

# The Palaeontology Newsletter

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Reminder: The deadline for copy for Issue no. 97 is 12th February 2018.

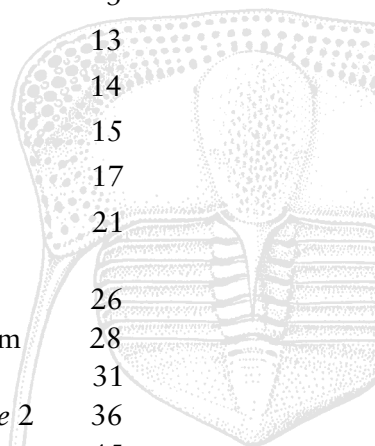
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## Editorial

2017 has been a busy year for PalAss and this jam-packed final issue of the year highlights the range and sheer volume of activity that has been taking place. The 'usual suspects', *i.e.* supporting the Annual Meeting, Progressive Palaeontology, and the Lyme Regis and Yorkshire Fossil Festivals, awarding grants for research, meetings and public outreach, and honours, are accompanied by progress on other important fronts. Our incipient mentorship scheme (see p. 13), which will initially focus on assisting postdoctoral researchers transition to permanent jobs, has recruited a number of mentors, but we still require additional mentors to realize the full potential of the scheme. If you are an academic in a permanent position, please consider joining the scheme as a mentor – let's help young palaeontologists compete for those rare permanent positions. In other news, a study of diversity in the Association and palaeontology more broadly is now under way (see p. 14). We will be asking all members to complete an electronic survey on diversity issues; we will also be seeking volunteers to participate in follow-up interviews and focus groups at the Annual Meeting. Your participation in this study is greatly appreciated and will be critical to the development of policies and practices that support a diverse Association and academic environment within palaeontology. Another item of interest is our new code of conduct (p. 17), which we have developed for our Association meetings in line with similar codes which already exist for the annual meetings of the SVP and GSA. If you are planning on attending the Annual Meeting this year, please do take a look at the new code, which includes guidelines regarding social media: while we very actively welcome and encourage discussion of the Meeting, including talks and posters, online and on social media, please respect requests by authors not to do so and don't photograph posters or record talks without the author's permission.

Finally, there are a number of imminent changes on the Association Council for 2018 (p. 3), including a new Newsletter Editor, as I am stepping down from this role. I have enjoyed continuing Jo Hellawell's work in updating the content of the *Newsletter* and would like to thank all the contributors who I have worked with over the last two years for their willingness to engage with the Newsletter despite other commitments, and for their essential role in keeping the Newsletter informative, current and, above all, interesting!

**Maria McNamara**

*Newsletter Editor*

<[newsletter@palass.org](mailto:newsletter@palass.org)>

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## Association Business

### Annual Meeting 2017

Notification is given of the 61st Annual General Meeting.

This will be held at Imperial College London, UK, on Monday 18th December 2017, following the scientific sessions.

#### AGENDA

1. Apologies for absence
2. Minutes of the 60th AGM, Université Claude Bernard Lyon 1
3. Trustees Annual Report for 2016
4. Accounts and Balance Sheet for 2016
5. Discussion of membership fees
6. Election of Council and vote of thanks to retiring members
7. Report on Council Awards
8. Annual address

### Nominations For Council

At the AGM in December 2017, the following vacancies will occur on Council:

- President Elect
- Vice President
- Editor Trustee
- Newsletter Editor
- Book Review editor
- Meetings Coordinator
- Education Officer
- Two Ordinary Members

Nominations received by the deadline are as follows:

- President Elect: Prof. Charles H. Wellman \*
- Vice President: Dr Caroline J. Buttler \*
- Editor Trustee: Dr Barry H. Lomax \*
- Newsletter Editor: Dr Graeme T. Lloyd \*
- Book Review editor: Dr Tom J. Challands (2nd term) \*
- Meetings Coordinator: Dr Uwe Balthasar
- Education Officer: Dr Maria E. McNamara \*
- Ordinary Members: Dr Stephen L. Brusatte, Dr Rachel C. M. Warnock, Zoë E. Hughes, Prof. Paul M. Barrett

\* denotes Council nominations



As there are four nominations for two Ordinary Member posts, there will be an election at the Annual General Meeting, as per clause 13(3) of the Association Constitution. This will take place at the AGM as per clause 11(6). There will be a postal/e-mail ballot of members not registered for the Annual Meeting, which will be carried out in accordance with clause 11(7) of the Association Constitution. Voting instructions will be sent to those members not registered for the Annual Meeting in early November. The statements of interest for the posts by the four nominated persons are as follows.

**Prof. Paul M. Barrett**

I am a vertebrate palaeontologist based at the Natural History Museum, London who works on the palaeobiology, systematics and macroevolutionary history of Mesozoic and Paleogene reptiles, primarily non-avian dinosaurs. In addition to my research, I have been strongly involved in public outreach, helping to raise awareness of the subject through popular science books and frequent engagement with national and international media. Over the course of my career, I have held numerous editorial and scientific citizenship roles in which I have supported the field more generally, including editorships of *Palaeontology* and *Journal of Vertebrate Paleontology*, as well as leadership roles within the Palaeontographical Society and Society of Vertebrate Paleontology. In addition, as the head of an active research group, I have strong interests in postgraduate and postdoctoral training. As a member of 25 years standing, I will be able to bring to Council the extensive experience that I have gained from working in the university and national museums sectors in the UK, together with that from my engagement with other society and editorial roles. I would regard the opportunity to serve on Council as a privilege and I look forward to helping the Association achieve its goals going forward.

**Dr Stephen L. Brusatte**

I am a Reader in Vertebrate Palaeontology at the University of Edinburgh, where I joined the faculty in 2013. I grew up in the USA and obtained a BS from the University of Chicago (2006), then went to Bristol for the MSc course in Palaeobiology (2008), and completed my doctorate at Columbia University in New York (2013). I specialise in the anatomy, phylogeny, and macroevolution of vertebrates, particularly dinosaurs, birds and mammals. I have led many field expeditions, described several new species of dinosaurs and mammals, and have developed new approaches for studying anatomical evolution over deep time. Along with over 100 peer-reviewed papers, I am the author of the leading textbook *Dinosaur Paleobiology* (Wiley-Blackwell, 2012). At Edinburgh I lead the Vertebrate Palaeontology Research Group and am a founding member of the PalAlba consortium for studying and preserving Scottish vertebrate fossils. I am a keen communicator of science: I have served as the 'resident palaeontologist' for the BBC's *Walking With Dinosaurs* programme, written several books on dinosaurs for kids, and appear regularly on television, radio, and at science festivals.

**Zoë E. Hughes**

I am Curator of Fossil Invertebrates (Brachiopods and Cephalopods) at the Natural History Museum London and believe that I would make a good addition to the Palaeontological Association Council. It is important that curators and, by extension, collections are represented in learned societies such as the Palaeontological Association. Furthermore, I am aware that after next year there will be no representative from the NHM on Council. In my view it will be a loss to the Association if one of the biggest collective groupings of palaeontologists in the UK is no longer represented on Council.



I fully intend to be a proactive member of Council if elected; I am the Programme Secretary of the Geological Curators Group and have demonstrated myself to be an engaged member of committees. I am passionate about the care and usage of palaeontological collections, including engaging with the research community in order to get the best from, and to preserve, our collection. Looking after a diverse collection I have broad interests, though I tend to focus on the Jurassic of both of my curatorial groups. Public outreach is another aspect to my role which is important to both the Association and myself, in my case raising the awareness of brachiopods in particular!

### **Dr Rachel C. M. Warnock**

I am a research fellow at ETH Zürich, Switzerland, working on the development and application of methods and tools for analysing the fossil record. In 2010 I transitioned from biology to the Earth sciences, and throughout my doctoral and postdoctoral career the Palaeontological Association (including Progressive Palaeontology) have played an important role in introducing me to the community of researchers in palaeontology. An important part of my work is communicating concepts to cross-disciplinary researchers. Experience has shown me that short courses and workshops, involving researchers at all levels, are an effective way of achieving this. My motivation to stand for the position of Ordinary Member is to advocate this perspective within the Palaeontological Association and beyond. I recently secured funding through the Association to sponsor a technical session and workshop at GSA, recruiting participants from outside the field, which has been received enthusiastically. I recently put forward an application to host a similar event at EGU and hope to further expand the network of international researchers involved in these events. I will continue to organize and promote short courses, encouraging palaeontologists to participate actively in the use and development of novel approaches to understanding the fossil record.

## **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 medal 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.

### ***Lapworth Medal***

The Lapworth Medal is the most prestigious award made by the Association. It is awarded by Council to a palaeontologist who has made a significant contribution to the science by means of a substantial body of research; it is not normally awarded on the basis of a few good papers. Council will look for some breadth as well as depth in the contributions, as well as evidence that they have made a significant impact, in choosing suitable candidates.



The medal is normally awarded each year. Candidates must be nominated by at least two members of the Association. Nominations should include a single page that summarizes the candidate's career, and further supported by a brief statement from the nominators. A list of ten principal



publications should accompany the nomination. Letters of support by others may also be submitted. Council reserves the right not to make an award in any particular year.

The career summary, statements of support and publication list should be submitted in MS Word or PDF format, ideally as a single document if possible. Nominations should be sent by e-mail to <secretary@palass.org> by 31st March.

The Lapworth Medal is presented at the Annual Meeting.

## ***President's Medal***

The President's Medal is a mid-career award given by Council to palaeontologists who have had between 15 and 25 years of full-time experience after their PhD, in recognition of outstanding contributions in their earlier careers, coupled with an expectation that they will continue to contribute significantly to the subject in their further work.



The medal is normally awarded each year. The candidate must be nominated by at least two members of the Association. Nominations should include a single page that summarizes the candidate's career, and further supported by a brief statement from the two nominators. A list of ten principal publications should accompany the nomination. Letters of support by others may also be submitted. Council will reserve the right not to make an award in any one year. If a candidate has taken time out from their professional career for family and other purposes, this should be highlighted.

The career summary, statements of support and publication lists should be attached in MS Word or PDF format, ideally as a single document if possible. Nominations should be sent by e-mail to <secretary@palass.org> by 31st March.

The President's Medal is presented at the Annual Meeting.

## ***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 at least two members of the Association and the application must be supported by an appropriate academic case, namely a single page of details on the candidate's career, and a brief statement from each of the two nominators. A list of principal publications should accompany the nomination. Letters of support by others may also be submitted. If a candidate has taken time out from their professional career for family and other reasons, this should be highlighted.

The academic case, statements of support and publication list should be attached in MS Word or PDF format, ideally as a single document if possible. Nominations should be sent by e-mail to <secretary@palass.org> by 31st March.

The award will comprise a fund of £1,000, and is presented at the Annual Meeting.



## ***Mary Anning Award***

The award is open to all those who are not professionally employed within 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 at least one member of the Association. Nominations should comprise a short statement (up to one page of A4) outlining the candidate's principal achievements, as well as one or more letters of support. Members putting forward candidates should also be prepared, if requested, to write an illustrated profile in support of their nominee for inclusion in the *Newsletter*.

Nominations should be attached in MS Word or PDF format, ideally as a single document, and should include the full contact details of the candidate. Nominations should be sent by e-mail to <secretary@palass.org> by 31st March.

The award comprises a cash prize of £1,000 plus a framed certificate, and is presented at the Annual Meeting.

## ***Golden Trilobite Award***

Golden Trilobite Awards are given at the discretion of Council for high-quality websites that promote the charitable aims of the Association. Nominations for websites should consist of a link to the site and a brief supporting case from a member of the Association. Nominations should be sent by e-mail to <secretary@palass.org> by 31st March.



The award comprises a 'Golden Trilobite banner' and links to the Association's own website. Awards will be announced in the *Newsletter* and on the Association website.

## ***Honorary Life Membership***

To be awarded to individuals whom Council deem to have been significant benefactors and/or supporters of the Association. Recipients will receive free membership. Nominations should be sent by e-mail to <secretary@palass.org> by 31st March.

Honorary Life memberships are announced at the Annual Meeting.

## ***Annual Meeting President's Prize***

Awarded for the best talk 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 this award. Individuals may nominate themselves for consideration when submitting abstracts for the meeting. The prize consists of a cash award of £200, and is announced immediately after the oral sessions at the end of the Annual Meeting.



## ***Annual Meeting Council Poster Prize***

Awarded for the 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 this award. Individuals may nominate themselves for consideration when submitting abstracts for the meeting. The 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 Award***

Awarded since 2015 for the best papers published in *Palaeontology* and *Papers in Palaeontology* during the calendar year. 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, the corresponding author can, by agreement, transfer the prize to one of the co-authors. All eligible papers are automatically considered for this award by the Editor-in-Chief and Editorial Board members, and their decision is announced at the Annual Meeting.

Palaeontological Association Undergraduate Prize Scheme

## ***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 their 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, postal address and e-mail) and we will then sign up the student as a member and send them a certificate. There is no deadline for this award.





## 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](http://www.palass.org)>).

### ***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. Application should be made in good time by the scientific organizer(s) of the meeting using the online application form on the PalAss website (<[www.palass.org/awards-grants/grants/grant-aid](http://www.palass.org/awards-grants/grants/grant-aid)>). Such requests will be considered by Council at the March and the 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. Inquiries may be made to the Secretary (e-mail <[secretary@palass.org](mailto: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
- 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 the keynote speaker agrees to submit their paper as a review article for possible publication in *Palaeontology*.

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

### ***Engagement Grants***

Awards are made to encourage educational outreach, public engagement and related initiatives in palaeontological themes. Normally, the budget for an individual grant would be less than £5,000.



However, in exceptional circumstances, a budget of up to £15,000 for an individual application will be considered. Grants can support either stand-alone complete projects, or they can be 'proof of concept' case studies that have their own outcomes but that form the groundwork for a larger bid elsewhere. The award is open to both amateur and professional palaeontologists and the principal applicant must be a member of the Association. Preference will normally be given to candidates who have not previously received a grant.

Proposals must fit with the charitable aims of the Association and preference is given to applications for a single purpose (rather than top-ups of grants for existing projects). We particularly encourage applications with an innovative aspect, such as engaging with new media, and especially cases that will disseminate good practice. Successful applicants must produce a report for the Palaeontological Association *Newsletter*, and any publicity associated with the activity should mention the support of the Association. Full details of application procedures, terms and conditions are available on the Association's website at <[www.palass.org/awards-grants/grants/engagement-grants](http://www.palass.org/awards-grants/grants/engagement-grants)>

For more information, please contact the Association's Outreach Officer, Dr Lucy McCobb, Department of Geology, National Museum of Wales, Cathays Park, Cardiff CF10 3NP; e-mail <[outreach@palass.org](mailto:outreach@palass.org)>.

The deadline is 1st October each year. The awards will be announced at the AGM, and funds will normally be available from 1st January.

## ***Small Grants Scheme***

The Association offers multiple awards each year, in honour of four donors, to fund palaeontological research, travel and fieldwork; these are integrated together under the Small Grants Scheme. These grants are open to any member of the Association, although preference is given to students, early-career researchers, and members of the Association who are retired.

- Sylvester-Bradley Awards: Multiple awards of up to £1,500 each, for palaeontological research.
- Callomon Award: An award of up to £1,500 for a project which is normally field-based.
- Whittington Award: An award of up to £1,500 for a project which is normally based on museum collections.
- Stan Wood Award: A maximum of two awards of up to £1,500 for projects in vertebrate palaeontology, and ideally involving fieldwork and fossil collecting.

There will be one application form and Council will decide on the allocation of the awards based upon the nature of the project made in the application.

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

- An account of project aims and objectives and expected outcomes
- A breakdown and justification of the proposed expenditure
- A curriculum vitae
- Two references: one to review the project, and one personal reference for the applicant
- A summary suitable for the non-specialist, which will be published in the *Newsletter* when the award is made



Successful applicants will be required to produce a final project report that will be published in the *Newsletter* and are asked to consider the Association's meetings and publications as media for conveying the research results.

Further details and a full list of terms and conditions for the Small Grants Scheme can be found on the appropriate page of the Association's website. Inquiries may be made by e-mail to the Secretary (<secretary@palass.org>). The deadline is 1st November each year. The awards will be announced at the AGM, and funds will normally be available from 1st January.

## ***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. The bursaries provide a stipend for the student of £262.50 per week 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.

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 and academic track record 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 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 Bursary Scheme, can be found on the appropriate page of the Association's website. Inquiries may be made to the Secretary (<secretary@palass.org>).

The deadline is 24th February each year. Successful applicants will be notified by the middle of May and funds will normally be available from 1st June. A full list of awards will be announced at the AGM.



## Research Grants

Awards are made to assist palaeontological research up to a maximum value of £10,000 each, normally in support of single research projects or 'proof of concept' proposals with an aim of supporting future applications to national research funding bodies. Field-based projects are eligible, but the scientific objectives and outcomes of the research must be made clear. Applications for investigator's salary costs will only be considered in exceptional circumstances and if awarded all legal and financial liability will lie with the applicant.

Preference is given to applications for a single purpose (rather than top-ups of other grant applications). The award is open to both amateur and professional palaeontologists, but applicants will normally have a PhD as a minimum qualification and must be members of the Association.

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

- A two-page curriculum vitae of the principal researcher
- A two-page 'Case for Support' which addresses the following points:
  - Underlying rationale and scientific issues to be addressed
  - Specific objectives of the research
  - Anticipated achievements and outputs
  - Methodology and approach
  - Programme and/or plan of research
  - How the research fits the charitable aims of the Association
  - Proposals for wider dissemination of results including those relating to the wider public understanding of science
- A list of pending and previous applications (with funding bodies and results) for funds to support this or related research
- A breakdown and justification of the proposed expenditure
- A list of suggested referees that may be approached to review the proposal

Successful applicants will be required to produce a final project report that will be published in the *Newsletter* and are asked to consider the Association's meetings and publications as media for conveying the research results.

Further details and a full list of terms and conditions for the Research Grants Scheme can be found on the appropriate page of the Association's website. Inquiries may be made by e-mail to the Secretary (<secretary@palass.org>).

The deadline is 1st March each year.

Funds will normally be available from 1st June, and the awards will be announced at the AGM.



# The Palaeontological Association needs mentors!

Are you interested in raising the profile and increasing the competitiveness and diversity of scientists working in palaeontology and allied fields? The Palaeontological Association is establishing a mentoring scheme to assist palaeontologists to progress in their careers. Mentoring is a tool to support the development of an individual, helping him or her make informed choices via the exchange of knowledge and experience. **At this stage in the process we are seeking academics in permanent positions, regardless of seniority, to step forward as potential mentors.**

## Who will you be mentoring?

We have identified priority areas as major career transitions, in the first instance focusing on the postdoc-to-permanent job transition (in academia or elsewhere). You will therefore be paired with a postdoc palaeontologist. Other transition points such as late-stage PhD to postdoctoral position and mid-career to senior leadership role will be the focus of later mentoring schemes.

## What is required?

The Palaeontological Association mentoring scheme will be via direct mentoring. That is, direct contact between the mentor and mentee via e-mail, skype or other forms of communication. The expectation is that you will have formal meetings two or three times per year, and mentors should provide open and honest advice whilst maintaining confidentiality at all times. Full guidelines on lines of communication and flexibility (length of the mentorship) will be provided.

## How will the scheme be monitored?

Mentors and mentees will have a point of contact via a member of Council, the Vice-President in the first instance, who will oversee all mentor-mentee pairings and the general running of the scheme.

## Who do I contact?

To express interest in acting as a mentor, please e-mail Vice-President Prof. Emily Rayfield (<[e.rayfield@bristol.ac.uk](mailto:e.rayfield@bristol.ac.uk)>). To emphasize, we are looking for academics in permanent jobs at *any* level of seniority. Those obtaining permanent jobs in recent years have as valuable experiences to share as more senior academics. Aside from the warm glow of knowing you are making a positive difference to someone else's career, there is much to gain from being a mentor, such as enhanced leadership skills and personal reputation. We hope you can take part and contribute to the continued development and success of the palaeontological sciences in a competitive academic world.

**Emily Rayfield**  
*University of Bristol*



## Diversity in PalAss

The purpose of the Palaeontological Association is to promote the study of palaeontology and its allied sciences and the Association is open to any adult with an interest in these subjects regardless of colour, ethnic or national origin, race, gender, disability, age, sexual orientation, religious or other beliefs, marital status or family circumstance.

The Association takes issues of equality and diversity very seriously and has begun to investigate the diversity of its current membership and the wider palaeontological community. The Association has commissioned a study by consultants Parigen Ltd that will run from November 2017 to May 2018. The study will gather baseline data on a range of protected<sup>1</sup> and non-protected characteristics such as gender and socio-economic factors, respectively. The purpose of the study is to identify under-represented groups in order to consider how the Association's activities can be tailored to be more inclusive and ultimately to increase diversity in the discipline of palaeontology. The key elements of this study are (1) an online survey of current members, (2) focus groups at the Annual Meeting, (3) interviews (some via telephone or Skype, others at the Annual Meeting), (4) case study 'snapshots' of diversity in selected departments where palaeontology is taught in the UK, Ireland and Europe, and (5) comparison of these data with comparable data from the broader bio- and geosciences.

The online survey of current Association members will be launched before the Annual Meeting. Participation in the survey will be voluntary and all data will be collected anonymously. In addition, members will be asked to indicate their willingness to take part in a follow-up interview (via telephone, Skype or at the Annual Meeting) and focus group discussion (at the Annual Meeting). The success of the study is dependent on the participation of members. We hope that as many members as possible will take part, thus supporting our drive to develop a diverse Association and academic environment within palaeontology.

**Fiona Gill**  
*University of Leeds*

**Maria McNamara**  
*University College Cork*

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<sup>1</sup> As defined by the Equality and Human Rights Commission:  
<<https://www.equalityhumanrights.com/en/equality-act/protected-characteristics>>



# ASSOCIATION MEETINGS



**61st Annual Meeting of the Palaeontological Association**  
Imperial College, London 17 – 20 December 2017

The 61st Annual Meeting of the Palaeontological Association will be held at the institution in which the Association was founded 60 years ago – the Royal School of Mines (now Department of Earth Science and Engineering) at Imperial College, London. The organizing committee is chaired by Dr Mark Sutton.

The Annual Meeting of the Palaeontological Association will be held at the South Kensington campus of Imperial College London. Dr Mark Sutton is the primary convener, and the e-mail address for all meeting-related matters is <[annualmeeting2017@palass.org](mailto:annualmeeting2017@palass.org)>.

Information about the meeting is provided in the coloured supplement at the back of this *Newsletter* and on the PalAss website at <<http://www.palass.org/meetings-events/annual-meeting/2017/annual-meeting-2017-london-overview>>.

Due to unusually high demand this year the registration for the Annual Meeting has closed early. This is regrettable but unavoidable as the meeting must adhere to fire safety regulations and lecture theatre maximum capacities. We apologize to those who are unable to attend this year and look forward to welcoming you to our Annual Meeting in 2018.

The abstracts for the talks and posters will be available on the PalAss website and will be included in the conference pack at the Meeting. We look forward to seeing you in London in December!

## Abstract of Annual Address

The Annual Address will be given on Monday 18th December.

### **101 uses for a dead fish. Experimental decay, exceptional preservation, and fossils of soft bodied organisms**

**Mark Purnell**

*University of Leicester*

The use of experiments to understand post-mortem processes and their role in exceptional preservation goes back decades, but a wide range of known and unknown variables influences how soft tissue remains become fossilized — variables that at first sight might seem to limit the applicability of experiments to analysis of fossils. Focussing on character-based experimental decay I have worked with a small group of colleagues (particularly Sarah Gabbott, Duncan Murdock and Robert Sansom) to develop methods that allow clear analysis and quantitative testing of the repeatability and comparability of experiments. Our approach allows factors that retard onset of decay to be differentiated from those that reduce the rate of character loss, and demonstrates that sequences of character loss are generally unaffected by the environment in which carcasses decay. Empirically derived sequences can thus be applied to exceptionally preserved fossils to disentangle the relative importance of, and interactions between, decay, maturation, and mineralization, and to inform our interpretations of fossil morphologies. Far from being of limited value, data from well-designed taphonomic experiments provide fundamental new insights into the processes and biases that have produced exceptionally preserved fossils, and the degree to which they distort our view of the past.



### Meeting support

The organizers of the Annual Meeting gratefully acknowledge the support of the following sponsors and exhibitors:

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Palaeontology

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# 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.

**Reporting unacceptable behaviour:** If you are the subject of unacceptable behaviour or have witnessed any such behaviour, please notify the meeting coordinator, for the Annual Meeting 2017 this is Dr Mark Sutton (<[M.Sutton@imperial.ac.uk](mailto:M.Sutton@imperial.ac.uk)>), and/or a member of the Palaeontological Association Council in a designated leadership position: Executive Officer Dr Jo Hellawell (<[executive@palass.org](mailto:executive@palass.org)>); President Prof. Paul Smith (<[paul.smith@oum.ox.ac.uk](mailto:paul.smith@oum.ox.ac.uk)>); Vice-Presidents Profs Emily Rayfield and Richard Twitchett (<[e.rayfield@bristol.ac.uk](mailto:e.rayfield@bristol.ac.uk)>, <[r.twitchett@nhm.ac.uk](mailto:r.twitchett@nhm.ac.uk)>).

Anyone experiencing or witnessing behaviour that constitutes an immediate or serious threat to public safety, or a criminal act, is expected to contact the emergency services by phoning 999. Those witnessing a potential criminal act should also take actions necessary to maintain their own personal safety.



**Lyell Meeting 2018: Mass extinctions – understanding the world's worst crises**  
Geological Society of London, Burlington House, UK 7 March 2018

The 2018 Lyell Meeting aims to highlight advances in understanding the great environmental catastrophes of the Phanerozoic using atmospheric modelling, high-precision age dating, volcanology, geochemistry, stratigraphy and palaeontology.

The study of mass extinctions is one of the most interdisciplinary research areas in the Earth- and environmental sciences. The Meeting will provide a platform to assess the current stratigraphic and geochemical records of environmental change during mass extinction events and the role of atmospheric climate modelling in understanding the causes of the crises. The Meeting aims to encompass the full spectrum of crises seen in the Phanerozoic fossil record. The goal is to evaluate the relative importance of environmental changes in major episodes of species extinctions, and to further explore the mechanisms that link these proximal kill mechanisms to the ultimate drivers, such as large igneous province eruptions and meteorite impacts. This will be a rare opportunity to hear research developments from diverse disciplines applied to all mass extinction events.

Keynote Speakers: Prof Mike Benton (University of Bristol); Dr Sofie Lindström (Geological Survey of Denmark and Greenland). Conveners: Paul Wignall (University of Leeds, UK), David Bond (University of Hull, UK). Oral and poster abstract submissions should be sent in a Word document to Naomi Newbold by 1st December 2017. For further information please contact Naomi Newbold (e-mail <[naomi.newbold@geolsoc.org.uk](mailto:naomi.newbold@geolsoc.org.uk)>) or see <<https://www.geolsoc.org.uk/lyell18>>.

Registration rates are reduced for PalAss members. The abstract deadline is 1st December 2017.

# Lyell Meeting 2018

## Mass extinctions: understanding the world's worst crises

7 March 2018

### The Geological Society, Burlington House

The study of mass extinctions is one of the most interdisciplinary research areas within Earth and environmental sciences. Recent, major advances have come from a broad spectrum of fields, including atmospheric modelling, high-precision age dating, volcanology, geochemistry, stratigraphy and palaeontology. The 2018 Lyell Meeting aims to highlight these achievements and showcases the improved understanding we now have of the great environmental catastrophes of the past. The Meeting aims to encompass the full spectrum of crises seen in the Phanerozoic fossil record.

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#### Convenors:

Paul Wignall (University of Leeds, UK)  
Dave Bond (University of Hull, UK)

#### Keynote Speakers:

Prof Mike Benton (University of Bristol)  
Dr Sofie Lindström (Geological Survey of Denmark and Greenland)


#### Further information:

For further information about the conference please contact:

Naomi Newbold, Conference Office, The Geological Society, Burlington House, Piccadilly, London W1J 0BG  
T: 0207 434 9944

E: [naomi.newbold@geolsoc.org.uk](mailto:naomi.newbold@geolsoc.org.uk)

Web: [www.geolsoc.org.uk/lyell18](http://www.geolsoc.org.uk/lyell18)

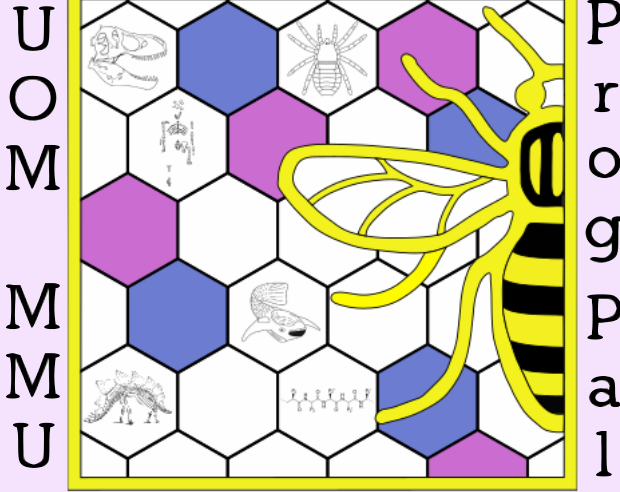
 Follow this event on Twitter #lyell18

#### Call for Abstracts:

We invite oral and poster abstract submissions for the meeting, and these should be sent in a Word document to [naomi.newbold@geolsoc.org.uk](mailto:naomi.newbold@geolsoc.org.uk) by 1 December 2017. Abstracts should be approximately 250 words and include a title and acknowledgement of authors and their affiliations.

# Manchester

# 7-9th June



Hosted by SEES,  
University of  
Manchester  
and  
CEEB, Manchester  
Metropolitan  
University

## 2018

### Registration free of charge

Panel discussion - 'Careers  
in Palaeontology'

Fieldtrip to the Peak  
District

Workshops on 3D  
Visualisation and  
Biomechanical Modelling



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/progpal2018/

Abstract submissions will be open to final year undergraduates,  
masters level and PhD level students







## Putting the oo in news

Knowing very little about dinosaurs, I am frequently out of my depth as a palaeontological publicist. The recent Yorkshire Fossil Festival in Scarborough, UK was one such occasion: assisting on the PalAss stand on the Schools' Day, I was asked dozens of questions about extinct reptiles by small children, and couldn't answer most of them. I tried to divert the topic of conversation to Silurian invertebrate Problematica, but it didn't work, so I just handed out stickers of Carboniferous plants and told the disgruntled urchins to harass my colleagues.

Similarly, a geological-but-non-palaeontological colleague at Hull recently asked me to vet his list of 32 candidate taxa for an upcoming Twitter competition, #DinoCup. I had to look up about half of the names on his list to check whether they were real or not, and in the end, my primary editorial contributions could be summarized as 'oo', in that I had to point out that *Stegosaurus* had an 'o' in it, and *Giganotosaurus* had more than one 'o' in it.

It is wholly appropriate/inappropriate, therefore, that the only Association paper to have attracted much media attention this quarter was both dinosaurian and oological. The study of oviraptorosaur egg geochemistry by Romain Amiot and colleagues (Amiot *et al.* 2017) was first published in *Palaeontology* at the end of June, and picked up immediately by Phys.org (Le Roux 2017). The website article focused initially on the misleading name given to oviraptorosaurs, since it was now generally accepted that they were not the 'egg thief lizards' scientists had originally thought them to be. The focus then moved on to whether oviraptorosaurs were warm-blooded, noting that the study's lead author had concluded that they 'had a body temperature at least as high as the [egg] incubation temperature.'





The other early birds to pick up on this cracker of a story were our old friends at the *Daily Mail* (Borkhataria 2017), who decided a ‘chickenosaur’ headline was in order. Some of the accompanying images were a bit cartoonish too, but the nub of the article seemed at least to contain much of the information included in the press release, without deviating into the unfounded speculation one might have anticipated.

Things then turned confusing (at least to me), as, having published its own take on the story, Phys.org simply published the original press release the next day (<<https://phys.org/news/2017-06-brooding-dinosaurs.html>>). The *Daily Mail*, meanwhile, waited a week or so, before deciding to provide a second summary of the oviraptorosaur paper, hidden inside a different story, about the owner of a fossil shop in Peterborough having apparently found some dinosaur bones in a brick pit in Surrey (Collins 2017). One had to read many paragraphs of this article before finally stumbling upon a sub-section discussing the paper by Amiot *et al.* (2017), but I suppose two bites of the cherry are better than none at all. This second summary was fairly inoffensive, but the comments section for the online article was not. My favourite (publishable) footnote was the bold claim by one “Sassylassy” of York that “Dinosaurs never have and *never will* exist” [my italics]. Predictive palaeontology is the science of the future, and Sassylassy will unquestionably be there at the forefront of its development.

Last, but definitely not least, *Inside Science* offered up the headline that “the ‘Chickens From Hell’ were probably good parents” (Shurkin 2017). It then went on to disparage the oviraptorosaurs as looking like they were “constructed by a malignant committee from spare bird parts”, and claiming that their mothers were ugly, though it did at least recognize that they stuck around long enough to incubate their broods. Disappointingly, neither this nor any other of the media articles picked up on my favourite term from the scientific paper, and if you can’t crowbar ‘elongatoolithid’ into your copy, well, you’re a pretty bad egg.

### Liam Herringshaw

<[publicity@palass.org](mailto:publicity@palass.org)>

@fossiliam

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# GIG

GIRLS INTO GEOSCIENCE

## Girls into Geoscience

The seemingly distant shores of Plymouth and Cork will bear witness next year to twin events showcasing women in geoscience with the express purpose of attracting girls and young women to careers in the sector. The events, called 'Girls into Geoscience', each consist of a one-day workshop (with an optional full-day field-trip included in the Plymouth event) featuring short seminars by women working in diverse areas of geoscience (e.g. academia, industry, consultancy), networking coffee breaks, and short workshops where participants can get hands-on experience of specific topics and skills, e.g. fossil analysis, GIS and petrography.

The events are free to participants and are targeted primarily towards secondary school students in the latter years of their school careers; the Cork event is also open to first-year university students who have not yet chosen their specialized degree path. The Plymouth event is now in its seventh year and is supported by BP, The Micropalaeontological Society, The Royal Astronomical Society and The Geological Society. 2018 will be the inaugural year for the Cork event, which is supported by the UCC School of Biological, Earth and Environmental Science, the Irish Centre for Research into Applied Geosciences (iCRAG) and the Irish Association for Women Geoscientists.



Image by Dr Jodie Fisher

For more information please see <<https://www.plymouth.ac.uk/whats-on/girls-into-geoscience>> (Plymouth) and <<http://www.icrag-centre.org/education-and-public-engagement/gig/>> (Cork).

**Maria McNamara**

*University College Cork*



Image by Dr Sarah Boulton



## Lyell Meeting 2019 – Call for Proposals

A call for proposals for the 2019 Lyell meeting is now open. This is an annual flagship event for palaeontology organized by the Joint Committee for Palaeontology (JCP) and held in London, UK. The meeting is planned to take place in March 2019 and further information is available on the JCP web pages <<https://www.geolsoc.org.uk/jcp>>. The co-ordination of the meeting is open to members of any of the four constituent societies making up the JCP, which includes the PalAss. Proposals should have a lead convenor and one or two co-convenors. The JCP welcomes submissions that are ambitious in scope and trans-disciplinary, which are more likely to attract a larger and potentially international audience. Proposed topics should appeal to a wide cross-section of the geological and palaeontological community. Those wishing to propose a topic and convene this meeting should submit developed proposals to <[naomi.newbold@geolsoc.org.uk](mailto:naomi.newbold@geolsoc.org.uk)> by Friday 2nd February 2018.

### *The Tasmanian tiger: whodunnit?*

Returning from a week-long workshop in Germany focused on the causes of mass extinctions – chiefly the climate-changing abilities of large igneous provinces and bolide impacts – my eye was caught by an open-access study on the demise of the Tasmanian tiger<sup>1</sup>. My meeting in Germany naturally wound up in the ‘Anthropocene’ and the debate over the sixth mass extinction (a mandatory component of any successful palaeontological funding application?). Critics of the notion that we can better predict (and mitigate) the biotic effects of modern climate change by studying its most extreme ancient examples often cite human activities (hunting, deforestation *etc.*) as a fly in the ointment: it’s like comparing apples with oranges.

The Tasmanian tiger, or thylacine (*Thylacinus cynocephalus*) – a textbook example of human-induced species loss – was hunted to extinction less than 150 years after European arrival in Tasmania when the last, sorry individual died in Hobart Zoo in 1936. However, their extinction was not quite so straightforward. In fact, the iconic marsupials (Figure 1) were once widespread across Australia until 3,200 years ago when, in theory, competition from the dingo, Aboriginal impacts and climate change left them clinging to life only on the island from which it takes its common name (Tassie had its own ‘Auxit’ 12,000 years ago as sea-levels rose at the end of the ice age). Lauren White and co-authors from the University of Adelaide have now untangled the thylacine’s complex pattern of extirpation. By generating 51 new thylacine mitochondrial DNA (mtDNA) genome sequences from sub-fossil remains and museum specimens, the team was able to reconstruct the thylacine’s phylogeography and demographic history, and estimate population sizes through time. As with all murder mysteries, timing is key to knowing “whodunnit”, and comparison of their DNA database with radiocarbon dates has helped White *et al.* evaluate the key factors in the thylacine demise. The thylacines contracted into separate eastern and western populations prior to the Last Glacial Maximum, around 25,000 years ago. A large and genetically diverse population flourished in Australia’s west, whilst the eastern population was less diverse, but nevertheless kept going until its mainland coup-de-grace.

<sup>1</sup> WHITE, L.C., MITCHELL, K.J. and AUSTIN, J.J. 2017. Ancient mitochondrial genomes reveal the demographic history and phylogeography of the extinct, enigmatic thylacine (*Thylacinus cynocephalus*). *Journal of Biogeography*. DOI: <[10.1111/jbi.13101](https://doi.org/10.1111/jbi.13101)>.





So what happened 3,200 years ago? Following the relatively wet and stable period of the Holocene optimum (8,000 to 5,000 years ago), a strengthening of the El Niño Southern Oscillation (ENSO) caused a shift in Australia's climate towards a dry, drought-prone system<sup>2</sup> (its effects on Tasmania were more muted). An evolutionary bottleneck combined with a peak in ENSO activity 3,200 years ago is thought to have driven the thylacine's abrupt mainland extinction. The dingo is off the hook (partly).



Figure 1. One of the last thylacines, eating a chicken. Thylacines were carnivorous marsupials, but was climate change or hunting responsible for their demise?

White *et al.*'s study has ramifications for the conservation of another endangered Australian icon, and allowed them to use possibly the best subheading in any paper ever: "4.4 Implications for the devil..." (the devil in question being the Tasmanian variety, *Sarcophilus harrisi*). This serves as a reminder that as well as habitat destruction and over-exploitation for economic gain, climate change is a potentially potent driver of modern extinction. Stopping cutting down Brazilian hardwoods, firing guns at elephants, and eating too much cod might help these species survive, but it is no guarantee. Avoiding the sixth mass extinction will require more drastic measures. The leading protagonists in the Anthropocene debate believe that it is not too late, but "the window of opportunity is rapidly closing"<sup>3</sup>. Let's hope it has not closed, and that we do not see more sad tales like that of the thylacine.

**David Bond**

*University of Hull*

<sup>2</sup> DONDERS, T.H., WAGNER-CREMER, F. and VISSCHER, H. 2008. Integration of proxy data and model scenarios for the mid-Holocene onset of modern ENSO variability. *Quaternary Science Reviews*, 27, 571–579.

<sup>3</sup> CEBALLOS, G., EHRLICH, P.R., BARNOSKY, A.D., GARCÍA, A., PRINGLE, R.M. and PALMER, T.M. 2015. Accelerated modern human-induced species losses: Entering the sixth mass extinction. *Science Advances*, 1, 1400253.



# Legends of Rock

## Tilly Edinger

Tilly Edinger (1897–1967) was a German palaeontologist who founded modern palaeoneurology (the study of fossil brains) in the 1920s and for the first time discussed problems that still form the basis of palaeoneurology.

Johanna Gabrielle Ottilie “Tilly” Edinger was born into a Jewish family in Frankfurt, Germany in 1897. Her father Ludwig Edinger (1855–1918) was a neurologist who founded Frankfurt’s first neurological research institute. Nevertheless, he did not support Tilly’s early interests in neurology because of her gender.

She was educated at home by French and English governesses until the age of 12, after which she attended Frankfurt’s high school for women, the Schiller-Schule.

Edinger took classes in geology, zoology and palaeontology at Heidelberg University and the University of Munich, and received a

PhD in natural philosophy from the University of Frankfurt in 1921. Her dissertation topic was a detailed study of the skull and cranial cavity of *Nothosaurus*, a long-extinct marine reptile of the Triassic era. Her research focused on endocasts of fossil crania, which can reflect in detail external brain anatomy. The description of the *Nothosaurus* specimen was the subject of Edinger’s first publication in 1921.

Immediately following her dissertation, Edinger worked as an unpaid volunteer at the Geological-Palaeontological Institute of the University of Frankfurt (1921–1927). She continued her scientific work at the same university in another unpaid position, this time as curator in vertebrate palaeontology at the Forschungsinstitut und Naturmuseum Senckenberg (1927–1938).



Figure 1. Edinger measuring an endocranial cast in 1926. Image reproduced with the permission of the Museum of Comparative Zoology, Harvard.

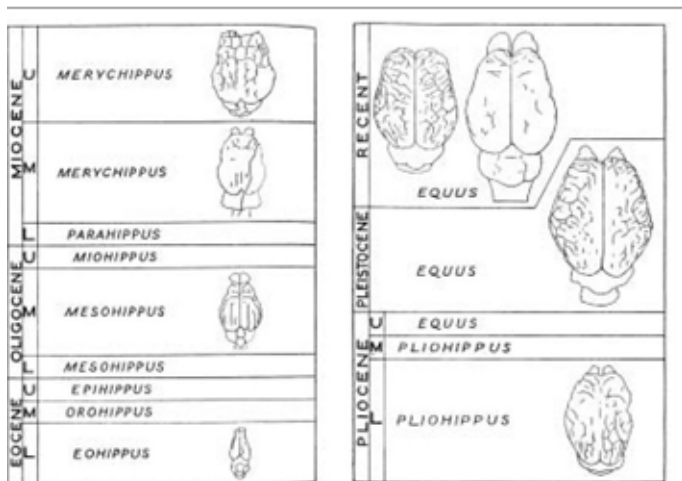


Figure 2. Edinger's series of horse brains, showing differences in size and external anatomy as well as order of stratigraphic occurrence. From 'Letters from Gondwana: Tilly Edinger and the study of "Fossil Brains" ' (Edinger 1948).

This provided Edinger with access to the collections, allowing her free rein to extend her palaeontological education and spend time studying vertebrates. During her years as a curator, Edinger wrote "Die Fossilen Gehirne" (*Fossil Brains*), a landmark study which was based on her discovery that mammalian brains left imprints on fossil skulls, allowing palaeoneurologists to reconstruct the neural anatomy of ancient mammals.

In 1933, the rise of the Nazi Party in Germany radically changed Edinger's personal and scientific life. She retained her curatorial position for five more years, but in 1938 was dismissed, shortly after which she emigrated to England (May 1939). While in London, Edinger worked as a translator but continued her research and published three palaeoneurological papers in English and French.

Edinger applied to the US Consulate for entry into the United States and was issued quota number 13,814, for planned entry in the summer of 1940. Edinger's US colleagues provided important support for the visa process, including a letter from George Gaylord Simpson to the State Department which stated: "She is a research scientist of the first rank and is favorably known as such all over the world. She is everywhere recognized as the leading specialist on the study of the brain and nervous system of extinct animals and on the evolution of the gross structure of the brain. She is so preeminent in this field that she may really be said to have created a new branch of science, that of paleoneurology, a study of outstanding value and importance".

Edinger arrived in New York on 11th May 1940 and soon thereafter relocated to Massachusetts to take a position at the Harvard Museum of Comparative Zoology; this represented her first position as a salaried palaeontologist. Edinger attended the founding meeting of the Society of Vertebrate Paleontology (SVP) in 1940, where she was the first and only woman.

Edinger became a citizen of the USA in 1945. She continued her work on fossil brains for over twenty years and published a landmark book on the evolution of the horse brain and many controversial articles, as well as comprehensive bibliographies of her field.



In 1963 Edinger was elected president of the SVP; she was the first woman to serve in this role.

Edinger died in 1967 as the result of a traffic accident at the age of 69. Her final book: *Paleoneurology 1804–1966*, was completed posthumously by her colleagues and is considered the essential starting point for any project in palaeoneurology.

**Anna Aivazyan**

*University of Tübingen*

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## Behind the Scenes at the Museum

### *The Cockburn Geological Museum*

Legend has it that the Grant Institute, which houses the Cockburn Geological Museum and the University of Edinburgh's School of GeoSciences, was funded by the man who invented digestive biscuits. It is part of a group of buildings called The King's Buildings, and was designed by the famous 20th century Scottish architects Sir Robert Lorimer and John Fraser Matthew. Building work took place from 1926 to 1932. Upon the opening of the Museum, it housed the University's first gathering of historical mineralogy, palaeontology and instrument collections, many of which pre-date the building. It also contained the University's then-existing collection of teaching material.



*The entrance to the Grant Institute. Photo courtesy of Magnus Hagdorn, University of Edinburgh.*



The Museum comprises over 130,000 specimens and other materials, from rare minerals to Neolithic tools, Australian graptolites and Carboniferous corals. The historic nature of the collections means that the Museum houses multiple specimens from sites that are either no longer accessible or have been exhausted. Particularly noteworthy collections include the Lyell collection, consisting of stone artefacts, meteorites, rocks and fossils collected by Sir Charles Lyell (1797–1875); the Currie mineral collection from Dr James Currie; and the Davidson mineral collection from James Davidson.



*Historical collection of shells. Image © University of Edinburgh Digital Imaging Unit.*

The palaeontological collection consists of over 10,000 specimens, including fish, reptiles, trilobites, brachiopods, molluscs, corals, sponges, foraminifera and plants. Within this are the Jehu-Campbell Collection of Highland Border Fossils and the John Smith of Dalry Fossil Collection, comprising Dalradian graptolites and brachiopods, and Carboniferous fossils from Ayrshire, respectively. The Museum also has an 'original' Whitby snakestone. Although largely housing historic collections, the Museum is still growing by the archiving of recently studied specimens.



*Fossilised shark teeth from the collections. Image © University of Edinburgh Digital Imaging Unit.*



*Engaging with the public at an exhibit about the Carboniferous. Image © Chris Scott.*

The Cockburn prides itself in its involvement with the public, where it aims to represent the department's work in volcanology, oceanography and palaeontology. Recent outreach events include the Edinburgh Open Doors Day, where the small Museum attracted over 450 visitors in a single day, with interactive activities for younger visitors including fossil handling, searching for fossils in sand pits, and painting trilobites. The Cockburn was also involved in the Explorathon's Curiosity Forest, using a replicate Carboniferous forest to explore past diversity with adults and children alike. Finally, the Museum is keen to explore the links between science, art and place, and collaborates with local artists wishing to unite the three-dimensional structures of minerals and modern art.

**Catherine G. Klein**  
*University of Bath*

The Cockburn Geological Museum, School of GeoSciences:  
Grant Institute, James Hutton Road, The King's Buildings, Edinburgh EH9 3JW

The Museum is open 9am to 5pm Monday to Friday, by prior arrangement with the Curator.  
E-mail: <cockburn.museum@ed.ac.uk>.

On the Web: <<https://www.ed.ac.uk/geosciences/about/history/museum>>

The Museum is always looking for volunteers to help document and digitize its collections.



## Eating fossils

The rock lying by the roadside did not look like much of interest at first: a rather nondescript limestone, with little more to show to casual observation than a few vague blotches. Anyway, old habits die hard, so I picked it up, licked the surface and put it, and my hand lens<sup>1</sup>, to my eye. The memory of the shock, and the thrill of minor discovery, is still fresh. The little blotches turned out to be the most superb three-dimensionally preserved *Nummulites* foraminifera that one could hope to see, set in a marvellously revealing natural cement of sparitic calcite. Part of the sample still graces my desk, while the rest has been sacrificed for microscope thin sections for students. Such treasures should not be withheld from the younger generation.

Licking the rock, of course, is part of the geologist's and palaeontologist's armoury of tried-and-much-tested techniques used to help survive in the field. Wetting the surface allows fossil and mineral textures to stand out sharply, rather than being lost in the blur of intersecting micro-reflections and micro-refractions that come out of a dry surface. On that day, it brought out the handsome nummulites a treat. The taste, now, was likely merely registered as generically-slightly-dusty and then instantly forgotten; I had always thought it entirely superfluous to identification. But perhaps not so. As we contemporary types develop capabilities in one direction, we might be entirely losing them in another. Go right back to the beginnings of our science, and our ancestors, and their senses, were attuned to different settings. One could then, it seems, literally develop a taste for stratigraphy.

If one was to choose an ancestral stratigrapher, then Giovanni Arduino (1714–1795) would be as good a candidate as any. He was the man who set up the Primary, Secondary and Tertiary 'orders' of strata that were ultimately to morph and diversify into what we now know as the Geological Time Scale (together with an offhand mention of a 'fourth order' that itself was to evolve – with a few fits and starts – into the Quaternary).

Arduino was a busy man who had to be 'everywhere at once', with a number of working personae, although neither he nor his colleagues would include within these the role of theoretical scholar or academic. A mining engineer and surveyor, and self-confessed 'mineralogist' – a term in which he cheerfully lumped together a keen interest in minerals, rocks and fossils – he had boundless energy and enthusiasm for practical fieldwork, and a magnificent and marvellously diverse field area – the Veneto of north-east Italy. Stretching from the plains of the Po Delta by Venice through the foothills of the Alps to the north towards the high Dolomites, it was a profitable playground for Arduino, whose expertise was constantly in demand by the local mines, foundries and quarries.

His growing realization that there was an ordered pattern behind the bewildering diversity of rock types of his large playground was not set out in some learned treatise or monograph, but in a couple of letters to a friend who *was* a scholar and academic. This was the 'respected professor' Antonio Vallisnieri of the University of Padua: these representatives of contrasting worlds had become close friends. Arduino supplied Vallisnieri with specimens picked up on his travels, and in the learned professor he found a kindred spirit with whom he could share his enthusiasm and curiosity about all things 'mineralogical'. Vallisnieri simply published the letters wholesale

<sup>1</sup> You see what I mean about old habits. I still rarely travel without one.



in 1760 in the local Venetian journal, grandly entitled *Nuova raccolta d'opuscoli scientifici et filologici*. There they, and Arduino's insights, would likely have languished, had not a travelling Swedish mineralogist, Johann Jakob Ferber, come along, realized the significance of Arduino's study, and paraphrased the important bits into German. This was further translated into French and English, and so they travelled farther afield. Ferber was to Arduino a little as was John Playfair to the brilliant if prolix James Hutton. The rest is history, or rather, stratigraphy.

For Arduino's letters were exactly that: letters, nicely easy-going as between friends and discursive as you please. While Arduino's system has now grown gigantic, the original letters have remained in the shade, unknown to anyone except scholars of geological history who could read eighteenth-century Italian. Indeed, they have only in the last year received a full published English translation, thanks to the efforts of Theodore Ell, who also provides useful context to Arduino's life and work. They make absorbing reading, and are thankfully *much* shorter, and livelier, than is Hutton's epic. And within them – particularly in the first letter – Arduino conversationally describes the local rocks, minerals and fossils<sup>2</sup> of the sequence of rocks, that he depicted in that famous – and still impressive – annotated geological field section across the valley of the Agno 'as far as the highest summits of the Alps above Recoaro'. It is in these initial descriptions that the question of taste looms large.

Once the preliminaries are over – and Arduino shows elegant manners in these, proclaiming himself grieved 'to be kept from research and contemplation of the productions of the Fossil Kingdom' and from 'regular correspondence with Men of Philosophy' – his list of 'curious observations' was unfurled, spiced with those sensory grace-notes. Fossil shells in a mudrock, for instance, and coal fragments, when burned, leave an ash that '*as soon as it is placed on the tongue, it burns like fire and leaves a flavor equally bitter and urinous; when spat out, it leaves a certain sweetness, and a skinned tongue*'. Springs that emerge from a stratum full of marcasite and coal '*have an acid spicy flavor; vitriolic, yes, but with a certain pleasantness that I cannot describe, like the acidity of wine*'. These waters '*made me far less nauseous than did the waters from the same source that I have tasted here in Vincenza and at Scio*'. The white and micaceous sediment from one stratum has no taste in the raw state, he said, but once burnt '*acquired a flavor, as well as a caustic quality from the calcining of the spar*'.

It is a taxonomy of taste – and of sight and smell too, as the specimens are burnt, boiled, dissolved, all reacting in different ways, minutely described. The account as a whole is redolent with a literary flavour that is part alchemy, part sensual experience of rock, part scientific analysis. And, of course, in days when there was no chemical analytical equipment – and indeed no framework of chemistry in any way that we now understand it – it was a sensible means to throw a little light on those enigmatic but useful rocks.

This was taste, therefore, as analytical tool. The whim of some jaded gourmet, or perhaps gourmand, though, can also be thrown into the mix. One can imagine that the shade of the Reverend William Buckland, celebrated Dean of Westminster, dinosaur hunter and man with a mission to eat his way through the animal kingdom, might begin to stir and take an interest at this point. Even the Reverend Buckland though did not, as far as I know, make much headway through the *extinct* animal kingdom<sup>3</sup>. But, on one notorious occasion, others reputedly did.

<sup>2</sup> Arduino set out his 'orders' in the second letter.

<sup>3</sup> He apparently made a play for a morsel of the embalmed heart of an extinct French monarch, but even if successful, that would have been cheating, taxonomically.





The 1951 annual dinner of the Explorers Club in the grand ballroom of the Roosevelt Hotel, New York, had more of a buzz than usual. The promoter of the event, Commander Wendell Phillips Dodge, sent out a press release to say that prehistoric meat would be on the menu. Impresario and one-time agent for the film star Mae West, he knew to be shameless in attracting attention. On the evening the dish was labelled *Megatherium*, while in the following days the *Christian Science Monitor* got in on the act. This august journal said that the meat was in fact that of a frozen woolly mammoth, fully a quarter of a million years old, and excavated from one of the far Aleutian islands. It was, it was said, from the private stock of yet another hungry and peripatetic Reverend, Bernard Hubbard, who was also known as the Glacier Priest.

As urban legends go, it had impressive longevity, and persisted for decades, only to be eventually undone by the cold and indigestible light of science. A morsel of the meat, requested by an absent Explorer but never eaten (one can see a spectral Rev. Buckland sorrowfully shaking his head), had found its way into the Yale Peabody Museum of Natural History. In 2014, a couple of curious PhD students, intrigued by the story, decided to put it in for DNA testing. Analysis was not straightforward (slow cooking plays hell with DNA) but enough was found to show that the steak was neither sloth nor mammoth, but quite clearly green turtle<sup>4</sup>.

A sad story, somehow rendered a little more melancholy due to the statement released by the Explorers Club after the debunking, in that they were glad – they averred – that it had not really been a mammoth that had been served, as they would not wish to be associated with serving meat from unsustainable sources (though it is uncertain whether they sought the views of the turtle community on this matter).

If mammoth is off the menu, what about the edibility of other fossils? One might think here of edibility more widely, without a strict focus on the whims and fancies of the human palate and stomach, which arguably has had more than its fair share of attention. One might come full circle to think of who, or what, might wish to eat – for example – a *Nummulites*. This is genuinely intriguing, particularly when one goes to the more spectacular end of that inherently impressive genus.

*Nummulites*, in general, must have been like its much smaller foraminifer brethren that live today: essentially a modest amount of protozoan protoplasm bound up within an awful lot of calcium carbonate shell, with at least one of the uses of this shell being to deter those creatures that might wish to snack on the protoplasm. That must work up to a point, but it's not completely predator-proof. There are animals today that do eat foraminifera – some worms, snails, fish, sea urchins and suchlike<sup>5</sup>. Much of such foraminiferovory<sup>6</sup> is a little like deposit feeding, with the tiny skeletons subsequently excreted as a kind of lime sand. It is not always easy to see if the foraminifera have been eaten by design or by accident, but in at least some instances selective ingestion has been inferred. There are other means of getting into a foraminifer. Some fossil specimens have holes bored into them, some of which show signs of healing, showing that the boring was done while the foraminifer was alive, and not post-mortem<sup>7</sup>. Wholesale crunching has also been suggested, though it takes a little work to discriminate that from wave damage<sup>8</sup>.

<sup>4</sup> And therefore real turtle, though mock mammoth.

<sup>5</sup> Culver and Lipps (2003) discuss the chapter and verse.

<sup>6</sup> A real word, or at least one invented in published print: Hickman and Lipps (1983).

<sup>7</sup> Syed *et al.* (2014).

<sup>8</sup> Beavington-Penney (2004).



But let's now scale up to the more hulking ancient relatives, pass by the modest giants discovered earlier by idle curiosity (and a hand lens), and head straight towards the top: *Nummulites millecaput*. Pictures of this monstrous protozoan show it resting on the palm of a hand like a discus, and it could reach 16 centimetres across. The enigmatic name (why a thousand heads?) was given to it by someone who possessed something of an enigmatic name himself, Nérée Boubée, in 1832. Nérée is one of the rarer first names in the French language, being derived either – one must take one's pick – from a mariner of Greek mythology, who fathered the Nereids, or Saint Nérée, eunuch of the Roman Emperor Domitian. Whatever M. Boubée's parents might have had in their heads when they saddled the poor infant with this identity, it seems not to have done him irreparable harm. He became an enthusiast, collector and teacher of natural history 'of insatiable curiosity' and set up a thriving business selling specimens. Somewhere along the way he found, and named, this monster foram.

What, though, could eat a living rock of this proportion? Some have suggested that its very gigantism was a means of outgrowing potential predators. Most Eocene would-be nummulitovores, in this view, would have regarded this beast with much the same sense of baffled impotence that our house cat displays when a hedgehog passes by. Even the Rev. Buckland, if transported by some time machine to nummulite times, may have wondered where his knife and fork might get purchase.

The importance of this question may be moot, given that *Nummulites* – common enough at times and in places to be a rock-builder effective enough to catch the eye of an Egyptian pharaoh – nevertheless seems to have been a bit player in the ancient Earth's food chain. But what if it formed a whole food chain in itself? – or even formed the whole of the Earth's surface?

This is perhaps the purest and most sublime example of wishful thinking in the annals of palaeontology. Its author was Randolph Kirkpatrick, who in his professional career was assistant keeper of lower invertebrates in the British Museum, from 1886 to 1927. He did some methodical science, and made one or two minor but significant discoveries, such as the discovery of a sponge that secreted a coral-like calcareous skeleton. But then he discovered *Nummulites*, and made not only a virtue out of its presumed inedibility, but made a planet too.

The *Nummulosphere*, he called it, and described it in a book of the same title, in 430 pages of prose that, if perhaps not exactly deathless, is attractively assembled, while his evidence is laid out with the utmost clarity. The intentions are set out on the title page, with a quote from Homer's *Odyssey*. Kirkpatrick would not, thus, 'swerve from the truth' in revealing the declared speech of 'the ancient one of the sea'. The ocean, Kirkpatrick said, is full of organisms which efficiently extract calcium carbonate and silica from the seawater to create a myriad skeletons, which then go on to become geological strata. Look at thin sections of those ancient strata through a microscope and you will see traces of those skeletons.

Many of them, he went on to say, show the traces of the curved shells and chambers of *Nummulites*; these were not always obvious, but could be detected with the trained eye. That trained eye then put other rocks under the microscope. With just a little more training, the same shapes could be detected in all of the specimens that Kirkpatrick looked at – including in lavas, granites and even meteorites. The inference was clear. All rocks were the more or less silicified remains of a globe-encircling layer built up by countless generations of nummulites which,



indigestible to other organisms, built up to form the Earth's crust. To critics who said that he did not understand the basics of igneous petrology and the crystallization of minerals from magma, Kirkpatrick quite reasonably replied that that may be so – but he did know his nummulites, and that is what mattered.

'Crazy old Randolph Kirkpatrick', Stephen Jay Gould called him in one of his essays<sup>9</sup>. And his ideas were so completely and certifiably bonkers, but also so politely and doggedly expressed, that he did not draw out Gould's sharpness, but rather an amused sympathy and even a hint of admiration. Even in such extreme alternative hypotheses, Gould suggested, there was food for thought.

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<sup>9</sup> In *The Panda's Thumb*.



# R for palaeontologists

## 6. The tidyverse Part 2: Data wrangling with dplyr and tidyr

### Introduction

Last time I focused on using the *ggplot2* package to make charting your data quicker and easier and by extension provided an introduction to the *tidyverse*. However, at that time I didn't go any further into the wider *tidyverse*, specifically the *dplyr* and *tidyr* packages that are used for data processing and are the real work horses of the *tidyverse*. The aim of this article is to cover the main functions of these packages, to demonstrate how they can make your code more efficient and, importantly, easier to understand and duplicate for others.

### What makes a tidy dataset?

One of the essential elements of the *tidyverse* is the development of a standardized format for data; these are known as *tidy datasets*. I am not going to spend a great deal of time delving into the philosophy of tidy datasets (that has been done better elsewhere, for more detail see Wickham (2014)). Put simply, there are three rules that define whether a dataset is tidy or not:

1. Each variable must have its own column.
2. Each observation must have its own row.
3. Each value must have its own cell.

Taking an example from Wickham (2014) to illustrate the difference between *tidy* and *untidy* datasets (any dataset not in a tidy format is by definition untidy).

	Name	treatment (a)	treatment (b)
1	John Smith	NA	18
2	Jane Doe	4	1
3	Mary Johnson	6	7

This is an example of an untidy dataset and is only one way in which these data could be arranged (in itself a marker of an untidy dataset). Using the above definition of a *tidy* dataset we can see that this violates the first two rules, as each row contains more than one observation; *i.e.* each row has a value for both treatments, and also the variable for what treatment is being used is split over two columns in this example. Below are the same data but in a tidy format. I hope you can appreciate that this better adheres to these rules, in that each row only contains one observation, *i.e.* a row for every combination of person and treatment:

	Name	Treatment	n
1	John Smith	a	NA
2	John Smith	b	18
3	Jane Doe	a	4
4	Jane Doe	b	1
5	Mary Johnson	a	6
6	Mary Johnson	b	7



There are several advantages to having all your data in a consistent format: (1) it makes all the techniques we will go through below easier to learn because they will operate the same on any tidy dataset; (2) R is particularly effective at working with data in a vector format and tidy datasets make this a lot more intuitive (and allows others to use your code on their tidy data easier); and (3) if your datasets are already in this format it reduces the amount of time you will spend cleaning your data – which can be the most time-consuming part of any analysis.

### An introduction to piping

Another aspect of the *tidyverse* I didn't discuss last time but we did see it in operation are pipes. These are extremely useful in making your code easier to follow and the process of debugging much simpler; this is especially important for the replication of your work by others. A pipe works by passing the output from one function directly into the next. This is useful if you are prone to either creating many intermediate versions of your data for each data processing step, or if you tend to nest functions within each other; *i.e.*:

```
results <-functionThree(functionTwo(functionOne(data), arguments),
  morearguments)
```

By using a pipe you no longer need to employ either of these methods. The pipe function is built into the *magrittr* package which will be loaded with the rest of the *tidyverse*, and is defined as `%>%` (shortcut key: Cmd+Shift+M for Mac, Ctrl+Shift+M for Windows). In simple terms the way this works is that the output from one function is 'piped' directly into the next function. We'll go over this in more detail below but for now here is a simple example:

```
x <- rnorm(10)
x %>% max()
```

Here we take the values of `x` (calculated in a normal fashion) and 'pipe' them into the `max` function, which then prints the maximum value of all values in `x` to the R console. We can still assign the results of this pipe to a new variable if we need to through the usual method:

```
y <- x %>% max()
```

At the moment this may not seem like a big deal, and if anything may involve more typing (!), but by the end of the article I hope you will be able to appreciate the benefit of this method when writing code that involves lots of data processing.

### Cleaning and tidying a dataset

For the bulk of this article I will walk through a series of data processing steps, using a pipe, to create a clean and tidy dataset that is ready to be used to create plots in *ggplot* or for further analyses. For this tutorial I have created a dataset that does not fit the rules for a tidy dataset. It contains 31 rows of information, each of which contains measurements for a species across 31 different localities. The entire pipe we are going to use looks like this:

```
tidy <- untidy %>% tbl_df() %>%
  select(-Unknown) %>%
  mutate(species=str_to_lower(species)) %>%
  gather(key=Location, value=Size, starts_with("Loc")) %>%
  filter(!is.na(Size)) %>%
  rename(layer = Location) %>%
  left_join(locations, by="layer")
```



A couple of quick notes before we start: (1) *ggplot2* works in a similar way but uses an addition symbol (+) instead of a %>% ; (2) the %>% symbol must be at the end of each line and not the beginning for the pipe to work; (3) to run the code up to any individual line just omit the %>% from the end of the line you want to stop at.

Before we work through this pipe line-by-line it is worth having a close look to see if you can get a sense of what each process is carrying out; this is because one of the principles of the *tidyverse*, as mentioned above, is to make coding more intuitive to follow.

The first step, as always, is to set up the workspace for our purposes by loading in the relevant libraries and data we need. As mentioned last time, we can use the following code to install (if you haven't already) and load all the associated *tidyverse* libraries in one step:

```
install.packages("tidyverse", dependencies=TRUE)
library(tidyverse)
```

Next we need to load in the datasets we require, including our untidy dataset and a second dataset containing location information that we will use later:

```
untidy <- read.csv("untidy.csv", header=TRUE)
locations <- read.csv("locations.csv", header=TRUE)
```

Now, we have everything we need and can start to create a tidy version of these data. To start with, as we did when exploring *ggplot2*, we should convert the untidy dataset to a *tibble* using *tbl\_df*. This makes the data easier to explore as rather than printing all the data only a selection is shown:

```
tidy <- untidy %>% tbl_df() %>%
```

If we look at these data more closely, by asking R to print them, we can see that they contain information on 31 species (rows) for 31 localities (columns), of which only a handful will be printed to the R console with the rest listed below. It is worth noting at this stage that there are a lot of missing data here as not all species are found at every locality. We can also see that among the variable names in this dataset there is one for species where the location was unknown. As we don't need this we can start by removing it using the *select* function that allows us to list variables we want to keep or remove. In this instance the Unknown column is the only one we want removed and we only need to put its name with a minus sign in front of it to achieve this:

```
select(-Unknown) %>%
```

There are several ways to select the relevant variables depending on your data, such as selecting all columns between species and LocB\_30 using:

```
select(species : LocB_30) %>%
```

or using helper functions to provide *select* with a list of columns to remove. In the example below we can specify the *species* variable as well as those that start with 'Loc':

```
select(species, starts_with("Loc")) %>%
```

When looking at the data you may have noticed that the first two rows have the same species but in the second row the name has been capitalized. This issue may cause problems later on so it is best we fix it early. A simple fix for this is to convert all the species names to lower case using the *str\_to\_lower* function from the *stringr* package (the *tolower* function in base R can also be used) as follows:

```
mutate(species=str_to_lower(species)) %>%
```



### Making the data tidy

At the outset we discussed the definition of a *tidy* dataset, and if you have a look at this dataset once again you will see that it still doesn't fit this definition. Firstly, not every variable has its own column: locality is a variable in its own right and should be in a distinct column. Also each row contains multiple observations, *i.e.* one for each species per locality. So, how do we make this dataset comply with the rules? This may sound like a complicated affair, involving many steps, but handily the *gather* function does everything we need in one step:

```
gather(key=Location, value=Size, starts_with("Loc")) %>%
```

This function will 'gather' all the values contained in the columns that start with 'Loc' and will create two new variables: the *key* (which we have called *Location*) contains the location names (*i.e.* LocA\_01 *etc.* that were column names in the original dataset), and the *value* (called *Size*) contains the size information in observations spread across multiple columns. If you now open this dataset, either by printing it to the console or by using `View(tidy)`, you will see that it is a lot easier to navigate with only three variables and a row for each observation; thus it now complies with the rules defining a tidy dataset.

Before we move on to undertaking some analyses there is some additional cleaning we can do. As highlighted earlier the dataset contains missing observations; these can be easily removed using the *filter* function, which works in a similar way to *select* but operates on observations (rows) rather than variables (columns). Here we can use a logical statement to retain all observations that are not NA:

```
filter(!is.na(Size)) %>%
```

As will become clear in a moment we will also want to rename the *Location* variable to *layer*. This can be done using the *rename* function:

```
rename(layer = Location) %>%
```

### Merging datasets

It is very common that as analysts we may want to combine various datasets prior to conducting any analyses. Within *dplyr* there are several functions that can be used to combine datasets (with similar functions in base R). Each of these is designed to join datasets in different ways (Figure 1). The last step in the pipeline we have been working through is to merge our new tidy dataset with the other file we loaded in at the start. If you now look at the *locations* dataset you will see it contains information about each locality, including a broader location category and an age value.

Here we will use the *left\_join* function which will match the rows in **b** with those in **a**. As such the resulting dataset won't include any rows from **b** where a match wasn't found in **a**.

```
left_join(a, b, by="variable") %>%
```

In our analyses, as we are using a pipe, we only need to input the name of the dataset to be merged (*i.e.* not the one that will be automatically input from the previous steps in the pipe), and the name of the variable we want the datasets to be matched using. In this instance we want to use the name of the localities, which is the common variable between both datasets (hence the use of the *rename* function to ensure the matching variables in both datasets had the same name):

```
left_join(locations, by="layer") %>%
```



Data A		Data B	
V1	V2	V1	V3
A	1	A	TRUE
B	2	B	FALSE
C	3	D	TRUE

---

left_join(a, b, by="V1")			right_join(a, b, by="V1")		
V1	V2	V3	V1	V3	V2
A	1	TRUE	A	TRUE	1
B	2	FALSE	B	FALSE	2
C	3	NA	D	TRUE	NA

inner_join(a, b, by="V1")			full_join(a, b, by="V1")		
V1	V2	V3	V1	V2	V3
A	1	TRUE	A	1	TRUE
B	2	FALSE	B	2	FALSE
			C	3	NA
			D	NA	TRUE

Figure 1. Examples of four simple ways to merge two datasets.

With that, all the steps in the pipe are completed. If we run all of these together and view the resulting tidy dataset using **View(tidy)** the result is a dataset that contains four variables: the name of the species, its location, the size of the species, and the age of that location.

### Plotting data

With all this work to tidy our dataset it is now fully compatible with the analytical tools available in the *tidyverse*. But before we do any analyses it is worth returning to the topic of the last article and plotting some of these data. Creating a plot using *ggplot* will now be much easier than it would have been with the data in their original untidy state.

Below are two examples of code that will take in our tidy data to create a scatterplot and a histogram. If you are uncertain of what this code is doing, I recommend going back to the previous article that explains these methods in more detail. The first example is a scatterplot of all sizes against age of locality, coloured by the values in the location variable. In addition, a smoothing line for all data is fitted (Figure 2).

```
sizeagePlot <- ggplot(tidy, aes(x=age, y=Size))
sizeagePlot +
  geom_point(aes(colour=location)) +
  geom_smooth()
```

The second example uses the same data but is represented as a histogram for the sizes of all species occurrences, again grouped by location (Figure 3).

```
sizelocationPlot <- ggplot(tidy, aes(location, Size))
sizelocationPlot +
  geom_boxplot(aes(fill=location))
```



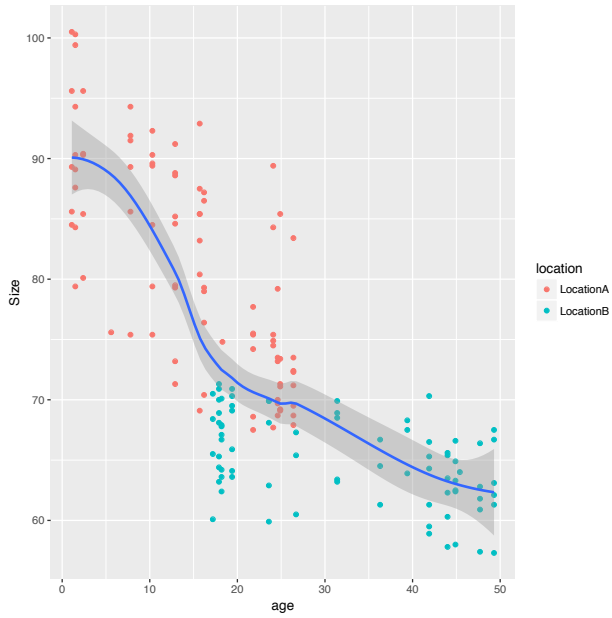


Figure 2. A plot of size versus age using the tidy dataset.

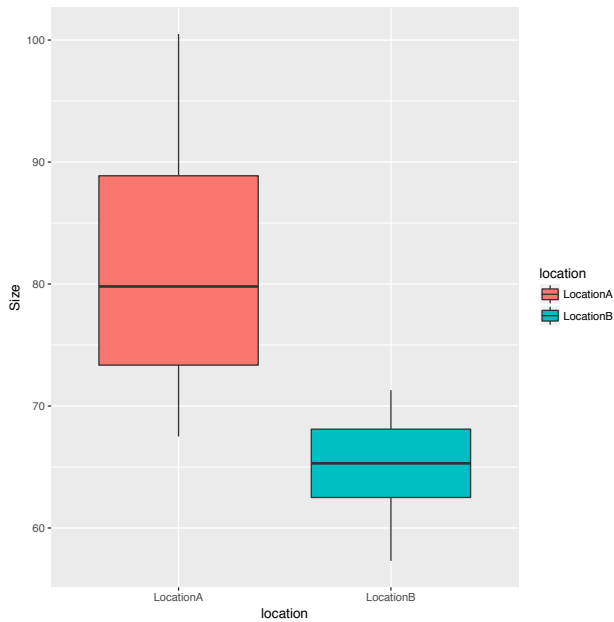


Figure 3. A histogram of sizes grouped by location.



## Grouping, summarizing and mutating data

As mentioned above we can now easily employ other analytical techniques contained in the *tidyverse*. One of the handy functions in the *tidyverse* is *summarise*. This is used to calculate descriptive statistics using your data. A simple example, in which we can also use a pipe, would be to calculate the mean size of all species in our data:

```
tidy %>% summarise(avg=mean(Size))
```

This will return the mean value of the *Size* column under the new variable *avg*:

```
# A tibble: 1 × 1
  avg
  <dbl>
1 73.59091
```

However, while we could also do this using the *mean* function, the *tidyverse* allows us to go one step further and include the *group\_by* function so we can calculate these statistics for groups within the data. For example, if we wanted to calculate a range of statistics (e.g. the minimum, mean, maximum values and standard deviation for each species), and also the first and last appearance of each species, we could use the following code:

```
species_summary <- tidy %>% group_by(species) %>%
  summarise(Min=min(Size), Avg=round(mean(Size),2), Max=max(Size), N=n(),
            round(SD=sd(Size),2), FA=max(age), LA=min(age))
```

This will create a new dataset with a row for each species, and a column for each new calculated variable. The first three rows of this dataset look like this:

```
# A tibble: 26 × 8
  species      Min      Avg      Max      N      SD      FA      LA
  <chr>      <dbl>  <dbl>  <dbl>  <int>  <dbl>  <dbl>  <dbl>
1 ashcroft   69.2   84.35  100.5   15   10.36   26.4   1.1
2 bowie     67.7   75.55   89.3    10    8.86   24.9   1.1
3 clapton   83.4   87.98   90.4     9    2.36   26.4   1.5
```

We are not limited to grouping by one variable; if we wanted to group by both species and location we can use:

```
group_by(species, location)
```

The last function I want to cover, called *mutate*, allows us to calculate new variables based on the existing data which are then appended to the end of those data. In the previous example we calculated the first and last appearance of each species using the *min* and *max* functions. Now using *mutate* we can also calculate the range of each species. By adding the line of code below to the previous example a new variable, called *Range*, will be added to *species\_summary* that contains the difference between the *Max* and *Min* variables we created earlier:

```
%>% mutate(Range=Max - Min)
# A tibble: 26 × 9
  species      Min      Avg      Max      N      SD      FA      LA      Range
  <chr>      <dbl>  <dbl>  <dbl>  <int>  <dbl>  <dbl>  <dbl>  <dbl>
1 ashcroft   69.2   84.35  100.5   15   10.36   26.4   1.1   31.3
```

There is one final example, combining all the elements of this article with those of the previous one. In an earlier example we used *ggplot* to plot elements of the *tidy* dataset, however, we didn't include this code in the original data processing pipe. If we wanted to, we could combine all the steps above to *summarise* and *mutate* the *tidy* data then pipe the results into *ggplot* directly. By adding the code below to the previous pipe we plot the average size of each species against its first appearance date (Figure 4) (remember that the syntax for a pipe in *ggplot2* is represented by a + symbol):

```
ggplot(aes(x=FA, y=Avg)) + geom_point()
```

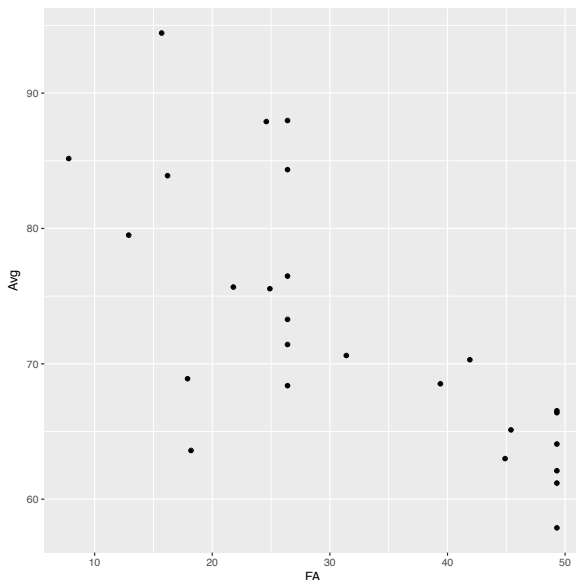


Figure 4. A plot of the average size of each species plotted against the first appearance of each species.

### Summary

The aim of this article, as well as the preceding example, was to demonstrate just how much the *tidyverse* has influenced coding in R in recent years and how, by learning to use it effectively, it can help make your coding life easier and your code simpler for others to follow. Also I hope you can appreciate how pipes have these above benefits as well as lowering the risk of creating errors that can be introduced easily through the use of intermediate datasets, and making the flow of data through your code easier to understand.

There was only so much I could cover in a short article and this only scratches the surface of the *tidyverse*. Hadley Wickham and colleagues have written a number of books on the subject that are an excellent resource for learning more about the techniques covered here. Also a number of useful 'cheat sheets' are provided on the RStudio website (<<https://www.rstudio.com/resources/cheatsheets/>>) which cover everything I have discussed here and more besides.

**Mark A. Bell**  
Scottish Government  
<mark.bell521@gmail.com>



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<<http://r4ds.had.co.nz/tidy-data.html>>.

WICKHAM, H. 2014. *Advanced R*. Chapman & Hall/CRC, 478 pp.  
<<http://adv-r.had.co.nz/>>.

Data Wrangling with dplyr and tidyr Cheat Sheet:

<<https://www.rstudio.com/wp-content/uploads/2015/02/data-wrangling-cheatsheet.pdf>>.

Data Visualisation with ggplot2 Cheat Sheet:

<<https://www.rstudio.com/wp-content/uploads/2015/03/ggplot2-cheatsheet.pdf>>.

You can find the support material for this column, such as the data files *untidy.csv* and *locations.csv*, in the *Newsletter* section of the PalAss website, at

<<http://www.palass.org/publications/newsletters/r-palaeontologists>>.



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



**Linnean Society Palaeobotany and Palynology Specialist Group Meetings**  
London, UK 8 – 9 November 2017

The 2017 autumn meetings of the Linnean Society Palaeobotany and Palynology Specialist Groups are open to anyone interested in palaeobotany or palynology and related fields. Attendance is free and advance registration is not necessary. The meetings will be held at the Linnean Society, Burlington House, in Piccadilly on consecutive days. For further information on the palaeobotany or palynology meetings, please contact Peta Hayes, (e-mail <[p.hayes@nhm.ac.uk](mailto:p.hayes@nhm.ac.uk)>) or Barry Lomax (e-mail <[barry.lomax@nottingham.ac.uk](mailto:barry.lomax@nottingham.ac.uk)>), respectively.



**26th International Workshop on Plant Taphonomy**  
University of Göttingen, Germany 24 – 26 November 2017

The International Workshop on Plant Taphonomy is an annual discussion meeting that focuses on plant taphonomy and actualistic palaeobotany to help understand the fossil plant record. Anyone interested in plant taphonomy and palaeobiology can participate. At this meeting topics will be emphasized related to maintenance and availability of palaeobotanical collections such as deterioration and preservation, and non-invasive 3D imaging, including for amber, a speciality in Göttingen. There will be two keynotes on these topics and a round-table discussion, in addition to contributed talks and posters. The workshop has an informal, discussion-oriented style and is free for student attendees. The Museum and extensive amber collections will be open to attendees. There will be a field-trip to Willerhausen.

For more information see:

<<http://www.geobiologie.uni-goettingen.de/Taphonomy%20Meeting%202017/index.shtml>>.



**The Early Tetrapod World: laying the foundations of the modern vertebrate fauna**  
University of Cambridge, UK 13 December 2017

To mark Prof. Jennifer Clack's formal retirement from the University of Cambridge and celebrate her 70th birthday, this one-day conference, hosted by the Department of Zoology and the University Museum of Zoology, will present new research by Jenny's colleagues, collaborators and former students on many of the topics that she has explored during her remarkable career. The conference is free, but please register by 17th November 2017.

For further information and to register please contact Tim Smithson: e-mail <[ts556@cam.ac.uk](mailto:ts556@cam.ac.uk)>.

**New perspectives on evolution in molluscs: from fossils to next generation sequencing**

London, UK 21 March 2018

The Malacological Society of London and the Natural History Museum are co-hosting this special day-long symposium to celebrate the Society's 125th AGM. Talks from world-renowned experts will cover aspects of life history and evolution in the phylum Mollusca ranging from pharmacology, palaeontology and chemosymbiosis to larval development and shell structure. Although focused on molluscs, these talks will be of interest to evolutionary biologists, biogeographers, marine biologists and palaeontologists. The meeting will run from 10am to 5:10pm in the Flett Theatre, Natural History Museum, and will be followed by a wine reception. Speakers include Prof. Dan Distel (Northeastern University, USA), Prof. Yasunori Kano (University of Tokyo), Dr Carmel McDougall (Griffith University, Australia), Prof. Toto Olivera (University of Utah, US), Prof. Sarah Samadi (Muséum National d'Histoire Naturelle, Paris), and Prof. Geerat Vermeij (UC Davis, USA). See <<http://malacsoc.org.uk/meetings/125th-anniversary-symposium-agm/>>.

The meeting is free but registration is necessary. Please register by e-mail to <[MSL-events@nhm.ac.uk](mailto:MSL-events@nhm.ac.uk)>. You will receive a bounce-back message to say that you have successfully registered. Please do not send queries to this automated account. Each participant must register in a separate e-mail.

**European Geosciences Union (EGU) General Assembly 2018**

Vienna, Austria 8 – 13 April 2018

The EGU General Assembly 2018 will bring together geoscientists from all disciplines of the Earth, planetary and space sciences, including palaeontology. The EGU aims to provide a forum where scientists, especially early-career researchers, can present their work and discuss their ideas with experts in all fields of geoscience. The PalAss will continue to give its support to sessions under the Division on Stratigraphy, Sedimentology and Palaeontology, and for 2018 is sponsoring two sessions via the Grant-in-Aid scheme, SSP4.3 'Advances in palaeobiological modelling' and SSP4.4 'Geochemical-palaeobiological interactions throughout Earth history'. Abstract submission is open online until 10th January 2018.

See the website for more details: <<https://egu2018.eu>>.

**15th Larwood Bryozoan Conference**

Cardiff, UK 6 – 8 June 2018

The Larwood Conference is an international meeting for both palaeontological and zoological bryozoan researchers, held in Europe twice every three years. Papers and posters describing new work are welcomed from established scholars and students. This is a forum for informal discussions and a place where PhD students often present their first talk to a specialist audience. The dialogue between zoologists and palaeontologists enhances existing research and frequently results in the



development of new interdisciplinary collaborations. The 15th Larwood meeting will be held in Wales at Amgueddfa Cymru – National Museum Wales located in the centre of Cardiff. During the meeting there will be the opportunity to visit the Museum exhibitions and tour the collections. There will also be a field-trip to the Big Pit National Coal Museum. Contact Caroline Buttler for more information: e-mail <[caroline.buttler@museumwales.ac.uk](mailto:caroline.buttler@museumwales.ac.uk)>.

**FORAMS 2018**

University of Edinburgh, UK 7 June 2018

Papers investigating the impacts of our changing world on foraminifera are welcomed. Contributions are sought on topics ranging from foraminiferal biology, evolutionary and population dynamics to molecular works on single-cell genomics and environmental genomics. Papers are also invited that discuss the impacts of our changing world on foraminiferal geochemical and biomineralization responses to multi-stressor events and biogeographical perturbation. Papers incorporating all aspects of applied micropaleontology, for biomonitoring and industry, are encouraged. The Symposium will also celebrate the 50th year anniversary of ocean drilling (IODP), and the history of foraminiferal research featuring the role of micropaleontological schools with two dedicated sessions. FORAMS 2018 will also host the TMS Spring Forum and Nanno Group Meeting on Friday 22nd June 2018. FORAMS 2018 specialist workshops will follow the Congress and will be hosted at the nearby coastal university town of St Andrews. The reception will include a ceillidh, and there are several field-trips planned to showcase the geology of Scotland. Registration is open until 2nd February 2018.

See the website for more details: <<http://forams2018.wp.st-andrews.ac.uk/>>.

**International Palaeontological Congress (IPC5)**

Paris, France 9 – 13 July 2018

The IPC is organized every four years under the auspices of the International Palaeontological Association (<[www.ipa-assoc.org](http://www.ipa-assoc.org)>). After Sydney (Australia) in 2002, Beijing (China) in 2006, London (UK) in 2010 and Mendoza (Argentina) in 2014, it will convene in Paris (France) in 2018. The organizing committee welcome you to France for “the Fossil week”, the fifth edition of the International Palaeontological Congress. This event is a unique opportunity for the palaeontological community to present new results and discuss all aspects of the discipline. There will be 42 scientific sessions. Field-trips are planned pre- and post-congress, in France, Belgium and Italy. Travel grants will be available to student members of PalAss; with information on <[www.palass.org](http://www.palass.org)> in due course.

Registration is now open and abstract submission closes on 28th February 2018. See the website for more details: <<https://ipc5.sciencesconf.org/>>.



**International Conference on Ediacaran and Cambrian Sciences**

Xian, China 11 – 21 August 2018

This is a joint meeting of the Ediacaran and Cambrian subcommissions and will feature three days of topical sessions focusing on Neoproterozoic–Cambrian life and environments. Pre- and post-conference field excursions will be arranged. Registration and abstract submission will open in January 2018. Please fill out an expression-of-interest form and e-mail it to Dr Wei Liu at <[liuw.mus@nwu.edu.cn](mailto:liuw.mus@nwu.edu.cn)>.

See the circular for more information: <<http://www.palaeontology.geo.uu.se/ISCS/ICECS-2018.pdf>>.



**10th European Palaeobotany & Palynology Conference (EPPC)**

University College Dublin, Ireland 12 – 17 August 2018

The organization committee would like to extend a warm welcome and invite you to Dublin in August 2018 to attend the 10th EPPC. The disciplines of palaeobotany and palynology are integrative and multidisciplinary by nature. As a community we are constantly seeking new tools and techniques to answer both long-standing and new questions. Palaeobotanists and palynologists demonstrate a strong history of partnership with disciplines that are outside our core biological and geological fields of research, such as with chemistry, physics, maths and computer science. Our community have been early adopters of state-of-the-art technology in visualization, experimentation and chemical analyses, to name but a few. The theme for EPPC 2018, ‘A Multidisciplinary Science’, seeks to highlight multi- and inter-disciplinarity in palaeobotanical and palynological research, past, present and future. We aim to showcase disciplinary diversity in palaeobotanical and palynological research through themed and open sessions, via demonstrations of new technology platforms in a dedicated exhibition space and during post-conference field excursions.

See the website for more details: <<http://eppc2018.ie/>>.



**3rd International Congress on Stratigraphy (STRATI 2019)**

Università degli Studi di Milano, Italy 2 – 5 July 2019

Following the highly-successful first meeting held in Lisbon (Portugal) in 2013 and second meeting held in Graz (Austria) in 2015, the 3rd International Congress on Stratigraphy will be held in Italy. The Congress venue is Milan, in the historical buildings of the University, with pre- and post-congress field-trips to the Alps, Appennines, and the Italian islands.

For more information e-mail <[info.strati2019@unimi.it](mailto:info.strati2019@unimi.it)>.

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*Please help us to help you! Send announcements of forthcoming meetings to*  
<[newsletter@palass.org](mailto:newsletter@palass.org)>.

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# Meeting REPORTS



**2nd International Meeting of Early-stage Researchers in Palaeontology (IMERP)**  
Natural History Museum of the Lesvos Petrified Forest, Sigri, Greece  
19 – 22 May 2017

In May 2017, the 2nd IMERP was held at the Natural History Museum on the Aegean island of Lesvos. The Meeting brought together undergraduate, masters and PhD students, as well as postdoctoral researchers, from different fields of palaeontology from all over the world. A total of 92 delegates from Greece, Poland, France, Spain, Turkey, Germany, Italy, Serbia, Cyprus, Denmark, Lithuania, Sweden and the UK took part in the meeting, presented their work or simply attended. Different fields of palaeontology were represented in the Meeting's sessions, with the Vertebrate Palaeontology session dominating (14 oral presentations), followed by Micropalaeontology: Ostracoda & Foraminifera (10 presentations). Other sessions included Palaeoanthropology, General Palaeontology, Invertebrate Palaeontology and Palynology & Palaeobotany. A total of 23 posters were displayed for the duration of the meeting.

The first day began with welcoming speeches from the local authorities and the organizing committee and ended with a lecture on the Petrified Forest of Lesvos from **Prof. Nikolaos Zouros** (Director of the Natural History Museum of the Lesvos Petrified Forest), a guided tour through the Museum's halls, followed by an icebreaker party with local treats and drinks to welcome the participants.



*Commemorative photo of the 2nd IMERP delegates outside the Natural History Museum of the Lesvos Petrified Forest.*



The second day was somewhat eventful. Due to unexpected ferry strikes many of the participants could not arrive in time and the meeting programme was severely disrupted. Thankfully, in spite of every difficulty that arose, at the end of the day everything went smoothly and the delegates found the necessary changes trivial. The Palynology & Palaeobotany session started with our first invited speaker **Andreas Koutsodendris** (Heidelberg University) and continued with talks on newly discovered fossilized plants. The next two morning sessions were on Invertebrate Palaeontology and General Palaeontology, while the whole afternoon was dedicated to the Micropalaeontology session. **Prof. Cemal Tunoglu** (Haccetepe University) opened the Micropalaeontology session with his lecture, which was followed by many interesting talks given mainly by members of the Polish and Greek contingents. The second day ended with the presentation of the documentary "*Aristotle's Lagoon*", which impressed the delegates with all the information on the biodiversity of Lesvos and the bonds it shares with the famous ancient naturalist, Aristotle. The delegates, however, didn't wish the day to end so 'scientifically' and most of them met in a local bar for drinks that led to a street party with ouzo, live Greek folk music and lots of dancing!

The third day of the meeting was rather dominated by vertebrates. The third invited speaker, **George Lyras** (National and Kapodistrian University of Athens), opened and closed the Vertebrate Palaeontology session with two lectures, both times captivating the audience with his vivid and descriptive oration. In between Dr Lyras's lectures, interesting talks from the delegates included new taxonomical discoveries, new sites or new techniques that can be used in palaeontological research. Whether it concerned larger mammals and reptiles or small rodents, the delegates from Thessaloniki, Spain and Italy showed that vertebrates are still a favourite among palaeontologists. After the Vertebrate Palaeontology session, **George Iliopoulos** (University of Patras) gave the last guest lecture before the Palaeoanthropology session, where speakers – mostly students from the University of Patras – impressed the other delegates with results on human burials and palaeopathology of different Greek populations.

The poster sessions were successful as well, with several delegates (mainly the contingent from Athens) presenting their work via imaginative and colourful posters and taking part in constructive discussions regarding their projects. The third day of the Meeting ended with the 2nd IMERP's closing ceremony, in which awards were given to the best and most popular presentations (the winners were chosen by the organizing committee and the invited speakers, or were voted on earlier in the day by the delegates themselves). The dinner and party took place later that night in local restaurants, where the participants had the chance to taste Greek delicacies and drinks and celebrate the closing of the three-day productive and fun conference.

The last day of the meeting was dedicated to the field-trip. We had a long bus ride from Sigri to Mytilene including multiple stops, during which the participants had the opportunity to be guided through the most important geological and biological sites of Lesvos (Petrified Forest Park and the wetland of Kalloni Bay). We passed interesting geosites along the way as well as a special cultural site, the Barbayannis Ouzo Liquor Distiller and Museum in Plomari.

As an afterword, the 2nd IMERP organizing committee would like to thank all the participants, contributors and sponsors for a great conference in Lesvos. Following in the footsteps of the 2016 1st IMERP in Spain, we would like to believe that this year's IMERP was also successful in providing a very economical package of accommodation, transportation and lunch for the participants, while



creating a friendly environment where young researchers felt comfortable presenting their work in front of colleagues from different parts of the world. We hope that the future IMERPs will only surpass these early meetings and that we manage to continue meeting on an annual basis. See you next year in Krasiejow (Opole), Poland for the 3rd IMERP!

**Maria Kolendrianou**

*University of Patras*

The 2nd IMERP was supported by PalAss Grant-in-Aid number PA-GA201704.



*The field-trip participants in front of the largest known standing trunk of a petrified sequoia tree in the world.*



**VII Workshop on Non-Pollen Palynomorphs**

University of Liverpool, UK 12 – 14 June 2017

This Workshop, supported by the School of Environmental Sciences of the University of Liverpool and by grants from The Micropalaeontological Society and the Palaeontological Association (Grant-in-Aid PA-GA201708), was attended by 34 participants from 12 countries, and consisted of 16 oral presentations, 14 posters, two lab sessions, a round-table discussion and many networking opportunities.

The first day kicked off with a keynote lecture by **Emilie Gauthier** (University Bourgogne Franche-Comté, France) on medieval human impacts on environments in the Jura mountains in France, Norse settlements in Greenland, and the Serteya region in Russia. **Jen O'Keefe** (Morehead State University, USA) detailed the ability of fungal palynomorphs from Cretaceous and Eocene coals to provide information on peat deposition and decomposition. **Daniil Gornov** (Saint Petersburg State University, Russia) compared palynomorphs from a volcanic caldera on Kunashir Island with modern vegetation. **Lyudmila Shumilovskikh** (University of Göttingen, Germany) presented a new



database of non-pollen palynomorphs (NPPs) (<<http://nonpollenpalynomorphs.tsu.ru/>>). This database is an incredibly useful tool that can help facilitate identification of NPPs. Interested individuals can sign up for a newsletter on NPPs, and are also invited to help further develop the database by e-mailing <[shumilovskikh@gmail.com](mailto:shumilovskikh@gmail.com)>. **Maia Chichinadze** (Georgian National Museum) presented the results of a palynological analysis of artifacts from Vani, an archaeological site in Georgia, to understand the manufacture and use of artifacts. **Eline van Asperen** (Newcastle University, UK) closed the first oral presentation session of the workshop by discussing taphonomic factors that may bias the interpretation of dung fungal spores in palaeorecords.

Following the first round of oral presentations, **Jen O'Keefe** and **Eline van Asperen** provided a crash course on fungal palynomorphs, including laboratory preparation and interpretation concerns. After their presentation, an open microscope session took place where participants checked out fungal spores and exchanged slides with unknown NPPs.



*The microscopy session.*

The second day of the workshop began with another oral presentation session. **Eliso Kvavadze** (Georgian National Museum) first discussed how starch, plant epidermis and insect assemblages indicate that Neolithic and Bronze Age ceramics were used to store wine. Her colleague at the Georgian National Museum, **Inga Martkoplshvili**, used NPPs to distinguish between storage of flour, cooked cereals and meat. **Benjamin Dietre** (University of Bourgogne Franche-Comté, France) then presented how plant and fungal spores react differently to fire events based on cross correlations between palynomorphs and charcoal. **Angelina Perrotti** (Texas A&M University, USA) discussed Terminal Pleistocene environmental change from an archaeological site in Florida. **Frank Shlütz** (Lower Saxony Institute for Historical Coastal Research, Germany) presented NPPs from marine and coastal environments. **Irene Tunno** (Lawrence Livermore National Laboratory, USA) compared NPPs with modern vegetation in the Great Basin. **Marie-Claire Ries** (University of Innsbruck, Austria) demonstrated how NPPs can indicate livestock presence and human health. **Althea Davies** (University of St Andrews, UK) tested the use of dung fungi as indicators of historical grazing in peatlands. **Jean Nicolas Haas** (University of Innsbruck, Austria) questioned the use of the fungus *Gelasinospora* as an indicator of fire events. The last talk of the session was given by **René Enevold** (Aarhus University, Denmark), who advocated that NPPs of unknown taxonomy can still provide valuable environmental information.



Posters were presented and discussed during the lunch break. Following lunch, everyone filtered back into the lecture hall for an open session on identification of unknown NPPs, whereby participants could present problem specimens to the entire group. This was a very successful activity, as the identities of quite a few NPPs were revealed. However, there were many NPPs that stumped all of the participants, further demonstrating how much more is left to learn. The merriment continued into the evening at the Ego Restaurant for the conference dinner.

The meeting concluded on the third morning with a round table discussion. Topics included developing overarching research questions, funding and publication options, and special sessions at upcoming meetings. Special sessions on NPPs will be proposed for the next EPP (Dublin, 2018) and INQUA (Dublin, 2019) meetings. The locations for future NPP workshops were also discussed and are expected to be held in Barcelona (2019), Poland (2021), and Baton Rouge, USA (2023).

### **Angelina Perrotti**

*Texas A&M University*



*The meeting delegates.*



### **6th International Conference on Trilobites and their Relatives**

**Tallinn, Estonia 3 – 15 July 2017**

More than 80 participants from 20 countries came to the 6th International Conference on Trilobites and their Relatives in Tallinn, the capital of Estonia, ready to present talks and posters. The pre-conference field-trip took us to the Lower Cambrian outcrops of the Saviranna cliffs, with one of the earliest trilobite faunas in all the world, where the transition from trace fossils to fragments of trilobite shells up to the first more-or-less complete specimens can be clearly observed. Passing through the wonderful green Estonian landscape and by the beautiful Jägala waterfall we saw several localities through the Ordovician succession in highly stratified near-shore limestones, and nice examples of the extremely diverse fauna in organic rich oil-shales. Further stops on this trip were the impressive medieval castle at the Narva riverbank facing the Russian border, the small convent Kuremäe, and a visit to an enchanting Võivere windmill, a locality where rather unexpectedly a point of Struve's Geodetic Arc was found in the garden and later included in the UNESCO World Heritage List. In Tartu, the very interesting collection of Armin Öpik (1898–1983) and the collection of the Natural History Museum/University of Tartu were opened for the participants.





*Tallinn seen from one of the numerous towers.*

The Conference itself was held in the atmospheric medieval old town of Tallinn, in the Gustav Adolf Gymnasium where famous palaeontologists such as Friedrich Schmidt, Armin Öpik, Valdar Jaanusson and Harry Mutvei had studied in former times. The participants were welcomed during the opening ceremony by the historian **Jüri Kuuskemaa**, and the president of the Academy of Sciences of Estonia, **Tarmo Soomere**. **David Bruton's** report about memories from past meetings was very enjoyable and impressive. One of the keynote talks was given by **Derek Briggs**, about thresholds in trilobite taphonomy, and the other by **David Kisailus** on new materials inspired by fossils.

The Conference itself covered 55 oral contributions split into sessions regarding Lagerstätten and exceptional preservation, functional morphology, the early evolution of arthropods, Cambrian trilobites, Devonian trilobites, and an IGCP 653 session. These were accompanied by a great number of excellent posters. On a wonderful sunny day the mid-conference field session took us to the Cambrian trace fossils of the Kakumäe locality at Rocca al Mare Open Air Museum, and the Ordovician trilobites in Paldiski and Suhkrumägi Cliffs. The blue sea, blue sky, nice fossils and good mood characterized this trip. Traditionally, a highlight of palaeontological conferences is the conference dinner, where all delegates meet, talk, discuss and sit together. In Tallinn it took place, following a guided tour through the gothic Town Hall, in the authentic medieval restaurant Olde Hansa, offering a feast of true and plentiful medieval treats, complete with music and candles. Immediately one became transported for a while to medieval times among friends, with this otherworldly light and atmosphere.

Each field excursion was accompanied by an excellent excursion guidebook, covering all sites with informative text, photographs and graphics. Finally, the post-conference excursion brought us to Upper Ordovician and Silurian localities on the mainland as well as to the popular tourist islands of Hiiumaa, Saaremaa and Muhumaa. Here the differences between trilobite associations of the late Ordovician and early Silurian reefs could be studied, and one could see the poor recovery of low diversity faunas of various facies types. It was even a rendezvous point for eurypterids from time to time.



*The conference participants pictured at the Tallinn Song Festival Grounds, site of the 1988 Estonian 'Singing Revolution' that led to the restoration of independence. Photo by Helje Pärnaste.*

The whole Conference and the field-trips were excellently organized by Helje Pärnaste, who was always everywhere, making sure everything functioned, and indefatigably caring for our every need. Thank you Helje for the wonderful Conference, for this wonderful time. Quite suddenly the Conference was over, after more than ten days of sitting together, laughing and discussing, and meeting old friends, young people, people one had only heard of, and completely new wonderful people. We all became a kind of family, and at the end the farewell was perhaps a little clouded by a bit of melancholy in the evening sunset glow above the towers of Tallinn. See you all again in Cincinnati, Ohio in 2021!

**Brigitte Schoenemann**  
*University of Cologne*

The 6th International Conference on Trilobites and their Relatives was supported by PalAss Grant-in-Aid number PA-GA201706.



*Field-trip participants searching for fossils in Narva quarry. Photo by Helje Pärnaste.*

**2017 International Workshop on Konservat-Lagerstätten**

Cork, Republic of Ireland 15 – 16 July 2017

Exceptionally-preserved fossils, collected from specific localities called Konservat-Lagerstätten, play an important role in understanding evolution and are often involved in wonderful discoveries in palaeobiology with much attention from the general public and media.

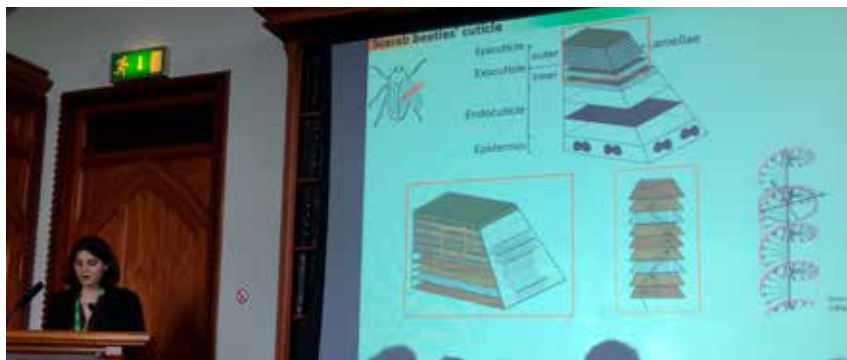
Following a spate of recent new fossil discoveries and advances in analytical and imaging techniques, this expanding field in palaeontology saw an entire weekend devoted to it in July. Set in the beautiful Irish city of Cork, the 2017 International Workshop on Konservat-Lagerstätten was the theatre of interesting talks and passionate discussions about experimental taphonomy, development of synchrotron-based methods, fossil colours, microscopy techniques, fossilization processes and new fossil discoveries and interpretations. The conference was organized by Maria McNamara of the School of Biological, Earth and Environmental Sciences and her research group, and was supported by a PalAss Grant-in-Aid (PA-GA201705), a Meeting Support grant from the Paleontological Society, Fáilte Ireland and the Irish Centre for Research into Applied Geosciences.

The meeting was hosted in the heart of University College Cork: in the northern part of the neo-Gothic Main Quadrangle, guarded by much older ogham stones covered in an ancient Irish script. Talks were held in the Council Room, conveniently located only a few stairs away from the Aula Maxima, which more than comfortably hosted the c. 55 participants for coffee breaks and discussions around posters. The first day of the workshop was dedicated to current research, with regular and 'lightning' oral presentations and posters, whereas the second day saw a succession of workshop sessions on key techniques used in the field, with a veritable feast of invited speakers.

After Dr McNamara had welcomed the participants, **Derek Briggs** opened the meeting with the first keynote talk: his was a grand overview of the field of study of Konservat-Lagerstätten, its strengths and weaknesses, its past and potential future. The rest of this opening session on 'Experimental Taphonomy' featured a series of talks with an experimental bent: **Mark Purnell** gave an overview of experimental taphonomy and its importance in resolving soft tissue anatomy, **Nidia Álvarez** spoke about biases in the fossil record of insects with colour patterning, **Miguel Iniesto** described the results of some intriguing experiments with microbial mats, and **Sharon Newman** described some experiments in siliciclastic settings. **Tim Astrop** concluded the session with a discussion of the difficulties of identifying and characterizing melanin in eyes and the importance of understanding ocular anatomy for accurate interpretation of fossils.

The second session combined experimental taphonomy with synchrotron-based analyses. **Philip Donoghue** opened the session with the day's second keynote talk, featuring new advances in the interpretation of Doushantuo-type fossils: animal-specific characters seem to be in fact the result of diagenetic void-filling mineralization (occurring much later than organic structures decay). **Tom Clements** reported new results from experiments investigating the presence of chemical microenvironments in decaying carcasses. **Clement Jauvion** presented work on remarkably preserved crustaceans from La Voulte, and **Valentina Rossi** and **Chris Rogers** discussed new research on melanosome chemistry. The meeting was then treated to three lightning presentations: **Lindsay MacKenzie** with intriguing preliminary data from pyritisation experiments, **Giliane Odín** and an experimental study of polarizing nanostructures in insects, and **Pierre Gueriau** with carbon speciation work in fossils.





Dr Giliane Odin of UCC presenting a lightning talk in the Council Room.

**Johan Lindgren** opened the first session of the afternoon, 'Biomolecules and morphology', with a keynote on the exceptional preservation of sea turtle soft tissues from the Eocene Fur Formation of Denmark. Lindgren and his colleagues were able to confirm the presence of melanosomes in a juvenile turtle fossil. This was followed by **Kenneth De Baets** with a talk on ammonoids from the Hunsrück Slate, **Evan Saitta** on biomolecules in dinosaur eggshells, and **Roy Plotnick** on the enigmatic *Essexella* from Mazon Creek. **Angela Buscalioni** then spoke about soft tissue structures in *Spinolestes* from Las Hoyas, and **Nick Longrich** described some new ideas on the tail geometry of *Archaeopteryx* and *Microraptor*. The session concluded with three additional lightning talks: **Bruno Campos**, **Ninon Robin** and **Jonas Barthel** described novel anatomical features preserved in fossils from Solnhofen, Kerguelen and Dominican amber, respectively.

The last session of the day, 'Palaeoenvironment', hosted two keynote speakers, **Baoyu Jiang** and **Bob Gaines**. Prof. Jiang described various mechanisms linked to the exceptional preservation of fossils in lakes associated with volcanism, such as the Yanliao and Jehol Biotas. Several factors were highlighted, the dominant factors being mass mortality, transport and rapid burial by pyroclastic sediments, and preservation of soft tissues through charring. Prof. Gaines discussed the origin of



Conference participants outside the Main Quad.



the Early Phanerozoic taphonomic window that led to Burgess Shale-type deposits, in particular, seawater chemistry and biostratigraphic controls. The two remaining talks of the session were given by **Farid Saleh**, who described the taphonomy of the Fezouta biota, and **Uwe Kaulfuss**, who introduced the audience to two new Lagerstätten from New Zealand.

Overall, the composition of the day's talks was a balanced and very engaging mixture of keynotes from prominent workers in the field and regular talks and lightning talks largely featuring new research by students, postdocs and more established workers. It is worth noting that the lightning talks were very successful, with most presenters following the spirit of the game. The high proportion of talks by early-career researchers was facilitated in large part by the Grant-in-Aid from PalAss, which provided financial assistance to offset the costs of travel and accommodation.

The icebreaker reception took place in the gardens of UCC's Glucksman Gallery and the conference dinner followed inside the building at Fresco's restaurant. After dinner, some of the conference participants took advantage of the coincidence of the Workshop with the renowned charity concert "A Summer's Evening on the Quad" to continue their evening with the beautiful voices of Fiona Murphy, Karen Underwood and Ronan Tynan accompanied by the Band of An Garda Síochána and the Chorus of Cork Operatic Society. The gamble paid off and despite early weather warnings, the evening stayed dry!

The technical sessions on the second day of the workshop opened with **Stuart Kearns**, who discussed best practice in scanning Electron Microscopy of exceptionally-preserved fossils. Following this, **Maria McNamara** walked us through the (difficult) process of fossil sample preparation for transmission electron microscopy. After the coffee break, **Duncan Murdock** and **Rob Sansom** gave a tag-team workshop session on best practice in experimental decay: design, analysis and application, followed by some lively discussion stimulated by questions addressed to the audience by Murdock



*Palaeontologists at a Summer's Evening on the Quad (note: no rain!).*



and Sansom (rather than the other way round!). After lunch, **Patrick Orr** presented a hypothesis on the skeletal taphonomy of fossil vertebrates – “stick 'n' peel”, which might explain some fossils with weird preservation. **Roy Wogelius** gave us an overview of synchrotron-based analytical methods featuring beautiful examples of the great possibilities of synchrotron-based X-ray fluorescence and X-ray absorption spectroscopy for the understanding of ancient life and preservation processes. After coffee, **Mike Buckley** discussed palaeoproteomics: its strengths, controversies and limitations. Finally, **Imran Rahman** presented the final workshop session on X-ray computed tomography applied to exceptionally preserved fossils. He presented the main steps required by the method and each time and how to optimize the method when dealing with fossils.

In sum, the 2017 International Workshop on Konservat-Lagerstätten was a highly successful scientific meeting as the first dedicated meeting in over ten years to bring together palaeontologists working on exceptionally-preserved fossils. Many thanks to the speakers for the very high quality of scientific presentations and, of course, the organizers of the meeting itself.

**Clément Jauvion**

*Muséum national d'Histoire naturelle, Paris.*



**15th Annual Meeting of the European Association of Vertebrate Palaeontologists**  
Munich, Germany 31 July – 5 August 2017

This EAVP Meeting introduced a record 209 attending delegates (from all over the globe) to Munich, a city bustling with culture, personality, beer and over 250 years of palaeontological history. The Meeting itself took place in the Palaeontological Museum, an architecturally fascinating building located close to the Königsplatz and boasting an impressive collection of fossils ranging from plants to reptiles and mammals. It is a truly awe-inspiring venue, as you pass through the front doors and are met with the signature *Gomphotherium* towering over you. No doubt many a palaeontologist was amazed when walking into their new ‘home’ for the next few days!

The pre-meeting workshops were informative and helpful, and included 3D modelling, finite element analyses, and gender disparity in palaeontology (see following article). These were followed by the icebreaker reception (held in the Palaeontological Museum), which, as always, presented a wonderful opportunity for old friends and new colleagues to be able to get together for refreshments and chats.

The official EAVP meeting began with a warm welcome by the director of the Palaeontological Museum, the dean of the Faculty of Geosciences, the director general of the Bavarian Natural History Collections and the president of EAVP. This was followed by a welcome from our host, **Gertrud Rößner** and a delightful line-up of invited speakers. **Maria McNamara** (University College Cork) opened the scientific sessions by explaining the preservation and biological significance of melanin in vertebrate fossils, and **Bhart-Anjan Bhullar** (Yale University) on developmental insights into major evolutionary transformations of the vertebrate head. After coffee break, **Serdar Mayda** (Ege University) discussed mammal biostratigraphy and its relevance for interpretation of Anatolian palaeogeography and phylogeny of Afro-Eurasian mammals, and **Daniel DeMiguel** (Institut Català de Paleontologia Miquel Crusafont) taught us about fossil evidence and tracing key



*Impressive entrance to the Palaeontological Museum. Courtesy of Tom Trapman.*

innovations through the evolution of ruminant mammals. Post-lunch, when everyone had the chance to venture out into the city and experience the tantalising meals that Munich has to offer (including wiener schnitzel, sauerkraut and bratwurst), we were introduced to the first batch of a remarkable variety of talks. Delegates attended sessions ranging from fossil fishes to cave bears.

**Alejandro Pérez-Ramos** delved into the feeding performances of cave bears using 3D imaging while **Aubrey Roberts** wowed the audience with a new plesiosaurian from the Slottsmøya member (Spitsbergen). **Judit Marigó** wondered if the calcaneus could help interpret the locomotion of extinct primates, and **Georgios L. Georgalis** examined the biogeographical origins of European Paleogene trionychian turtles. Once the last talk had concluded, delegates had the opportunity to mingle in the midst of the conference posters. In the evening, attendees were treated to guided tours of the Palaeontological Museum and the Zoological State Museum.

The morning of day two saw more fascinating talks. Invited speaker **Anjali Goswami** (University College London) began by delving into the macroevolutionary consequences of phenotypic integration. Sauropods were the stars of the Archosauria sessions, and included **Mario Bronzati** and **Verónica Díez Díaz** discussing evolution of the sauropod neck and braincase, and new titanosaur remains from southern France, respectively. Meanwhile the Ecomorphology and Functional Anatomy session featured **Bastien Mennecart** discussing the inner ear shape of toothed whales and **Soledad De Esteban-Trivigno** speaking about conodont functional morphology. After coffee, **Femke Holwerda** provided a redescription of *Patagosaurus* and **Jordi Marcé-Nogué** inferred locomotor behaviours in Miocene New World monkeys through finite element analyses. The afternoon sessions included **Eric Buffetaut** on the systematic positioning of *Gargantuavis*; **Alberto Valenciano** on the locomotion and body mass of giant mustelids and additional musteloids;



**Jonathan Paul Rio** on phylogenetic relationships of madtsoiid snakes; and **Anneke H. van Heteren** on the skull and talon of Haast's eagle. Lastly, delegates were also introduced to a short talk about ecological conference management (the first of its kind at an EAVP conference). As on the previous day, the posters provided interesting discussion topics.

That night saw the much-anticipated EAVP annual auction take place. The auction, hosted by the untouchable **Jeff Liston**, was featured on the first floor above the atrium, a new and invigorating layout design (to bid on an item you had to constantly keep an eye on those around you and be loud to boot)! Many amazing items were sold (including a limited edition calendar featuring Jeff Liston and Dino Frey!) and the total raised was an impressive €1,040. (The money raised by the auction goes exclusively to the Annual Meeting Grant fund of EAVP to support future meeting participants who don't have funding options, such as students and colleagues from eastern Europe.)



*Eager participants at the 2017 EAVP annual auction. Courtesy of Tom Trapman.*

The last day of the meeting again had a wonderful line-up. Invited speakers **Walter Gordon Joyce** and **Alexandra Houssaye** kicked things off with the basal evolution of turtles and 3D microanatomical features of semi-aquatic mammals, respectively. The latter half of the morning saw **Lucja Anna Fostowicz-Frelik** discuss the postcranial skeletal adaptations of basal glires, **Erin Maxwell** speak about evolutionary implications of ontogeny and reproduction of Saurichthyidae, and **Maren Jansen** introduce Permian 'microsaur' batropetes as models for frog origins. After lunch, the talks included **Paloma López-Guerrero** speaking about a new rodent species from Mongolia, **Faysal Bibi** on new fauna from Olduvai Gorge (Tanzania) and **Konstantina Agiadi** on fish otoliths from the southeastern Aegean.

The final poster session was once again both informative and immensely enjoyable. Closing remarks by Gertrud Rößner, Dino Frey and Jeff Liston were followed by a tour of the botanical gardens and then the conference dinner: a hearty three-course meal consisting of an aperitif, a buffet of Mediterranean starters, a choice of ravioli, grilled gilthead fillet and salmon or Piccata Lombarda, and multiple desserts and drinks. Of course none of this would have been possible without funding gratefully received from the German Science Foundation, the Ludwig-Maximilians-Universität München (GeoBio-Center, Faculty of Geosciences) and the Bavarian Natural History Collections (Palaeontology and Geology, Zoology, Botany).

This was an immensely successful EAVP and over 200 delegates from 24 countries attended; we look forward to Portugal in 2018!





*EAVP 2017 group photo. Courtesy of Bayerische Staatssammlung für Paläontologie und Geologie.*

<http://www.geobio-center.uni-muenchen.de/eavp2017/index.html>

**Michela Johnson**

*University of Edinburgh*

## **EAVP Women in Palaeontology workshop: report**

On the first official day of the 17th EAVP Annual Meeting, in Munich, Germany, on 31st July, the very first **EAVP Women in Palaeontology** workshop was held. The idea was to bring women and men together to talk about gender-related issues in palaeontology and science in general. The workshop was a success, with over 50 attendees (about a quarter of all EAVP Munich attendees), both women and men. Four speakers – **Femke Holwerda**, **Veronica Diez**, **Soledad de Esteban Trivigno** and **Edina Prondvai** – identified issues they themselves had encountered, or wanted to address, such as the difficulty of having a family as a woman in science, the issues with gender stereotyping and how that translates into science, and the real biological differences between men and women. After this introduction, a round-table discussion was held, moderated by **Bettina Reichenbacher** from the LMU Munich.

Two main issues were identified (unfortunately there wasn't time enough for more):

Firstly, various problems arise from the system of short-term grants for men and women who are parents as well as scientists, combined with a lack of proper and/or lengthy paternity leave (sometimes also maternity leave, but overwhelmingly paternity leave seems to be absent from most short-term contracts). This doesn't give men the chance to be fathers or to participate in the household as much as they would like to, and adds to the burdens of child-rearing and working that mothers already have. It was very good to see that most of the men present were very much in favour of better policies for paternity leave, and in the end it was decided by **Maria McNamara** that lobbying at EU level was needed. A positive sign! For women, the lack of proper parental leave also makes it difficult to start a family and stay in science in the first place. We see therefore a gap arising between the number of women and men as representatives in science at later career stages.



Secondly, our society stereotypes men and women from a very early age. These stereotypes come from society and culture, not from biological differences. Enhancing mechanisms include toys, books and clothes. Toys are a particularly good example, as girls for instance are systematically discouraged from playing with 'construction' toys that give boys their early spatial insight and mathematical skills, and boys are systematically discouraged from playing with 'caring' toys that give girls more empathy and force them into caring roles (a fun 'try this at home' exercise is to google 'clothes for girls' vs. 'clothes for boys'. What comes out is boys' clothes with rockets, science themes, and 'you can do it' logos, whereas girls' clothes feature glitter, hearts, kittens and unicorns). To combat this stereotype we need to actively engage with girls from a very young age about science and ensure that they receive equal opportunities to experience STEM at home and at school and to pursue scientific careers.

Unfortunately time did not allow anywhere near enough discussion, but the high turnout and lively debate demonstrated the strong interest in these topics in our community. We hope to run this workshop again next year, and it may even become an annual event at future EAVP meetings.

### Femke Holwerda

*Bavarian State Collections for Palaeontology and Geology/LMU Munich*



**50th Annual Meeting of the American Association of Stratigraphic Palynologists with CIMP and the TMS Palynology Group**  
The Palynological Society, Nottingham, UK 3 – 7 September 2017

This year, 2017, the American Association of Stratigraphic Palynologists (AASP) celebrates its golden anniversary and I, as a recent member of this society, had the honour to be part of it! The 50th Annual Meeting of the AASP was led jointly with the *Comission Internationale Microflore Paléozoïque* (CIMP) and the Palynology Group of The Micropalaeontological Society in the amazing campus of the British Geological Survey (BGS), in Keyworth, about 15 km from Nottingham. The pre-meeting field-trip on Sunday 3rd September, led by **Duncan McLean** and **David Bodman**, was a fantastic adventure (in wellington boots!) in the Peak District of Staffordshire to visit the Carboniferous Stage Stratotype. The afternoon saw a welcome retreat to the beautiful Fat Cat Bar in the centre of Nottingham.

In order to pay fitting tribute to 50 years of promotion of and commitment to palynology, the first session of the Meeting, on 4th September, was dedicated to the past, present and future of the AASP–The Palynological Society, an interesting reflection guided by **Thomas Demchuck**.

The remaining 12 scientific sessions were diverse and dynamic, encompassing the Palaeozoic through to Quaternary palynology. Two sessions were dedicated to the superb work of **Dave Batten** and **Gordon Wood**. In my opinion, all presentations (oral and poster) attested to the high-quality work of the many teams across the world and the importance of a transversal approach to palynology, combining it with other scientific subjects in order to resolve major geological problems and to help prevent (or at least predict) future examples. The first day of the meeting ended with a dedicated poster session in the BGS exhibition area, where participants combined discussion of recent research with very welcome refreshments.



The second day of the meeting featured another full programme of scientific sessions followed by the Conference Dinner, which took place in The Boundary Edge restaurant in the Nottinghamshire County Cricket Club Stadium. Included with the dinner was a tour of Trent Bridge. The meal and view were fantastic and we also had the privilege to listen to the charismatic Barrie Dale recite tales of remarkable and funny events over the last 50 years.

On the final day of the meeting, participants could choose between another field-trip, this time to Charnwood Forest (led by **Jim Riding**) or one of two workshops, on Strata Bugs (led by **Paul Britton** and **John Athersuch** (StrataData Ltd.)) or biostratigraphy (led by **Iain Prince** and **Katrin Ruckwied** (Shell)). I opted for the field-trip to Charnwood Forest, located immediately north of Leicester. It was a blissfully rain-free day full of remarkable Precambrian, Triassic and Quaternary geology, biodiversity and even British history! We visited no less than seven geological sites. Among the highlights were the spectacular 'Sliding Stone', composed of deformed volcanoclastic sediments, and the amazing and famous Memorial Crag. The latter is famed as the original outcrop where Ediacarian fossils were first discovered in the late 1950s.



*The famous Memorial Crag where Ediacarian fossils were first discovered.*

As a young palynologist and a first-time participant at an AASP Meeting, I couldn't be more grateful to the meeting organizing committee, especially to the local organizers at the BGS: Jim Riding, Jan Hennissen and Maria Wilson, for this memorable meeting!

**Vânia Fraguito Correia**

*Algarve University and Portuguese Geological Survey (LNEG)*



*Participants at the joint 50th annual meeting of the AASP with CIMP and TMS.*





## The Old Red: Hugh Miller's Geological Legacy

Cromarty, Scotland 9 – 10 September 2017

This 'legacy' conference was organized by The Friends of Hugh Miller and aimed at geologists and palaeontologists internationally, and anyone with a general interest in Hugh Miller, fossils and the natural world. It was held over a day and a half at the Victoria Hall in Cromarty and achieved outstanding success according to all those present. It was attended by 49 delegates and two volunteers, and was addressed by 12 speakers. Among the many highlights was a *tour de force* on the subject of Hugh Miller's classic geological work, *The Old Red Sandstone*, by the editors currently working on a comprehensive new edition of the great work, which has been out of print for almost a century. The editors, **Ralph O'Connor**, University of Aberdeen professor in the Literature and Culture of Britain, Ireland and Iceland, and **Michael A. Taylor**, research associate at the National Museums Scotland (NMS), emphasized with many examples why its outstanding literary qualities make it as worth reading today as when it was first published in 1841.

Keynote speaker **Prof. John Long** of Flinders University, South Australia presented new revelations concerning the complex reproduction structures in Devonian fossil fish, including some in the very same animals Hugh Miller first discovered nearly 200 years ago. He showed how, while placoderms reproduced principally by spawning (external fertilization), internal fertilization (copulation) must have been lost and regained at least once, indicated by evidence of strong claspers similar to those used by sharks. **Martin Brazeau** of Imperial College London further developed the theme of vertebrate evolution, exploring how fish from the Orcadian basin have helped shape our understanding of evolutionary relationships, ranging from the origin of jaws, teeth and paired appendages, to the eventual conquest of the land by tetrapods. The lively and productive scientific debate that followed has likely stimulated researchers to revisit and revive their interest in these fossils.

In probably a first for many conference delegates, they were invited by retired oil and gas consultant **Roger Jones** to view an extraordinary fossil named for Miller, *Homotius milleri*. At 66 cm long and



*Prof Ralph O'Connor, the talk's joint author, poses the question: what category as a work does Hugh Miller's The Old Red Sandstone fall into: geological textbook; fossil fish treatise; basic introduction to geology; epic poem in prose; philosophical essay; topographical work; working class autobiography or personal memoir? And the answer is: all of these and more! Photo by Laura Thompson.*



40 cm wide, it is potentially the largest and most complete specimen of this species known. Roger forms one of a group led by Prof. Nigel Trewin known as ‘The Old Red Fish Filleters’, particularly due to his interest in new techniques for high-quality fossil preparation that can reveal morphological detail not seen in traditionally ‘split’ fish. Roger has had five exceptionally good casts made of this *H. milleri* specimen, one of which the delegates were later able to see on display during their tour of Hugh Miller Museum. **Andrew Ross**, head of the NMS Palaeobiology Section, brought to our attention several samples from the NMS Miller collection purchased from his family after his death, all rarely, if ever, seen before. He said they numbered some 4,000 fossils, a small proportion of NMS holdings which amount to a quarter of a million specimens.

**John Hudson**, Emeritus Professor of Geology at the University of Leicester, has researched the Jurassic rocks of the Inner Hebrides since 1956, and used many quotations from Miller’s writings in co-authoring *The Geology of Eigg* (2nd edition) published by the Edinburgh Geological Society in 2016. Miller’s “Lias” is now known to be Late Jurassic, Kimmeridgian, in age. His observations on the brackish “estuarine” molluscan faunas on Eigg were notable in anticipating later research. In general, Miller was more interested in fossils than in rocks, but striking phenomena like the concretionary sandstones on Eigg, and the modern ‘musical sands’ derived from them, called forth enthusiastic descriptions and speculations. **Elsa Panciroli**, a palaeobiologist from the Highlands of Scotland, is a member of the Isle of Skye research teams from NMS, and the universities of Edinburgh and Oxford. She described how their fieldwork has yielded exceptionally-complete mammal skeletons. Many of these are revealed through micro-CT scanning and digital reconstruction in unprecedented detail. Elsa went on to talk about their National Geographic-sponsored fieldwork in 2017, including revisiting Miller’s Reptile Bed. She also reviewed the larger animals and the fossil localities being studied in the Inner Hebrides, including dinosaurs, flying and marine reptiles, expansive fossil footprint sites, and elusive fish groups.

**Alan McKirdy**, author of a wide-ranging series of geological guidebooks, took as his starting point Miller’s quote: “Let me qualify myself to stand as interpreter between nature and the public”. He said a challenge was facing today’s Earth scientists: “Geology is still one of the lesser known of the sciences. Many of the exciting facts about the geology of Scotland remain locked in academic texts and are not widely known by the general public”. Gold prospector **Gavin Berkenheger** then raised the audience’s spirits by invoking how two of Miller’s maxims inspired his work, about using



*Delegate Sidney Johnston finds a Devonian fossil fish, *Coccosteus*, from Miller’s famous Cromarty Fish Bed during the post-conference excursion. Photo by Laura Thompson.*



your eyes properly, and treating life itself as a 'school', through which new discoveries in the natural world could become covered in "a coat of magic".

The Friends of Hugh Miller's chairman, palaeontologist **Bob Davidson**, said Miller was one of many scientists who attempted to rationalize body plans of the fossils they collected by producing models of them. His eventual paper version of his *Pterichthyodes* remained reasonably accurate. Today technological advancement has allowed the recreation of ancient forms via computer media in place of the rubber moulds, gutta-percha and plaster materials of old. **Alison Morrison-Low**, writer and publisher on the history of NMS science and photography collections, gave a visually striking account of geology's early years as represented in the new art form, encompassing the Hill/Adamson calotypes of the early 1840s, and photography's meteoric rise from the 1850s onwards.

Among the most pleasant, and indeed thrilling, aspects of the event, was the post-conference excursion to Miller's famous Cromarty Fish Bed, during which several delegates and some speakers found remarkable Devonian fish specimens, from virtually the same locality as Miller did. We hope the conference has stimulated future research on this interesting area.

### **Martin Gostwick**

*Secretary, The Friends of Hugh Miller*

The Old Red: Hugh Miller's Geological Legacy received PalAss Grant-in-Aid number PA-GA201703.



**65th Annual Symposium on Vertebrate Palaeontology and Comparative Anatomy**  
University of Birmingham, UK 12 – 15 September 2017

The 65th SVPCA was held in Birmingham for the first time, hosted by Richard Butler and held at the University of Birmingham. It was a smashing success, with the highest number of delegates to date and the most money raised at the Jones-Fenleigh Memorial Fund auction, which helps people with no funding (like myself!) to attend the meeting.

The conference started out with more SVPCA firsts – Tuesday morning held two workshops, from **Paul Upchurch** on BioGeoBears and **Graeme Lloyd** on Claddis, while the afternoon consisted of a special symposium on 'Macroevolution and the Vertebrate Fossil Record'. This Symposium was kicked off by **Anjali Goswami**, and featured speakers from across the UK and overseas, including **Tom Kemp, Daniel Field, Lauren Sallan, Catalina Pimiento, Graeme Lloyd** and **Jason Head**. It was a great start to the conference, including a diverse group of people and topics, spanning most of vertebrate evolution from fish to birds.

The icebreaker was held immediately following the symposium in the newly refurbished Lapworth Museum of Geology, named for the geologist Charles Lapworth. The Museum is one of the oldest geology museums in the UK, and following its recent upgrade was a finalist for the Art Fund Museum of the Year 2017.



*Icebreaker at the Lapworth Museum of Geology. Image by Emma Dunne.*

The conference officially kicked off on Wednesday morning, with the first regular session beginning with **Joe Keating** on jawless fish and difficulties in total evidence dating. This was followed by **Emma Randle**, winner of this year's best student talk, on new relationships of heterostracans. The second session continued with fishes, including **Emily Rayfield** talking about mechanical loads affecting the cranial shape and function in development of zebrafish, and **Tom Challands** describing new lungfish material from the Frasnian of Russia. After lunch, we saw some beautiful CT reconstructions of the early diapsid reptile *Orovenator* from **David Ford**, which won him an honourable mention for the best student talk for his potential shake-up of the early amniote tree. We also had a few lightning talks, in which **Mark Evans** introduced a beautifully preserved plesiosaur skull. This was followed by a dedicated poster session, featuring 31 posters. Birmingham swept the poster awards with the best student poster going to **Emma Dunne** for her poster on terrestrial tetrapod diversity through the Carboniferous/Permian boundary, and honourable mentions to **Emily Brown** and **Andrew Jones**.

The annual SVPCA auction for the Jones-Fenleigh Memorial Fund took place at the Old Joint Stock pub and theatre, and despite lacking our usual auctioneer Jeff Liston, went on to raise a record-breaking £2,580, thanks to our replacement auctioneers Aubrey Roberts, myself and Alessandro Chiarenza. We thank everyone for the donations, and fantastic support of the Jones-Fenleigh Fund.

The second and final day of talks started with the return of **Jeff Liston** on some pachycormiform characters, followed by several archosaur-related talks. The second session featured **Don Henderson** discussing the amazing Suncor nodosaur, *Borealopelta*. After being treated to an impromptu mini-auction by Jeff Liston, we broke for lunch. The penultimate session kicked off with **Phil Mannion** discussing sampling bias in crocodylomorph evolutionary history, and finished with some great new mammalian material coming out of the Isle of Skye, from **Elsa Panciroli**, which earned her an honourable mention for best student talk. And finally, the last session



featured **Charlotte Brassey** on the functional morphology of the carnivoran baculum, and finished off with a very interesting virtual reconstruction of Lucy, *Australopithecus afarensis*, by **Thomas O'Mahoney**.

The field-trip for this year went to Wollaton Hall in Nottingham, where the *Dinosaurs of China* exhibition was being held. While I was unable to attend, Elsa Panciroli reports that delegates were given guided tours around the exhibition, featuring specimens of *Microraptor*, *Sinosauropteryx*, and *Confuciusornis*, as well as the existing natural history collections at Wollaton Hall. I heard only good things about the trip, and it was a great end to the week.

I'm already looking forward to SVPCA 2018, which will be hosted by Rob Sansom and the University of Manchester. Those of you on social media can find out more on Facebook (Symposium on Vertebrate Palaeontology and Comparative Anatomy) and Twitter (@SVPCA\_Bham, #SVPCA2017).



*Sinosauropteryx at Wollaton Hall. Image by Elsa Panciroli.*



*Adam Smith of Wollaton Hall and artist Bob Nicholls with his Liopleurodon model. Image by Darren Naish.*

**Liz Martin-Silverstone**  
*University of Southampton, UK*



## Yorkshire Fossil Festival

Scarborough, UK 22 – 24 September

Now in its fourth year, the Yorkshire Fossil Festival has become a staple in the calendar of fossil enthusiasts across the north of England and beyond. The Rotunda Museum in Scarborough plays host to this exciting event for one weekend each September.

Despite a blustery, rainy set-up on Thursday evening, the weather cleared by Friday morning and welcomed in a surprisingly sunny weekend. The first day of the Festival was 'Schools Day', during which groups of children from local primary schools were given the opportunity to spend the day enjoying the activities on offer. The weekend saw the event opened up to the general public, with attendees of all ages engaging with the exhibitions.



*Jake Morton helping visitors make their own trace fossils. Photo by Thomas Clements.*

This year, the exhibitors included groups from organizations such as the Natural History Museum, Oxford University's Museum of Natural History, the Geological Society and the Palaeontological Association, alongside representatives from the Universities of Leicester, Leeds and Hull, amongst many others. The activities on offer enabled visitors to engage with a wide range of palaeontological topics, from dinosaurs to microfossils, and mass extinctions to tooth microwear. A favourite from previous years, the baby *T. rex* made a return, wandering around the town centre and the Rotunda area. Sessions on rock-pooling and 'dinosaur footprint' walks were also popular. New for this year was a Soapbox Science stand, where palaeontologists involved in the exhibits – including PalAss' own **Lucy McCobb** and **Maria McNamara** – were given the opportunity to tout their wares (in this case, their palaeontological expertise) with passing members of the public.

The PalAss stall was a hive of activity for the full duration of the Festival. Visitors were given the chance to make their own trace fossil to take home, using a toy dinosaur or ammonite to create a footprint or shell mould in a pot of salt dough. Also popular was the 'Fossilisation Frenzy' board game, challenging players to successfully complete the various stages of burial, diagenesis and discovery in order to become a fossil in a museum collection. A diorama of the Jurassic oceans enabled visitors to explore the ecology of the fossils they were handling. As in previous years, part of the exhibit encouraged visitors to create and draw their own enigmatic fossil chimeras using body





*James McKay painting a fossil chimera, based on the drawing of one of our younger visitors. Photo: Thomas Clements.*

parts from real fossils. PalAss palaeoartist James McKay's talent was in huge demand as he brought these creations to life in colourful paintings.

Incredibly, more than 5,000 people visited the Yorkshire Fossil Festival, including seven groups from local schools. The efforts of the many volunteers involved and the sponsorship of the Palaeontological Association were both fundamental in enabling its success.

**Bethany Allen**  
*University of Leeds*



*The PalAss team. Top, L to R: Sally Thomas, James McKay, Lucy McCobb, Jo Hellawell, Tom Raven, Bethany Allen. Bottom, L to R: Maria McNamara, Jake Morton. Liam Herringshaw also lent a hand for 'Schools Day'. Photo: Thomas Clements.*



## — OBITUARIES —

# Anthony Hallam 1933 – 2017

Tony Hallam passed away on 23rd October 2017 after a short illness. Tony was a lifelong supporter of PalAss; he served as its President in the 1980s, was an Honorary Life Member and in 2007 was awarded the Association's highest accolade, the Lapworth Medal.

Tony was one of the greatest geologists and palaeontologists of his generation, who made pioneering and fundamental contributions to a broad spectrum of subjects including palaeoecology, biogeography, sea-level change, mass extinctions, evolutionary biology, palaeoclimate and the history of science. He was especially fond of the Jurassic, a legacy of his childhood days spent collecting fossils from outcrops in Leicestershire.

He did his degree at Cambridge University as well as his thesis when he was under the tutelage of that other great Jurassic worker, W. J. Arkell. Tony was fond of relating the tale that, at the start of his PhD, he was talking to a senior member of the Cambridge faculty and told him that his PhD was on the Jurassic. The response was, "What do you want to study the Jurassic for, it's all been done". This was in 1955. In fact, as Tony soon demonstrated, much remained to be discovered and old myths needed overturning. I imagine Tony as something of a Young Turk in those days, always keen to challenge orthodoxy. Among his first targets were the prevailing ideas on evolution, focused on the oyster *Gryphaea*. The title of his 1959 paper *On the supposed evolution of Gryphaea in the Lias* leaves the reader in little doubt about his stance. At the same time, Tony initiated studies that provided the foundation for entire research fields. His 1961 paper on the role of sea-level, anoxia and mass extinction in the Early Jurassic (Toarcian) was the first to identify this common motif in the geological record, and contains ideas that were literally decades ahead of their time. His enormous influence in the field of mass extinction studies has been recently reviewed (Wignall and van de Schootbrugge 2016).

After Cambridge, Tony moved to Edinburgh University where he continued his Jurassic investigations, notably on sea-level change and the cyclostratigraphic record of the Blue Lias. Again these were pioneering contributions (the sequence stratigraphic revolution was more than a decade away), but our understanding of Mesozoic eustasy (and the role of tectonism) was already on a firm footing well before this (e.g. Hallam 1969).

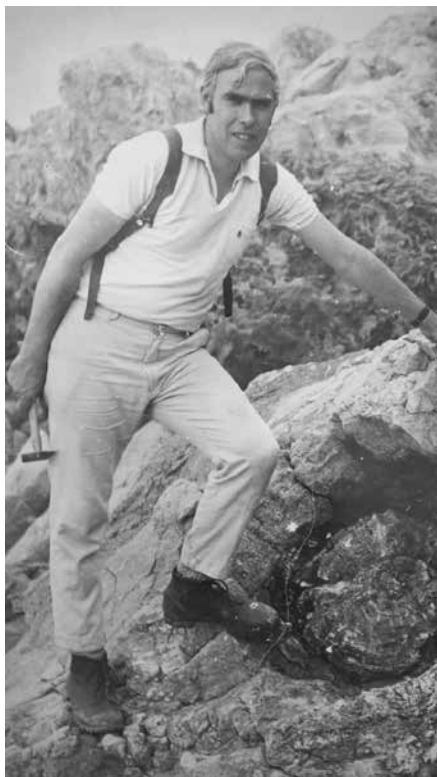


Photo courtesy of Sara Hallam.





In 1967 Tony moved again, this time to Oxford University, and began a productive ten years of research marked by contributions to the role of biogeography in understanding continental drift (Hallam 1967) and the publication of several seminal books: *Jurassic Environments* (Hallam 1975), *Atlas of Palaeobiogeography* (Hallam 1973b) and the first synthesis of the plate tectonic revolution (Hallam 1973a). He also grew a highly successful team of research students who included Bruce Selwood, Geoff Townson, Franz Fürsich and Tim Palmer. Forty years later, looking back on these achievements now, in a time when academics pursue their increasingly ultra-specialized interests, Tony's broad-ranging output looks like the efforts of an entire research school. This is particularly so if the papers of his research students are included – in those days it was not the fashion for PhD supervisors to append their name to the efforts of their students.

In 1977 Tony made his final move, to take up the post of Lapworth Professor of Geology at the University of Birmingham. There was no let-up in his productivity and he continued to publish numerous classic books that are masterpieces of scientific prose. His writing style was accessible, lively and concise: Tony always said he would have been a journalist if not an academic and there is no doubt he would have made a good one. His books have been translated into numerous languages and used in the education of geologists throughout the world. He is especially revered in China where his *Facies Interpretation and the Stratigraphic Record* (Hallam 1981) was, for long, a standard text.

Tony retired in 1999 but continued his research interests for many years afterwards. At the age of 68 he could still be found bounding up Tibetan mountainsides at 16,000 feet elevation happily collecting fossils and musing, in his distinctive, booming voice, about mass extinctions. He was always a reassuringly cheery presence on fieldwork, however arduous the conditions. I once pointed out to him that he had been described in a book as “the ebullient Tony Hallam”, which made him chuckle. On hearing of his death, Lai Xulong of the China University of Geosciences (Wuhan), fittingly summed him up as “a teacher, a friend, and an outstanding scientist forever”.

## Paul Wignall

*University of Leeds*

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## John Pojeta, Jr. 1935 – 2017

The palaeontological community lost an outstanding member when John Pojeta, Jr. died peacefully on 6th July 2017 after a series of debilitating illnesses. He had been married to his life's partner, Mary Lou, for 60 years in June. He achieved that deadline and then perhaps aimed for Independence Day because of his love for America and its opportunities for all.

John was a biologist, palaeontologist, geologist, educator, scientific administrator and long-serving supporter of many professional organizations, including the Palaeontological Association, which he joined in 1963. He was educated at Capital University – where he met and married Mary Lou – and the University of Cincinnati, where he worked with Ken Caster studying Ordovician bivalves. His work was

of such high quality that he was offered his dream job as geologist/palaeontologist with the U.S. Geological Survey in Washington, D.C. upon graduation in 1963. He became, as he once expressed it, “the President’s advisor on Paleozoic pelecypods”. A major early project was the *Ordovician Paleontology of Kentucky and Nearby States*, published in sixteen parts as USGS Professional Paper 1066, which John initiated, led, and edited from 1979 to 1995. He had already used the beautifully preserved calcitic and silicified bivalves from this region to review the great Ordovician radiation of the bivalved molluscs and had misgivings about retaining genera such as *Eopteria* and *Euchasma* within the Bivalvia. The discovery of a univalved larval shell in a Carboniferous *Conocardium*, plus input from Norman Newell and Noel Morris, led swiftly to the proposal of the extinct class *Rostroconchia* (Pojeta *et al.* 1972), which was then monographed from worldwide collections assembled in Washington (Pojeta and Runnegar 1976).

John’s father had emigrated from Czechoslovakia to New York in the 1920s, so the realization that one of Barrande’s species, *Fordilla troyensis* from Troy, NY, was the oldest known pelecypod (John was never really comfortable with “bivalve”), rather than a bivalved crustacean, was an unexpected blessing. Even better was the fact that Jiri Kriz, Geological Survey, Prague was on hand to help re-describe it (Pojeta *et al.* 1973). These two breakthroughs stimulated Pojeta and Runnegar to explore jointly the early history of the Mollusca as revealed by the Cambrian and Ordovician fossil record over the next two decades and John continued this thrust until the end of his career. Major accomplishments include monographic treatments of the Cambrian and Ordovician bivalves and rostroconchs of Australia (Pojeta and Gilbert-Tomlinson 1977; Pojeta *et al.* 1977) and New Zealand (Pojeta *et al.* 2014), the Cambrian molluscs of the Ellsworth Mountains, Antarctica (Webers *et al.* 1992), and the Cambrian chitons of Missouri (Pojeta *et al.* 2010). Late in his career, John



*John and Mary Lou Pojeta: partners in palaeontology.*



had a particularly significant collaboration with Jimmie DuFoe, an amateur who discovered rare articulated specimens of the extraordinary stem polyplacophoran *Echinochiton dufoei* (Pojeta *et al.* 2003). John also studied bivalves from the Devonian, Carboniferous and Triassic of China, explored the Precambrian–Cambrian boundary in Senegal, and worked and dived with Smithsonian marine biologists at Eniwetak in the Marshall Islands and in Belize.

John Pojeta retired from the Geological Survey in 1994, having eventually served as Chief of the Paleontology and Stratigraphy Branch during difficult times when project-oriented investigations were subsuming the roles of traditional taxonomic specialists. John's courteous, level-headed approach and moral principles made him an effective and popular administrator. These personal qualities also served the palaeontological community well in his efforts to guide and rationalize approaches to collecting fossils on public lands. His own views may be best recorded in the review he wrote for *Science* of Steve Fiffer's book *Tyrannosaurus Sue* (Pojeta 2000).

For more than fifty years, John and Mary Lou have been generous and tireless supporters of palaeontologists and the palaeontological community. Hundreds of visiting scientists (and their families) from all parts of the world have been welcomed at the Pojeta home in Rockville, MD. His and Mary Lou's contributions to the profession are celebrated by the Pojeta Award (<[paleosoc.org/grants-and-awards/pojeta-award](#)>), which commemorates their indefatigable and splendidly cheerful service to the Paleontological Society and its members over several decades.

### **Bruce Runnegar**

*University of California, Los Angeles*

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# Small Grant REPORTS

## *Middle Triassic conodont apparatus reconstruction from China*

**Jinyuan Huang**

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### **Introduction**

Conodont clusters and assemblages are very important to reconstruct conodont apparatus; they provide the most direct information on the component elements, structures and relationships of the complex conodont. Dozens of new clusters have been recovered from the lower fossil unit of the Luoping biota (Anisian, Middle Triassic; Hu *et al.* 2011). As shown in fused clusters (Figure 1), the ramiform elements preserve the original three-dimensional structures of the multielement apparatus. The new material increases the fossil record from Permian to Triassic the world over, particularly in China (Zhang and Zhang 1986; Huang *et al.* 2010; Goudemand *et al.* 2011; Zhang *et al.* 2017).

This project sought to understand the components of the conodont apparatus in the Luoping biota, reconstruct a new model of conodont apparatus, distinguish differences in component type, structure, and function of apparatus and test and revise the architecture of the superfamily Gondolelloidea. Future work will include the examination of clusters or assemblages from the different Triassic Lagerstätten in China, such as the Chaohu Fauna, Xingyi Fauna and the Guanling Biota.

### **Results**

Previous work on the ratios of the discrete elements revealed the presence of the entire conodont element apparatus of a traditional Ozarkodinid in the collections, but neither the real composition nor the apparatus architecture was elucidated (Huang *et al.* 2011). However, the study of a complete cluster of *Nicoraella* showed a 15-element conodont apparatus, including one pair of segminate P1 elements, one pair of bipennate P2 elements, one alate S0 element, a pair of dolobrate S1 elements, a pair of breviform digyrate S2 elements, two pairs of bipennate S3 and S4 elements and one pair of digyrate M elements. The relative positions of the different elements in the clusters locates the S0 element at a central and inner position of the apparatus, the dextral and sinistral S1 to S4 elements lie beside the S0 element, and the M elements, fused together with an S array, in the most external location. P1 and P2 elements are fused together with their denticles opposing each other and in a more caudal position.

The clusters described here follow the classical 15 element Ozarkodinid apparatus. Our architecture unequivocally confirms the position of S1 and S2 elements in multielement apparatus, confirming the proposal of Goudemand *et al.* (2011) to swap the S1 and S2 positions, in contrast with previous interpretations where the positions of the S1 and S2 are occupied respectively by the enantiognathiform and cypridodellan elements of the superfamily Gondolelloidea (Orchard

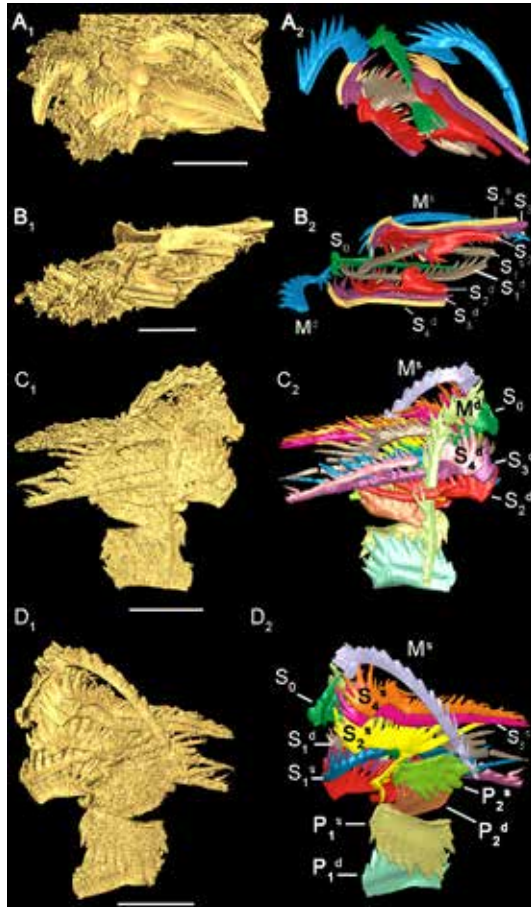


Figure 1. A1 and B1, surface specimen derived from SRXTM data of the specimen (pm028-25-wy1-C2), most conodont elements enclosed in the crystals of specimen, sinistral lower part exposed outwith the crystals. The cluster has lost the P1 and P2 elements, preserving a relatively dislocated 9-element 3D cluster. A2 and B2, surface model extracted from the specimen; B2, displaying a complete 9 element symmetrical S array. C1 and D1, surface specimen derived from SRXTM data of the cluster specimen (pm028-18-wy1-C1). A laterally compressed cluster containing 15 elements of Nicoraella. C2 and D2, surface model extracted from the specimen, all S, M and P elements flatly fused together. Scale bars are 400  $\mu$ m.

2005). In addition, the multielement apparatus includes the S0, S3-4, M and P elements, allowing us to reinterpret the architecture of the apparatus in the superfamily Gondolelloidea, e.g. with the architecture of the natural assemblages of the genus *Neogondolella* from the Middle Triassic Switzerland (Rieber 1980; Orchard and Rieber 1999). It also permits us to compare the structure with the newly reconstructed apparatus of the genus *Novispathodus* (Orchard 2005; Goudemand et al. 2011). Our results confirm that the S3 and S4 elements are much more conservative, showing similar outlines and being at the same positions in all the Gondolelloidea superfamily apparatus.



## Conclusions

The fused cluster and co-occurring isolated elements reveal the topological position and pattern of the *Nicoraella* conodont apparatus (Figure 2), allowing us to reconstruct its multi-element architecture. The apparatus contain 15 elements, as proposed for other ozarkodinid conodont apparatus. The first reconstruction of a complete 3D conodont apparatus based on a complete cluster of *Nicoraella* cloud also represents the typical apparatus in the superfamily Gondolelloidea, giving our specimens a similar pattern of juxtaposition with the specimens of *Novispathodus*. These new data open discussion of the structure of the Gondolelloidea superfamily apparatus architecture.

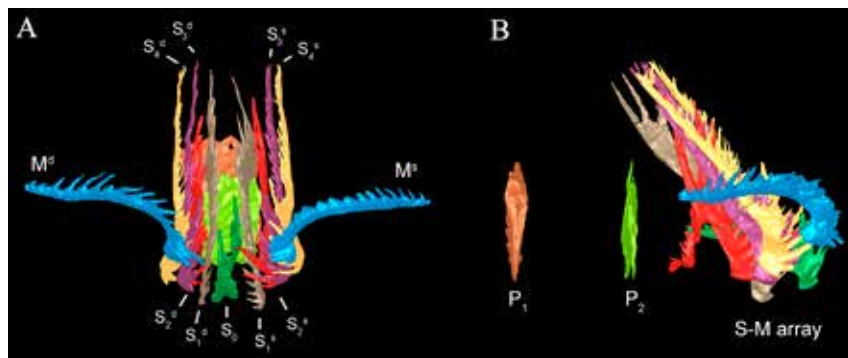


Figure 2. Anatomical notation of *Nicoraella* apparatus. (A) Rostral view of the closed apparatus, S0 element located in the middle, S1-4 and M elements distributed on dextral and sinistral sides of S0 elements. (B) Dextral view of the apparatus, the dextral P1 and P2 elements located rostral to the sinistral elements. Scale bars are 200  $\mu\text{m}$ .

## Acknowledgements

I would like to thank the Palaeontological Association for the Sylvester-Bradley Award (PA-SB201401) that supported my visit to the University of Bristol. I would also like to thank those who facilitated my visit in Bristol: Profs Mike Benton and Philip Donoghue (University of Bristol) and Dr Carlos Martínez-Pérez (University of Valencia).

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## *Postembryonic development of the olenelline trilobites from the Cambrian Series 2 strata of Newfoundland*

**Lukáš Laibl**

*Department of Palaeontology, National Museum (Prague)*

### **Introduction**

Trilobites of the suborder Olenellina were a major component of the Cambrian Series 2 ecosystems and are characterized by the absence of dorsal ecdysial sutures and calcified protaspis stage (Whittington 1989; Palmer and Repina 1993). Post-embryonic development of some members of Olenellina has been studied by various authors (*e.g.* Palmer 1957; Palmer and Halley 1979), most recently and most exhaustively by Webster (2007; 2009; 2015). However, olenelline phylogeny is still far from being effectively resolved, partly because of insufficient knowledge regarding development in many other olenelline species. This project describes post-embryonic development of *Fritzenellus lapworthi* and compares it to other olenelline trilobites. To date, the project results comprise quantitative description of the cephalic development and the discovery of articulated juvenile individuals, and will be submitted to a peer-reviewed journal at the beginning of 2018.

### **Fieldwork, geology and taphonomy**

Juvenile specimens of *F. lapworthi* were collected in lower to middle levels of the Forteau Formation (Cambrian Series 2, Labrador Group) during the 2015–2017 field seasons. In 2015 and 2016, the material was collected by Jörg Maletz and his group. In 2017, additional material was collected by Jörg Maletz and the author. Most of the juveniles come from fine-grained dark-grey shales, and are usually preserved as internal and/or external moulds, sometimes overgrown by secondary calcite. Despite dorso-ventral flattening and fractures due to sediment compaction, no tectonically-related deformation has been recorded in the samples.

### **Development of the cephalon**

The size of *F. lapworthi* cephalon ranges from 0.95 to 25 mm in length and from 1 to 38 mm in



width. Morphologically, the smallest cephala can be assigned to developmental pre-phase 3 of Webster (2015). They are characterized by long intergenal spines, the absence of genal spines, and by indistinct axial furrows. The size of the smallest cephala of *F. lapworthi* is slightly larger than the size of developmentally equivalent cephalo of *Olenellus gilberti*. Slightly larger cephalo (phase 3) have already developed short genal spines, located opposite to the posterior tip of the ocular lobe. Interestingly, the early configuration of intergenal and genal spines differs from that seen in *O. gilberti*, *O. puertoblanconensis*, *O. aff. fowleri*, *Nephrolenellus multinodus* and *N. geniculatus*, and is rather similar to the configuration seen in *Bristolia anteris*, *Elliptocephala asaphoides* and *Holmia kjerulffi* (cf. Størmer 1942; Palmer 1957; Whittington 1957; Palmer and Halley 1979; Webster 2007; 2015). The subsequent morphological changes during the post-embryonic development of *F. lapworthi* (phase 4 and 5) comprises mainly the modification of the cephalic shape from sub-circular to semi-circular, expansion of the frontal lobe of glabella, widening of third glabellar lobe, gradual shortening of intergenal spines and prolongation of genal spines. The morphological development of cephalo of *F. lapworthi* and its comparison with other species is currently prepared for publication (Laibl and Maletz *in prep.*).

### Articulated individuals

In addition to the isolated cephalo, we discovered 15 complete or nearly complete articulated individuals. These individuals are in various stages of their post-embryonic development, from small specimens with five post-cephalic segments up to larger specimens with at least fifteen post-cephalic segments. All articulated individuals show comparatively long macropleural spines. The long axial spine is not developed in specimens with less than 15 post-cephalic segments. This material, although certainly not comprising individuals of each meraspid instar, provides a unique opportunity to compare the cranial development with the ontogeny of segmentation in Olenellina. This has not previously been possible since the majority of olenelline juveniles are known exclusively as disarticulated silicified sclerites.

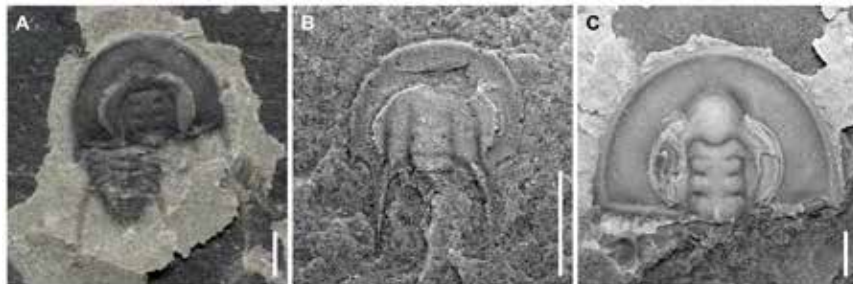


Figure 1. *Fritzolenellus lapworthi*, Forteau Formation, Newfoundland. A, complete meraspid specimen; B, cephalo in phase 3 of development; C, cephalo in early phase 5 of development. Scale bars are 1 mm.

### Acknowledgements

I would like to thank the Palaeontological Association for the Callomon Award (PA-CA201601), as a result of which I could visit the exposures in western Newfoundland and collect new material. I would also like to thank Jörg Maletz, who informed me about juveniles from the Forteau Formation and was my colleague and tutor during our fieldwork of 2017.





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# *Vetulicolian affinities reconsidered through the lens of ecdysozoan anterior organization*

**Martin R. Smith**

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The exceptionally-preserved macrofossils of the Cambrian period have long been considered as evolutionarily puzzling “weird wonders” (Gould 1989). The integration of modern cladistic approaches and developmental data from extant model organisms has played a key role in elucidating the morphology and phylogenetic affinities of such Palaeozoic problematica. Nevertheless, some of these extinct taxa still express seemingly incomprehensible morphologies, leaving their relationships to extant groups hotly contested.

Perhaps the most controversial members of the Cambrian fauna are the vetulicolians: problematic metazoans that occur in many marine fossil Lagerstätten. These peculiar organisms comprise a barrel-shaped anterior body region that somewhat resembles an arthropod carapace, and a prominently segmented paddle-like ‘tail’ (García-Bellido *et al.* 2014). These features were originally taken to establish vetulicolians as limbless arthropods, but the discovery of paired openings on the



anterior body region – usually regarded as gill slits – has prompted an alternative interpretation as deuterostomes (Ou *et al.* 2012), perhaps even with an affinity to the chordate crown group. Although this model has become the status quo in recent years, there are fundamental aspects of the vetulicolian anatomy that have been systematically omitted from these discussions.

Most prominently, the vetulicolian mouth is surrounded by a circlet of sclerotized plates that have been compared with the oral armature of certain ecdysozoans (Briggs *et al.* 2005). The precise arrangement of these elements has been said to contradict this interpretation, which is difficult to reconcile with perceived evidence for a deuterostome affinity (Vinther *et al.* 2011). Recently, however, the detailed analysis of fine morphological data on panarthropods and its incorporation into a robust phylogenetic framework has provided a new paradigm for the anterior organization of the ancestral ecdysozoan (Smith and Caron 2015). Sclerotized circumoral structures, similar to those observed in vetulicolians, are now recognized as an ancestral character that persists in each of the extremely diverse lineages within Ecdysozoa. This new interpretation reinvigorates the possibility of reconciling vetulicolian mouthparts with an ecdysozoan affinity.

Receipt of a PalAss Whittington Award (grant number PA-WA201501) allowed a detailed re-examination of the Burgess Shale vetulicolian *Banffia constricta*, clarifying some of the details that have previously been described (Caron 2006). The mouth of *Banffia* is ringed by three circlets: proximally, a flattened collar containing weak longitudinal joints or plates; medially, a high-relief ring of small subconical teeth; and distally, a ring of broader, elongate teeth with multiple cusps (Figure 1). Notwithstanding taphonomic factors that obscure certain rings in many specimens, there is no evidence that any circlets were invertible; indeed, the rectilinear outline and close packing of teeth in the distal row (Figure 1B) poses a geometric obstacle to any inversion. This is despite substantial variation in the position of the circlets, which seem to have retracted into and protruded beyond the barrel-shaped carapace without any modification to their geometry.

These observations are difficult to reconcile with the common architecture shared by all ecdysozoan mouthparts (Conway Morris 1977; Smith and Caron 2015). With no evidence of an armed introvert or pharynx, the teeth of *Banffia* would necessarily be equated with the circumoral sclerites of the ecdysozoan Zone II. Even then, the particular arrangement of teeth lies beyond the variability observed in ecdysozoans: Zone II elements tend to occur in a single flat ring, and where multiple rings of armature occur, the morphology and spacing of constituent elements is conserved. Moreover, the prominent relief of these elements (Figure 1C) – presumably indicating an originally recalcitrant (?biomineralized) constitution – contrasts with the conspicuously two-dimensional preservation of ecdysozoan oral elements in the Burgess Shale, which are preserved as compressed carbonaceous films associated with late diagenesis.

Taken together, the mouthpart configuration in *Banffia* deviates significantly from the situation exhibited in ‘archaeopriapulids’ and palaeoscolecid, presumed to approximate the ecdysozoan ground plan, and has no clear parallel in any derived ecdysozoan group. Circumoral armature has arisen independently in multiple groups across the animal kingdom (*e.g.* Gastrotricha, Sipuncula); the lack of a detailed correspondence with the situation in any ecdysozoan serves to limit the phylogenetic value of this particular observation.

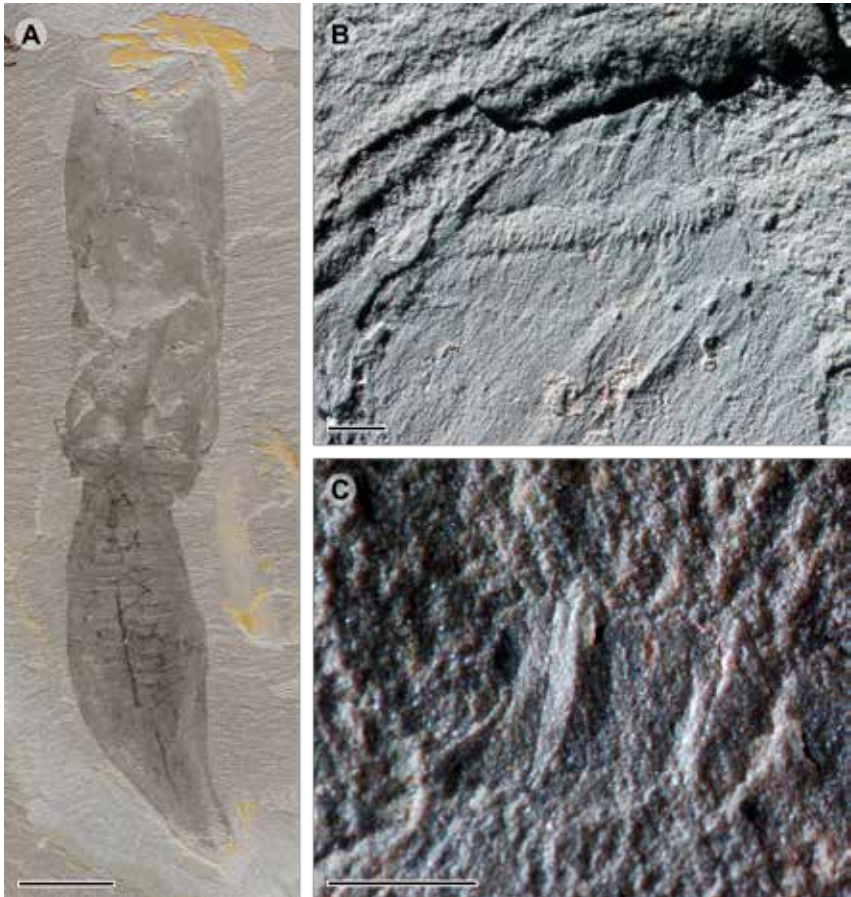


Figure 1. *Banffia constricta* from the Burgess Shale. A, ROM 49888, anterior to top of page; B, ROM 49930, magnification of three circumoral circlites; C, ROM 53640, high-relief tricuspid tooth from distalmost circlite. Scale bars are 10 mm (A) and 1 mm (B, C).

Further gross morphological observations seem to point away from an ecdysozoan affinity. The epidermal segmentation of the *Banffia* tail does not correspond to segmentation of the underlying organ systems (Figure 2A), so seems not to compare well with instances of true segmentation within Ecdysozoa. A ladder-like structure in the anterior trunk (Figure 2B) bears an intriguing, if perhaps superficial, resemblance with the pharyngeal basket of certain deuterostomes.

These observations have been integrated into an inclusive and conservative phylogenetic framework, along with a representative selection of other vetulicolians. Intriguingly, this analysis converges on two equally likely (and equally parsimonious) topologies: one places vetulicolians among the deuterostomes; the other prefers an ecdysozoan position. These results suggest that the long-standing debate regarding the affinities of vetulicolians within Bilateria is well justified – current evidence is insufficient for a decisive classification of these morphologically bizarre organisms.

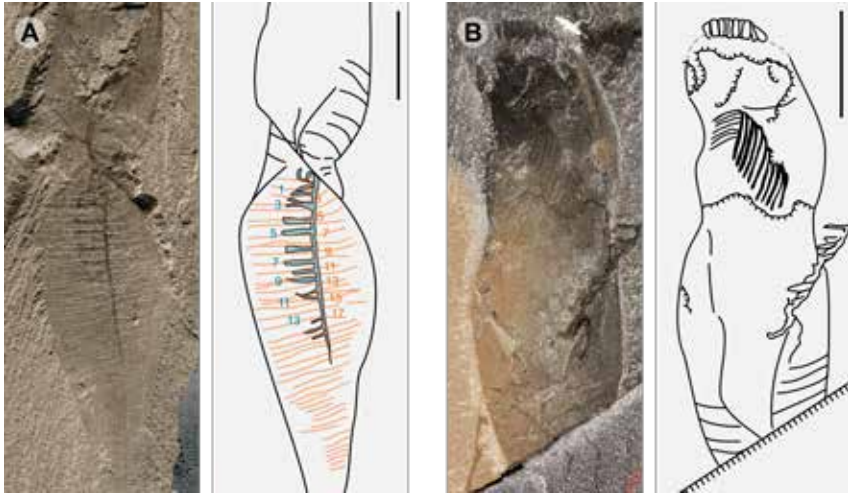


Figure 2. A, ROM 49917, partially decayed specimen showing arched structure with putative semblance to pharyngeal basket of certain deuterostomes; B, ROM 53644, 'gut diverticulae' do not coincide with segment boundaries, demonstrating non-segmental origin. Scale bars are 10 mm.

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# Undergraduate Bursary REPORTS

## *An enigmatic early diapsid from the Late Triassic of England*

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### Introduction

Lepidosaurs today comprise Squamata (lizards, snakes and relatives) and Rhynchocephalia (the tuatara). They originated in the Early Triassic, and diverged into these two groups in the Mid-Late Triassic, approximately 225–200 million years ago. The Rhynchocephalia have an extensive fossil record in the Late Triassic, with prominent morphological diversity and disparity (Jones 2008). However, the earliest fossil records for Squamata are known from the Early Jurassic, though molecular clocks suggest that they originated much earlier than this (Jones *et al.* 2013). Stem group lepidosaurs, such as *Sophinetta* (Evans and Borsuk-Bialynicka 2009) have been well described, but non-rhynchocephalian lepidosaurs from the Late Triassic remain enigmatic.

Obtained from a Late Rhaetian Triassic fissure fill, Cromhall Quarry, Gloucestershire, the specimen held in the Natural History Museum, London is of an unknown taxon, previously mis-identified only as 'other reptile'. It is the partial skull of a lepidosaur with some possible squamate characteristics (Morton *et al.* 2017). The skull (Figure 1) is partially embedded in a red sandy limestone that also contains the fossil remains of several other small reptiles including two clevosaurus and an unidentified basioccipital.



*Figure 1. Light micrograph of the medial view of the left side of the partial skull. Note there is some damage, as well as some disarticulation, and note the breaks to the rostral tip of the maxilla and dentary as well as the missing posterior region of the lower jaw.*



The aim of this summer project was to digitally extract the skull from the rock (Figure 2), and reconstruct the bones as they would have been in life. Despite the incomplete state of the skull, due to the asymmetry of the missing bones I was able to make a partial reconstruction using some duplication. In addition, I took some light photomicroscopy images for use in future description and illustration (e.g. Figure 1).

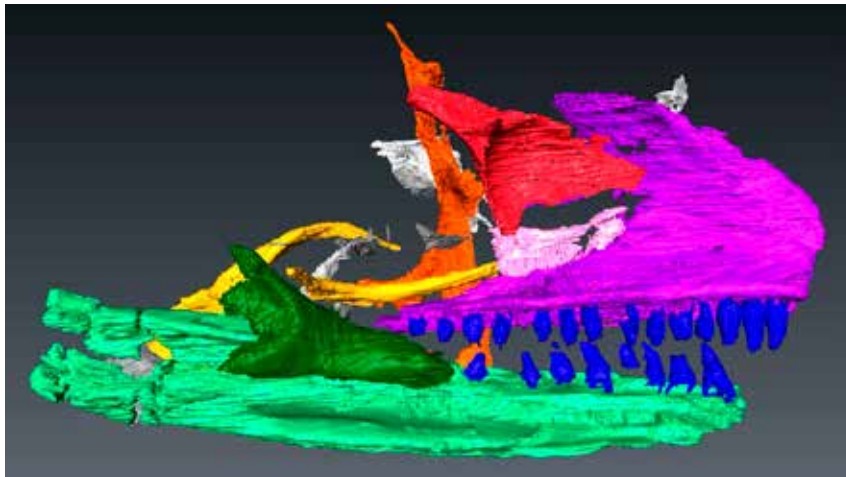


Figure 2. The surface of part of the digitally extracted skull in Avizo.

### The bones of the skull

The partial skull is disarticulated, and appears to be missing all dermal roofing bones. Positively identified bones include two maxillae, a dentary, both premaxillae, a jugal, a prefrontal, a palatine and a vomer and a pterygoid. There are a few other bones that are still unidentified, including a relatively large hollow bone that is potentially a postorbital or jugal, a potential prefrontal possibly fused to a dermal roof bone, a possible septomaxilla, a long narrow “hockey stick-shaped” bone that is a potential squamosal, two possible halves of a quadrate and some small bony fragments.

The skull was scanned in the University of Bristol’s CT-scanner, and the individual bones were segmented with Avizo 8 to create a 3D model (Figure 2). Some of the finer detail was lost in the process, and some of the thinnest portions of bone were not discernible on the scans due to the small size of the skull (the articulated portion is just ~5mm) and the similar density between the bones and rock. The 3D surface was then imported into Blender, where the bones were separated, reoriented, and had the largest fractures fixed. Missing bones that were present on one side of the skull but not the other were duplicated to reconstruct a more complete skull.

### Potential squamate characteristics

There are a number of general characteristics in the skull that would be expected of an early squamate, including:

- the size of the palatines suggests that they meet in the mid line;
- the vomer is relatively large, making it unlikely to be a rhynchocephalian (such as *Gephyrosaurus*);



- the possible squamosal has a shape that is indicative of anguimorphs (a group of squamates currently known from the Middle Jurassic (Evans 2002) onwards);
- the coronoid bone looks to be typically squamate (further analysis is required); and
- teeth are pleurodont. This character is what initially alerted us to the fact that this animal could not be an archosaur.

We have yet to eliminate possible affinities with non-squamate lepidosaurs such as *Marmoretta* Evans, 1991 from the Middle Jurassic of England. Future work on this skull could include cladistics and character analyses, using such approaches as geometric morphometrics. Further fossils, recently identified as potentially belonging to the same taxon, including definite frontal bones, should be assessed as they may prove useful to further reconstruction.

### Acknowledgements

I would like to thank my supervisor Prof. Philip Donoghue and the Palaeontological Association for Undergraduate Research Bursary PA-UB201702.

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## ***Chitinozoan biostratigraphy of the elusive *P. linearis* graptolite biozone in Girvan, Scotland***

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### Introduction

Graptolites of the *Pleurograptus linearis* biozone have long been used to identify the boundary between the Caradoc and Ashgill series of the Ordovician in the UK. This is largely based on observations of these graptolites in the Whitehouse Group of the classic Girvan area in southern



Scotland, where they straddle the Caradoc and Ashgill (C/A) boundary as defined by shelly fauna. However, in the type Cautleyan–Rawtheyan area of northern England, graptolites of the same biozone have been observed to range into the Rawtheyan (upper Ashgill) by Rickards (2002), and would thus be significantly younger. This revised age for the *linearis* zone has not been uniformly accepted, which has created considerable confusion with regard to both the regional and global correlation around the C/A boundary. For instance, the ‘*P. linearis*’ Zone has been suggested as one of the new global ‘Stage Slices’ for the Upper Ordovician (Bergström *et al.* 2009).

We suggest that a large part of the correlation problem is that the index fossil *P. linearis* only occurs sporadically, and that accessory graptolite species are regularly used to identify the biozone. Instead, our main objective here was to use chitinozoan microfossils to correlate the same strata in an independent manner. A pilot study had already demonstrated that chitinozoans occur in the Upper Ordovician and lower Silurian of the Girvan area (Vandenbroucke *et al.* 2003). Here we focus on the chitinozoan biostratigraphy of the Penwhapple Formation of the Whitehouse Group in Girvan, currently unstudied, although this is the only stratigraphic interval in the Girvan district that has yielded *P. linearis* biostratigraphy.

Chitinozoans have been recovered in abundance from the graptolite slabs of the type Cautleyan–Rawtheyan area where a detailed biostratigraphy has been established (Vandenbroucke *et al.* 2005). In addition, the Ashgill chitinozoans from England and Scotland (partly) have a Baltoscandian palaeobiogeographic signature, which suggests the potential to correlate with the recently developed chitinozoan high-resolution biostratigraphy on the island of Bornholm in Denmark (Vandenbroucke *et al.* 2013). In Bornholm, the chitinozoan biozones are tightly calibrated against the recently revised graptolite biostratigraphy.

## Methods

Samples from the Penwhapple Formation and the adjacent units were collected by Thijs Vandenbroucke and Keith Ingham, and processed using standard palynological techniques. Chitinozoans were hand-picked from the resulting organic residue. I used scanning electron microscopy to identify key species. A subset of 26 samples were analysed: 14 from the Penwhapple Formation, two samples from the Mill Formation, four from the Myoch Formation, one from the Three Mile Formation, four from the South Shore Formation and one from the Ardwell Formation. Chitinozoan assemblages were moderately well-preserved and diverse.

## Palaeogeography

The samples yielded a mixed Baltoscandic–Laurentian assemblage. This allows us to correlate between the palaeobiogeographically separate provinces of Baltica and Laurentia. *Lagenochitina baltica*, which has a typical Baltoscandic signature and *Spinachitina bulmani*, typically Laurentian, were both recovered from the Ardwell and the South Shore Formations. Identification of *Armoricochitina reticulifera* in the Penwhapple formation is diagnostic of the eponymous Baltoscandic chitinozoan biozone. *Belonechitina Americana* is present in the Penwhapple Formation and other stratigraphic levels, and has a Laurentian signature.

## Biostratigraphy

The newly exposed chitinozoan assemblages aid in the establishment of an emerging and integrated chitinozoan–graptolite biozonation. *A. reticulifera*, found in the Penwhapple formation, is the





index species of the *A. reticulifera* subzone. This subzone is associated with the *Normalograptus* proliferation interval in the Whitland area of South Wales. The incursion of normalograptids was correlated with the base of the *Pleurograptus linearis* Biozone by Zalasiewicz *et al.* (1995). However, *A. reticulifera* is also known to co-occur with graptolites of the underlying *Dicellograptus morrisi* subzone of the *Dicranograptus clingani* biozone of late Caradoc age in the Cardigan area in South-West Wales and at Dob's Linn, in Scotland (Verniers and Vandenbroucke 2006). *Lagenochitina baltica*, recovered from the Ardwell and South Shore formations, makes its first occurrence in the British Isles in the upper Caradoc of the Onny valley (Vandenbroucke *et al.* 2008) and ranges upwards. Our preliminary data, based on only part of the available samples, clearly illustrate the potential of chitinozoan biostratigraphy to help solve the stratigraphic conundrum. Taken at face value, our initial correlations suggest that the Penwhapple Formation dates to close to the C/A boundary.

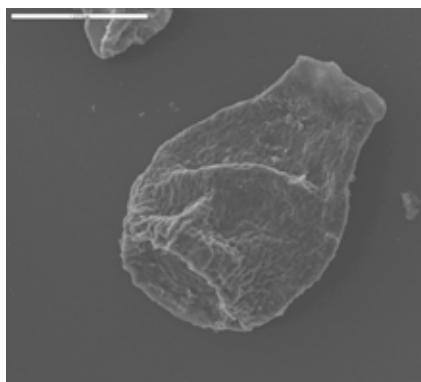


Figure 1. *Armoricochitina reticulifera* (TVDB 07-088, Penwhapple Formation, scale bar is 100 microns).

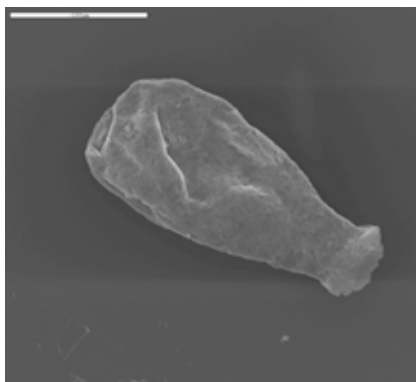


Figure 2. *Lagenochitina baltica* (TVDB 07-081, South Shore Formation, scale bar is 100 microns).

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## *Reconstruction and analysis of a 3D Silurian fossil sponge*

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### **Introduction**

Sponges (Porifera) are traditionally regarded as the most primitive metazoans and may have existed since the Proterozoic (Orlov 1971). The origins and phylogeny of the phylum are controversial, but understanding them is key to interpreting early metazoan evolution. Although sponge paraphyly has been suggested (Sperling *et al.* 2007), the general consensus is that the sponges are a monophyletic group of basal metazoans, and within them the Silicea (classes Hexactinellida and Demospongiae) form a sister clade to Calcarea and Homoscleromorpha (Botting and Muir in press). Understanding of sponge phylogeny derives primarily from molecular evidence, but there is now mounting evidence from the fossil record that has the potential to greatly improve our understanding (*e.g.* Pisera, 2006; Botting and Muir in press).

In this project, I built a 3D reconstruction of a new sponge representing a new genus and species that will be named in a forthcoming publication. Specimens were studied using synchrotron X-ray tomography and physical-optical tomography (see Sutton *et al.* 2014). The specimens originate from the Silurian Herefordshire Lagerstätte (Briggs *et al.* 1996), which has an exceptional reputation for preserving three-dimensional soft-morphology of fossils. The sponge spicules are curious; they were apparently calcareous in mineralogy and are hexactines (6-rayed forms). This combination does not occur in living sponges, in which hexactines are restricted to the Hexactinellids, and are always siliceous in mineralogy. Hexactines have been reported in diverse early sponges (*e.g.* Botting and Butterfield 2005; Harvey 2010), but while some have previously been reported as being calcareous in composition (*e.g.* Sdzuy 1969; Ding and Qian 1988) these claims have been disputed; they may have been biminerallitic (with siliceous cores), or have been taphonomically replaced with calcite. In addition to the mineralogy, I studied the preserved soft tissue to determine what implications it has for the ancestral state of the poriferan aquiferous system, and how it contributes to the phylogenetic debate.



## Description

The proposed holotype (Figure 1A, D-H), is a complete specimen reconstructed from synchrotron data; most of the description is based on this specimen. The body is thin-walled and ovoid, with a regular orthogonal reticulate network of calcareous hexactine spicules arranged in a single layer. Sizes range from a few mm in length to a maximum length estimated to be 13-14 mm. The osculum (Figure 1G) is a central subcircular opening at the top of the sponge, with a maximum diameter of 1.4 mm which sinks to a depth of 0.3 mm. The root tapers gradually to form a rounded, obtuse termination.

The spicules are of one size order with rays arranged at 90° to each other. Spicule spacing is ~500 µm in the centre of the body, with lateral rays having a mean diameter of ~100 µm. The spicules' spacing tightens towards both the top and the bottom of the sponge, with the rays fining in diameter. The lateral rays of spicules appear unfused with those of adjacent spicules. The reticulation corners consistently alternate between spicule bosses and points where lateral rays overlap or converge, *i.e.* spicules are set in a quincuncial array. Tracing spicule columns vertically, we identify points of trifurcation – here spicules can be rotated by angles of up to 40° as the

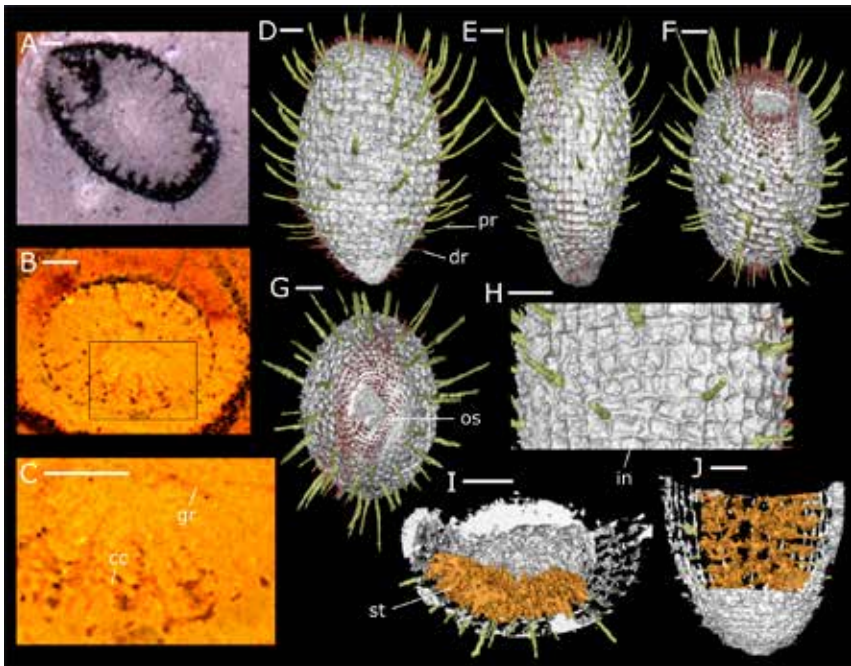


Figure 1. Specimens of the new sponge (A-C) with their virtual reconstructions (D-I). (A, D-H) proposed holotype, complete specimen reconstructed from synchrotron data; (A) anterior view, (D) right lateral view, (E) oblique view, (F) view of osculum, (G) view of spicule network. (B-C, I-J) Additional specimen, partially reconstructed through physical-optical tomography; (B) transverse section from physical-tomography data, (C) close-up of internal structures, (I, J) transverse and upright views, respectively, of the virtual model. Abbreviations: cc = choanocyte chamber, dr = smaller distal ray, os = osculum, pr = prostalia, st = soft tissue. All scale bars are 1 mm.



network is 'disturbed', accommodating increased spicule numbers towards the centre of the sponge by introducing a new pair of spicule columns (Figure 1H).

Elongate prostaia ('spines') reach up to 3.3 mm out from the body, and are 200  $\mu\text{m}$  in diameter. They are sub-evenly distributed over the body, curving upwards. Smaller spines are borne by all spicules that do not have prostaia; these are typically  $\sim 600$   $\mu\text{m}$  in length and 50  $\mu\text{m}$  in diameter. The top of the sponge bears numerous shorter distal rays which are not limited to the oscular margin.

Internal structures are known from a second specimen (Figure 1B-C,I-J), analyzed through physical-optical tomography. Gastral rays of spicules protrude into the central cavity (Figure 1B, C); the longest arise from the spicules with prostaia and are  $\sim 100$   $\mu\text{m}$  in diameter and between 1.5–1.8 mm in length. They are not curved. Smaller gastral rays arise from spicules with smaller distal rays and are  $\sim 50$   $\mu\text{m}$  in diameter. Sections of imperisistently-preserved soft tissue adhere to these rays forming 'platforms' with a thickness of 1 mm, that have quadrate gaps reflecting spicule reticulation. Filter-feeding 'choanocyte' chambers are visible within the tissue as clusters of sub-spherical sediment-filled structures with a mean diameter of  $\sim 117$   $\mu\text{m}$ , frequently connected to each other by gaps in their walls. This arrangement suggests a relatively 'advanced' sylleibid- to leuconoid-like aquiferous system.

## Discussion

We are still in the process of preparing a manuscript fully analyzing the significance of this new species, but it is already clear that it provides important new data. It belongs within the paraphyletic order Reticulosa. Its spicules are certainly primarily calcareous, but we are still investigating whether they might be biminerallic with a siliceous core (as in the Cambrian *Lenica*, Botting *et al.* 2012); elemental mapping work should soon clarify this point. If we show that the spicules were not biminerallic (as seems likely), then this is likely a stem-group Silicean that has independently swapped silica for calcite; it would show a plasticity of mineralogy that has not hitherto been documented.

Additionally, the presence of a relatively complex aquiferous system in an early-branching sponge is not compatible with traditional assumptions of simplicity in early poriferans. If our species is a stem-group silicean, it might support the theories in which leuconoid systems are ancestral for Silicea (Burton 1963). More likely, however, it should be taken as support for the position of Voigt *et al.* (2011) – that complex aquiferous systems probably evolved many times, and were present by the early Palaeozoic.

## Acknowledgements

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# Does a taxonomic identification bias affect diversity analyses on dinosaurs?

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## Introduction

Prehistoric life is not always recorded reliably in the fossil record. Preservational and sampling biases exist and must be recognized if biodiversity in the past is to be understood fully. Among those that have been identified and corrected for via the use of data standardization methods, but not yet investigated (to our knowledge), is a taxonomic identification bias. This bias is rooted in the potential for certain taxa to be more readily identified due to the higher likelihood of preservation of the bones on which their autapomorphies, or diagnostic characteristics, are present. This could be an important trend, as identified taxa are more likely to be scientifically described and stored in databases, for example the Paleobiology Database (PBDB; <[www.paleobiodb.org](http://www.paleobiodb.org)>), which serves as a key data reserve for a great number of biodiversity studies. This study aims to investigate whether such a bias exists among the theropod dinosaurs in the Upper Jurassic Morrison Formation of the western United States. The Formation was deposited by fluvial systems along channels and flood plains 155–145 million years ago. A great deal of attention was given to the Morrison after the discovery of its abundant dinosaurian fauna during the late 19th century (Turner and Peterson 2004). *Allosaurus* is clearly the most well-known and best-described of the eleven theropod genera found in the Morrison (Figure 1), with just over 68% of theropod remains belonging to this taxon (PBDB, accessed February 2017). My project attempted to test the hypothesis that the high abundance of *Allosaurus* is because it is more readily identified than other Morrison theropod taxa, as its autapomorphies occur on skeletal parts more likely to be preserved in the fossil record.

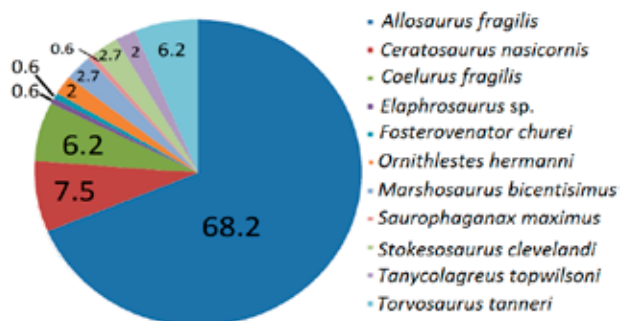


Figure 1. Percentage distribution of the Morrison Formation theropods.

## Methodology

Using the PBDB, the theropods that have been described in the Morrison Formation were noted (a total of 11 taxa) along with the number of individuals discovered. From this, the percentage distribution of the theropods could be attained (Total number of theropod specimens/Number of x specimens = Overall percentage representation in Morrison Formation). The abundance percentages (%Abd) were the constant factor against which all other variables were ranked and correlated. Both the number of autapomorphies that enable the identity of each taxon and the



osteological position of these were required. These data were acquired by searching for the most recent diagnoses of the theropods in question in the published literature, as shown in Table 1.

Taxon	Source Cited
<i>Allosaurus fragilis</i>	Madsen 1976, Chure 2001
<i>Ceratosaurus nasicornis</i>	Marsh 1884, Rauhut 2003
<i>Coelurus fragilis</i>	Carpenter <i>et al.</i> 2005a
<i>Elaphrosaurus sp.</i>	Rauhut 2003
<i>Fosterovenator churei</i>	Dalman 2014
<i>Marshosaurus bicentisimus</i>	Madsen 1976
<i>Ornitholestes hermanni</i>	Rauhut 2003
<i>Saurophaganax maximus</i>	Chure 1995
<i>Stokesosaurus clevelandi</i>	Madsen 1974, Benson 2008
<i>Tanycolagreus topwilsoni</i>	Carpenter <i>et al.</i> 2005b
<i>Torvosaurus tanneri</i>	Britt 1991

**Table 1. Literature from where data on the autapomorphies for each theropod were collected.**

Research by Aslan and Behrensmeyer (1996) into the nature of bone transport within fluvial environments was examined in order to attain an understanding of any noteworthy patterns or traits exhibited by certain body elements, so any important information could be applied to this investigation. It was presumed that the most fragile and the lightest skeletal parts (*e.g.* teeth, metacarpals, phalanges) would be the most likely to be transported away from their original deposition site, whilst the largest and more dense parts (*e.g.* femur, humerus, ischium) would remain unaffected. After the number and locations of autapomorphies had been identified for each taxon, these were ranked in order of preservation potential, from 1 (least likely; delicate/light skeletal part) to 5 (most likely; dense/robust elements), as shown in Table 2. This method was adapted from previous research into the nature of bone transport and the effects of water abrasion on bone fragments in a fluvial setting (see Fernández-Jalvo and Andrews 2003; Fiorillo 1991).

Group No.	Skeletal Elements
1	Skull, lower jaw, teeth, osteoderms, phalanges
2	Vertebra, carpals, tarsals
3	Ribs, scapula, ilium, sternum
4	Radius, ulna, fibula, metapodials
5	Humerus, femur, tibia, pubis, ischium

**Table 2. Elements ranked 1-5 by preservation potential.**

A method was then established by which a likelihood of preservation (LoP) potential for each taxon could be calculated, being the sum of autapomorphy numbers in each group multiplied by the specific group number, *e.g.* *Allosaurus* = G1[2], G2[1], G3[0], G4[0], G5[1], or  $1 \times 2 = 2$ ,  $2 \times 1 = 2$ ,  $5 \times 1 = 5$ , therefore  $LoP = 2 + 2 + 5 = 9$ . This was done in order to identify which skeletal parts (and therefore autapomorphies) are the least or most likely to survive in the environment for the fossilization



process to commence. If the diagnostic autapomorphies of a certain taxon are found on the elements least likely to become fossilized, it therefore becomes more likely that discovered bones belonging to that taxon will not be assigned correctly, if at all.

In order to allow for the presence of size bias in the Morrison fossil record to be tested, it was important to include body mass as a factor. The hypothesis proposed was that the remains of the larger taxa would have been more resistant to weathering and dispersion prior to fossilization than those of the smaller ones. If this were the case it would then be represented in the fossil record in the higher abundance of fossilized skeletal elements of larger animals, causing the Morrison fossil record to show a bias against the smaller animals. Tibial and femoral lengths were also recorded as a more direct representation of theropod body sizes. The body mass estimates and femoral/tibial lengths were obtained from Benson *et al.* 2014. Regarding a statistical analysis test for these data, the most suitable choice was Spearman's Rank, allowing for non-parametric datasets to be correlated through the use of a ranking system replacing the data values. The testing was conducted using Excel and the coding program R. It should be noted that not all data for every taxon were available, as shown in Table 3. Consequently these were excluded from covariance test(s), as one dataset cannot be ranked against another with a value of 0% Abd. LoP was also conducted as two separate tests, firstly with the LoP groups being counted individually, then with the values in groups 1-3 and 4-5 being combined.

Taxon	Absent data
<i>Elaphrosaurus</i> sp.	Tibial Length
<i>Fosterovenator churei</i>	Body Mass / Femoral Length / Tibial Length
<i>Marshosaurus bicentisimus</i>	Body Mass / Femoral Length / Tibial Length
<i>Ornitholestes hermanni</i>	Femoral Length
<i>Stokesosaurus clevelandi</i>	Body Mass / Femoral Length / Tibial Length

**Table 3. Examples of missing data from various taxa.**

## Results and discussion

Overall, the results of the correlation tests indicated a weak positive correlation between abundance and the likelihood of preservation, although not statistically significant. There is no relationship between any of the body size estimates and abundance. Analysis of the data when displayed on a bivariate plot reveal that the *Allosaurus* data were wholly responsible for driving this positive trend. This is further highlighted when the *Allosaurus* data are removed from the dataset, where no correlation between %Abd or LoP can be seen. This indicates that there is no taxonomic identification bias affecting Morrison theropods; the hypothesis that *Allosaurus* is more common due to its autapomorphies existing on bones that are more likely to be preserved, is false. The statistical analysis also showed no correlation with body size, so large size is not the reason for the abundance of *Allosaurus* either. This suggests that *Allosaurus* was more abundant in the Jurassic landscape than the other theropods, and the argument can be made that *Allosaurus* was the most successful predator in this prehistoric environment. The palaeoenvironment of the Morrison is thought to have been similar to the current-day African savanna (Turner and Peterson 2004) and I propose that *Allosaurus* fulfilled the role of a top predator, reminiscent of African lions in the present, with the lesser theropods adopting niches that allowed them to survive alongside *Allosaurus*, quite possibly as scavengers, similar to vulture species or hyena in some instances.





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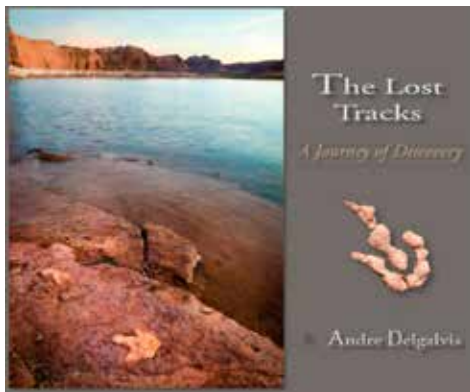


# Book Reviews

## The Lost Tracks: A Journey of Discovery

Andre Delgalvis, 2015, 160 pp., Studio 2138 LLC; 1st edition, US\$30.

Every cloud has its silver lining ... or, to rephrase for this particular case, a dearth of rain clouds can yield positive fruits in the desert. In 2003, the southwestern United States was gripped in a drought that had many folks worried about having enough water. Often the images that provoked the most anxiety were those of reservoir levels rapidly falling. The 'bathtub ring' discoloration of the rocks around reservoirs like Lake Powell resulted in a striking visual contrast that everyone, from climate scientists to school children, could appreciate. As the waters crept lower in Lake Powell, rocks that had been hidden since the construction of the Glen Canyon Dam in 1963 emerged on the shoreline.



Enter the intrepid photographer, Andre Delgalvis, Susan, his wife and their houseboat, the *Diana Marie*, into the drama. During a photography trip around the noticeably depleted reservoir, the couple saw something unusual on a rock just above the waterline. Delgalvis was intrigued by several impressions on the slab and in a casual remark to his wife observed that they might be dinosaur tracks. A photograph taken later in the day (when the light was at a lower angle) strengthened their conviction that they had stumbled across something exciting. Thus, began a quest of discovery that spanned several years and, eventually, included the expertise of noted trackway researcher, Martin Lockley.

In some ways, the deck was stacked in Delgalvis' favour when it came to the discovery of these remarkable sites. Glen Canyon National Recreation Area (encompassing Lake Powell and the surrounding landscape) protects one of the largest surface exposures of Mesozoic rocks in the National Park Service (Graham 2016). The latest-Triassic to Jurassic-aged rock units where the tracks were found – the Wingate Sandstone, the Kayenta Formation, and the Navajo Sandstone – span a range of terrestrial environments from fluvial systems characterized by braided and meandering streams to aeolian sand dunes. The combination of the right period of geologic time and appropriate depositional environment resulted in the existence of dinosaur footprints being firmly in the realm of possibility for the area. The fact that dinosaur footprints had previously been observed and described in Glen Canyon National Recreation Area (Riggs 1904; Stokes 1978; Lockley *et al.* 1998; Santucci 2000) elevated possibility to probability. Delgalvis' work is of note, not just for the discovery of his first track site, but for the rigour and energy with which he followed up the



initial find. Due in part to Delgalvis' persistence in exploring the shores of Lake Powell, the number of known dinosaur tracksites from Glen Canyon National Recreation Area jumped from thirty-six (Lockley *et al.* 1998) to over 110 sites (Lockley *et al.* 2014) over the course of about fifteen years. The results of Delgalvis' years of exploration of the track sites are published both in *The Lost Tracks* and more rigorously, in a recent paper in the *New Mexico Museum of Natural History and Science Bulletin* (Lockley *et al.* 2014).

Delgalvis captured his adventures in dinosaur tracking around the shores of Lake Powell in an abundance of striking and often haunting photographs. The presentation style of the book – a photo essay accentuated by short, simply written, and informative paragraphs – holds the reader's attention. Delgalvis expertly communicates information garnered from his conversations with Lockley and carefully walks the reader through the geological context of the track sites, the dominant ichnotypes of the area, the different ways in which dinosaur tracks can be preserved, how scientists document and describe dinosaur tracks, and some of the more exciting individual discoveries along the shores of Lake Powell.

The most useful part of the book for me as a postgraduate in the early stages of studying ichnology was a section titled *The Art of Seeing* which contained a series of unenhanced photographs that invited readers to discover the tracks on their own. This particular exercise helped train my eye to the subtleties that a dinosaur tracker needs to be on the lookout for in the field. I have also found this section useful in demonstrating to my non-scientist friends what I actually do when I am in the field. The rare criticisms I have about the book arise chiefly from the fact that I am not a member of the book's primary audience – the general public. I would have loved a little bit more technical detail in Delgalvis' discussion of how he determines which of his discoveries constitute 'definite' footprints. I wish that more photographs had included some sort of scale so that the size of track could be more easily appreciated. However, *The Lost Tracks* wasn't intended to be a palaeontology reference and certainly was not written to sit on a shelf in the so-called ivory tower of academia. The book exists to be shared, widely, among non-specialists, and, in this context, is hard to top.

Ultimately, *The Lost Tracks* makes an ideal coffee-table fixture for a palaeontologist's abode. The beautiful photographs and simple language of the text can appeal to the casual visitor looking to kill a few minutes. The exuberance of exploration and excitement that permeates the book can uplift the palaeontologist on slow days. In *A Study in Scarlet*, Sir Arthur Conan Doyle remarks in the persona of Sherlock Holmes, "There is no branch of detective science which is so important and so much neglected as the art of tracing footsteps." The sheer number of footprints in the fossil record validates their importance in our 'detective' work. However, through the efforts of both professionals and dedicated amateurs, like Delgalvis, this art can no longer be described as neglected.

**Paige dePolo**

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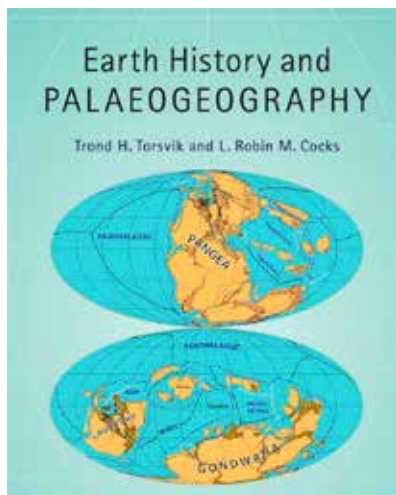
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### Earth History and Palaeogeography

Torsvik, T.H. and Cocks, L.R.M., 2016. Cambridge University Press. £49.99. ISBN: 9781107105324.

Perhaps surprisingly, the science of palaeogeography is often rather under-appreciated by many palaeontologists. It has become increasingly easy to access excellent and well-illustrated palaeogeographic reconstructions of any time period in Earth History for use in papers or books. While this is welcome, it does perhaps lead to a situation where it's easy to not fully appreciate or question the data behind how these reconstructions are produced, or how accurate they may be. *Earth History and Palaeogeography* provides an excellent and thought-provoking introduction to the science behind palaeogeographic reconstructions, and the often surprising links between tectonic and biotic evolution of our planet.

Following a brief introduction, the book contains a technical but well-illustrated review of plate tectonic theory and methods for the reconstruction of past plate distributions and the supercontinent cycle. This is probably the most challenging part of the book for a non-specialist, written in a rather dense and technical style with much discussion of deep-earth geophysical techniques which are not necessarily part of the average palaeontologist's repertoire. It is however, fascinating, and made me appreciate how much of a knowledge gap I had in this area of our science. This chapter, and indeed the whole book, contains a multitude of excellent (if sometimes very technical) illustrations. The following chapter introduces the tectonic units used to construct palaeogeographies, and serves as a kind of index to the remainder of the book. This represents an astonishing amount of data synthesis, and really drives home the point of how complicated the crustal evolution of our planet has been.





Having set the scene, Cocks and Torsvik then proceed in Chapters 4 to 16 to describe, discuss and present evidence for global palaeogeographical reconstructions in chronological order from the Precambrian to the present day. The Precambrian chapter is by necessity a rather broad-brush overview, discussing the origin of plate tectonics on the early Earth, the importance of zircons for providing a snapshot of conditions during this time, the supercontinent cycle, and the origin of life. Each Phanerozoic chapter is divided into several sections, starting with an overview of tectonics and igneous activity for each major crustal region (e.g. Gondwana) and oceans, and evidence for the evolution of tectonics in these regions through time. A second section focuses on facies and faunal evidence from the same cratonic regions which bolster the interpretations from the more 'hard rock' data.

The Paleozoic chapters emphasize the use of marine (and later, terrestrial) fossils in delineating not only past continental distribution but also climatic conditions, whilst during the Mesozoic and Cenozoic other proxies such as geochemical data rather than simply faunal distributions become increasingly more important. The final chapter provides a broad overview of climate evolution and the relation of this to palaeogeographic changes through time, and is an excellent synthesis.

The only drawback to the book is that some of the CGI illustrations and reconstructions are a little out of place alongside the more technical figures, and I found some of the facts and figures provided in the fauna and facies sections to be a little outdated. This is perhaps inevitable in such a broad overview and while not exactly a coffee table book, *Earth History and Palaeogeography* is an excellent reference source for anyone wishing to get a handle on the technical side of palaeogeographic reconstruction and crustal evolution without having to access the often daunting primary literature. It is a worthy addition to any palaeontologist's bookshelf.

**James Witts**

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### **The sauropod dinosaurs: Life in the age of giants**

Matt Wedel and Mark Hallett, 2016, Johns Hopkins University Press, 320 pages, £26.65, ISBN:978-1-4214-2028-8

What are sauropods? How did they get so big? How did their physiology work, especially as they were so huge? What did they eat? What did the world look like with these giants in it? Did any predators dare to attack them?

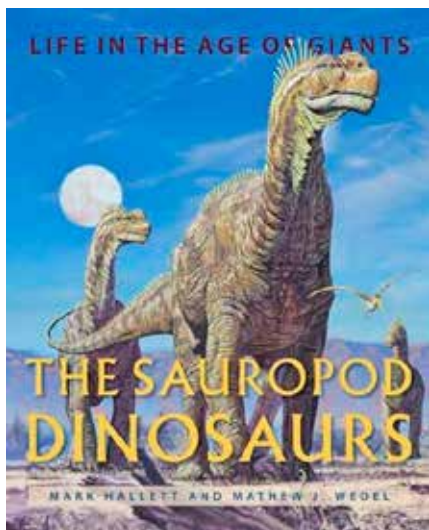
These are some, but certainly not all, of the questions answered in this new book, written by sauropod palaeontologist Matt Wedel and beautifully illustrated by Mark Hallett. With 320 pages, it is a book full of information that will assist both professional and lay palaeontologists with handy (background) information on everything sauropod. However, it may also serve dinosaur and sauropod enthusiasts who want a bit more information than the conventional dinosaur textbook.

The book is divided into twelve chapters, each with a specific theme, all of which are quite up to date with the latest sauropod research. Examples are: the origin of sauropods and the transition from sauropodomorphs to sauropods, sauropod physiology, and the demands of gigantism on the body of a terrestrial animal, the sauropod phylogenetic tree and major groups, the vegetation they



would have been feeding on, and sauropod reproduction, to name but a few.

Especially impressive is the extensive artwork, including some classic pieces by Hallett from the 1980s. These show not just the sauropods reconstructed in their palaeoenvironment (with possible frills and neck flaps), or even sauropod reproduction, but also the internal anatomy, with every bone of the skeleton faithfully reproduced, every muscle, blood vessel, organ, and even the neural system. This, together with the sauropod phylogenetic review (including a quick 'how to' on building a phylogenetic tree), is extremely useful and helpful for sauropod palaeontologists who need a quick answer for that one anatomical element they are studying, or those who need a quick précis for a particular sauropod group. For phylogeny enthusiasts there might not be enough cladistics here, but the overview works very well for the purposes of background information.



Another interesting feature is inclusion of the latest, state-of-the-art work techniques that are employed by sauropod researchers, for example, CT scanning of skulls for biomechanics and feeding mechanisms, 3D reconstructions rendered from photogrammetry and/or CT scans of sauropod feet and limbs to figure out stance and weight load. Highlighting the research conducted using these techniques really brings sauropods back to life and demonstrates the progressive nature that sauropod workers are adopting. The result of this is to create a more lucid understanding of gigantism in general, in the present and the past.

Finally, many pages have small tidbits of information inserted throughout and separate from the main text. This makes the book a pleasure to idly leaf through and undoubtedly a more accessible source of information for non-palaeontologists who may be intimidated by the lengthier and more detailed blocks of text. The fantastic illustrations help greatly with this with, for example, the sauropod size and diversity being nicely illustrated through comparisons to elephants and whales, immense beasts that even a child is familiar with. Though certainly not written for children I can see a child picking up this book and leafing through the pages in awe at the artwork of these titanic animals. If it appeals to a child it will certainly appeal to the discerning dinosaur palaeontologist.

The only real technical point of tension that sauropod workers could potentially have is the monophyletic grouping of the cetiosaurs. The authors meant to show that the inter-relationships of most basal (eu)sauropods are still not fully resolved, and much more work is necessary on this group. To avoid over-complicating matters, the cetiosaurs are created as a sort of waste-bin group. However, recent studies are showing that in reality, the 'cetiosaurs' have much more complex phylogenetic relationships (see for instance Wilson and Upchurch 2009).

This brings up one other (small) flaw: the missing, elusive Middle Jurassic. It is understandable,



as sauropod fossils from this particular slice of time are not well known; however, it is also an important time in sauropod evolution. Recent work from (especially) Argentina gives substantially more insight into the sauropod world of the Middle Jurassic (see for instance Escapa *et al.* 2008).

These are minor flaws, however, as the sauropod world of the Late Jurassic and especially the Cretaceous get ample room in this book. Overall, many sauropod experts and enthusiasts alike can benefit from the information available in this work.

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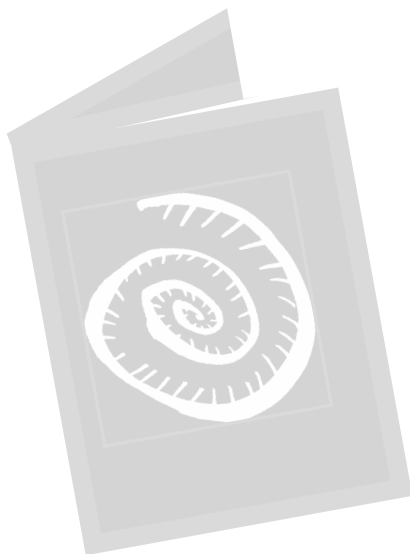
# Books available to review

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.

- *The White River Badlands: Geology and Palaeontology*, by Rachel C. Benton, Dennis O. Terry Jr., Emmett Evanoff and H. Gregory McDonald.
- *Acrocanthosaurus inside and out*, by Kenneth Carpenter.
- *Dinosaur Tracks: The next steps*, by Peter L. Falkingham, Daniel Marty and Annette Richter.
- *Terrestrial Conservation Lagerstätten: windows into the evolution of life on land*, by Nicholas Fraser and Hans-Dieter Sues (eds).
- *The Tyrannosaur Chronicles*, by David Hone.
- *Phylogenomic data acquisition: Principles and approaches*, by W. Bryan Jennings.
- *Dinosaurs: The textbook*. (6th Edition), by Spencer G. Lucas.
- *The Princeton Field Guide to Prehistoric animals*, by Donald R. Prothero.
- *Integrated Molecular Evolution*, by Scott. O. Rogers.
- *Die fossilen Brachiopoden der Schweiz* (2nd Edition), by Heinz Sulser.
- *The Cambrian Fossils of Chengjiang, China: the flowering of early animal life*, by Hou Xianguang, Richard J. Aldridge, Jan Bergstrom, David J. Siveter, Derek J. Siveter, Xiang-Hong Feng.

## Dr Tom Challands

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# Careering off course!

## *Inspirational palaeontologists*

**Rhys Charles**

*Education officer and Consultant*

*Bristol Dinosaur Project and the Bristol City Museum*



*Rhys Charles has an MSc in Palaeontology and Evolution. He was a founding member and president of the University of Bristol Palaeontology Society – DinoSoc. His job and interests revolve around science communication in palaeontology.*

---

### **Why did you become interested in studying palaeontology?**

I've been interested in palaeontology from a very young age, as I think is the case for most people in the field. The more I went through education, through school and sixth form, the more I liked it and the more convinced I became that it was the career path I wanted.

### **How did you start your role as an educator and promoting palaeontology to the general public?**

I started through my work with both the Museum and *DinoSoc*. I volunteered my society to take part in the geology public outreach day event *Bristol Rocks* at the Museum back in 2014. We used a room filled with fossils, which

the public could handle, and we acted as the experts, explaining to the visitors what the fossils were and answering their palaeontology questions. I discovered that I thoroughly enjoyed doing it and started volunteering at more events like it, in the Museum and beyond. Then, after a year of communicating animal science to the public as a Zoo Ranger, giving talks and animal feeds, I was keen to return to my roots in palaeontology, so when the Bristol Dinosaur Project position opened up, I jumped at it.

### **What are the most important skills in your job?**

The most important and most challenging aspect is being able to communicate the more



complex science ideas without losing any of the fun. People love dinosaurs and palaeontology because of what they can see, there are amazing things to look at. But when you start getting deeper into the technical details, many people switch off. The key is to explain these ideas step by step, in language that is easy to digest and with relatable and interactive content, in a way that still accurately reflects the latest advances in the science.

**And the more challenging aspects of your job?**

Being in charge of a large group of children roaring like dinosaurs on a Friday afternoon can be somewhat of a unique challenge!

**As a curator/researcher and educator, what do you think is the best way to transfer knowledge from the collections to the public?**

The most effective way to transfer knowledge is through handling collections. People are used to going to museums and seeing the fossils behind glass, but you give them even a small piece of the real thing and they become very interested and take in a lot more information. One of our most popular specimens is a fragment of an *Iguanodon* femur, and people absolutely love getting to touch a real dinosaur. Simple things like the weight of the fossil act as a great way to communicate ideas such as fossilization too.

A very important thing is then to use the easy gateway of dinosaurs to hopefully get children started along a career path in the sciences. All kids love dinosaurs, and through their love of them they might some day discover their love of physics from looking at sauropods, or the chemistry of fossilization, or even just that they really get a kick out of one genus of Cambrian algae.

**What is the most exciting part in your job in the Bristol Dinosaur Project?**

The most exciting part is getting involved in big projects. Recently we teamed up with Bristol Zoo during summer 2017 to help out with their “DinoMania” event, featuring many full-sized animatronic dinosaurs which the visiting public loved. To live the dream job of effectively being a ‘Dinosaur Handler’ is certainly an exciting thing.

**How do you see the future of your work in engaging with the general public?**

The future will definitely involve expanding the workshops, designing and trying out new activities for the children to take part in, going to more big public events to expand our reach. In the short term, there are many little jobs that need doing, such as caring for and hopefully growing our own little handling collection to make sure the children always have new and exciting fossils to see.


**Adrian Paramo Blasquez**  
*Universidad Autónoma Madrid*

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Bristol Dinosaur Project: <<http://www.thebristoldinosaurproject.org.uk/>>

Bristol City Museum: <<https://www.bristolmuseums.org.uk/bristol-museum-and-art-gallery/>>

 @bristolmuseum

 <<https://www.facebook.com/BristolMuseumandArtGallery>>

YouTube: <<https://www.youtube.com/channel/UCpTTINGDoN4Gjwfls5fDSWQ>>



# Palaeontology

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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 Maria McNamara, e-mail <[newsletter@palass.org](mailto:newsletter@palass.org)>. The *Newsletter* is prepared by Nick Stroud, and printed by Y Lolfa, Talybont, Ceredigion.

Deadline for copy for Issue No. 97 is 12th February 2018.

## Palaeontological Association on the Internet

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 R. T. Spencer can be reached by e-mail at <[webmaster@palass.org](mailto:webmaster@palass.org)>. The locator is <<http://www.palass.org/>>.

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

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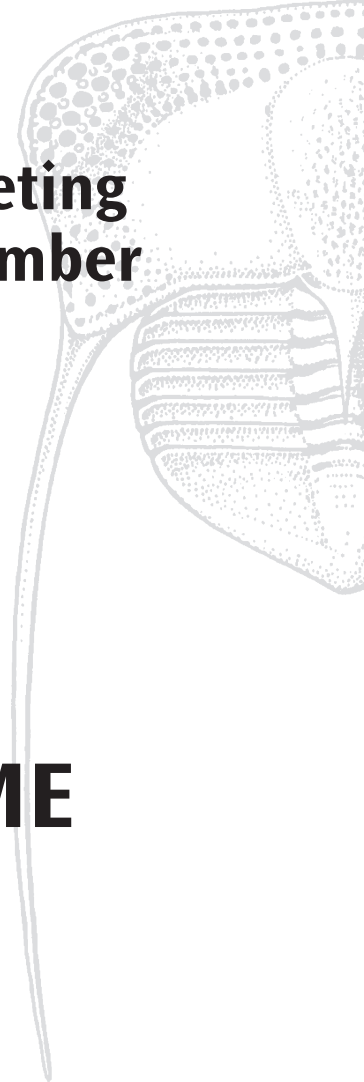


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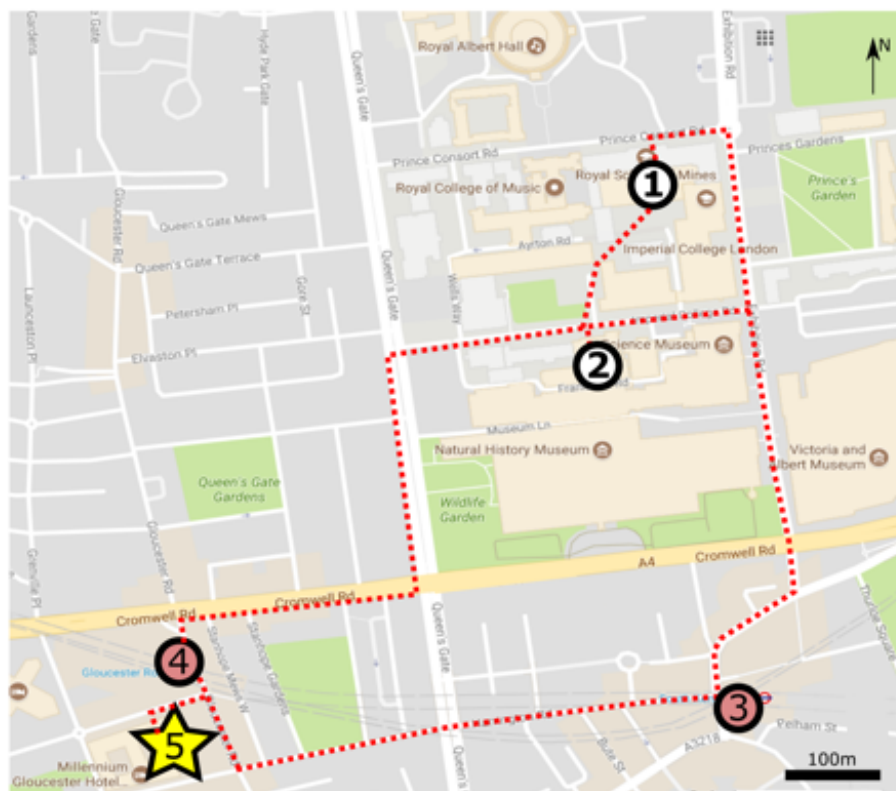
**61st Annual Meeting  
17th–20th December  
2017**

***Imperial College  
London***

**PROGRAMME**



# SOUTH KENSINGTON AREA MAP



## MAIN VENUES

- ① Royal School of Mines (RSM)
- ② Sir Alexander Fleming (SAF)

★ Millennium Hotel for Annual Dinner

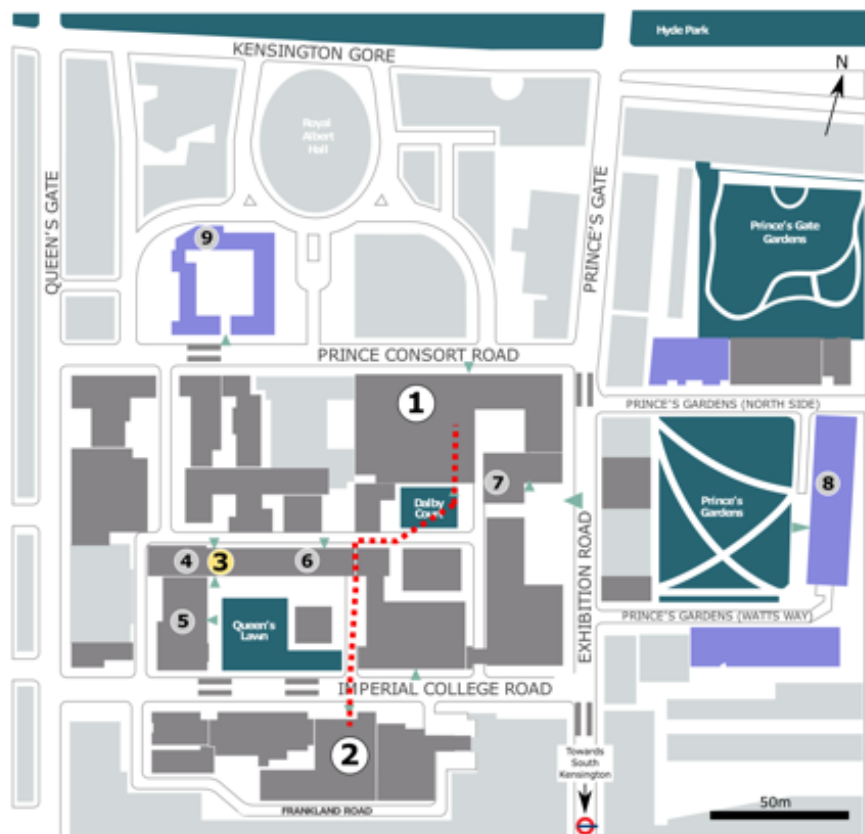
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- ③ South Kensington
- ④ Gloucester Road

## MISCELLANEOUS

⋯ Pedestrian route

# IMPERIAL COLLEGE CAMPUS MAP



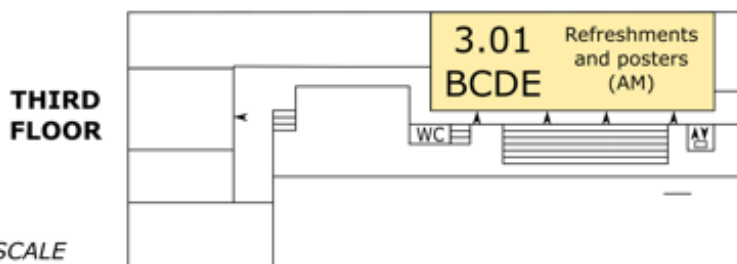
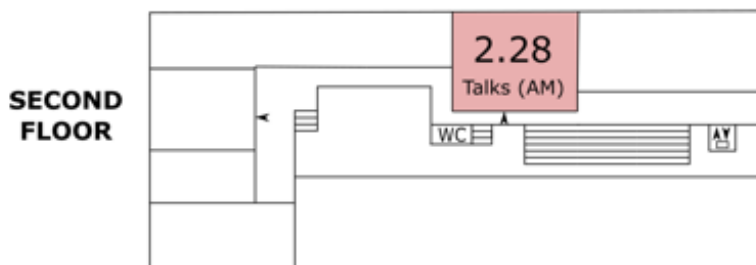
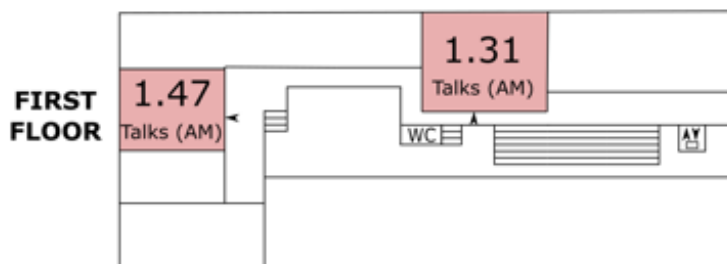
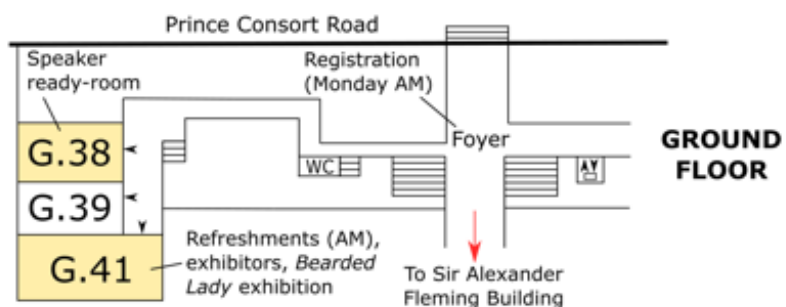
## MAIN VENUES

- 1** Royal School of Mines (RSM)
- 2** Sir Alexander Fleming (SAF)
- 3** Queen's Tower Rooms (Icebreaker)
- Best route RSM to SAF
- Entrance

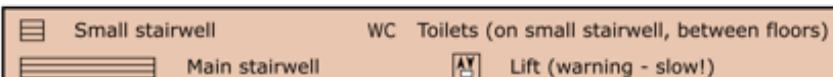
## SERVING LUNCH

- 4** H bar
- 5** Library Café
- 6** Senior Common Room
- 7** College Café
- 8** Eastside Bar
- 9** Union Bar

# ROYAL SCHOOL OF MINES MAP



NOT TO SCALE





# The Palaeontological Association

## 61st Annual Meeting

### 17th–19th December 2017

#### Imperial College London

The programme for the 61st Annual Meeting of the Palaeontological Association is provided after the following summary of the Meeting. An abstract booklet including details of the AGM will be distributed at the Meeting.

#### Venue

The meeting will take place at the South Kensington Campus of Imperial College, London; see maps on previous pages for details. Further details of the venue and transport advice are provided on the Association website.

#### Natural History Museum collections

The meeting will take place adjacent to London's Natural History Museum, and we are aware that delegates may see this as an opportunity to visit the Museum collections. Please be aware that the Museum curators expect to be very busy in this period, and will not be able to grant ad-hoc access to collections during the meeting. Requests for access should be made four weeks in advance to the relevant curator, and will be granted on a first-come first-served basis.

#### Oral presentations

All speakers (apart from the Symposium speakers) have been allocated either a **15 minute** or a **10 minute** slot. Most 15 minute talks take place in parallel sessions, while 10 minute talks take place in front of all delegates. If allocated a **15 minute** talk slot you should present for 12 minutes to allow time for questions and switching between speakers. If allocated a **10 minute** slot, you should likewise present for 8 minutes. All lecture theatres have a digital projector linked to a large screen. All presentations should be in PowerPoint or PDF format. They should be submitted on a memory stick (by hand) to your session chair *at least 15 minutes* before the session you are taking part in begins. You are strongly advised to check your presentation on the Imperial College system before delivering it; this is particularly relevant for Mac-based presentations as Imperial College uses Windows PCs. A ready-room in the Royal School of Mines building (RSM G.38) will be provided for speakers to test their talks.

#### Poster presentations

Individual posters will be on display for only a single day of the meeting. Each has been allocated (alphabetically) to either Group A (Monday) or Group B (Tuesday); please find your poster in the abstract list below to determine your group. To ensure that posters are at all times in proximity to the delegates, they will be on display in the Royal School of Mines building in the morning, and the Sir Alexander Fleming building in the afternoon. You will have the choice of (a) bringing two copies of your poster, one for each venue, (b) moving your poster yourself during the lunch-break (less than



5 minutes walk), or (c) leaving us to move your poster for you (the default). Please consider which option you prefer; we will be in touch by email to determine your choice.

Poster boards will accommodate an A0-sized poster presented in PORTRAIT FORMAT ONLY. Materials to affix your poster to the boards will be available at the meeting. Presenters are responsible for taking their own posters down at the end of the day's sessions. Posters not recovered by their presenters by 7pm on Monday or 6pm on Tuesday will be taken down by meeting organisers, and we cannot guarantee that they will be returned to their owners.

#### **Travel grants to student members**

Students who have been awarded a PalAss travel grant should see the Executive Officer, Dr Jo Hellawell (e-mail <[executive@palass.org](mailto:executive@palass.org)>) to receive their reimbursement.



## *Summary of Schedule*

### **Sunday 17th December: Registration, Symposium and Reception**

Registration will open at 12.30 in the foyer of the Sir Alexander Fleming Building.

The Annual Meeting will begin with a welcome at 13.30 in Lecture Theatre G.16 of the Sir Alexander Fleming Building, followed by the Symposium *Evolutionary modelling in palaeontology*.

Following the Symposium there will be an icebreaker reception at 18.00 in the Queen's Tower Rooms, less than five minutes' walk from the Sir Alexander Fleming Building.

### **Monday 18th December: Conference, AGM, Annual Address and Dinner**

Registration will open at 08.00 in the foyer of the Royal School of Mines Building.

The conference will commence at 09.00 with a full day of talks and posters. The morning sessions are held in parallel, in rooms 2.28, 1.47 and 1.31 (Royal School of Mines building). During the break, delegates can either view the posters in room 3.01 BCDE (Royal School of Mines Building), or visit the exhibitors and the *Bearded Lady* art exhibition in G.41 (Royal School of Mines Building). Both rooms will serve refreshments.

The afternoon sessions are not parallel, and will commence at 13.45 in Lecture Theatre G.16 (Sir Alexander Fleming Building). The first session comprises ten shorter (10 minute) talks. During the break, posters, exhibitors, refreshments and the *Raising Horizons* art exhibition will all be available adjacent to the lecture theatre.

The Association Annual General Meeting commences at 17.00, and the Annual Address at 17.30, both in Lecture Theatre G.16 (Sir Alexander Fleming Building).

The Annual Dinner takes place at the Millennium Hotel, Gloucester Road, less than 15 minutes' walk from the Imperial College Campus. It will commence with a drinks reception at 19:00.

### **Tuesday 19th December: Conference and Prizes**

The Conference programme will proceed as on the previous day, although posters will be rotated so a new set will be available to view.

Talks will end by 17.00, when the Conference will close with the award of the President's Prize and the Council Poster Prize, presentations by the organizing committees of upcoming meetings, and concluding remarks.

### **Wednesday 20th December: Post-Conference Field-trips**

Field-trips to Down House and the Isle of Sheppey will depart from the Royal School of Mines at 08.00 and 07.30 respectively. Please see the Association website for further details.



**Meeting support**

The organizers of the Annual Meeting gratefully acknowledge the support of the following sponsors and exhibitors:

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# Schedule of events and timetable of presentations

Underlined author denotes designated speaker.

\* denotes eligibility for President's Prize or Council Poster Prize.

## Sunday 17th December

### REGISTRATION

12.30 – 18.00 Foyer, Sir Alexander Fleming Building

### *Symposium “Evolutionary Modelling In Palaeontology”*

G.16, Sir Alexander Fleming Building Chair: Paul Smith

13.30 – 13.45 **Welcome Address**

13.45 – 14.15 **Journeys through discrete character morphospace**

Graeme Lloyd

14.15 – 14.45 **How different is reality from mathematical perfection in taxonomy?**

Julia Sigwart

14.45 – 15.15 **Using evolutionary models to assess the accuracy of phylogenies estimated with Bayesian, Maximum-Likelihood, and Parsimony methods**

Mark Puttick, Joseph O'Reilly, Davide Pisani and Phil Donoghue

15.15 – 15.45 Break and Refreshments

15.45 – 16.15 **Simulating evolution in space and time**

Russell Garwood, Mark Sutton, Chris Knight, Guillaume Gomez and Alan Spencer

16.15 – 16.45 **Slicing the stratigraphic cake: the effects of time subsample variation in disparity-through-time analysis**

Natalie Cooper and Thomas Guillerme

16.45 – 17.15 **Evolution and Earth Systems: modeling population-level processes on palaeontological scales**

P. David Polly

17.15 – 17.45 **Modelling biotic interactions using data from the fossil record**

Lee Hsiang Liow

### *Reception*

Queen's Tower Rooms, Sherfield Building

18.00 – 20.00 Icebreaker Reception and *Bearded Lady* Exhibition



## Monday 18th December

### *Conference, Association AGM, Annual Address, and Annual Dinner*

#### REGISTRATION

08.00 – 13.00 Foyer, Royal School of Mines Building

13.15 – 18.00 Foyer, Sir Alexander Fleming Building

#### POSTERS

08.00 – 09.00 Poster group A – setup in Royal School of Mines

09.00 – 12.45 Poster group A on display in Royal School of Mines, Room RSM 3.01 BCDE

12.45 – 13.45 Poster group A – move from Royal School of Mines to Sir Alexander Fleming

13.45 – 17.00 Poster group A on display in Sir Alexander Fleming Foyer

#### Session 1A (in parallel with sessions 1B and 1C)

1.31, Royal School of Mines Chair: Nick Butterfield

09.00 – 09.15 **A 3.77 (or possibly 4.28) billion year history of microbial communities associated with marine hydrothermal vents**  
Crispin Little

09.15 – 09.30 **Life at the end of the Boring Billion: microfossil record from the c. 1 Ga Bylot Supergroup, Arctic Canada**  
\*Heda Agic, Susannah M. Porter, Sarah Wörndle, Timothy M. Gibson, Peter W. Crockford, Malcolm S.W. Hodgskiss, Marcus Kunzmann and Galen P. Halverson

09.30 – 09.45 **Substrate relationships and biomineralization of an Ediacaran encrusting poriferan**  
Rachel Wood and \*Amelia Penny

09.45 – 10.00 **Evolution of complex life: Late Neoproterozoic co-divergence of bilaterians and their gut microbiota**  
Joanna Wolfe

10.00 – 10.15 **Colonies, clones and modularity: a new view of Ediacaran fronds**  
Alex Liu, Frances Dunn, Charlotte Kenchington and Philip Wilby

10.15 – 10.30 **What were the Ediacaran biota? Answers from the Chengjiang Lagerstätte**  
Jennifer Hoyal Cuthill and Jian Han

10.30 – 10.45 **A mineralogical signature for Burgess Shale-type preservation**  
\*Ross P. Anderson, Nicholas J. Tosca, Robert R. Gaines, Nicolás Mongiardino Koch and Derek E. G. Briggs

**Session 1B (in parallel with sessions 1A and 1C)**

2.28, Royal School of Mines Chair: Richard Butler

09.00 – 09.15 **A ‘reptilian’ mode of reproduction in pterosaurs and its implications for pterosaur palaeobiology**

David Unwin

09.15 – 09.30 **Scotland’s Jurassic Park: new dinosaurs, crocodylomorphs, pterosaurs, and fishes from the Middle Jurassic of Skye**

Stephen Brusatte, Thomas J. Challands, Neil D.L. Clark, Paige de Polo, Davide Foffa, Nicholas C. Fraser, Mojirayo Ogunkanmi, Elsa Panciroli, Dugald A. Ross, Stig Walsh, Mark Wilkinson and Mark T. Young

09.30 – 09.45 **The ‘pliable’ nature of the phylogenetic relationships within early ornithopods**

Daniel Madzia and Clint A. Boyd

09.45 – 10.00 **High diversity of small dinosaurs preceding the Cretaceous- Paleogene (K-Pg) mass extinction**

Nicholas Longrich

10.00 – 10.15 **Mosaicism, development, and the early evolution of birds**

Ryan Felice and Anjali Goswami

10.15 – 10.30 **The multiple origins of powered flight among paravian theropod dinosaurs: constraints from new phylogenetic, aerodynamic and anatomical data**

Michael Pittman, Rui Pei, Pablo A. Goloboff, Thomas A. Dececchi, Mark A. Norell, Thomas G. Kaye, Hans C.E. Larsson, Michael B. Habib, Stephen L. Brusatte and Xing Xu

10.30 – 10.45 **Newly discovered complete skull of *Ichthyornis* reveals unforeseen mosaicism late in the dinosaur-bird transition**

\*Daniel Field, Michael Hanson and Bhart-Anjan Bhullar

**Session 1C (in parallel with sessions 1A and 1B)**

1.47, Royal School of Mines Chair: Margaret Collinson

09.00 – 09.15 **Tracking genome size variation in a 407 million year old plant**

Zuzanna Wawrzyniak and Paul Kenrick

09.15 – 09.30 **Assessing changes in leaf morphology in *Ginkgo biloba* and their suitability to act as a palaeoclimate proxy**

Karen Bacon and Claire Belcher

09.30 – 09.45 **Stomata, carbon isotopes and past CO<sub>2</sub> reconstruction: a critical comparison of fossil plant-based CO<sub>2</sub> proxy models and methods**

Jennifer McElwain, Amanda Porter, Charilaos Yiotis, Christianna Evans-Fitzgerald and Isabel Montañez



- 09.45 – 10.00 **Fossil plant cuticles may track SO<sub>2</sub> pollution during LIP volcanisms - implications for understanding mass extinctions**  
Margret Steinhorsdottir, Caroline Elliott-Kingston and Karen L. Bacon
- 10.00 – 10.15 **The Tournaisian recovery of terrestrial vegetation following the end Devonian mass extinction**  
\*Emma Reeves, John Marshall, Carys Bennett, Sarah Davies, Timothy Kearsey, David Millward, Timothy Smithson and Jennifer Clack
- 10.15 – 10.30 **Insights into the taphonomy of *Weichselia reticulata***  
\*Candela Blanco, Hugo Martín-Abad, Bernard Gomez and Ángela D. Buscalioni
- 10.30 – 10.45 **The importance of microenvironment in determining the roles of early diverging fungi in early terrestrial ecosystems**  
Christine Strullu-Derrien, Paul Kenrick and Tomasz Goral
- 10.45 – 11.15 BREAK – Refreshments available in *two* rooms:  
Royal School of Mines G.41: Refreshments, Exhibitors, *Bearded Lady* exhibition  
Royal School of Mines 3.01 BCDE: Refreshments, Poster Group A

#### Session 2A (in parallel with sessions 2B and 2C)

- 1.31, Royal School of Mines Chair: Derek Briggs
- 11.15 – 11.30 **Cambrian weird wonders and the origin of ctenophores**  
Jakob Vinther, Zhao Yang, Peiyun Cong, Luke Parry, Davide Pisani and Gregory D. Edgecombe
- 11.30 – 11.45 **Naked chancelloriids from the lower Cambrian of China: evidence for sponge-type growth**  
P.-Y. Cong, T.H.P Harvey, M. Williams, D.J. Siveter, D.J. Siveter, S.E. Gabbott, Y.-J. Li, F. Wei and X.-G. Hou
- 11.45 – 12.00 **Helcionelloid molluscs from Cambrian Series 2, Stages 3-4 of East Antarctica and outline morphometric approaches to taxonomy of problematica**  
Thomas Claybourn, Iliam Jackson, Lars Holmer, Christian Skovsted, Tim Topper and Glenn Brock
- 12.00 – 12.15 **Three-dimensional priapulid trace fossils from the early Cambrian (Series 2, Stage 4) of Sweden**  
Giannis Kesidis, Graham Budd and Sören Jensen
- 12.15 – 12.30 **The earliest evidence of metazoan symbiosis**  
Xiaoya Ma, Peiyun Cong, Mark Williams, David Siveter, Derek Siveter, Sarah Gabbott, Dayou Zhai, Tomasz Goral, Gregory Edgecombe and Xianguang Hou
- 12.30 – 12.45 **An Early Ordovician somasteroid from Morocco reveals the origin of crown-group Echinodermata**  
Aaron Hunter and Javier Ortega-Hernández

**Session 2B (in parallel with sessions 2A and 2C)**

2.28, Royal School of Mines Chair: Michael Benton

- 11.15 – 11.30 **The Middle Devonian Kačák Event: its identification and effects in Northern Spain**  
\*[Alexander Askew](#) and Charles Wellman
- 11.30 – 11.45 **Climate change and rates of crocodylomorph body size evolution**  
\*[Maximilian Stockdale](#) and Michael Benton
- 11.45 – 12.00 **Faunal response to sea level and environmental change in the Jurassic Sundance Seaway, western United States: a stratigraphic palaeobiological approach**  
[Silvia Danise](#) and Steven Holland
- 12.00 – 12.15 **The ecological consequences of extinctions: from giant sharks to small mollusks**  
[Catalina Pimiento](#), John Griffin, Daniele Silvestro, Alexandre Antonelli and Carlos Jaramillo
- 12.15 – 12.30 **The Estuary Effect and the origin of lake faunas: critical linkages between global tectonics, sea level and biodiversity**  
[Lisa Park Boush](#), Andrew Bush, Michael Hren, Gary Motz and Timothy Astrop
- 12.30 – 12.45 **A minimum population extinction time driven by stochastic environmental forcing**  
[Christopher Spalding](#), Charles Doering and Glenn Flierl

**Session 2C (in parallel with sessions 2A and 2B)**

1.47, Royal School of Mines Chair: Anjali Goswami

- 11.15 – 11.30 **An enigmatic amphibian from the Early Cretaceous of Japan**  
[Susan Evans](#) and Ryoko Matsumoto
- 11.30 – 11.45 **High-dimensional geometric morphometric approach to understanding skull shape evolution in squamates**  
[Akinobu Watanabe](#), Ryan Felice, Jessica Maisano, Johannes Müller, Anthony Herrel and Anjali Goswami
- 11.45 – 12.00 **A new chroniosuchian (non-amniotic tetrapod) from Laos revealed by micro-CT scanning: anatomy and palaeobiology**  
\*[Thomas Arbez](#), Christian Sidor and Jean-Sébastien Steyer
- 12.00 – 12.15 **A bizarre early tetrapod from the Early Permian of Kansas, USA, provides further support for radical polyphyly of 'lepospondyls'**  
\*[Jason Pardo](#), Aja Carter, Lauren C. Sallan and Jason S. Anderson
- 12.15 – 12.30 **Sampling biases constrain interpretation of the fossil records of non-marine lepidosaurs and turtles**  
\*[Terri Cleary](#)



12.30 – 12.45 **Increased disparity in Therapsida coincides with emergence of novel ecologies: Cistecephalidae (Therapsida:Anomodontia) as a case study**

\*[Jacqueline Lungmus](#) and Kenneth Angielczyk

12.45 – 13.45 LUNCH BREAK – Packed lunches available from Royal School of Mines, G.41  
See maps for locations of cafeterias on campus

### Session 3

G.16, Sir Alexander Fleming Building Chair: Mark Sutton

13.45 – 13.55 **Oxygen minimum zones in the early Cambrian ocean**

[Romain Guilbaud](#), Ben J. Slater, Simon W. Poulton, Thomas H.P. Harvey, Jochen J. Brocks, Benjamin J. Nettersheim and Nicholas J. Butterfield

13.55 – 14.05 **Coupling palaeoclimate data and numerical climate models to constrain Cambrian palaeogeography**

\*[Thomas Hearing](#), Alexandre Pohl, Mark Williams, Thomas Harvey and Yannick Donnadieu

14.05 – 14.15 **Carbon characterization in the Sirius Passet Biota and a geothermal gradient through Cambrian Lagerstätten**

[Timothy Topper](#), Francesco Greco, Axel Hofmann, Andrew Beeby, Zhifei Zhang and David Harper

14.15 – 14.25 **Experimental modelling of sedimentary processes for the Burgess Shale: implications for the transport and preservation of soft-bodied organisms**

\*[Orla Bath Enright](#), Nic Minter, Esther Sumner, Gabriela Mángano and Luis Buatois

14.25 – 14.35 **Burgess Shale fossils reveal the ancestral state of annelid nervous systems**

\*[Luke Parry](#) and Jean Bernard Caron

14.35 – 14.45 **Dietary ecology of pterosaurs from quantitative 3D textural analysis of tooth microwear**

\*[Jordan Bestwick](#), David Unwin, Richard Butler, Don Henderson and Mark Purnell

14.45 – 14.55 **Hidden diversity of small theropods from the Bathonian (Middle Jurassic) of the UK**

\*[Simon Wills](#), Charlie J. Underwood and Paul M. Barrett

14.55 – 15.05 **Approaching sexual dimorphism in non-avian dinosaurs and other extinct taxa**

\*[Evan Saitta](#), Maximilian Stockdale, Vincent Bonhomme, Michael Benton, Nicholas Longrich, Innes Cuthill

15.05 – 15.15 **Phylogenetic position of a new Late Cretaceous duck-billed dinosaur (Hadrosauroidea) from the Dorotea Formation, Chilean Southern Patagonia**

\*[Alexis Jujihara](#), Sergio Soto-Acuña, Wolfgang Stinnesbeck, Alvaro Zúñiga-Reinoso, Penélope Cruzado-Caballero, Alexander O. Vargas, Marcelo Leppe, Hector Mansilla, David Rubilar-Rogers, Jhonatan Alarcón-Muñoz, Manfred Vogt and Eberhard Frey



15.15 – 15.25 **Integrating genomic and fossil evidence to date the tree of life**

\*[Holly Betts](#), Mark N. Puttick, Tom A. Williams, Philip C. J. Donoghue and  
Davide Pisani

15.25 – 16.00 BREAK

Posters (group A), exhibitors, refreshments and the *Raising Horizons* exhibition will  
all be available in the Foyer of the Sir Alexander Fleming Building

#### Session 4

G.16, Sir Alexander Fleming Building Chair: Phil Donoghue

16.00 – 16.15 **The environmental context of early animal evolution**

[Erik Sperling](#), Una Farrell and the SGP Collaborative Team  
(<https://sites.stanford.edu/sgp/>)

16.15 – 16.30 **Geobiology and palaeogenomics: genes that make rocks**

[David Bottjer](#)

16.30 – 16.45 **Reconciling the commonality of long-term stasis in the fossil record and the  
rare detectability of stabilizing selection in extant biota**

[Bert Van Bocxlaer](#)

16.45 – 17.00 **The “push of the past”: an important bias in the fossil record**

[Graham Budd](#) and Richard Mann

## Annual General Meeting of the Palaeontological Association

G.16, Sir Alexander Fleming Building

17.00 – 17.30 Annual General Meeting

## Palaeontological Association Annual Address (sponsored by Wiley)

G.16, Sir Alexander Fleming Building

17.30 – 18.30 **101 uses for a dead fish. Experimental decay, exceptional preservation, and  
fossils of soft bodied organisms**

Professor Mark Purnell, University of Leicester

## Palaeontological Association Annual Dinner

Millennium Hotel, Gloucester Road

19.00 – 23.30 Drinks Reception and Annual Dinner



## Tuesday 19th December

### CONFERENCE AND PRIZES

#### POSTERS

- 08.00 – 09.00 Poster group B – setup in Royal School of Mines
- 09.00 – 12.45 Poster group B on display in Royal School of Mines, Room RSM 3.01 BCDE
- 12.45 – 13.45 Poster group B – move from Royal School of Mines to Sir Alexander Fleming
- 13.15 – 17.00 Poster group B on display in Sir Alexander Fleming Foyer

#### Session 5A (in parallel with sessions 5B and 5C)

1.31, Royal School of Mines Chair: Greg Edgecombe

- 09.00 – 09.15 **Asymmetry of paired endites on frontal appendages in Amplectobeluidae (Radiodonta: stem Euarthropoda) and its taxonomic significance**  
Peiyun Cong, Gregory Edgecombe, Allison Daley and Xianguang Hou
- 09.15 – 09.30 **Diversity and disparity of USA Radiodonta**  
\*Stephen Pates and Allison C. Daley
- 09.30 – 09.45 **Punctualistic disparity patterns and step-wise body plan canalization in euarthropods**  
\*Cedric Aria
- 09.45 – 10.00 **Molecular clocks on Chelicerata recover monophyly of mites and arachnids and suggest an early colonization of land**  
Jesus Lozano-Fernandez, Alastair R. Tanner, Jakob Vinther, Gregory D. Edgecombe and Davide Pisani
- 10.00 – 10.15 **The central nervous system of Trilobitomorpha – taphonomy, morphology and evolutionary implications**  
Javier Ortega-Hernandez
- 10.15 – 10.30 **A total-evidence approach to resolving pancrustacean phylogeny**  
Albert Chen, Davide Pisani, Jesus Lozano-Fernandez, David Legg and Jakob Vinther
- 10.30 – 10.45 **Trilobite evolutionary faunas**  
Jonathan Adrain

#### Session 5B (in parallel with sessions 5A and 5C)

2.28, Royal School of Mines Chair: Paul Taylor

- 09.00 – 09.15 **Brachiomatic: automated measurement of brachiopod size using new museum collections digitization protocols**  
Rachel Belben, Kenneth Johnson, Zoë Hughes, Chris Hughes and Richard Twitchett





- 09.15 – 09.30 **Accounting for differences in species frequency distributions when calculating beta diversity in the fossil record**  
Neil Brocklehurst, Michael Day and Jörg Fröbisch
- 09.30 – 09.45 **The murky history of Cenozoic coral reefs in the “Coral Triangle”**  
Kenneth Johnson, Nadia Santodomingo and Brian Rosen
- 09.45 – 10.00 **Differences in extinction rates explain contrasting regional diversity patterns in modern tropical bryozoans**  
Emanuela Di Martino, Jeremy B.C. Jackson, Paul D. Taylor and Kenneth G. Johnson
- 10.00 – 10.15 **Species discovery and changing taxon concepts in Cenozoic molluscs - after 50+ years what does revision of a popular handbook tell us?**  
Jonathan Todd and Kenneth Johnson
- 10.15 – 10.30 **New record of an abundant ammonite assemblage from the latest Cretaceous Corsicana Formation, Brazos River, Texas. Implications for the Cretaceous–Paleogene (K–Pg) mass extinction event in the Gulf of Mexico**  
James Witts, Neil Landman, Matthew Garb, Nicolas Thibault, David Jones, Ekaterina Larina and Thomas Yancey
- 10.30 – 10.45 **New insights on the correlation of Permo-Triassic terrestrial faunas of South Africa with those of European Russia**  
Michael O. Day, Fernando Abdala, Valeriy K. Golubev, Andrey G. Sennikov and Bruce S. Rubidge

#### Session 5C (in parallel with sessions 5A and 5B)

1.47, Royal School of Mines Chair: Zerina Johanson

- 09.00 – 09.15 **The first functional analysis of the lateral line system in fossil fish**  
Tom Challands, Mark Naylor and Stephen Brusatte
- 09.15 – 09.30 **Skull development and biomechanics in the coelacanth *Latimeria*; implications for fossil coelacanths and fossil lobe-finned fishes**  
Hugo Dutel, Peter J. Watson and Michael J. Fagan
- 09.30 – 09.45 **The evolution of acellular bone in teleosts: structure-function relationship in fish bone histology**  
Donald Davesne, François J. Meunier, Olga Otero, Matt Friedman and Roger B.J. Benson
- 09.45 – 10.00 **Tooth replacement and tooth resorption mechanisms in Osteichthyes**  
Martin Ruecklin, Phillip C.J. Donoghue, Kate Trinajstic, John A. Cunningham and Floortje P.C. Mossou
- 10.00 – 10.15 **A new ray-finned fish from the late Devonian: fresh insights into the rise of actinopterygians**  
Sam Giles, Stephanie Pierce and Matt Friedman



- 10.15 – 10.30 **A chondrichthyan-like shoulder girdle in an “acanthodian” helps tease apart early chondrichthyan relationships**  
\*[Richard Dearden](#), Jan den Blaauwen, Carole Burrow, Mike Newman, Bob Davidson and Martin Brazeau
- 10.30 – 10.45 **Patterns of morphological evolution in Pelagia (Teleostei: Acanthomorpha) consistent with ancient adaptive radiation**  
\*[Hermione Beckett](#), Zerina Johanson, Sam Giles and Matt Friedman
- 10.45 – 11.15 BREAK – Refreshments available in *two* rooms:  
Royal School of Mines G.41: Refreshments, Exhibitors, *Bearded Lady* exhibition  
Royal School of Mines 3.01 BCDE: Refreshments, Poster Group B

**Session 6A (in parallel with sessions 6B and 6C)**

1.31, Royal School of Mines Chair: David Harper

- 11.15 – 11.30 **Breathing life into an extinct sea scorpion: revealing the gill structure of a three-dimensionally preserved eurypterid through MicroCT scanning**  
[James Lamsdell](#), Victoria McCoy and Melanie Hopkins
- 11.30 – 11.45 **The Downton Bonebed: insights into a lost world**  
\*[Luke Hauser](#)
- 11.45 – 12.00 **Rotten livers, muscles and guts: controls on exceptional preservation of internal organs**  
\*[Thomas Clements](#), Mark Purnell and Sarah Gabbott
- 12.00 – 12.15 **The end-Ordovician Anji Biota (Zhejiang, China) and a wider Hirnantian sponge mega-community**  
[Joseph Peter Botting](#), Lucy A. Muir, Yuandong Zhang and Wenhui Wang
- 12.15 – 12.30 **Biom mineralization of Palaeozoic sponges and aragonite-calcite seas**  
[Uwe Balthasar](#), S Kershaw, A.C Da Silva, B. Seuss, M. Cusack, K. Eichenseer and P. Chung
- 12.30 – 12.45 **Phylogenomic analysis of Brachiopoda and Phoronida: implications for morphological evolution, biomineralization, and the Cambrian radiation**  
[Aodhan Dermot Butler](#), Michael Eitel, Gert Wörheide, Sandra J. Carlson and Erik A. Sperling

**Session 6B (in parallel with sessions 6A and 6C)**

2.28, Royal School of Mines Chair: Christine Janis

- 11.15 – 11.30 **Long-term mammalian stable isotope record across the Great American Biotic Interchange**  
[Laura Domingo](#), Rodrigo L. Tomassini, Claudia I. Montalvo and Paul L. Koch
- 11.30 – 11.45 **The influence of cranial biomechanics on the evolution of the mammalian jaw joint and definitive mammalian middle ear**  
[Emily Rayfield](#), Stephan Lautenschlager, Pamela Gill, Zhe-Xi Luo and Michael Fagan



11.45 – 12.00 **Evolutionary adaptation to aquatic lifestyles can lead to systemic alteration of bone structure**

Eli Amson, Guillaume Billet and Christian de Muizon

12.00 – 12.15 **A model for marine reptile taphonomy in the Late Jurassic Slottsmøya Member Lagerstätte**

\*Lene L. Deltett, Aubrey J. Roberts, Patrick S. Druckenmiller and Jørn H. Hurum

12.15 – 12.30 **First virtual endocasts of fossil Aplodontidae and their relevance in understanding the relationship between brain evolution and locomotion**

\*Ornella Bertrand, Farrah Amador-Mughal, Madlen Lang and Mary Silcox

12.30 – 12.45 **Sporadic sampling not climatic forcing drives early hominin diversity**

\*Simon Maxwell, Philip Hopley, Paul Upchurch and Christophe Soligo

### Session 6C (in parallel with sessions 6A and 6B)

1.47, Royal School of Mines Chair: Lesley Cherns

11.15 – 11.30 **A dichotomous key for the morphological identification of coprolites**

\*Sandra Barrios, Francisco Jose Poyato-Ariza, Jose Joaquin Moratalla and Ángela D. Buscalioni

11.30 – 11.45 **Evolution or revolution at the Jr/K boundary: The case of the Ammonoidea**

Luc Georges Bulot and William A.P. Wimbledon

11.45 – 12.00 **Jurassic onychites (arm hooks from squid-like cephalopods) associated with statoliths in the Wessex Basin, southern England**

Malcolm Hart, Zoe Hughes, Gregory Price and Christopher Smart

12.00 – 12.15 **Get across the wood: exceptional preservation of Cretaceous soft-bodied xylophagous molluscs**

Ninon Robin, Anaïs Boura, Marcel Velasquez, Géraldine Garcia, Clément Jauvion, Jean-Marie Boiteau and Xavier Valentin

12.15 – 12.30 **A Triassic-Jurassic window into the early evolution of Lepidoptera**

Bas van de Schootbrugge, Timo Eldijk, Torsten Wappler, Paul Strother, Carolien van der Weijst, Hosein Rajaei and Henk Visscher

12.30 – 12.45 **Gymnosperm–insect pollination relationships in Early Cretaceous amber from Spain**

Ricardo Pérez-de la Fuente, David Peris, Antonio Arillo, Eduardo Barrón, Xavier Delclòs, David A. Grimaldi, Conrad C. Labandeira, André Nel, Patricia Nel and Enrique Peñalver

12.45 – 13.45 LUNCH BREAK – Packed lunches available from Royal School of Mines, G.41

See maps for locations of cafeterias on campus

**Session 7**

G.16, Sir Alexander Fleming Building Chair: Philip Mannion

- 13.45 – 13.55 Evaluating bite marks and predation of fossil jawless fish during the rise of jawed vertebrates  
\*[Emma Randle](#) and Robert Sansom
- 13.55 – 14.05 **The other old red continent: ichnological signatures of arthropod terrestrialization throughout the Silurian of Australia**  
\*[Anthony Shillito](#) and Neil Davies
- 14.05 – 14.15 **High-resolution virtual histology in 3D for understanding development in living and fossil birds**  
\*[Katherine Williams](#), Neil J. Gostling, Gareth Dyke, Richard O.C. Oreffo and Philipp Schneider
- 14.15 – 14.25 **Get low: the evolution of the baleen whale auditory pathway**  
[Travis Park](#), Alistair Evans and Erich Fitzgerald
- 14.25 – 14.35 **Evidence for a rapid recovery of snakes following the Cretaceous-Paleogene mass extinction**  
\*[Catherine G. Klein](#), Davide Pisani, Daniel J. Field, Matthew A. Wills and Nicholas R. Longrich
- 14.35 – 14.45 **Contrasts in the early evolution of taxonomic richness and morphological disparity of the Ammonoidea: The Devonian record from Morocco**  
\*[Ninon Allaire](#), Claude Monnet and Catherine Crônich
- 14.45 – 14.55 **Towards more accurate inference of phylogeny from morphology: a case study from extant crocodylians**  
[Roland Sookias](#)
- 14.55 – 15.05 **The positive influence of continuous characters and extended implied weighting on phylogenetic reconstruction: a crocodylian case study**  
\*[Selina Groh](#), Paul Upchurch, Julia Day and Paul Barrett
- 15.05 – 15.15 **Is parsimony dead? Bayesian and parsimony phylogenies tested using both empirical and simulated morphological data**  
\*[Joseph Keating](#), Russell Garwood, Mark Sutton and Robert Sansom
- 15.15 – 15.25 **Incorporating inapplicable data in phylogenetic analysis**  
[Martin Smith](#), Martin D. Brazeau and Thomas Guillaume
- 15.25 – 16.00 BREAK  
Posters (group B), exhibitors, refreshments and the *Raising Horizons* exhibition will all be available in the Foyer of the Sir Alexander Fleming Building

**Session 8**

G.16, Sir Alexander Fleming Building Chair: Paul Barrett

16.00 – 16.15 **The search for physical sedimentary-stratigraphic signatures of ancient life**  
Neil Davies

16.15 – 16.30 **Re-evaluating the function of cephalopod septa**  
Robert Lemanis

16.30 – 16.45 **Decoupled morphological and phylogenetic diversification during the rise of the ruling reptiles and their kin**  
Richard Butler and Martin Ezcurra

16.45 – 17.00 **Closing the gap between palaeontological and neontological speciation and extinction rate estimates**  
Daniele Silvestro, Rachel C.M. Warnock, Alexandra Gavryushkina and Tanja Stadler

## CLOSING BUSINESS

G.16, Sir Alexander Fleming Building

17.00 – 17.15 Presentations from the organizing committees of Palass 2018 (Bristol), Progressive Palaeontology 2018 (Manchester) and the 5th International Palaeontological Congress (Paris)

17.15 – 17.25 Presentation of the President's Prize and the Council Poster Prize

17.25 – 17.30 Closing remarks

**Wednesday 20th December**

## FIELDTRIP 1 – DARWIN'S DOWN HOUSE

08:00 – 10.00 Coach travel from the Royal School of Mines to Downe

10.00 – 13.00 Down House and Garden tours

13.00 – 15.00 Lunch in the Queen's Head, Downe Village

15.00 – 17.00 Coach travel from Downe to the Royal School of Mines (return time is approximate).

## FIELDTRIP 2 – ISLE OF SHEPPEY

07:30 – 10.00 Coach travel from the Royal School of Mines to Isle of Sheppey

10.00 – 13.00 Fossil hunting at Warden Point

13.00 – 13.30 Coach travel from Warden Point to Sheerness

13.30 – 15.30 Lunch at the Abbey Hotel Restaurant and Conference Centre, Sheerness

15.30 – 18.00 Coach travel from Sheerness to the Royal School of Mines (return time is approximate).



## Abstract of Annual Address

The Annual Address will be given on Monday 18th December at 17:30.

**“101 uses for a dead fish. Experimental decay, exceptional preservation, and fossils of soft bodied organisms”**

**Mark Purnell**

*University of Leicester*

The use of experiments to understand post-mortem processes and their role in exceptional preservation goes back decades, but a wide range of known and unknown variables influences how soft tissue remains become fossilized – variables that at first sight might seem to limit the applicability of experiments to analysis of fossils. Focusing on character-based experimental decay I have worked with a small group of colleagues (particularly Sarah Gabbott, Duncan Murdock and Robert Sansom) to develop methods that allow clear analysis and quantitative testing of the repeatability and comparability of experiments. Our approach allows factors that retard onset of decay to be differentiated from those that reduce the rate of character loss, and demonstrates that sequences of character loss are generally unaffected by the environment in which carcasses decay. Empirically-derived sequences can thus be applied to exceptionally preserved fossils to disentangle the relative importance of, and interactions between, decay, maturation, and mineralization, and to inform our interpretations of fossil morphologies. Far from being of limited value, data from well-designed taphonomic experiments provide fundamental new insights into the processes and biases that have produced exceptionally preserved fossils, and the degree to which they distort our view of the past.



