**>.]

Recap

Last session, we loaded a data matrix into RevBayes and gathered some simple facts about it, such as how much missing data we have. Today, we'll be looking at setting up a simple Bayesian model to estimate phylogeny.

Overview of Discrete Morphology Models




```
for (i in 1:n_branches) {
        bl[i] ~ dnExponential(10.0)
}
topology ~ dnUniformTopology(taxa)
psi := treeAssembly(topology, bl)

Q_morpho <- fnJC(2)

phyMorpho ~ dnPhyloCTMC( tree=psi,
Q=Q, type="Standard",
coding="variable" )

phyMorpho.clamp( morpho )
```

Graphical model showing the Mk model (left panel). Rev code specifying the Mk model is on the right-hand panel.

As technologies for obtaining low-cost and high-throughput nucleotide sequence data have become available, many scientists have become reliant on molecular data for phylogenetics. However, morphological data remain the only direct observations we have of most extinct organisms, and are an independent data source for understanding phylogeny. Many of the phylogenetic methods we will discuss in this tutorial were invented for use with sequence data. However, these methods are still very useful for discrete morphological data. We will examine some common assumptions for modelling data in a phylogenetic context, then move on to look at relaxing these assumptions.

Modelling discrete morphological data requires an understanding of the underlying properties of the data. When we work with molecular data, we know a priori that certain types of changes are more likely than others. For example, changes within a type of base (purine and pyrimidine) are much more likely than changes between types of bases. This information can be used to add parameters to the phylogenetic model. There are not equivalent and generalizable truths

across characters in a morphological data matrix. For example, while 0 and 1 are commonly coded to "presence" and "absence" this is not always the case. Nor are all characters atomized at the same magnitude. For example, at one character, changing character states may not reflect a large amount of genetic change. Theca shape (character 2 in the Zamora *et al.* 2013 dataset), for example, appears quite labile. At another, the changes to the character state may reflect a rearrangement of genetic elements, or might have larger ramifications for the organism's life and behaviour. Character 38, the central plate of the lintel, may be one such character, as it seldom changes.

When we work with morphological data in a Bayesian context, we are performing these analyses after a long history of workers performing phylogenetic analysis in a maximum parsimony framework. Under maximum parsimony, multiple trees are proposed. The number of changes in the data implied by the tree are then counted and the tree implying the fewest changes is considered best. There may be multiple equally most parsimonious trees in a dataset. Parsimony has been the dominant method for estimating phylogenetic trees from discrete morphological data. Characters that cannot be used to discriminate between tree topologies are not typically collected by workers using parsimony. For example, characters that do not vary are not collected, as they all have the same length (0 steps) on any tree. Likewise, autapomorphies are typically not collected. As we will see later, this has ramifications for how we model the data.

For many years, parsimony was the only way to estimate a phylogenetic tree from morphological data. In 2001, Paul Lewis published the Mk model of morphological evolution. The Mk model (Lewis 2001) is a generalization of the Jukes-Cantor (JC) model (Jukes and Cantor 1969) of nucleotide sequence evolution. This model, while simple, has allowed researchers to access the toolkit of phylogenetic methods available to researchers working with other discretely-valued data, such as nulceotides or amino acids.

The Mk Model

As mentioned above, the Mk model is a generalization of the JC model. This model assumes that all transitions between character states are equal, and that all characters in the matrix have the same transition matrix. The transition matrix for a binary trait looks like so:

$$Q = \begin{pmatrix} -\mu_0 & \mu_{01} \\ \mu_{10} & -\mu_1 \end{pmatrix},$$

In this matrix, represents the transition probability between the two states that follow it. A transition matrix for multistate data simply expands.

$$Q = \begin{pmatrix} -\mu_0 & \mu_{01} & \mu_{02} & \mu_{03} \\ \mu_{10} & -\mu_1 & \mu_{12} & \mu_{13} \\ \mu_{20} & \mu_{21} & -\mu_2 & \mu_{23} \\ \mu_{30} & \mu_{31} & \mu_{32} & -\mu_3 \end{pmatrix},$$

However, the Mk model sets transitions to be equal from any state to any other state. In that sense, our multistate matrix really looks like this:

$$Q = \begin{pmatrix} -(k-1)\mu & \mu & \mu & \mu \\ \mu & -(k-1)\mu & \mu & \mu \\ \mu & \mu & -(k-1)\mu & \mu \\ \mu & \mu & \mu & -(k-1)\mu \end{pmatrix}.$$

You might notice that these transition rates are not different to what we might expect from an equal-weights parsimony matrix. In practice, the Mk model makes very few assumptions due to the complexity and non-generalizability of morphological data.

This model may strike some readers as too simplistic to be adequate for morphological data. However, Bayesian methods are less likely to be misled by homoplasy than is parsimony (Felsenstein 1983). More recent work has demonstrated that the model outperforms parsimony in many situations, particularly those in which there is high homoplasy (Wright and Hillis 2014), with empirical work demonstrating that it fits many datasets reasonably well (Wright *et al.* 2016).

In the first part of this tutorial, we will estimate a tree under the Mk model as proposed by Lewis (2001). We will then relax core parameters of the model.

Ascertainment Bias

One remaining component of the model we have not yet discussed is ascertainment bias. Because workers using parsimony do not collect invariant characters and seldom collect autapomorphies, our data are *biased*. Imagine, for a moment, that you were to measure the average height in a room. But first, you asked the ten shortest people to leave. Your estimate of the average height would be too tall! In effect, this happens in the morphological data, as well. Because the characters with the fewest changes are not collected, we overestimate the amount of evolutionary change on the tree. At the time of publication, Lewis (2001) also included a correction factor for this bias.

These original corrections involved simulating parsimony non-informative characters along each proposed tree. These would be used to normalize the likelihood value. While this procedure is statistically valid, it is a bit slow. There are multiple ways to perform this correction (Allman and Rhodes 2008). RevBayes uses a dynamic likelihood approach to avoid repeated simulations.

Example: Inferring a Phylogeny of Extinct Cinctans Using the Mk Model

Tutorial Format

This tutorial follows a specific format for issuing instructions and information.

> The boxed instructions guide you to complete tasks that are not part of the RevBayes syntax but rather direct you to create directories or files or similar.

Information describing the commands and instructions will be written in paragraph-form before or after they are issued.

All command-line text, including all Rev syntax, are given in `monotype font`. Furthermore, blocks of Rev code that are needed to build the model, specify the analysis or execute the run are given in separate shaded boxes. For example, we will instruct you to create a constant node called `example` that is equal to `1.0` using the `<-` operator like this:

```
example <- 1.0
```

It is important to be aware that some PDF viewers may render some characters differently. Thus, if you copy and paste text from this PDF, you may introduce some incorrect characters. Because of this, we recommend that you type the instructions in this tutorial or copy them from the scripts provided (see link at top of article).

Data and Files

We will work with the same cinctan dataset from Issue 104 (Zamora *et al*. 2013).

Creating Rev Files

In this exercise, you will work primarily in this R text editor and create a set of files that will be easily managed and interchanged.

In this section you will begin the file and write the Rev commands for loading in the taxon list and managing the data matrices. Then, starting in the section "The Mk Model", you will move on to specifying each of the model components. Once the model specifications are complete, you will complete the script with the instructions given in section "Complete MCMC Anslysis".

Load Data Matrices

RevBayes uses the function `readDiscreteCharacterData()` to load a data matrix to the workspace from a formatted file. This function can be used for both molecular sequences and discrete morphological characters. Import the morphological character matrix and assign it the variable `morpho`.

```
morpho <- readDiscreteCharacterData("data/Cinctans.nex")
```

Create Helper Variables

We will dig into the model momentarily. But first, we will create some variables that are used in our analysis, but are not parameters. We will assign these variables with the constant node assignment operator, `<-`. Even though these values are used in our scripts, they are not parameters of the model.

We will first create a constant node called `num_taxa` that is equal to the number of species in our analysis (23). We will also create a constant node called `num_branches` representing the number of branches in the tree, and one of the taxon names. This list will be used to initialize the tree.

```
taxa <- morpho.names()
num_taxa <- morpho.size()
num_branches <- 2 * num_taxa - 2
```

Next, create two workspace variables called `moves` and `monitors`. These variables are iterators that will build a vector containing all of the MCMC moves used to propose new states for every stochastic node in the model graph. Each time a new move is added to the vector, moves will be incremented by a value of 1.

```
moves = VectorMoves()
monitors = VectorMonitors()
```

One important distinction here is that `moves` is part of the RevBayes workspace and not the hierarchical model. Thus, we use the workspace assignment operator = instead of the constant node assignment `<-`.

The Mk Model

First, we will create a joint prior on the branch lengths.

```
br_len_lambda ~ dnExp(0.2)
moves.append(mvScale(br_len_lambda, weight=2))
```

Now, we combine the branch lengths with a uniform prior on topology to make a tree. The uniform prior simply means no tree is more likely *a priori* than any other. This can be easily changed, for example, to use a starting tree. We then specify MCMC moves on the topology, NNI and SPR. These moves propose new topologies. In this way, we propose and evaluate new sets of relationships. We perform these moves frequently because these parameters are really important. We will also move each of the branch lengths each iteration. The scale move scales the current branch length. Finally, we monitor the tree length. This is a quantity many biologists are interested in.

```
phylogeny ~ dnUniformTopologyBranchLength(taxa,
branchLengthDistribution=dnExponential(br_len_lambda))
moves.append(mvNNI(phylogeny, weight=num_branches/2.0))
moves.append(mvSPR(phylogeny, weight=num_branches/10.0))
moves.append(mvBranchLengthScale(phylogeny,
weight=num_branches))
tree_length := phylogeny.treeLength()
```

We will add Gamma-distributed rate variation and specify moves on the parameter of the Gamma distribution. This says that characters in the phylogenetic matrix may evolve at different rates.

```
alpha_morpho ~ dnUniform( 0, 1E6 )
rates_morpho := fnDiscretizeGamma( alpha_morpho,
  alpha_morpho, 4 )
#Moves on the parameters of the Gamma distribution.
moves.append(mvScale(alpha_morpho, lambda=1, weight=2.0))
```

Next, we will create a -matrix. Recall that the Mk model is simply a generalization of the JC model. Therefore, we will create a *Q*-matrix using `fnJC`, which initializes *Q*-matrices with equal transition probabilities between all states. Since we have multistate data, we need to specify different *Q*-matrices for the different number of character states. For example, it would not make sense to model a five-state character using a model saying there are only two character states.

To do this, we have written a loop in which we break up the data set into partitions according to the number of character states that character has. Then, we specify a *Q*-matrix in the correct dimensions. We do not retain any partitions that do not have any characters. For example, if we tried to partition the characters with four states, and there were none, we would not create a *Q*-matrix.

Then, we combine each partition, Gamma-distributed rate heterogeneity, and the tree together into what is called the `phyloCTMC`. This is the joint set of model parameters that will be used to model these data. Each partition is then clamped to its model.

```
n_max_states <- 7
idx = 1
morpho_bystate[1] <- morpho
for (i in 2:n_max_states) {
  # make local tmp copy of data
  # only keep character blocks with state space equal to
  size i
  morpho_bystate[i] <- morpho
  morpho_bystate[i].setNumStatesPartition(i)
  # get number of characters per character size with
  i-sized states
  nc = morpho_bystate[i].nchar()
  # for non-empty character blocks
  if (nc > 0) {
       # make i-by-i rate matrix
       q[idx] <- fnJC(i)
       # create model of evolution for the character block
       m_morph[idx] ~ dnPhyloCTMC(
            tree=phylogeny,
            Q=q[idx],
            nSites=nc,
            siteRates=rates_morpho,
            type="Standard")
       # attach the data
       m_morph[idx].clamp(morpho_bystate[i])
       # increment counter
       idx = idx + 1
       idx
  }
}
```

We see some familiar pieces: tree, *Q*-matrix and `rates_morpho`. We also have two new keywords: data type and coding. The data type argument specifies the type of data – in our case, "Standard", the specification for morphology. All of the components of the model are now specified.

Complete MCMC Analysis

Create Model Object

We can now create our workspace model variable with our fully specified model DAG. We will do this with the `model()` function and provide a single node in the graph (`phylogeny`).

```
mymodel = model(phylogeny)
```

The object `mymodel` is a wrapper around the entire model graph and allows us to pass the model to various functions that are specific to our MCMC analysis.

Specify Monitors and Output Filenames

The next important step for our Rev-script is to specify the monitors and output file names. For this, we create a vector called `monitors` that will record each sample and output our MCMC.

The first monitor we will create will monitor every named random variable in our model graph. This will include every stochastic and deterministic node using the `mnModel` monitor. The only parameter that is not included in the `mnModel` is the tree topology. Therefore, the parameters in the file written by this monitor are all numerical parameters written to a tab-separated text file that can be opened by accessory programs for evaluating such parameters. We will also name the output file for this monitor and indicate that we wish to sample our MCMC every ten cycles.

```
monitors.append( mnModel(filename="output/mk_gamma.log",
  printgen=10))
```

The `mnFile` monitor writes any parameter we specify to file. Thus, if we only cared about the branch lengths and nothing else (this is not a typical or recommended attitude for an analysis this complex) we wouldn't use the `mnModel` monitor above and just use the `mnFile` monitor to write a smaller and simpler output file. Since the tree topology is not included in the `mnModel` monitor (because it is not numerical), we will use `mnFile` to write the tree to file by specifying our phylogeny variable in the arguments.

```
monitors.append( mnFile(filename="output/mk_gamma.trees",
  printgen=10, phylogeny))
```

The third monitor we will add to our analysis will print information to the screen. Like with `mnFile` we must tell `mnScreen` which parameters we would like to see updated on the screen.

```
monitors.append(mnScreen(printgen=100))
```

Set-Up the MCMC

Once we have set up our model, moves and monitors, we can now create the workspace variable that defines our MCMC run. We do this using the `mcmc()` function that simply takes the three main analysis components as arguments.

```
mymcmc = mcmc(mymodel, monitors, moves, nruns=2,
  combine="mixed")
```

The MCMC object that we named `mymcmc` has a member method called `.run()`. This will execute our analysis and we will set the chain length to `10000` cycles using the `generations` option.

```
mymcmc.run(generations=10000, tuningInterval=200)
```

Once our Markov chain has terminated, we will want RevBayes to close. Tell the program to quit using the `q()` function.

```
q()
```

You made it! Save all of your files.

With all the parameters specified and all analysis components in place, you are now ready to run your analysis.

Begin by running the RevBayes executable. In Unix systems, type the following in your terminal (if the RevBayes binary is in your path):

```
rb
```

Provided that you started RevBayes from the correct directory, you can then use the `source()` function to feed RevBayes your Rev-script file (`mk_gamma.Rev`).

```
source("scripts/mk_gamma.Rev")
```

When the analysis is complete, RevBayes will quit and you will have a new directory called `output` that will contain all of the files you specified with the monitors.

We can look at the log files in the software `Tracer`. We can also calculate several different types of summary trees:

```
# Read in the tree trace and construct the maximum clade
  credibility (MCC) tree #
trace = readTreeTrace("output/mk_gamma.trees")

# Summarize tree trace and save MCC tree to file
mccTree(trace, file="output/mk_gamma.mcc.tre" )
```

RevBayes can calculate MCC trees, MAP trees, and consensus trees. Try each one, and see how they differ.

Ascertainment Bias

As discussed earlier in the section "Ascertainment Bias", we also need to correct for ascertainment bias.

Create a copy of your previous Rev script, and call it *mcmc_Mkv.Rev*. You will need to modify the Rev code provided in this section in this file.

In RevBayes it is actually very simple to add a correction for ascertainment bias. You only need to set the option `coding="variable"` in the `dnPhyloCTMC`. Coding specifies what type of ascertainment bias is expected. We are using the `variable` correction, as we have no invariant character in our matrix. If we also lacked parsimony non-informative characters, we would use the coding `informative`.

```
phyMorpho ~ dnPhyloCTMC(tree=phylogeny, siteRates=rates_
morpho,
  Q=Q_morpho, type="Standard", coding="variable")
```

Next time

We'll look at using priors to relax assumptions of the Mk model.

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Spotlight on Diversity

Highlighting different experiences in palaeontology. This issue two palaeontologists, Orla Bath Enright (University of Lausanne, Switzerland) and Farid Saleh (Yunnan University, China), discuss managing diabetes and being Lebanese in palaeontology, respectively.

"We are only about thirty minutes away from the Burgess Shale now!" I heard one of my PhD supervisors excitedly roar from further down the Kicking Horse Trail. I squinted into the sun and smiled in her general direction. Unusually, I was having trouble talking in that moment. My heart was pounding out of my chest, I was sweating uncontrollably and my legs felt extremely weak. "I think we need to stop", I said. Quite quickly I was acutely aware of the warning signs of my low blood sugar (hypoglycaemia). I sat down and took out my diabetic bag, or as I like to call it, my external pancreas. I pricked my finger, drew blood and dabbed it onto the test strip. My monitor read 3.1 (mmol/L). My typical hypo symptoms can range from feeling weak, difficulty concentrating, trembling, a fast heartbeat, fatigue, anxiety, sweating and I stop talking. In that moment, your entire energy and thoughts are completely focused on one thing, putting sugar into your system as fast as possible. I pulled out my glucose tablets, dried fruit and orange juice. I drank, ate and waited. Here I was, so close to seeing the Walcott Quarry with my own two eyes but I was low, so I rested on the dirt track trail with expansive views of the Canadian Rockies while I slurped on my orange juice. The fact of the matter is, even this close, my diabetes comes first, and the Burgess Shale came second.

Unless you see me injecting insulin or pricking my finger to draw blood, you would never really know I was a type 1 diabetic. Type 1 diabetes accounts for only 5–10 % of all cases and happens when the body completely stops producing insulin. It is an auto-immune condition where the body's immune system attacks the insulin producing cells in the pancreas and the body stops making insulin. The cause of this type of diabetes is not completely understood, but it is not related to lifestyle choices and is not preventable – it is not because I ate too much sugar as a kid. I still like to use the explanation the doctor gave me at 12 years old, to put it simply – for glucose to get into our cells, it needs a grounds keeper and insulin is the key that unlocks the gates.

During fieldwork, it can be complicated to get things right and under control. I can say now, after many mishaps, that it comes down to a lot of planning and discipline to manage your diabetes for excursions. The most difficult part for me is the low blood sugars. It takes at least 15 minutes to feel your blood glucose rise back to a normal level after a hypo. For a non-diabetic the normal range is 4.0 – 8.0 mmol/L, for me, I aim to be between 5.0 – 10.0 mmol/L. Four is the floor as we say, anything under 4.0 mmol/L is considered hypoglycaemia. If it is not treated, a severe hypo can lead to unconsciousness, seizures and/or a coma. If any of these incidents were to happen, I carry an emergency glucose injection. Yes, it can escalate pretty quickly. On the other end, a hyperglycaemia (high blood sugar) is when the blood sugar is too high and my symptoms can include extreme thirst, frequent urination, fatigue/drowsiness and often a strange tingling in my limbs.

Research has found that type 1 diabetics make an average of 180 extra decisions a day on how to manage their condition. Whether it be working in the field, at the desk, teaching or attending conferences, I have it almost down to a science at this point. Components of managing my illness day-to-day consist of multiple daily injections, self-monitoring of blood glucose, nutritional planning, avoidance or treatment of hypos, and attention to both physical and emotional wellbeing (stress and anxiety affects blood sugar levels). During my undergraduate degree, at the National University of Ireland, Galway, I was fortunate to have considerate friends and lecturers around me. From the moment I stepped onto the bus for my first ever field-trip, I felt I was in safe hands. I was asked to show the group what to do in an emergency and what signs they needed to look out for. I became well acquainted with having the teaching assistant walk alongside me asking if I was okay, did I need any glucose sweets. I was never made to feel like a burden on an excursion for needing extra breaks to check my blood levels if I was low, or need the toilet more often when my bloods were running high. This made a big difference to me and by the time I had reached my final year, I felt more confident in my personal management and that of my mapping partners who were aware of what to do and how to react while out in the field doing long days together. I have always been lucky in this regard – not everyone is afforded the same consideration on field outings.

Like a good experimentalist, I make a list of the variables that may play a factor in my blood sugar control for the day or event ahead. For example, if a field excursion is on the cards, the most crucial factors that affect my blood sugar will be weather – will it be hot or cold? If it is hot, my insulin sensitivity increases so I must remember to take less insulin at my previous meal before exposing myself to the heat. Are we walking, hiking or taking a car? Anaerobic and aerobic exercise? Anaerobic like walking will bring down my sugar, aerobic will cause my blood sugar to rise so I may need to take some extra insulin. At a conference – am I public speaking or presenting a poster? Stress strongly affects blood sugar levels so public speaking will most likely cause a small but noticeable adrenalin rush that will cause a spike in the blood glucose. Alcohol, conferences and diabetes can be complicated too. Alcohol prevents the liver from producing glucose so this can lead to an unnoticed low blood sugar. This is because the symptoms of the low blood sugar are like drunkenness – a bad cocktail at the best of times. This does not go to say that people with diabetes cannot drink – indeed we can, but it is also a factor as to why many times, we do not.

How diabetes is portrayed in the media and the surrounding social stigma remains prevalent and problematic. Diabetes can be used as the cheap way to ramp up the drama in TV shows, generally by an over-the-top diabetic hypo scene in which they are administered an injection and the diabetic is dramatically better within moments. In reality most hypos can be treated with some glucose sweets and orange juice, but I suppose that's not as dramatic as needing a life-saving injection. I myself have frequently been used as a punchline when the desserts or cakes come out for parties and events. Just like the "Ross from friends" line that as palaeontologists, we hear far too many times to count, hearing "I'm going to get diabetes from this" or, the one that really grates my teeth, "Can you eat that?" has become tiring. During the PalAss 2017 Annual Meeting in Lyon I was given a fruit bowl for dessert instead of the chocolate cakes that everyone else was given because I had indicated on my online form I was a type 1 diabetic. Yes, I can eat cake – and I will. A simple yet important problem for any chocolate lover.

These kinds of diabetic problems, however, are trivial, in comparison to the problems at large in the community and I do want to acknowledge how fortunate and privileged I feel to have lived in countries where diabetes medication and management is free or very affordable (Ireland, UK and Switzerland). I have had access to multidisciplinary healthcare teams consisting of physicians, nurses, dieticians and behavioural specialists experienced in the management of diabetes. This has meant that, so far, I have gone through my academic journey with no financial stress or burden from my illness. I have also been afforded the luxury of free mental health advice while tackling PhD stress with my diabetes. However, the cost of medication and management is not equal across ethnicities and countries. In Canada, the monthly cost for diabetes can be as much as 13 % of a person's income and in Brazil, it is 82 %. In the US, people living with type 1 diabetes without health insurance pay on average $300 for one vial of insulin. It costs me nothing while living in Ireland and the UK, for the exact same essential vial of insulin. In Switzerland, the mandatory basic health insurance covers nearly all treatment, with a vial of insulin costing around CHF55. Factors such as these play an important role in deciding where to move to within the academic community. It is also a cause for some serious disadvantages for those coming from areas where the cost of medication alone is an obstruction to their academic path.

Managing diabetes in the world of 2020 has been a bit of a roller-coaster, along with every other aspect of our lives – you just have to ride it. Like so many, I have spent months in isolation "cocooning", restricting movement and contacts. I have been surrounded by supportive and understanding colleagues who have allowed me to work from home, in-person teaching only when I feel comfortable to do so and taking lunch outside a busy cafeteria setting. As strange as it sounds, I would like to think COVID-19 has given us the opportunity to teach ourselves that we are very capable of actively listening to the needs of the more vulnerable and minority groups in our community.

Orla Bath Enright
University of Lausanne

"How does it feel to leave the desert and move to a big city?" This was among the first questions someone asked me at the first scientific conference I ever attended in 2017. I entertained the idea and explained that Lebanon was no desert, and that even Arab countries in the desert were as developed as many European countries. Back then, I thought this was just an icebreaker and a conversation starter. I did not overthink the situation. But I was wrong. It was just the beginning of many problematic statements to come.

"I have never heard of an Arab palaeontologist!"

"Wow, you did some nice work for a person from the Middle East!"

The fact that my ethnicity had formed somewhat of a glass ceiling that cannot be broken in the mind of some of my peers was offensive, and frankly hurtful, on so many different levels. First, a significant number of scholars and stellar students have emerged from the Middle East due to the high-quality education received. Just in 2013, Lebanon was ranked among the top five countries for maths and science education in the world (Bilbao-Osorio *et al.* 2013). However, unfortunately, the dire economic circumstances of the turmoil-filled region mean that, more often than not, scholars from the Middle East are not given access to the same opportunities as their Western peers. Many of us simply cannot afford to pay the subscription fees required to be affiliated to scientific organizations, nor attend scientific conferences, because our local institutions do not have the means to support us. Most importantly, it is true that I am openly, actively and politically engaged in what is currently happening in the Middle East that is sadly torn apart by wars. And I am more than happy to answer any questions about the complex situation in the region. But there is a fine line between having an interesting non-scientific conversation at a scientific conference and a racist comment: a line that continues to be crossed. In order to say that we enjoyed a talk or a presentation, we do not have to conflate scientific achievement with race, nor put down a whole ethnic group based on preconceived stereotypes.

In my opinion, this type of situation, that I and many others surely face at certain points in our lives, is not the result of individual misconceptions. Instead, the roots of the problem go much deeper, reaching the collective status quo of the palaeontological community. Our community is small and we all know each other. In theory, these conditions should favour communication and as such, inclusion. However, in reality, our community is niche constructed, forming a rather harsh environment for people from marginalized backgrounds and countries. In 2017, in order to improve the grant schemes, researchers voted in favour of an increase of £5 or £10 in the annual subscription fees for the Palaeontological Association. The decision was made almost unanimously because many thought that £5 or £10 is a negligible amount that everyone should be able to afford. To put it in context, £5 in 2020 is the equivalent of my weekly budget when I was doing my bachelor's in Beirut. It is the price of two months' worth of bread consumption by a family of four in Lebanon. It is the price of 100 subway tickets in Egypt. The fact that most scientific conferences are almost devoid of any Middle-Eastern participants (*i.e.* both academics and students) does not come as a surprise to me. Make no mistake, I am not asking the community to solve problems that local governments in certain regions fail to resolve. I am simply pointing out the counterintuitive outcome that some inclusion attempts in the palaeontological community actually lead to more exclusion.

I am lucky to be able to pursue my dreams. And the prior text represents a small dark spot of a much bigger positive academic experience. With that said, this does not stop us from working together to make the community a more inclusive space for everyone, regardless of race, gender, sexual orientation, *etc*. In 2020, scientific associations are investing more than ever into spreading awareness regarding marginalized communities in research and are aiming to change the current unbalanced situation. However, I am certain that a long route awaits ahead of us to fully break the misconception that all palaeontologists should adhere to the white, heterosexual, tall man with fishermen's hats archetype. The adequate way to change how palaeontology is perceived and achieve the ultimate goal of having an internationally active and healthy community must encompass both social and economic considerations. Until then, whether we are people of colour, women, members of the LGBTQ+ community, or from ethnic minorities, we certainly do not have to deal with discriminatory behaviour and speech, especially not at work.

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>>***Future*** Meetings of Other Bodies

XV International Palynological Congress and XI International Organization of Palaeobotany Congress (XV IPC-XI IOP)
Clarion Congress Hotel Prague, Czech Republic *1 – 8 May 2021*

The Congress is postponed from September 2020 and will celebrate 200 years of modern palaeobotany. 1820 saw the first use of binomial nomenclature for fossil plants by the Czech 'Father of Palaeobotany' Caspar Maria Sternberg, who published Flora der Vorwelt in this year. Palynology and palaeobotany have a long tradition in the Czech Republic with several eminent pioneers. The scientific programme will cover all aspects of palaeo- and actuopalynology and palaeobotany. Several Congress field-trips will be on offer around parts of Bohemia and Moravia. The International Organisation of Palaeobotany will financially support several postgraduate students, allowing them to participate in the conference and present their research results.

For more details please see the website: <**https://www.prague2020.cz/**>.

Marine Reptiles Conference 2020
The Etches Collection, Kimmeridge, UK *4 – 6 May 2021* ***NEW DATES***

This Conference has been rescheduled from May 2020 due to the coronavirus pandemic. Originally postponed to October 2020, this has now been postponed further as delegates were polled and preferred an in-person meeting. All professionals, amateurs and enthusiasts of marine reptiles are invited to attend. The primary focus will be on the fossil record, covering not only the marine reptiles but also the other organisms that formed part of their ecosystems. A session will also take place on modern reptiles, and we welcome abstracts from researchers studying all aspects of this field.

For more information please visit the website: <**http://www.marinereptiles.org/**>.

35th IAS Meeting of Sedimentology
Vienna House Diplomat Prague, Czech Republic *22 – 24 June 2021*

This meeting has been postponed from June 2020. The meeting will feature several sessions with a palaeobiological theme, including 'Sedimentary environments as the theatres of life and evolution' (session T05-SS05). Researchers from a broad range of fields including ichnology, palaeoecology, sedimentary geology, geochemistry and geomorphology, in both marine and non-marine settings, have been encouraged to contribute.

For more information please visit the website: <**https://www.iasprague2021.com/**>.

18th Conference of the European Association of Vertebrate Palaeontologists (EAVP2021)

Benevento, Italy Summer 2021 *NEW DATES TBC*

The 18th conference of the EAVP has been postponed from July 2020 due to the coronavirus pandemic. The Conference will be hosted by the Ente Geopaleontologico di Pietraroja and the operational office of the Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Caserta e Benevento in southern Italy, a land of history, art and culture. The Soprintendenza Archeologia has a special significance in the recent history of palaeontological research, being the resting place of the exceptionally well-preserved small theropod *Scipionyx samniticum* named 'Ciro', the first dinosaur discovered in Italy. The event is also supported by the SPI (Società Paleontologica Italiana), the Sapienza University of Rome and the University of Florence. Oral and poster sessions are planned as well as flash talk sessions for poster presenters, plus round-tables, workshops, symposia and field-trips.

For more information please visit the website: <**https://sites.google.com/view/eavp2020/**>.

International Conference on Modern and Fossil Dinoflagellates (DINO 12)

Palacio Congresos De Canarias, Gran Canaria, Spain *5 – 9 July 2021*

This Conference has been postponed from July 2020. The scientific programme will be devoted to the latest developments in studies of living and fossil dinoflagellates. Dinoflagellates are one of the most important groups of planktonic and benthic marine microalgae and, as such, are of interest to both biologists and geologists. In keeping with the tradition of this conference series, the programme of the meeting (held only every 3–5 years) will consist of oral presentations and posters, supplemented by a small number of invited and keynote talks.

For more information please see <**https://dino12conference.com/**>.

36th International Geological Congress

India Expo Centre, Delhi, India *16 – 21 August 2021*

The IGC was postponed from March 2020 due to COVID-19. The IGC is a non-profit scientific and educational organization whose meetings are held in collaboration with, and under sponsorship of, the International Union of Geological Sciences (IUGS). IUGS holds its General Assemblies in conjunction with Sessions of the IGC. The main purpose of the Congress is to encourage the advancement of fundamental and applied research in the Earth sciences worldwide.

For further information please visit the website: <**https://www.36igc.org/**>.

18th International Nannoplankton Association Meeting (INA 18)
Avignon, France *29 August – 2nd September 2021*

The INA brings together the world's approximately 200 nannofossil and nannoplankton (coccolithophore) scientists, and this biennial meeting is their main venue for the exchange of information. The meeting rotates amongst different continents and is back in Europe for the first time since Athens in 2017.

For more details please see the website: <**http://ina.tmsoc.org/meetings/conferences.htm**>.

9th International Meeting on Taphonomy and Fossilization (TAPHOS) and 6th ICAZ Taphonomy Working Group Meeting (ICAZ-TWG)
Museo Arqueológico Regional de Madrid, Spain *29 August – 5 September 2021*
NEW DATES

This meeting has been postponed from September 2020. The 9th edition of TAPHOS and the International Council for Archaeozoology will bring together palaeontologists and archaeologists and also calls on other researchers to participate, such as forensic scholars, molecular biologists, histologists and anthropologists. A special tribute will be paid to Sixto Fernández-López, founder of the TAPHOS meetings, and to Peter Andrews for his innovative work on small mammal taphonomic methodology and palaeoenvironmental interpretations.

For more information please visit the website: <**http://taphostwg2020.es/**>.

2nd Crossing the Palaeontological–Ecological Gap (CPEG)
Museum für Naturkunde Berlin, Germany *5 – 8 September 2021*

Postponed from September 2020, this three-and-a-half-day meeting is planned with oral and poster presentations and a workshop. Besides giving a platform to scientists and work that crosses the gap between modern and ancient worlds, the aim is to cover all major organism groups, ecological levels and process focuses. Keynote speakers, round-table discussion and goals will remain the same. The Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science, Berlin is one of the most important research institutions worldwide in the areas of biological and geological evolution and biodiversity. with a collection of over 30 million items covering zoology, palaeontology, geology and mineralogy.

See the website for further details: <**https://cpegberlin.weebly.com/**>.

XII Congress of the Asociación Paleontológica Argentina (CAPA 2020)
Auditorios UCA Puerto Madero, Buenos Aires, Argentina *22 – 26 November 2021*

This meeting is postponed from September 2020. The 12th cCongress of the Argentine Paleontological Association (APA) will commemorate the 65th anniversary of the Association, featuring recent advances in the field of palaeontology in Argentina. This meeting aims to

promote a favourable environment to exchange knowledge and coordinate joint actions between palaeontologists, museum workers, biologists, related Earth scientists, teachers, students and institutions linked to the areas of education, protection and tourism, strengthening links between palaeontologists and the broader community. Advances in the field and outreach communication are fundamental for the conservation of Argentinean palaeontological heritage.

For more information please visit the website: <**https://www.congresoapa.org.ar/**>.

VIII International Conference on Mammoths and their Relatives (ICMR)
Indian Institute of Science, Bangalore, India *2021* ***NEW DATES TBC***

The Conference is postponed from October 2020 and revised dates and deadlines will be announced later this year. However, participants are encouraged to submit abstracts without waiting for further announcements. The themes of the Conference will include evolution and biogeography, genetics, ecology, extinction, conservation, archaeozoology and others, with both oral and poster sessions. Field-trips include a visit to Asian elephants in Bandipur National Park and a chance to explore the famous Neogene–Quaternary vertebrate fossil site of the Siwaliks.

Please visit the website: <**https://mammothindia2020.org/**>.

5th International Congress on Ichnology (ICHNIA 2022)
Florianópolis Island, Brazil *April 2022* ***DATES TBC***

Every four years ichnologists from around the world join to discuss the progress of the science and share experiences and ideas. Previous congresses have been held in Argentina, Poland, Canada and Portugal, and Brazil is the next hub of ichnology to share some of the vast heritage of ancient and modern biogenic structures. The 5th edition of ICHNIA was planned for 2020 but, due to the pandemic, was postponed to April 2022. Several keynote speakers are already confirmed, including Karen Chin (University of Colorado Boulder), Koji Seike (Geological Survey of Japan) and Anthony J. Martin (Emory University). Please see the website for further information and updates.

Please visit the website: <**https://www.ichnia2020.com/**>.

Please help us to help you! Add your own meeting using the link on the Association's web page:
<https://www.palass.org/meetingsevents/future-meetings/add-future-meeting>.

Zoë Hughes
Outreach Officer

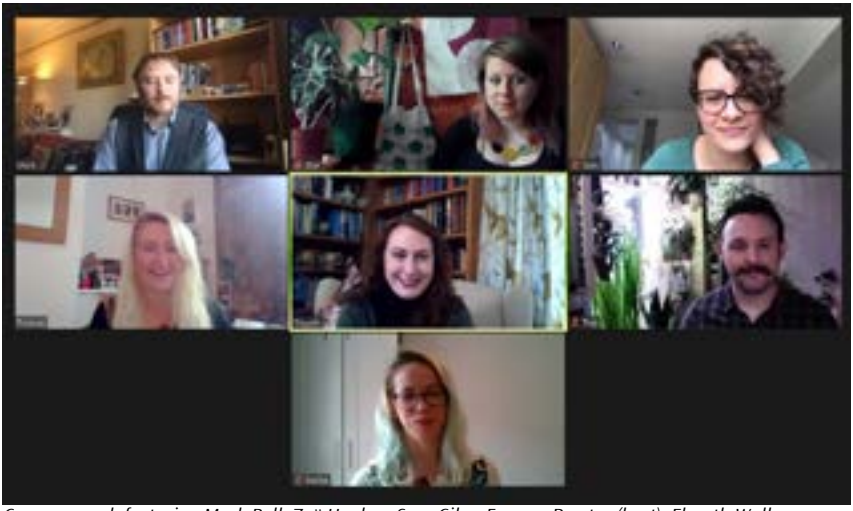
Meeting REPORTS

Progressive Palaeontology 2020
Virtual meeting *11 – 13 June 2020*

Renowned for its friendly and welcoming atmosphere, Progressive Palaeontology is one of our favourite conferences to attend each year, so we were thrilled to discover that instead of being postponed, the event would be moved to an online format. After a few productive months spent mastering the art of choosing amusing backgrounds for video conferencing, we now considered ourselves to be fairly tech-savvy, but the concept of an entirely virtual conference was something completely new to us, and our curiosity continued to increase as the day grew nearer.

The conference began on Thursday morning with the release of a very enticing array of talks and posters. As a duo, we comprise one self-professed night owl, and one (very) early bird, so we found viewing the content at our own pace to be very enjoyable. We were impressed by the work on show, with some of our particular highlights including **Matt Dempsey**'s incredibly slick talk on the evolution of forelimb anatomy and function in ornithischian dinosaurs (complete with background music!), and **Rebecca Bennion**'s beautifully presented poster on changes in skull ecomorphology during the initial aquatic radiations of mosasaurs and cetaceans.

Not long after the presentations had been uploaded, conference-goers had moved into the Discord server to introduce themselves and chat about all things palaeo. Despite the new virtual format, common conference lingo such as "I'm off to grab a coffee" was frequently uttered, but exclamations of "I'm listening to some talks whilst cleaning the kitchen!" and "be right back I've left my lasagne in too long!" took a little while to get used to. The tea breaks generally provided an excellent

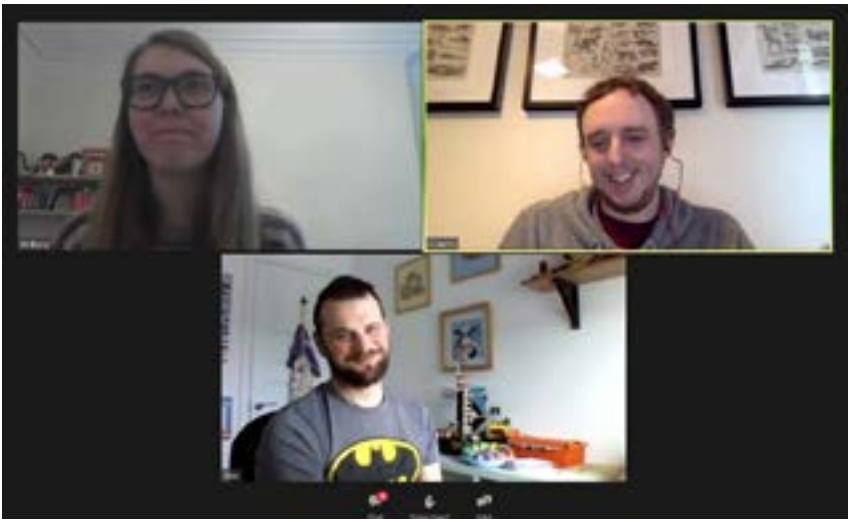


Careers panel, featuring Mark Bell, Zoë Hughes, Sam Giles, Frances Proctor (host), Elspeth Wallace, Tom Fletcher and Harrie Drage.

place to interact with other members of the community, and it was fun to watch the themes set by the committee slowly go off at a tangent as they were replaced by one palaeontological subject or another.

Halfway through the first day it was time for the careers panel with representatives from academia (**Sam Giles**), the museum world (**Zoë Hughes**), science communication (**Elspeth Wallace**), documentary making (**Tom Fletcher**), publishing (**Harriet Drage**) and the government (**Mark Bell**) [1]. The discussion was immensely enlightening, and gave an insight into the wide selection of potential opportunities available to palaeontology students in the future. Attendees left with the important message that our skills are more transferable than we might often think.

The day concluded with a designated Q&A session for the first batch of presenters, the format of which turned out to be hugely appreciated by all those who participated. The friendly atmosphere of ProgPal was certainly not lost during its conversion to an online setup, and compliments and constructive comments were aplenty. It was clear that the other attendees had enjoyed the talks and posters as much as we had, and were excited to learn more from the presenters. Many conference-goers praised the opportunity to chat with like-minded people without the anxiety that can sometimes occur as a result of a physical conference with a large room of unfamiliar faces.



Workshop drop-in session with Bethany Allen, Graeme Lloyd and Alex Dunhill.

The second day began with a workshop on sampling biases in the fossil record, led by **Bethany Allen**, **Alex Dunhill** and **Graeme Lloyd**. Two interesting talks were followed by some satisfyingly well-written R scripts and some slightly less satisfying R package incompatibility problem-solving. The drop-in session later in the day was especially useful, touching on subjects such as the problematic gap between big data and fossil-digging palaeontologists, and the importance of code reproducibility and sharing.

After a day of coding and another highly successful Q&A session, the conference quiz was upon us, testing our knowledge of everything from the smallest marine microorganisms to land's vertebrate

[1] Editor's note: Harrie and Mark have also appeared in our Careers Q&A in issues 102 and 105, respectively.

giants. Armed with a pint, and our best reproduction of the Union Bar's finest fodder (curly fries and nachos of course), we quickly discovered that our knowledge of Lagerstätte deposits from around the world was severely lacking. Undeterred, we powered through to finish very much mid-table, but feeling very content from the fun we'd had along the way.

Our favourite quiz round: guessing what creature is represented by renowned Yorkshire artist **Henry Dunhill***'s (aged 6) drawing.*

We were sad to see the arrival of the final conference day, but after the last group of presenters had discussed their work, we had some time to reflect on the whole experience. We met many new and interesting people at ProgPal, and saw some brilliant work being presented. The experience was overwhelmingly positive, with thought-provoking and fun events, engaged participants and guest appearances of a few pets, all adding to the great atmosphere. Times are strange and difficult at the moment, so huge thanks go to those who were part of the conference organization, especially this year's Chair, **Bethany Allen**. Creating such a successful conference in a short space of time is no mean feat, and our expectations for future virtual conferences are now set incredibly high.

Miranda Kouvari and Cecily Nichols [2]
University College London

[2] Editor's note: Look out for more from Cecily and Miranta next year as hosts of the 2021 meeting.

——OBITUARIES——

Richard Peter Spencer Jefferies 1932 – 2020

Richard (Dick) Jefferies worked for almost all of his academic life in the Palaeontology Department of the Natural History Museum in London. He was an early champion of Hennigian theory, playing an important part in spreading cladistic thinking through the UK's palaeontological community when the theory was still unfashionable, but is best known for drawing interest to the remarkable group of primitive, asymmetric, calcite-plated organisms, the carpoids. He firmly believed that these were forerunners to the chordates and tunicates and thus placed palaeontology at the centre of the deuterostome relationship debate.

Dick Jefferies being presented with the T. N. George Medal of the Geological Society of Glasgow, 2002. Photo courtesy of Tom Jefferies.

Dick was born in Croydon, London in 1932 and, during World War II, was evacuated to Steyning, on the South Downs, where he developed his interest in nature. After school he won a place at Gonville and Caius College, Cambridge in 1950 where he studied geology, before embarking upon a PhD under the supervision of the then curator of the Sedgwick Museum, Bertie Brighton. His doctoral research focused on the macro- and microfaunal succession of the Plenus Marls in the Anglo-Paris Basin (Late Cenomanian, at the boundary of the Lower and Middle Chalk) which involved making meticulous, high-resolution, bed-by-bed collections through a single zone at localities across the region. This was ground-breaking for its time, the first using closely-spaced samples to provide a detailed analysis of faunal change over what is now recognized as a critical interval of geological time for the understanding of the interaction of climate and the carbon cycle. "Dick's work on the Plenus Marls has retained great respect, and has had considerable influence on the present-day interpretations of OAE2 … The sheer originality of Dick's thesis work, combining lithology, detailed stratigraphy, macro- and micropalaeontology, to demonstrate the laterally persistent detail present in chalks, really broke the mould" (Professor Andrew Gale, personal communication, June 2020).

After completing his thesis around 1957, Dick joined the Iraqi Petroleum Company for a brief period where he undertook a taxonomic study of the brachiopods and bivalves from the Permo-Triassic of Oman. By 1960, he had joined the Geology Department at the British Museum (Natural History) as a Scientific Officer, initially in the mollusc section but soon after was promoted and put in charge of the echinoderm section. There his interest was sparked by a peculiar group of early Palaeozoic asymmetric to bilaterally symmetric calcite-plated fossils, the stylophoran carpoids. The Swedish naturalist Torsten Gislén had in 1930 proposed that these fossils possessed gill slits similar to those

Dick Jefferies in c. *1956 in Devon standing beside the Plenus Marl, the subject of his PhD. dissertation.* © *NHM, London.*

of primitive vertebrates and Dick's detailed investigation of the unrivalled collection of stylophorans housed in the Museum led him to go further, with a radical interpretation – that these were the direct ancestors of vertebrates. Having amassed evidence on the anatomy of *Cothurnocystis, Mitrocystites* and *Mitrocystella*, he published his ideas in 1967 in two ground-breaking papers which, following Hennigian principles, recognized stylophorans as taxonomically more closely related to chordates than to echinoderms. The presence of pharyngeal gill slits was confirmed and a complex pattern of nerves he had reconstructed from the canals left in their skeleton homologized in detail with the cranial nerves of the Palaeozoic heterostracan fishes. The calcichordate theory was launched.

Over the next two decades Dick published a series of highly detailed investigations on the anatomy of other key stylophorans and solutes, culminating in the publication of his 1986 book *The ancestry of the vertebrates* where he mustered his strongest case in support of the calcichordate theory through a set of wide-ranging arguments and observations. As an aside, he often joked that his father was a cobbler and that he now worked on 'boot-shaped' animals.

Yet the calcichordate theory from the start met with strong opposition from many echinoderm workers, who rejected his views outright, preferring to interpret stylophorans as crinoid-like echinoderms, and by many vertebrate morphologists or palaeontologists who continued to favour derivation of vertebrates from the paedomorphic larval stage of a tunicate. A third group emerged, who recognized the importance of Dick's observation that stylophorans showed deuterostome traits such as pharyngeal gill slits not seen in crown group echinoderms, but preferred the skeleton of stereom to have been acquired just once in the ancestry of echinoderms, when this creature still looked much like the proposed latest common ancestor of the deuterostomes. These divergent views meant that carpoids formed a topic of debate for many years at scientific conferences around the world, making for often lively meetings.

Dick continued to work on stylophorans until he retired from the Museum in 1992 (a sixty-year mandatory retirement age was in force then). He remained a Scientific Associate in the Department, coming in daily until 2009, by which time sadly the onset of Alzheimer's was in clear evidence. His last eight years were spent in nursing homes, first in Stockport then in London.

He was a patient teacher and very generous with his time. As one of the early converts to Hennigian phylogenetics, he helped spread the significance of synapomorphy and cladistic thinking, painstakingly explaining its rationale to students, including myself, visiting the Museum in the early 1970s and later over coffee in the Departmental fish library, or at Palaeontological Association conferences. He was a great linguist, fluent in German, and translated Rupert Reidl's *Die Ordnung*

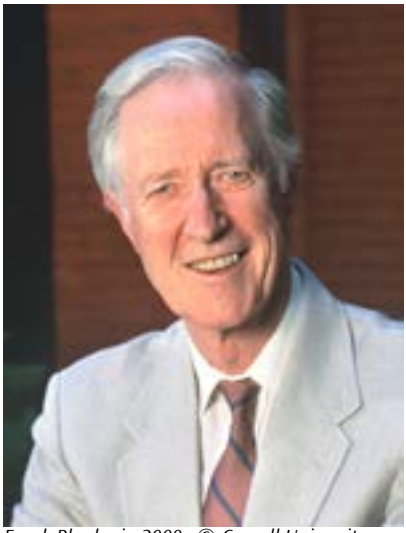
des Lebendigen for English publication. Although he always self-depreciatively denied it, he was also fluent in Russian. On several occasions I would take some Russian echinoderm paper to him and he would translate the abstract there and then without recourse to a dictionary!

In recent years molecular phylogenomics has finally given us a clear picture of deuterostome relationships, which is at variance to that championed by Dick. Nevertheless, his impressive body of anatomical work on carpoids represents a monumental contribution. Science advances through the development of bold new ideas based on sound empirical observation. While these ideas may not stand the test of time, they stimulate interest and lead to a clearer picture as others seek to confirm or refute them. Dick undoubtedly moved the field of deuterostome phylogeny forward with his bold thinking, forcing palaeontologists, developmental biologists and zoologists to confront and incorporate the evidence he presented from the fossil record of carpoids.

Andrew B. Smith FRS FRSE
Natural History Museum, London

Frank H. T. Rhodes 1926 – 2020

Frank Rhodes, who died on 3rd February 2020 aged 93, was a pioneer in the investigation of conodonts and a distinguished Darwin scholar. He is best known more broadly, however, for his leadership of Cornell University in Ithaca, New York State, where he served as president from 1977 to 1995. He was, by all accounts, a remarkable Ivy League president who transformed Cornell and its place on both the national and international stage. As such he became a national advocate for education and scientific research in the United States, serving as advisor to government.



Frank Rhodes in 2000. © Cornell University.

Rhodes grew up in Solihull, West Midlands, and studied geology at the University of Birmingham where he was Harry Whittington's first PhD student. Whittington, whose primary interest at that stage was in trilobites (and who subsequently led the reinvestigation of Walcott's Burgess Shale) set Rhodes the task of dissolving Palaeozoic limestones in pursuit of conodonts. Whittington knew little more about conodonts than his brilliant student but his instinct that novelty trumps familiarity as a thesis topic paid off in spades. Rhodes completed his PhD in record time before spending a postdoctoral year (1950–1951) at the University of Illinois investigating conodont assemblages with Harold Scott. He returned to the UK in 1951 to teach at Durham University, establishing a pattern of transatlantic seesawing. Rhodes was back at the University of Illinois in 1954, this time on the

faculty, before accepting an appointment as professor and head of the Department of Geology at the University of Wales, Swansea at the age of 29. Rhodes remained at Swansea for just over ten years, rising to Dean of the Faculty of Science, before moving back across the Atlantic in 1968 as professor of geology and mineralogy at the University of Michigan where he rose to Vice President of Academic Affairs. He became President of Cornell in 1977 where he spent the rest of his career.

Rhodes published his most influential papers on conodonts early in his career. His thesis on the Ordovician and Silurian material that he extracted from limestones in Wales, Staffordshire and Shropshire (Rhodes 1953) is arguably the first detailed systematic study of British conodonts. He used the then conventional taxonomy, which was based on individual elements, while acknowledging that they were almost certainly parts of an assemblage in the 'mouthpiece' of the animal. Rhodes' postdoctoral work in Illinois, in contrast, led to descriptions of three different bedding plane assemblages, the *in situ* 'hard parts' of buried conodont animals, from black shales in Illinois and Kentucky (Rhodes 1952). Here Rhodes followed Harold Scott's lead, erecting natural genera which included a diversity of individual elements then assigned to different taxa. Rhodes became a champion of this new biological taxonomy for conodonts and shifted his focus to their palaeobiology. His landmark paper on their zoological affinities (Rhodes and Phillips 1954) concluded that conodonts "appear to represent an extinct group of either worm-like creatures or primitive vertebrates".

Rhodes' interests were wide: his book *The Evolution of Life* (1962) was recommended reading for undergraduates and he published a major review of the course of evolution, with an emphasis on fossil evidence for pattern and process (Rhodes 1966). He provided the first 'modern' study of the end Permian extinction (Rhodes 1967), concluding that it was the result of 'multiple interactions of a wide variety of physical and biological factors'. In spite of his major administrative roles Rhodes published on various aspects of conodonts through the early 1980s. By then his research focus had shifted to Darwin's contributions and influence on evolutionary biology and geology, including explorations of Darwin's archived notes. In a *Nature* commentary, for example, Rhodes (1983) reviewed Darwin's views on the tempo and mode of evolution prompted by the debate on gradualism versus punctuated equilibrium and in 1991 he explored Darwin's theory of the Earth (Rhodes 1991). As a geologist Rhodes was acutely aware of our environmental impact: in *Earth: A tenant's manual* (2012) he explained the importance of ensuring that our exploitation of the planet is sustainable in terms of water, soil, air, energy and climate change.

I had the privilege of speaking at Cornell in 2016 at a special event to honour Frank Rhodes and his academic contributions on the occasion of his 90th birthday. Still a striking presence, he was, as ever, warm in his welcome, modest about his remarkable accomplishments, and gracious in his interactions. He gave me a copy of his last book, *Origins: The search for our prehistoric past*, published that year and signed on his birthday. His preface ends with: "No history is ever complete, no explanation infallible. The search continues to be open ended, subject to the next discovery in the field or the latest experiment in the lab", words which, like Rhodes' remarkable career, provide an inspiration to all of us.

Derek E. G. Briggs
Yale University

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Engagement Grant REPORT

Gesture control technologies and palaeontology: exploring innovative outreach and education approaches using 3D fossil models

Richard Butler
School of Geography, Earth and Environmental Sciences, University of Birmingham

Gesture control technologies allow users to engage in virtual activities and interact with digital content using intuitive motion and movements. The aim is to improve the user experience by allowing users to use simple gestures to control computers in a way that replicates movements and gestures made in everyday life. This touch-free approach facilitates new ways of user–computer interaction that look and feel very different from traditional approaches (*i.e.* interaction via keyboard and mouse, touch screen *etc.*). Our project aimed to explore how this rapidly growing field of technology could be used to provide new ways of exploring museum palaeontological collections to allow enhanced formal and informal learning opportunities. In addition to providing a user-defined interactive encounter with fossil specimens, other potential benefits include being able to examine 3D models of specimens that can only be fully understood when it is possible to study the object from different views. Such technologies have the potential to enhance the way people can interact with objects that might be static in display cases in a museum exhibition environment, as well as providing novel opportunities for investigations of palaeontological objects that might not otherwise be accessible, due to fragility, conservation requirements or rarity.

To achieve this, we worked with the collections of the Lapworth Museum of Geology, the expertise of the IT Innovation Centre at the University of Birmingham, and a variety of gesture control and virtual reality technologies, including Myo armbands, LeapMotion controllers, Google Cardboard viewers and Oculus Rift headsets. We digitized >20 specimens representing a broad diversity of fossil groups and time intervals, reflecting the Lapworth collections and regional geology (*e.g.* Wenlock crinoids, mammoth teeth, Carboniferous tracks). Specimens were digitized at high resolution using either an Artec Spider 3D scanner or photogrammetry. A PhD student from the IT Innovation Centre was then employed to create a virtual museum environment in which users could interact with, virtually handle and learn more about these fossil specimens. After considerable trial-and-error, we focused primarily on the Oculus Rift headset for our prototype virtual environment. One of the main challenges related to reducing the digital meshes to file sizes that were small enough for smooth and comparatively natural interaction while continuing to adequately render the original appearance of the object.

The resultant prototype was trialled in the Lapworth Museum, with staff, members of the postgraduate and research community, and the general public. Interest in using the technology was high, but overall feedback was mixed, and we noted a number of general problems. First, as noted above, reducing file sizes to a point where users could adequately interact with objects usually

required loss of realism in the virtual model. Second, although viewers were able to observe the object and manipulate it, there were mixed feelings about whether this adequately replaced direct tactile contact, as it was not possible to get a sense of *e.g.* weight or surface texture. Third, the fact that only one individual could use the technology at a time limited its potential for groups such as schools. Finally, the budget limited the reality of the virtual museum environment. Although gesture control and virtual reality technologies have clear potential for enhancing museums, at present the cost of using these approaches to a sufficiently high standard remains prohibitive for most small institutions.

3D scan of the holotype fossil specimen of Calymene blumenbachii*, the 'Dudley Bug', scanned and made available on Sketchfab as part of this project. The model has been viewed over a thousand times and downloaded over 100 times.*

The project did, however, have many significant additional outcomes. We established a Sketchfab page for the Lapworth Museum (<**https://sketchfab.com/LapworthMuseum**>) to make the models freely available to the public for the first time: there are now 55 models with 12,800 views, and these have been downloaded and printed by individuals, educators and museums around the world (*e.g.* <**https://bit.ly/2XVYSBs**>). We used the ongoing work in the Palaeontological Association digital technology project as a key pilot study in our successful application to Arts Council England in 2018 for the Lapworth Museum to become a National Portfolio Organisation. This application brought >£400,000 to the Lapworth from 2018–2022 and, for the first time, has allowed the Lapworth to employ a Digital Technologies Officer, palaeontologist Dr Andrew Jones, as well as to expand its learning and community programmes significantly. As part of his role, Andrew has continued to expand, and make available via Sketchfab, the collection of digital models initiated in this project, and during the current COVID-19 crisis is developing a virtual exhibition space that, once filled, will allow viewers to engage with the Museum while it is closed (<**https://bit.ly/300pKmD**>). The Palaeontological Association Engagement Grant PA-OE201501 provided vital seed funding that has allowed the Lapworth to draw down larger grants and substantially expand its digital technology work, greatly enhancing the engagement activity of this important regional museum.

Small Grant REPORTS

Patterns and processes in early arthropod evolution revealed by new animals from the Lower Cambrian of southwest China

David A. Legg
Department of Earth and Environmental Sciences, University of Manchester

Intrinsic factors play a crucial role in the evolution of organismal diversity, potentially accounting for most of the variation we observe today. Despite this, such factors are incredibly hard to test for in the fossil record, with many hypotheses seeming speculative and based on circumstantial evidence. Two of the more important intrinsic factors include changes in developmental time, *i.e.* heterochrony (Gould 1977) and sexual selection (Darwin 1871; Andersson 1994), with the latter potentially originating from the former (McNamara 2012). Although relatively easy to study in modern organisms where populations can be directly observed developing and interacting, such determinations are often limited for the fossil record, where additional proxies are usually employed to make inferences about ontogenetic and sexual variation. Sexual variation in the form of sexual dimorphism, for instance, can be particularly hard to prove as primary sexual characteristics, *e.g.* genitals, are often lacking, and variation in specimens might also indicate separation at the species level, or be part of the usual, non-sex-linked, variation of a population.

Studies of sexual dimorphism and ontogeny in Palaeozoic arthropods are most common for those taxa possessing a mineralized exoskeleton, particularly trilobites and ostracods; however, a number of recent studies have demonstrated both sexual dimorphism (Chen *et al*. 2018) and ontogenetic variation (Fu *et al*. 2018) in a small group of non-mineralized Cambrian arthropods, the fuxianhuiids. Specifically, Chen *et al.* (2018) noted an increased tergal spinosity in certain representatives of *Liangwangshania biloba* and *Fuxianhuia protensa*, both from the lower Cambrian Yu'anshan Member, whilst Fu *et al*. (2018) provided evidence for anamorphic development in the latter. Both studies also demonstrated the previous misidentification of ontogenetic variants and sexual dimorphs as separate species, thus emphasizing the importance of such studies for determining the actual diversity of their containment taxa.

The fuxianhuiids have gained considerable notoriety in recent years, largely due to reports of fossilized labile tissues, including those derived from the nervous (Ma *et al*. 2012; Yang *et al*. 2016) and circulatory systems (Ma *et al*. 2014), and for their phylogenetic position close to the base of crown-group arthropods (Legg *et al*. 2013; Yang *et al*. 2018). Their exquisite preservation, and relative abundance – *Fuxianhuia protensa*, the namesake of the group, is known from at least 2,000 specimens – makes them an excellent candidate for morphometric studies, such as those related to intraspecific variation including sexual dimorphism and ontogenetic variation, particularly as it pertains to the origin and diversification of crown-group arthropods.

Methods

A total of 597 specimens deposited at the Yunnan Key Laboratory for Palaeobiology (YKLP) at Kunming University, potentially belonging to six species of Yu'anshan Member fuxianhuiids (namely *Fuxianhuia protensa*, *Chengjiangocaris longiformis*, *Pisinnocaris subconigera*, *Jianshania furcatus* [= *Xiaocaris luoi*], *Liangwangshania biloba*, and *Shankouia zhenghei*) and including a large number of putative juveniles, were photographed using a Canon EOS 5DSR with an MP-E 100 mm objective lens, and measured using ImageJ (Schneider *et al*. 2012). Measurements were restricted to relatively complete specimens preserved in dorso-ventral habitus, which appears to be the stable orientation of burial for the majority of fuxianhuiid specimens. For each specimen, locality, segment count and any potential secondary sexual characteristics, such as tergal spinosity (Figure 1), were recorded. To aid comparison between purported species, which tend to possess different numbers of trunk segments, a set of standardized measurements was devised and plotted on a series of linear regressions (Figure 2), which were then compared to our original (qualitative) data.

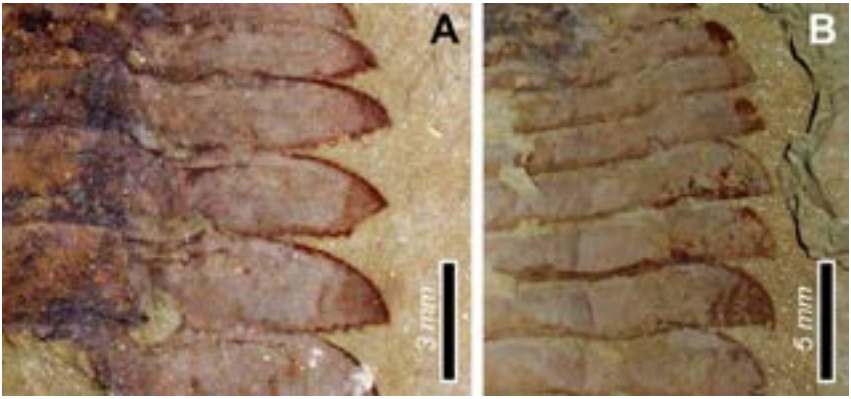

Figure 1. A potential secondary sexual characteristic in Fuxianhuia protena. A. YKLP 11287, showing a serration of the posterior tergal margin, and B. YKLP 11287, lacking serration. Both specimens are from Ma'anshan in Yunnan, China (from Chen et al. *2018, Fig. 5).*

Preliminary results and discussion

Although additional work is required, the preliminary analyses, including those results published in Chen *et al*. (2018, 2020), indicate that the diversity of fuxianhuiids, particularly those from the Yu'anshan Member, has been drastically over-estimated, with a number of purported species actually representing juveniles or sexual dimorphs of other species (Figure 2). A similar conclusion was also reached by Fu *et al*. (2018), who recognized *Pisinnocaris subconigera* as a juvenile of *Fuxianhuia protensa*. They did not, however, include much measurement data beyond total body length. Instead their primary criteria for recognizing different ontogenetic stages was segment number and an association between specimens. Comparing numerous measurements from various body parts, our study also reached the conclusion that *P. subconigera* is indeed a juvenile fuxianhuiid, albeit of *Chengjiangocaris longiformis* rather than *F. protensa*. This conclusion was further supported during the course of this study by the discovery of genuine juvenile specimens of *F. protensa* in the collection of the Yuxi Normal University in Yunnan (YXNU). These specimens possess a complete (adult) complement of segments (Figure 3). This is not to say that Fu *et al*. (2018)

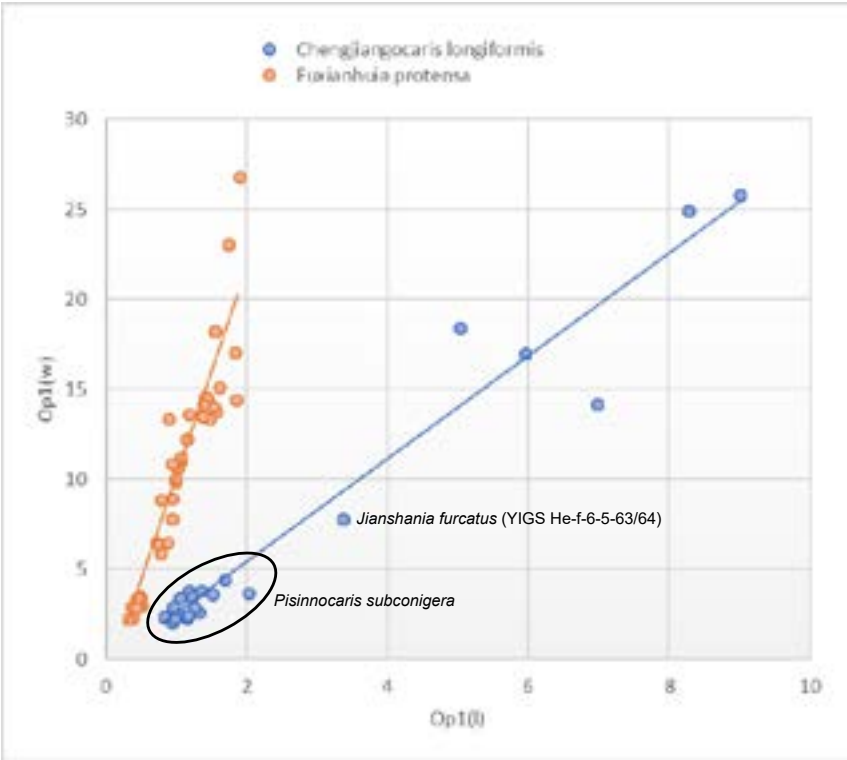

Figure 2. Linear regression showing the potential growth trajectories of fuxianhuiid form the Yu'anshan Member. This graph indicates that Pisinnocaris subconigera *is a junior synonym of* Chengjiangocaris longiformis. *Abbreviation: Op1(l) = length of opisthothoracic segment 1; Op1(w) = width of opisthothoracic segment 1.*

were wrong in their identification of segmental variation in *F. protensa*, however, the variation is less pronounced than they reported, and also appears to be geographically, rather than ontogenetically, variable (Figure 2). Specimens from the South, *e.g.* Chengjiang, Ma'anshan, possess a higher number of trunk segments than those from northern localities such as Haikou. Palaeogeographic reconstruction places those specimens with a greater segment count in a deeper water setting, suggesting the extra segment, which belong to the gill-bearing region of the trunk, evolved as a means to cope with lower oxygen concentrations. The high variability of segment number in Palaeozoic arthropods compared to their modern counterparts may therefore suggest that oxygen availability played an important role in early arthropod evolution.

Acknowledgements

This work was supported by a Whittington Award from the Palaeontological Association (PA-WA201701). Additional thanks are given to Yu Liu and Hong Chen for hosting me at the YKLP and aiding with photography and measurements.

Figure 3. A juvenile specimen of Fuxianhuia protensa *(bottom), next to a specimen of* Pisinnocaris subconigera *(=* Chengjiangocaris longiformis*). Note that although smaller, the specimen of* F. protensa*, has a higher number of segments than the accompanying specimen of* P. subconigera*. Scale bar in millimetres.*

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Palaeoclimatic variation in the Adriatic Sea during the Late Pleistocene Heinrich Event 1 (18–14 ka BP)

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Introduction

Heinrich events are past climatic events that have occurred due to large groups of icebergs breaking off from glaciers and traversing the North Atlantic, adding vast quantities of cold fresh water (Heinrich 1988; Andrews and Voelker 2018) and they have been extensively studied in the North Atlantic Ocean where they originate (Chapman *et al.* 1996; Stanford *et al*. 2011; Hodell *et al*. 2017). The meltwater disrupts the formation of North Atlantic Deep Water, in turn preventing the northern advection of warmer waters that would normally heat Western Europe. This reduced sea surface temperature (SST) creates a period of aridity over the European continent with a dominant cold and dry north-westerly wind (Sierro *et al*. 2005). It is thought that these dry winds combine with the cold-water incursion through the Strait of Otranto and could produce a biotic and geochemical response in the Adriatic Sea. However, few studies have been carried out here in relation to Heinrich events.

Core ND14Q was drilled on the edge of the South Adriatic Pit (SAP). This site was selected due to it being the point of convergence of the southward flowing Western Adriatic Current and northward flowing Ionian Surface Waters and Levantine Intermediate Waters. During Heinrich Event 1 (HE1, 18–14 ka) this would have been the entrance point for the fresher waters generated by the melting of icebergs in the North Atlantic. Due to the lack of studies on the Adriatic Sea in the context of Heinrich events, little is known about the impact of fresh water on this more isolated body of water. Siani *et al*. (2010) did conduct a study of planktic foraminiferal bioevents and climatic record in the SAP close to the site of ND14Q, but at a low resolution, covering a total period of 24 ka. Studies in the Mediterranean basin have focused in on the period of HE1, for example Sierro *et al*. (2005) which showed a similar response from planktonic foraminifera to that reported by Siani *et al*. (2010) for the SAP. My project aimed to provide a high-resolution reconstruction of the conditions in core ND14Q, assessing the impacts of HE1 on the abundance and geochemistry of foraminiferal tests during the Late Pleistocene and allowing comparison to these other studies and to present day conditions.

Materials and methods

Core ND14Q was drilled on the Next Data 2014 cruise on 17th July 2014 (17.61767°E, 41.284°N) by the TIMED Research Group. Drilling was undertaken to a depth of 540 cm into the sediment. The core was then cut longitudinally and sectioned every 1 cm. Samples are identified by their depth in the core. The lithology of core ND14Q 399–500 is dominated by grey to brown carbonaceous muds with foraminifera present throughout. Sections between samples 399 and 500 were washed under regular tap water over a 63 µm sieve mesh and the <63-µm sediment collected. Residue in the sieve was rinsed with distilled water and left to dry under a heater then emptied into a labelled sample bag. The <63-µm residue was left to settle overnight before being drained and dried in an oven at 60 °C. This was also dried and stored in bags.

The foraminiferal assemblage present in each sample was analysed by splitting the samples and counting the total number of benthic foraminifera and the total number of each species of planktonic foraminifera. Every benthic individual was recorded as the total population can indicate increasing or decreasing salinity and temperature (Dong *et al.* 2019). Each sample was counted to a minimum of 300 individual planktonic foraminifera in order to obtain an accurate representation of the assemblage. Percentage abundance of the coccolith *Coccolithus pelagicus pelagicus* was investigated by the TIMED Research Group at the University of Barcelona and was used in this study as a proxy for colder SSTs, due to it being a predominately polar species.

Several species of planktonic foraminifera were selected for closer analysis due to their potential use in reconstructing the conditions of the Adriatic Sea during HE1, including *Neogloboquadrina incompta*, *Globorotalia scitula, Cibicidoides pachyderma, Uvigerina mediterranea* and *Globigerinoides ruber*. The abundance of *N. incompta* has been used as a proxy for warming waters (Bauch *et al*. 2003) and that of *G. scitula* as a coldwater proxy (Corselli *et al*. 2002), *e.g.* a low abundance of *N. incompta* in conjunction with a high abundance of *G. scitula* (and *C. pel. pelagicus*) would suggest an incursion of colder meltwater into the Adriatic Sea. Geochemical analyses were carried out at the University of Barcelona, including U/Mn ratios and $\delta^{18}O$ isotopes as proxies for redox conditions and temperature, respectively. For U/Mn testing, a sample of *C. pachyderma* and *U. mediterranea* was crushed between glass and cleaned in Mili-Q distilled water in an ultrasonic bath. Samples of *G. ruber* were prepared in the same way and used in oxygen isotope analyses.

Age model

Radiometric dates of samples 460 to 399 were calculated in RStudio using accelerator mass spectrometry (AMS) measurements of ^{14}C (see Siani *et al*. 2010). The samples were found to span between 16.9 ka to 14.6 ka. Although the remaining sections from 500 to 460 were not dated, sample 500 is estimated to date from approximately 18 ka based on previous work (Siani *et al.* 2010).

Results and discussion

Between a depth of 480 cm and 460 cm the effects of HE1 can be identified in the planktonic foraminiferal assemblage. The abundance of *N. incompta* decreases by approximately 30 %. Simultaneously, the abundance of *C. pel. pelagicus* peaks during the same interval (Figure 1), suggesting a cooling SST due to the effects of HE1. The proportion of benthic foraminifera to planktonic foraminifera and the abundance percentages of *N. incompta* show a good correlation, with periods of warmer sea temperatures more recently in the core (see Figure 2): as the abundance of *N. incompta* in the samples increases to over 40 %, the benthic proportion increases to over 20 %.

In the interval 480–470, a dramatic fall in both percentages allows us to clearly identify a much lower SST, likely due to the impacts of HE1. This decrease in abundance of *N. incompta* was also seen by Siani *et al*. (2010) together with an increase in *G. scitula*.

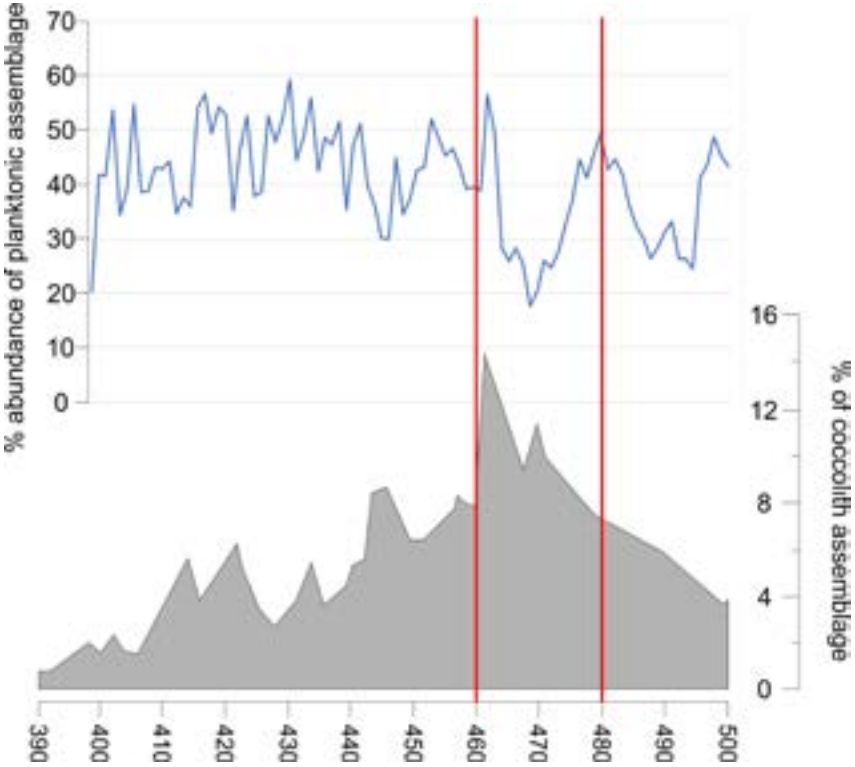

Figure 1. Percentage abundance of N. incompta *correlated with the percentage abundance data for* Coccolithus pelagicus pelagicus*, with core depth increasing to the right. Between a depth of 480 cm and 460 cm (highlighted) a cooling of SST, likely due to the effects of HE1, can be seen as a decrease in the abundance of* N. incompta *coupled with a peak in the abundance of* C. pel. pelagicus*.*

The results generated from the U/Mn tests support the interpretations of the faunal assemblages through HE1. The U/Mn readings decrease at the onset of HE1 and correlate with a decrease in *N. incompta* indicating decreasing temperatures. The results from the geochemical analyses will be revealed and discussed in full in a later publication from the TIMED Research Group.

Acknowledgements

I am grateful for the Sylvester Bradley Award (PA-SB201803) that allowed me to travel to Barcelona to conduct the geochemical analyses for this study. Thank you to Prof. Isabel Cacho and the TIMED Research Group at the Facultad de Ciencias de la Tierra, University of Barcelona for hosting me and facilitating the geochemical analyses. I am also grateful for the guidance and support of my MRes supervisors Dr David Loydell (University of Portsmouth) and Prof. Roberto Rettori (University of Perugia).

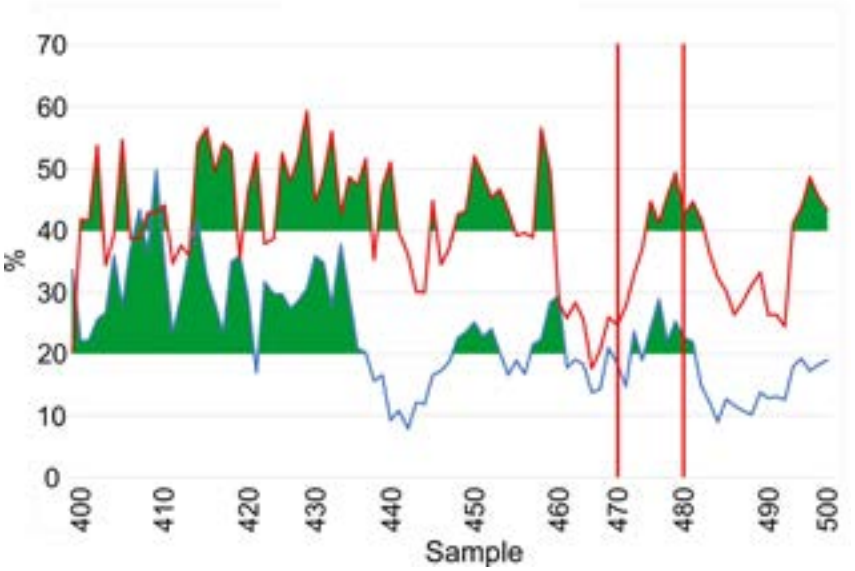

Figure 2. Percentage abundance data for N. incompta *(red) and the benthic foraminiferal assemblage (blue). The core depth increases to the right. Highlighted in green are periods where* N. incompta *increases to above 40 % of each sample and the benthic foraminifera increase above 20 %. A large drop in abundances in the interval 480–470 cm suggests a lower SST due to HE1.*

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Investigating the enigmatic Devonian arthropod Oxyuropoda

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The fossil arthropod *Oxyuropoda ligioides* was found in 1908, in the Upper Devonian Old Red Sandstone of Kiltorcan (Kilkenny, Ireland) and described by zoologists from the Royal College of Science, Dublin (Carpenter and Swain 1908). Found with ferns and strictly freshwater placoderms and bivalves, its ecology is thought to have ranged from lacustrine to fully terrestrial. At the time of its discovery, *Oxyuropoda* was identified as a genus of isopod, as were taxa such as *Arthropleura* or *Praearcturus*, recognized subsequently to be millipedes and arachnids. Since that time it has been ascribed to arachnomorphs (Schultze 1939), euthycarcinoids (Schram 1971) or isopod-relatives over the course of a dozen studies up to the 1980s (Almond and Lawson 1985), from which only three were based on actual specimen observations.

Isopoda are the most ecologically diverse crustaceans (predators, scavengers, parasites). These ecologies were acquired over time along with the colonization of land, deep sea and freshwater environments since their diversification in the Ordovician (Lins *et al*. 2017). Ecological transitions from shallow-water to land and deep sea were dated by molecular phylogenies to have occurred from the Late Carboniferous onward (Lins *et al*. 2012; 2017). However, when calibrated with the oldest fossil isopods (Schram and Hof 1998), molecular phylogenies evidence an even earlier ecological transition from shallow to freshwater environments (Phreatoicidea). Unlike the two other transitions, this earlier transition has never been studied, presumably due to a lack of fossilized examples of stem-isopods. This Sylvester-Bradley Award research (grant number PA-SB201902) aimed at testing for the affinity of *Oxyuropoda* with crown-Isopoda and other Malacostraca by analysing its holotype using recent light and scanning methods designed for flat fossil arthropods, potentially providing insight on the timing of freshwater colonization among Isopoda and their relatives.

The holotype part and counterpart, exhibited at the National Museum of Ireland, Dublin, were taken to Switzerland and studied at the ANOM lab, Lausanne. They were first imaged with a digital SLR camera (Figure 1A) and then studied using a Keyence digital microscope for high resolution 3D surface scanning. Finally, the specimens were imaged with a Multispectral Macroimaging system, based on the collection of reflectance or luminescence images in small regions of the visible and near-infrared light spectrum using different excitation wavelengths, the combination of which reveals anatomical details that are usually invisible or difficult to see in a wide range of fossils (Figure 1B). Together these techniques allowed for the exclusion of a previously controversial theory

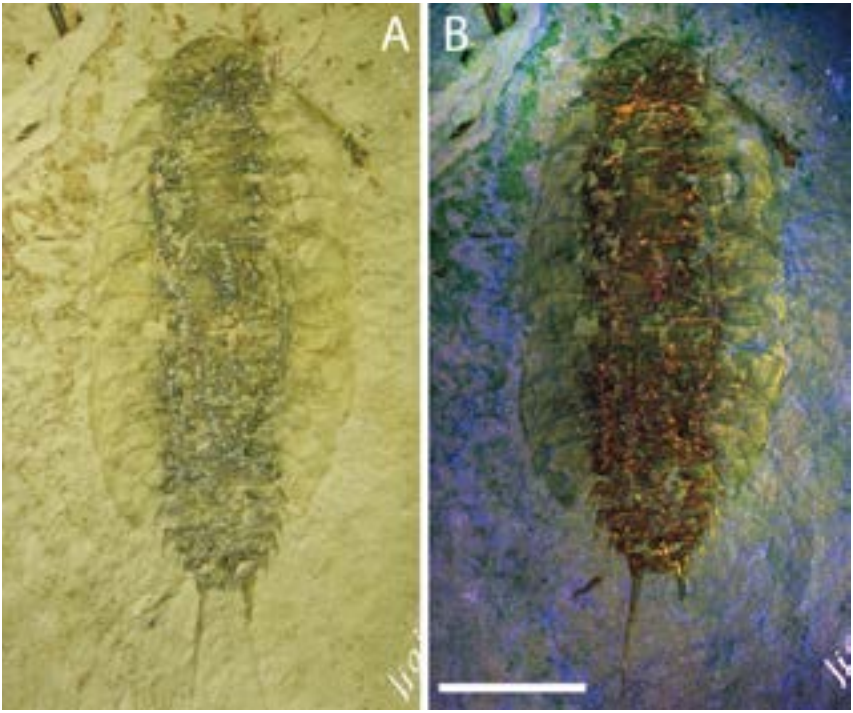

Figure 1. The Devonian Oxyuropoda ligioides *(Carpenter and Swain, 1908), stem-isopod, other peracarid, or syncarid? A. Polarized/filtered natural light image. B. Multispectral imaging: superposition of three luminescence images collected using filters 1, 5, 6 for specimens enlightened at 435 or 660 nm, and ultimately colourized (RGB). Scale bar is 2 cm.*

that an antenna was just bits of a plant, provided evidence of legs that had never previously been observed, showed novel details of the abdomen and telson, and suggested buccal appendages rather than the previously interpreted eyes. The interpretation of an actual carapace, as it is found in Peracarida and Eucarida, remains complex, so that additional characters must be studied to state whether a cladistic approach links *Oxyuropoda* with Peracarida-like isopods or rather to some Syncarida. Structure morphologies are currently being studied at the Palaeolab in the School of Biological, Earth and Environmental Sciences, University College Cork, using high magnification (SEM). A palaeoartist is also working on the reconstruction of *Oxyuropoda* in its Devonian Kiltorcan fluvial environment.

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Undergraduate Bursary REPORT

Testing Williston's Rule: a network analysis of skull evolution across the water to land transition

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Background

Williston's law proposes that vertebrate skulls follow a general trend towards reduction in the number of bones through loss or fusion (Gregory 1935), a process associated with structural simplification. Major changes in the vertebrate skull across the water-to-land transition have been associated with consolidation of the cranial bones during the shift from suction feeding to terrestrial biting. It has therefore been inferred, but not tested, that Williston's Law explains changes to skull anatomy across this period. However, we now know that some tetrapodomorph fish were efficient biters and the earliest tetrapods were primarily aquatic (Coates 1996; Ahlberg and Clack 2006; Ahlberg 2018), making the relationship between morphological evolution and ecological transition far less clear. In this project, we aimed to test how the architecture and topology of tetrapod skulls changed across the water-to-land transition and whether they followed the pattern of simplification predicted by Williston's law. We also aimed to place structural changes in an evolutionary context by examining skull topological disparity through time.

Materials and methods

In this project we used network analysis, a method in which connected elements are represented as graphs of nodes joined by links, to quantitatively measure and compare the architecture of fish and tetrapod skulls. This technique is commonly used in other fields such as statistical physics or computer science (Brandes 2005) but is novel in functional morphology. We built unweighted, undirected network models for the crania of 76 extinct and 34 extant taxa, in which nodes represent bones and links represent contacts between two bones. This technique allowed us to uniformly quantify important parameters of skull architecture while avoiding issues generated by homological uncertainty.

Using R, we ran a PCA of topological variables to test whether the anatomical organization of the skull differed between clades. Additionally, we performed a PERMANOVA over 10,000 permutations to test for significant differences between the architecture of fish and tetrapod skulls (Esteve-Altava *et al*. 2019).

To examine how topological disparity changed over time (DTT), we calculated the mean relative subclade DTT and compared the results to 10,000 simulated data sets under a Brownian motion model. This method accounts for phylogeny and was tested using two alternative time-calibrated trees from the literature (Marjanović and Laurin 2019; Ruta *et al*. 2018).

Results

Our PCA found significant topological differences between clades (Figure 1). PC1 (explaining 48.5 % of variance) discriminates between skulls that contain more bones, are sparsely connected and are composed of several tightly integrated modules, and skulls that have fewer elements, are densely connected and are less modular. PC2 (explaining 20.8 % of variance) discriminates between skulls with low assortativity (the tendency of bones to contact bones with a similar number of articulations), high clustering (the likelihood that two contacting bones share an articulation to a third bone) and have bones with a heterogeneous number of articulations, and those with high assortativity, lower clustering and have bones with more homogeneous numbers of articulations. Our PERMANOVA showed a significant difference in topological variability between different clades ($F_{4,105} = 23.467$, $P = 9.9 \times 10^{-5}$) and between fish and tetrapods ($F_{1,108} = 13.849$, $P = 9.9 \times 10^{-5}$).

Figure 1. PCA plot of topological variables in skull network models. Major clades are shown in various colours: 'fish' (blue); Amniota (red); Batrachia (yellow); caecilians (green); other early tetrapods (purple). Arrows denote the contribution of each topological variable to each principal axis.

DTT generally decreased over time (Figure 2) and drops below the 95 % confidence envelope for Brownian motion at around 380 Ma, at the origin of tetrapods. It also drops significantly at the end of the Devonian and continues to decrease until around 318 Ma, whereupon the disparity slowly increases before dropping again in the Mesozoic.

Discussion

Our results suggest that Williston's Law is not associated with anatomical simplification across the water-to-land transition. Though cranial bone number does decrease at the origin of Tetrapoda, this results in greater anatomical complexity as modularity decreases and bones become more densely connected. This pattern suggests that bones with fewer connections, such as the mosaic nasal and rostral bones of fish or the peripheral temporal bones of early tetrapods, are preferentially lost or fused throughout evolution.

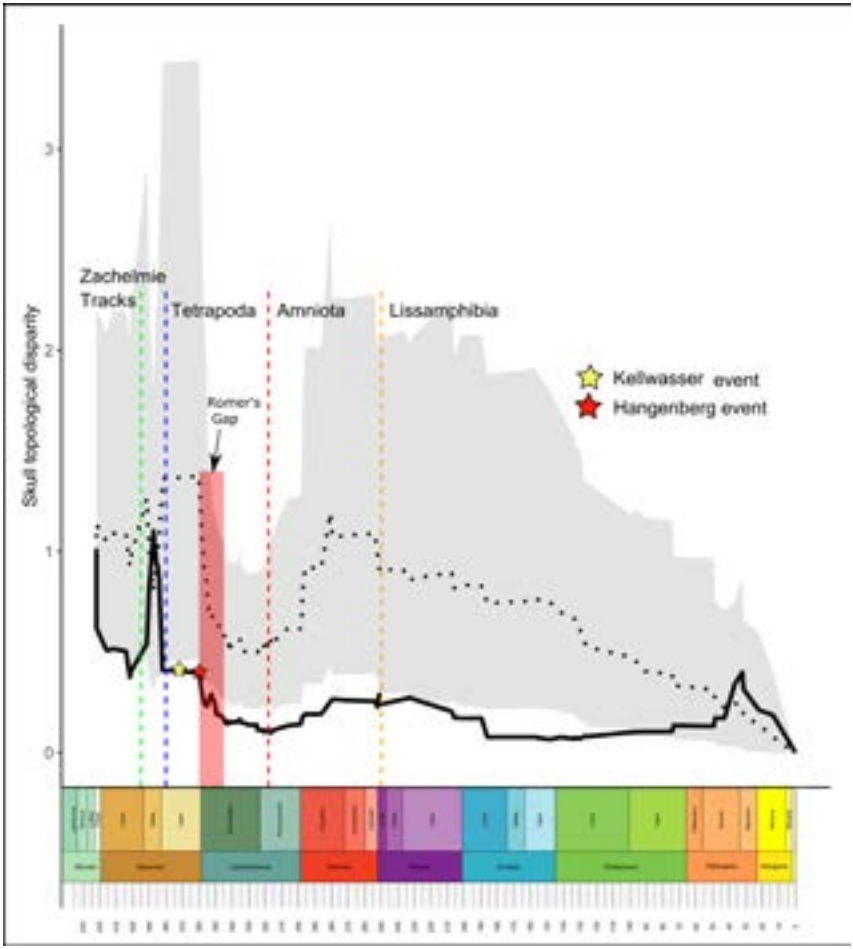

Figure 2. Topological DTT of tetrapod skulls through time (solid black line). Gray areas show the 95 % confidence intervals of the expected disparity based on 10,000 phylogenetic simulations under Brownian Motion. Horizontal black dotted line shows the mean of disparity for all simulations. Vertical colour dashed lines mark the estimated time of key events in sarcopterygian evolution for reference. Stars denote End-Devonian extinction events, and the red rectangle denotes Romer's Gap.

A drop in skull architectural disparity at the origin of Tetrapoda suggests that tetrapod skulls are subject to structural constraints, likely associated with terrestriality and bone loss. The drop observed in disparity at the Hangenberg event implies that the End-Devonian extinction, which caused widespread anoxia in aquatic environments (Algeo and Scheckler 1998), had a significant impact on the architecture of vertebrate skulls. The decrease in disparity beginning at this extinction persists throughout 'Romer's Gap', a period in which tetrapod remains are relatively rare (Ward *et al.* 2006). Overall, we conclude that the architecture of tetrapod skulls has been shaped by mechanical constraints associated with bone loss as well as influence from external extinction and diversification events.

Conclusion

This was a great project; it provided the opportunity to study a very important period of vertebrate history using both extinct and extant taxa. Learning about network analysis was a lot of fun, it's a method I'd never considered could be applied to palaeontology and will be a useful technique to know in the future. It also greatly improved my skills in anatomy, statistics and computation, all of which are widely transferrable across any scientific career. I learned how to assemble time-calibrated phylogenetic trees, which will be invaluable in my upcoming fourth year MSci project. This was also my first experience conducting an independent research project, which improved my time management, ability to use the literature and, going forward, my skills in presentation and publication.

Acknowledgements

I would like to thank my supervisors Emily Rayfield and Borja Esteve-Altara for their dedicated supervision as well as Laura Porro and Hugo Dutel for their expertise and guidance. This project was funded by the Palaeontological Association Undergraduate Research Bursary PA-UB202006.

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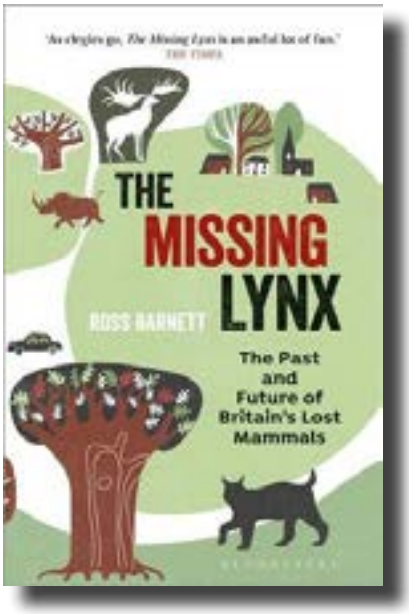
Book Reviews

The Missing Lynx: The Past and Future of Britain's Lost Mammals

Ross Barnett. 2019 (paperback edition 2020). Bloomsbury Wildlife. 352 pp. GBP10.99 paperback, eBook also available. ISBN: 9781472957344.



Being a researcher, I typically find it incredibly difficult to sink into a popular science book. I can't shake the feeling that the fascinating science I am reading about is somehow an extension of my workday and I feel cheated of the escapism I usually find in fiction books. But Ross Barnett's *The Missing Lynx* is one of those rare popular science books that manages to serve up a hearty plate of captivating science with a delicious side of escapism.

The book explores the scientific past, present and future of Britain's megafauna, covering topics such as ancient DNA, (de-)extinction, rewilding, and human impacts on biodiversity. The book's twelve chapters are each dedicated to a member of the megafauna, such as the infamous sabretooth cat, the vastly under-appreciated cave hyena, and the mighty Irish elk (an unbiased personal favourite). Each chapter also begins with an excerpt or quote from a poem or passage, which is one of many ways throughout the book that Barnett seamlessly unites science and art.

The pages are littered with maps of key fossil sites, keeping you on track as you're whisked away on a not-so-ancient tour of the British Isles. Footnotes, many witty and humorous, contain vast nuggets of information, which I guarantee will cause readers to fall down many rabbit holes (cryptorchidism, anyone?). Input from other scientists in the form of interviews and comments provide a taste of the incredible research that is currently being conducted in the connected fields of palaeobiology, palaeogenetics, ecology and conservation.

The Missing Lynx caters for every reader, whether you're a seasoned palaeontologist, a curious student, a natural history enthusiast or just someone interested in learning something interesting about British (pre)history. You won't find any complex jargon, unless it is accompanied by a sublime explanation (many of which I have highlighted while asking myself "why didn't I ever think to explain it like that?"). Barnett's writing style is best described as conversational – if you've listened to his interview on the Palaeocast podcast on ancient DNA or managed to catch recordings of book readings on Twitter during lockdown (or are fortunate to know him in real life), you might even find yourself reading the words on the page in his serene Scottish accent.

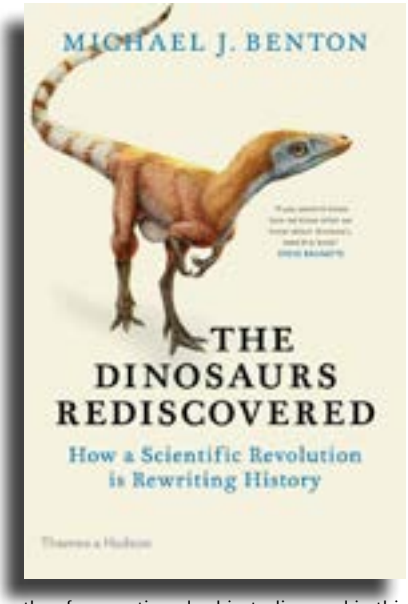
While there are countless laugh-out-loud moments throughout the book, Barnett ends on a serious note: we humans need to avoid repeating the mistakes of the past. We're all acutely aware of the impact that humans have had on global biodiversity, but nothing has quite managed to put the situation into perspective for me like *The Missing Lynx*. Barnett's descriptions of fossils and past biodiversity will captivate you, speaking directly to your palaeontological soul, and before you realize, you'll be transported from the past into the present and future, along the way gaining an intense appreciation for how palaeontology is fundamentally connected to modern ecology and the future of the biodiversity on our planet.

I first picked up a copy of *The Missing Lynx* the same month it was released, when my schedule was filled with train journeys. Traversing miles of railway situated on the very landscape Barnett writes so lucidly about was a rather idyllic way to read the book, but I promise you that no matter what your setting, this book will captivate you unlike any other.

Emma Dunne
University of Birmingham

The Dinosaurs Rediscovered

Michael J. Benton. 2019. Thames & Hudson Ltd. 336pp. GBP10.99 paperback. ISBN: 978-0500052006.



Our understanding of Mesozoic dinosaurs has advanced rapidly and dramatically over the past several decades, and *The Dinosaurs Rediscovered* offers an approachable overview of these recent developments. This book covers just about every aspect of Mesozoic dinosaur palaeontology, with chapters respectively dedicated to dinosaur origins, dinosaur phylogeny, fossil excavation and preparation, dinosaur physiology, molecular palaeontology, dinosaur ontogeny, dinosaur feeding behaviour, dinosaur locomotion and the end-Cretaceous mass extinction.

To most readers of this newsletter, the author of this title needs no introduction. Mike Benton is a Professor of Vertebrate Palaeontology and the head of the Palaeobiology Research Group at the University of Bristol. He has written or co-written dozens of books and literally hundreds of scientific papers, including studies that focus on nearly all of the aforementioned subjects discussed in this book. Although this vast experience allows him to write about these topics with great authority, Benton rarely puts himself on centre stage in the text, even when recounting research that he was personally involved in. Instead, he more commonly highlights the contributions of his colleagues and former students, many of whom are now recognized as leading experts in their fields of specialization.

The book is written in a straightforward, conversational tone that is, for the most part, probably very effective for explaining complex concepts to a non-specialist audience. I particularly appreciated the way Benton places emphasis on how the scientific process works, with various tales of palaeontological discovery being compelling demonstrations of what it takes for scientific paradigm shifts to occur. Also commendable is the fact that he regularly underscores how palaeontology does not work in isolation. As Benton describes, many palaeontological findings have been made through connections with other disciplines, and palaeontology has in turn fuelled other areas of research. One example mentions how the emerging field of studying melanosomes in fossil feathers has refined our understanding of feather coloration in living birds.

Throughout the book, "fact files" are provided on each species of extinct reptile mentioned in the main text, offering further details on their size, geologic age and geographic distribution, among other factoids. Especially useful for curious readers hungry for more information is the annotated bibliography towards the back of the book, in which Benton not only cites the original references for many of the ideas covered in the text, but also identifies resources that provide helpful introductions to each major subject.

This book is packed with numerous photographs, diagrams and even 19 colour plates, many of which have been adapted from figures in technical papers. Particularly worth mentioning are the restorations of prehistoric life that accompany each of the fact files, rendered by James Robins (unfortunately misspelled "Robbins" in the front matter of my review copy). Robins' familiarity with the latest scientific consensus on the life appearance of extinct animals is evident, and the scientific credibility of his illustrations stands far above the typical standard I have come to expect from popular books about palaeontology.

Although I have praised the clarity of the writing in this book, there were a handful of moments during my read through when I felt that important details were glossed over in ways that may be misleading to non-specialist readers. For example, while explaining that birds are saurischian rather than ornithischian dinosaurs, it is claimed that birds in fact exhibit the saurischian hip arrangement, when it probably would have been less confusing to say that some saurischians (including the ancestors of modern birds) convergently evolved hip arrangements similar to those of ornithischians.

The text is generally prudent about acknowledging dissenting points of view where appropriate, but I did notice a few statements in the book that are incorrect, or at least highly contentious. *Brachiosaurus* is said to be "the largest dinosaur of all time", a record that has long been broken by several species of giant titanosaur (Benson *et al.* 2018). I also found it puzzling that the dromaeosaurid *Microraptor* is described as having been limited to gliding whereas *Archaeopteryx* is characterized as a powered flier, even though a number of studies have suggested that both taxa were likely comparable in terms of their aerial abilities, as evidenced by feather structure (Feo *et al.* 2015) and quantitative biomechanics (Dececchi *et al.* 2016). In fact, it has been observed that the pectoral skeletal morphology of *Microraptor* is in some ways more similar to those of extant flying birds than that of *Archaeopteryx* (Zheng *et al.* 2014). Since the time that this book was released, several new studies have been published in favour of powered flight capabilities in both *Microraptor* and *Archaeopteryx* (Dececchi *et al.* 2020; Pei *et al.* 2020).

Despite these caveats, *The Dinosaurs Rediscovered* is overall a well-written, well-illustrated book that handles its subject matter skilfully and, furthermore, expertly directs readers towards sources of additional information. I would recommend this book to anyone who is looking for a multifaceted introduction to the many remarkable recent advances in dinosaur palaeontology.

Albert Chen
University of Bath and University of Cambridge

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Fossilien im Alpstein

Peter Kürsteiner and Christian Klug (eds.). 2018. Verlagshaus Schwellbrunn, Switzerland. 376pp. CHF89.00 (GBP110.00). ISBN: 978-3-85882-790-6.

This is the first book written exclusively about the Fossils of the Alpstein in the mountains of the Canton Appenzell, a welcome and long-overdue addition to the Swiss catalogue of geological literature. Author Peter Kürsteiner's collection provides the basis, which is then supplemented by samples from four Swiss museums and several other private collections.

Kürsteiner is a well-versed hobby palaeontologist who has been exploring the area for decades and collecting fossils systematically from a great number of sites. His co-author, Christian Klug, Professor of Palaeontology at the University of Zurich and curator of its' collection and museum, provides the scientific expertise. Their richly illustrated work is augmented by over 20 competent professionals who have contributed chapters on their various areas of specialization. The book is meticulously researched with typical Swiss precision and attention to detail. Each chapter has an extensive bibliography at the end which allows the reader to do further research.

The introductory chapters include a detailed description of the geological and tectonic units, their location and extent, and their genesis and emergence. This is followed by a section on the

formation and preservation of fossils, a history of palaeontological and geological research in the area, and is rounded off with the topic of the local palaeoecology and palaeogeography. The main section of the book is then dedicated to the fossils themselves. Christian Klug's introductory article on phylogenetic evolution and systematics is short, pregnant and instructive.

The fossils of the Alpstein, dominated by the Säntis-Altmann mountain range, are embedded mainly in Cretaceous and Eocene marine limestone sediments which are interspersed with sandstone and marly deposits. This book presents them in systematic order beginning with the simplest forms such as stromatolites and rhodolites and continues with fossilized wood, foraminifera, sponges, bryozoa and tube worms. The highly varied taxa such as ammonites, corals, echinoids, bivalves, gastropods, brachiopods and shark teeth are well-represented. Also included are scaphopoda, nautiloidea, crinoids, belemnites, decapods, bony fish and reptiles, as well as trace fossils. Each group is introduced separately before the details of the typical specimens are described. Every species, when known, receives a taxonomic and structural description and then the precise stratigraphic position and location are given. A few are presented with open nomenclature due to inadequate preservation. Also included is the original collection and the size of the object. High-quality photos of each specimen round off the picture.

This book provides primarily a valuable resource for the identification of practically every known fossil from this area, notwithstanding the fact that the background information is also extremely useful. It is also interspersed with explanations of the various scientific terminology, which makes it easy to understand for interested lay readers.

In my opinion it is more than worth the investment in *Fossilien im Alpstein*, since it has successfully accomplished a high-quality presentation of its subject matter. This is a book which can be highly recommended, both for professionals and hobby palaeontologists.

Roger Furze
Überlingen, Germany

Books available to review

The following books are available to review. Please contact the Book Review Editor Tom Challands (e-mail <**bookreview@palass.org**>) if you are interested in reviewing any of these.

- *History of Life*, 5th Edition, by Richard Cowen.
- *Fossils of the Milwaukee Formation: A Diverse Middle Devonian Biota from Wisconsin, USA*, by Kenneth C. Gass, Joanne Kluessendorf, Donald G. Mikulic and Carlton E. Brett.
- *Across the Bridge*, by Henry Gee.
- *Beyond Extinction: The Eternal Ocean. Climate Change & the Continuity of Life*, by Wolfgang Grulke.
- *Trilobites of the British Isles*, by Robert Kennedy and Sinclair Stammers.
- *William Smith's Fossils Reunited*, by Peter Wigley (editor) with Jill Darrell, Diana Clements and Hugh Torrens.

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Careers Q & A

Professional palaeontologists in the wider world

After doing a PhD at the American Museum of Natural History, USA and a Newton International Fellowship at the University of Edinburgh, UK, Shaena Montanari now works as a freelance journalist in the southwestern United States.

Q1: When you were a child, what did you want to be when you grew up?
I was extremely interested in science and I loved animals, so I thought I'd be a marine biologist or a biologist of some sort. I did a lab-based internship when I was 16 that did not involve field work, so I decided my biology career had to have a field-work component. Many people are surprised I actually wasn't particularly interested in fossils as a child!

Q2: How did you first get interested in palaeontology?
When I was in undergrad, I decided to check out the geology department on a bit of a whim. When I got there, the advisor for the department was amazing so I was convinced to take some geology courses that I ended up loving. At my university, the courses were small and there were many opportunities for research. I was able to explore geochemical methods to analyse fossils and I really enjoyed the interdisciplinary nature of the science. It also allowed me to approach the study of climate change and biodiversity in a unique way, which were two broad topics that fascinated me.

Q3: What is your favourite fossil and why?
I did a lot of my dissertation research on dinosaur eggshells, so I'm a big fan of oviraptorid eggs and eggshells from Mongolia. It is hard to imagine that these little fragments once contained an embryonic dinosaur, and now I'm holding it in my hand, 80 million years later.

Q4: What made you pursue your current job?
In 2017, I had the opportunity to do a media fellowship at *National Geographic* and it changed my life. I had a blog at Forbes from 2015 onward but working for a magazine and doing journalism at *National Geographic* awakened a new passion. I realized I loved telling a wide variety of stories about the world and wanted to do that instead of my own academic research.

Q5: What are the main responsibilities of your job?
Now, I am a freelance journalist and I am studying for a masters in investigative journalism. I find my own stories and pitch them to publications. I don't just write about science now; I write about many topics ranging from science to food to entertainment and I really love how varied it is.

Q6: What gives you the most satisfaction in your job?
I love giving people news they can use. I find a lot of joy in writing explainer-type articles that answer questions about big issues of the day. It is great hearing from readers when they email me to say I told them something new about an animal, fossil or place. It's really fun.

Q7: What are the worst things about your job?
Journalism is very competitive, and you always need to have new, creative ideas, so it is fairly similar to academia that way. There also isn't much job stability at times.

Q8: What has been the best career advice you have received?
Maybe not career advice, but lately I've been thinking that life is too short to not enjoy what you're doing. If academia isn't as fulfilling for you as it once was, it is more than okay to move on! It isn't a failure, it's simply a new season of life.

Q9: What skills does it take to be successful in your job?
Lots of the skills you learn in palaeontology or academia in general are applicable to journalism. Solid research skills, organizational skills and hypothesis testing are all very relevant, especially in investigative journalism.

Q10: Do you have any tips for students who would like to take a similar career path?
I recommend trying to find a media fellowship of some sort to see if you enjoy science writing and communication. A fellowship and internship can be done in a summer between semesters and might help you focus your career interests going forward. I know it changed my life.

Q11: Are there any major obstacles to being successful in a career like yours?
Many. These days there is a fairly poor public opinion of journalism, so you need to be ready to be criticized a lot. It is generally a fairly low-paying profession, and it is very competitive to get a job because the number of journalistic outlets is dwindling. Being a freelance reporter is a good option, but it is not easy because you are both a journalist and a business-owner at that point.

Q12: What's the best thing about your job?
Talking to dozens of people every single week and learning about their jobs and passions is probably the best thing in my eyes. As a journalist, rather than focusing on one research area, I can write about anything under the sun which I find immensely rewarding and educational.

Q13: What are your future ambitions?
I would like to continue getting better at the craft of journalism and potentially get a staff job in a newsroom so I can learn from other journalists. I also hope to report from outside of the United States once the pandemic ebbs and it's safe! I miss travelling.

You can follow Shaena:

- *on social media (Instagram and Twitter, both* @DrShaena*) or*
- *via her website:* <**http://shaenamontanari.com**>.

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A highly pneumatic middle Cretaceous theropod from the British Lower Greensand
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<https://doi.org/10.1002/spp2.1338>

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TAXONOMY/NOMENCLATURE UPDATE

This publication is now registered on ZooBank and is thus deemed to be valid for taxonomic/nomenclatural purposes. However we request contributors (especially those contributing grant reports) not to include names of new taxa in their reports.

Newsletter copy

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

Deadline for copy for Issue No. 106 is 8th February 2021.

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The Palaeontological Association has its own pages on the World Wide Web, including information about the Association, and copies of the *Newsletter*. Internet Officer Alan Spencer can be reached by e-mail at <**webmaster@palass.org**>. The locator is <**http://www.palass.org/**>.

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