The Palaeontology Newsletter

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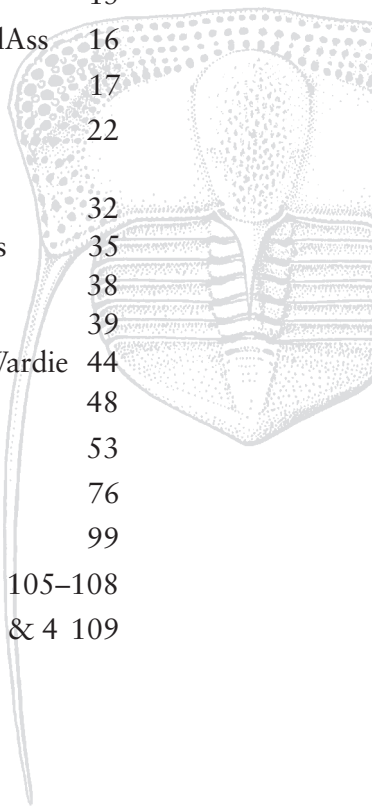

Reminder: The deadline for copy for Issue no. 100 is 11th February 2019.

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Editorial

This issue sadly sees the last ever news column from **Liam Herringshaw**, whose tenure is estimated to stretch back as far as the Permian[1]. He has used this opportunity to explore depictions of palaeontology in British children's television and his piece is jam-packed with libellous statements about the workings of Council. Speaking of which, our outgoing president **Paul Smith** gives us his promised *Legends of Rock* piece on Gertrude Elles, whose name now adorns the newly constituted public engagement prize (replacing the narrower-scoped Golden Trilobite), the first winner(s) of which will be announced at the Annual Meeting in Bristol.

Other highlights of the current issue include **Jan Zalasiewicz**'s piece, which features an athletic Darwin and ponders the distribution of biomass across time and taxa. **Tim Smithson**, **Nick Fraser** and **Mike Coates** tell the story of Stan Wood's remarkable contribution to Carboniferous vertebrate palaeontology through his many years of collecting at Wardie in Scotland and announce the digital availability of a previously incredibly hard to find publication by Stan[2]. On the other side of the Atlantic, the second ever *A Palaeontologist Abroad* gives three different accounts – from **Dahiana Arcila**, **Katie Collins** and **Nicolás Mongiardino Koch** – on doing palaeontology in the US. Finally, I would like to draw your attention to our Editor-in-Chief advertisement. **Andrew Smith** will soon be stepping down from the role having transformed the Association's publications into world-leading outlets for palaeontological findings, and we need someone similarly adept to step up.

Graeme Lloyd
Newsletter Editor
<newsletter@palass.org>

@ThePalAss

<**https://www.facebook.com/groups/palass/**>

[1] Or at least Issue 73.
[2] And made possible by Palaeontological Association funds.

Association Business

Annual Meeting 2018

Notification of the 62nd Annual General Meeting

This will be held at the University of Bristol, UK, on Saturday 15th December 2018, following the scientific sessions.

AGENDA

1. Apologies for absence
2. Minutes of the 61st AGM, Imperial College London *
3. Trustees Annual Report for 2017 *
4. Accounts and Balance Sheet for 2017 *
5. Election of Council and vote of thanks to retiring members
6. Report on Council Awards
7. Annual Address

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

Nominations For Council

At the AGM in December 2018, the following vacancies will occur on Council:

- Vice President
- Editor-in-Chief
- Editor Trustee
- Publicity Officer

Nominations received by the deadline are as follows:

- Vice-President: Prof. Thijs Vandenbroucke*
- Editor Trustee: Prof. Mark Purnell*
- Publicity Officer: Dr Susannah Lydon

* denotes Council nominations

Personal statement from Dr Susannah Lydon

I have been involved in palaeontological outreach since the 1990s, when I taught classes for the public at the University of Manchester while studying for my PhD in Mesozoic palaeobotany. Since

2003 I have specialized in outreach work. I spent four years improving UK geology teaching with the Earth Science Education Unit at Keele University. In 2007, I joined the University of Nottingham as the Outreach Officer for a systems biology research centre. I am now the School of Biosciences lead for public engagement, schools engagement and media work. I teach plant evolution to undergraduates and science communication to Masters students. From 2016–2018 I wrote for *Lost Worlds Revisited*, a palaeontology blog for The Guardian Science Blog Network, which received 870,000 page-views globally in its final year. The effective use of social media for publicity was integral to this work, and to my roles at Nottingham. I would relish the opportunity to work with the PalAss Council Public Engagement Group in promoting and publicizing the Association's work, and raising the profile of palaeontology more generally.

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 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 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 a palaeontologist who has had between 15 and 25 years of full-time experience after their PhD, in recognition of outstanding contributions in his/her earlier career, coupled with an expectation that they will continue to contribute significantly to the subject in their further work.

The 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 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 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 Mary Anning 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 to <**secretary@palass.org**> by **31st March**.

The Award comprises a cash prize of £1,000 plus a framed scroll, presented at the Annual Meeting.

Gertrude Elles Award for public engagement

In order to promote high quality public engagement in the field of palaeontology Council has instituted this new award, which is named after pioneering early 20th century palaeontologist Gertrude Elles.

The award is made by Council for high-quality, amateur or institutional, public engagement projects that promote the discipline. Nominated projects can include museum displays and exhibitions, outreach programmes to schools and/or communities, art/science collaborations, digital initiatives, or any other programme that falls broadly under the heading of public engagement with palaeontology.

How to nominate

Nominations should consist of a brief supporting case and a portfolio of up to four images. The supporting case should outline:

- the aims of the project;
- the nature of the target audience;
- the available budget and funding sources;
- visitor/audience numbers;
- the results of project evaluation to demonstrate the quality and effectiveness of the project;
- links to any digital components.

Self-nominations are permitted, and the nominators and proposed recipients do not need to be members of the Association. Nominations will be considered relative to the scale of the institution and the available project budget.

The supporting case and the portfolio of images should be compiled into a PDF of less than 10Mb and sent to <**secretary@palass.org**> by **31st March**.

The Gertrude Elles Award is presented at the Annual Meeting.

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 to <**secretary@palass.org**> by **31st March**.

Honorary Life Memberships are announced at the Annual Meeting.

Annual Meeting President's Prize

This is 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

This is 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

This has been 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

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 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.

Innovations in Palaeontology Lecture Series and the PalAss Exceptional Lecturer

In order to promote palaeontology to the wider academic community and public, and to recognize excellence in research among early to mid-career palaeontologists, the Palaeontological Association is introducing the **Innovations in Palaeontology Lecture Series**, to be given by the *PalAss Exceptional Lecturer* who will be selected in a competitive process.

This scheme aims to:

- Improve the dissemination of cutting-edge palaeontological research to the broader academic community and public.
- Raise the profile of palaeontology within the Earth sciences and related fields.
- Recognize outstanding research and science communication in palaeontology among members of the Association who are at early to mid-career stages.

Format of the scheme:

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

Eligibility and selection process of the PalAss Exceptional Lecturer:

- Eligible candidates will have a PhD in palaeontology or a related field and will be in the early to mid-stage of their career.
- Applicants can reside in any country, but must be members of the Association.
- Candidates must self-nominate.
- To self-nominate, a two-page CV, statement of motivation, and a title and illustrated 200-word abstract of a proposed seminar must be submitted via the Association's webpage.
- The *PalAss Exceptional Lecturer* will be chosen based on the career track record, including research impact (relative to their career stage) and oratorical skills.

Selection of host institutions:

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

Expectations for host institutions

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

Deadlines:

- 1st October 2018: Deadline for nominations for the *PalAss Exceptional Lecturer*.
- 15th December 2018: The *PalAss Exceptional Lecturer* will be announced at the Annual Meeting.
- February 2019: The call for host institutions to participate in the **Innovations in Palaeontology Lecture Series** will be published in the spring *Newsletter*.
- 1st May 2019: Deadline for applications from host institutions.
- September 2019 – May 2020: delivery of lectures.

Uwe Balthasar
Meetings Coordinator

GRANTS

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

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. 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. Enquiries may be made to the Secretary (e-mail <**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.

Postgraduate Travel Fund

Financial assistance is offered to postgraduate students who are members of the Association to attend international meetings that are not directly supported by the Association through the Grants-in-Aid scheme. A list of directly-sponsored meetings is given below. The funding is only intended for conferences that are explicitly scientific in nature. Inquiries can be made to the Meetings Coordinator (e-mail <**meetings@palass.org**>).

Terms and Conditions

Please read the following notes before applying:

- The award is specifically for travel.
- Applicants must be delivering a presentation (poster or oral) that falls within the scope of the Association's charitable aims.
- The maximum amount awarded will be £200 GBP.
- Successful awards will be paid retrospectively on the submission of receipts for reasonable travel costs.
- Applications should be made online no later than two months prior to the beginning of the conference.
- The total fund and number of awards will be at the discretion of Council.
- Only one travel grant will be awarded per applicant per year, but subsequent applications can be made.
- Applications are to be made through the application website (see below), and include the personal details of the applicant and his/her career stage, the title of the accepted abstract, and details of other funding obtained towards the cost of the meeting. Two letters must also be attached, in PDF format: a letter of confirmation from the meeting convenor which states the acceptance of the applicant's abstract, and a short status-confirming letter from the applicant's supervisor.
- Funding from the Association should be acknowledged on your poster or in your presentation.

Directly sponsored meetings (these are NOT eligible for the Postgraduate Travel Fund):

- Palaeontological Association Annual Meeting
- Progressive Palaeontology
- Any other meetings that have been awarded funds to support student attendance from the Association's Grants-in-aid scheme

Deadline

There is no deadline: applications are accepted throughout the year.

Engagement Grants

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

For more information please contact the Association's Outreach Officer, Dr Lucy McCobb, e-mail: <**outreach@palass.org**>.

The deadline is **1st September** each year. Successful applicants will be notified by the middle of October and funds will normally be available from 1st November. A full list of awards will be announced at the AGM.

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.

1. Sylvester-Bradley Awards: Multiple awards of up to £1,500 each, for palaeontological research.
2. Callomon Award: An award of up to £1,500 for a project which is normally field-based.
3. Whittington Award: An award of up to £1,500 for a project which is normally based on museum collections.
4. Stan Wood Award : An award 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 *Palaeontology 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 to the Secretary (e-mail <**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 careers. 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 £274 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 by e-mail to <**palass@palass.org**> within eight weeks of the stated end date of the project. Successful candidates are requested to prioritize the Association's meetings and publications as media for conveying the research results.

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

The deadline is **1st February** each year. Successful applicants will be notified by the middle of March 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 also 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 who may be approached to review the proposal

Successful applicants will be required to produce a final project report that will be published in the *Palaeontology 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 to the Secretary (e-mail <**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 following AGM.

The Palaeontological Association Wants You

The Association is searching for a new Editor-in-Chief to replace Andrew Smith, who will be stepping down from the role after a highly successful period of time in charge of the journals. The role involves the leadership and strategic development of the two journals of the Association, *Palaeontology* and *Papers in Palaeontology*.

Editor-in-Chief – job description

Oversee the production of the Association's publications and provide vision and leadership for their future development; act as line manager for the Publications Officer and set priorities and goals for the journals. Attend annual meeting with publisher (Wiley).

Select and invite members onto the publications editorial and science boards to ensure gender balance, geographical coverage and disciplinary representation is achieved.

Ensure the quality of papers being accepted for publication in *Palaeontology* and *Papers in Palaeontology* by: (1) acting as a member of the Editorial Board in the preliminary sift of all papers submitted; (2) assigning papers of suitable quality to a science editor; (3) vetting the recommendations made by the science editorial board and making final decisions.

Identify key topics and seek submission of high-quality review papers from potential authors.

Chair and organize the selection of best paper awards for each journal.

Current publication board structure supporting the Editor-in-Chief

Publications Officer (Sally Thomas) – responsible for: circulating all new submissions around Editorial Board and collating comments; copyediting and overseeing publications process; acting as interface between the Association and our publisher.

Editorial Board (four members covering plant, invertebrate, micropalaeontology and vertebrate expertise) – responsible for: recommending to the Editor-in-Chief whether submitted papers are of a suitable quality to send to review.

Science Editors (25 members representing diverse fields) – responsible for selecting referees and overseeing the review process; based on the reviews received, making a recommendation to the Editor-in-Chief on how to proceed.

Approximate time spent: 5-6 hours a week**.**

If you are interested in being nominated for the role and would like more information, please contact Andrew Smith (e-mail <**a.smith@nhm.ac.uk**>).

Become the face of PalAss on YouTube!

As part of our response to the results of the 2018 PalAss diversity study, we are developing a YouTube channel in order to reach out to a broader and more diverse audience.

We are launching an open call for contributions to the following series:

Flagship topical series. The first, flagship series will focus on the evolution of key adaptations, including (but not limited to) eyes, brains, limbs and colour. Each series will feature six 60 second episodes, all based on the same topic, *e.g.* 'Fossil eyes'; all episodes in a single series will be presented by the same researcher, designated a **PalAss YouTube Ambassador**. The Ambassador will be expected to lead the design of the series. Video filming, editing and production will be done by a professional filming company. Most of the video footage should be filmed in a single location (such as a laboratory), but the award includes a £300 budget available to the Ambassador for limited travel costs, for example to field locations and/or museum collections. Applications to become the 2019 PalAss YouTube Ambassador should include a description of the setting, content, props, narrative and a 30-second video, plus confirmation that the applicant will be available for 2-3 days during mid-2019 for video development and filming. The series will be launched in late 2019.

My fossil and me. A series of short videos (60-90 seconds), each featuring a single presenter with a fossil prop; one video per presenter. Three videos will be released per annum. Applicants will be required to submit a CV and a 20-second video. Successful applicants will be responsible for shooting the footage using *e.g.* a smartphone or digital camera, in line with style guidelines provided by the Association. No funding is available for contributors. All submitted videos will be reviewed by PalAss Council.

Life as a palaeontologist. A series of one-off short videos (60-90 seconds) each featuring a single presenter discussing aspects of their job. Three videos will be released per annum. Applicants are required to submit a CV and a 20-second video. Successful applicants will be responsible for shooting the footage using *e.g.* a smartphone or digital camera, in line with style guidelines provided by the Association. No funding is available for contributors. All submitted videos will be reviewed by PalAss Council.

Applications for the PalAss YouTube Ambassador scheme and for one-off contributions to the other two series should be submitted on the PalAss website by 23:59 GMT on **31st January 2019**. Applicants will be notified of the outcome of the selection process in early March 2019. There will be further calls for contributions, once the channel is up and running.

Lucy McCobb
Outreach Officer

ASSOCIATION MEETINGS

62nd Annual Meeting of the Palaeontological Association
University of Bristol, UK *14 – 17 December 2018*

The 62nd Annual Meeting of the Palaeontological Association will be held at the University of Bristol. The organizing committee is chaired by Dr Jakob Vinther. The e-mail address for all meeting-related matters is <**annualmeeting2018@palass.org**>.

Information about the meeting is provided in the coloured supplement at the back of this *Newsletter* and on the PalAss website at <**https://www.palass.org/meetings-events/annual-meeting/2018/annual-meeting-2018-bristol-overview**>.

Due to 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 2019. 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 Bristol!

Abstract of Annual Address

The Annual Address will be given on Saturday 15th December.

Ice in a greenhouse world – 60 Ma and 2060

Prof. Dame Jane Francis
British Antarctic Survey

The polar regions are the areas on Earth most sensitive to climate change, both in the past and today, as we are now seeing so clearly.

Evidence from fossil plants in Antarctic rocks confirms that during the geological past polar climates were much warmer than now, allowing temperate and tropical vegetation to thrive on Antarctica near the South Pole. This has led to the general view that the Cretaceous–Eocene world, 100–50 million years ago, was ice-free.

Was Antarctica really ice-free, even when the continent was over the pole and experienced dark winters? High resolution studies of Late Cretaceous and Paleocene (75–60 Ma) marine algae (dinoflagellate cysts), correlated with isotope evidence for cold climates during algal blooms, now suggest that seasonal sea ice – and even ice caps – existed on Antarctica while temperate floras lived on the coast.

CO_2 levels were ~400 ppm at that time, much like today. Can the Late Cretaceous provide us with a vision of our future world?

Meeting support

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

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TREATISE on Invertebrate Paleontology

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6th– 8th
June

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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.

The Geological Society

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Lyell Meeting 2019

Carbon: geochemical and palaeobiological perspectives

28 June 2019 | **The Geological Society, Burlington House**

The fundamental building block of life as we know it, carbon, is critical to the Earth system. Traditionally biological and chemical approaches to understanding carbon dynamics in the geological past have been considered in relative isolation.

For the 2019 Lyell Meeting we will to bring together a broad spectrum of scientists that address the big picture of carbon in the Earth system, drawing on expertise in palaeontology, geochemistry, palaeobotany, atmospheric processes, deep-Earth processes, and anthropogenic impacts.

This meeting seeks to foster conversation between these disparate communities to facilitate a more holistic approach to considering carbon, and how it cycles between Earth's organic and inorganic reservoirs.

Call for Abstracts

We invite oral and poster abstract submissions for the meeting, and these should be sent in a Word document to rhianna.mclean@geolsoc.org.uk by 4 February 2019. Abstracts should be approximately 250 words and include a title and acknowledgement of authors and their affiliations.

Convenors:

Barry Lomax (Nottingham University)
WT Fraser (Oxford Brookes University)

Further information:

For further information about the conference please contact:
Rhianna McLean, Conference Office,
The Geological Society, Burlington House,
Piccadilly, London W1J 0BG
T: 0207 434 9944
E: rhianna.mclean@geolsoc.org.uk
Web: www.geolsoc.org.uk/lyell19
Follow this event on Twitter #lyell19

news

Fossils on TV: child's play

So, nearly 18 years after first reporting for the *Newsletter*, and after nine years on the Association Council, my time here is done, and someone new and eminently more capable will pick up the role of Publicity Officer. It has been a great deal of fun working with everyone over the years, from the first Newsletter Editor (some bloke called Donoghue who I understood left academia many years ago to run a conodont retreat in mid-Wales) to the last, and I can only apologize to Graeme, Maria, Richard and co for never submitting anything on time (including this piece). I would also like to thank all the Council members, particularly Fiona, Caroline, Lucy, Maria and the PEG team, who have tolerated my persistent digressions.

To maintain this standard right to the end, therefore, I offer up the following valedictory: a news review of palaeobiology on British children's television. It is entirely altruistic, of course, and nothing to do with me now spending far more time watching such programmes with my toddler daughter than I do reading new palaeontological papers. It is also – genuinely – nothing to do with my daughter being indoctrinated: she is very much in control of the TV-viewing in our house. Though she has watched all the programmes described below, she currently prefers an American CGI search-and-rescue-dog-based cartoon, and a stop-motion show about implausibly inefficient postal delivery services in Northern England. I have had to carry out at least some[1] of this research after she has gone to bed.

I should make it clear that I like children's television. In fairly small doses, of course, but I have long felt that it is a medium that palaeontologists should engage with far more. Some years ago, a geological classmate and I even told the BBC this, and said classmate went on to become the only sedimentologist I'm aware of with a Children's BAFTA, so they should have listened to him. With this in mind, and with plans afoot to develop a PalAss YouTube channel, I was understandably interested to see how it currently fares.

I am pleased to report that, at least on *CBeebies* (the under-5s BBC Television channel), an encouragingly Reithian ambition often stretches to scientific matters, and occasionally introduces palaeontological or geological topics. I can't claim that this review is definitive or exhaustive, but to paraphrase Tom Lehrer, it may prove useful to somebody someday, in a somewhat bizarre set of circumstances.

Go Jetters

A cartoon series in which four small (super)humans explore the globe solving problems, *Go Jetters* is an ostensibly geography-focused enterprise. Indeed, it has a Geography consultant, Dr Paula Owens[2] to ensure that, even if the episodes are sometimes quite bonkers, the content is grounded in geographical reality.

It is not without its interests to the Palaeontological Association membership, either. Firstly, the operational structure of the Go Jetters Academy is very similar to that of the current PalAss

[1] OK, most.

[2] <**https://www.linkedin.com/in/drpaulaowens/**>.

Council, in that the leader and mentor, Ubercorn, is a funky-disco grooving unicorn[3]. Secondly, the Go Jetters occasionally venture a little deeper in time or stratigraphy. Episode 47 of Series 1 (yes, there are quite a lot of episodes) features the team hunting dinosaur fossils in the Gobi Desert, before a drilling-based disaster requires them to use their superpowers, whilst episode 24 of series 2 introduced me to a diagenetic phenomenon I had never heard of, but am now rather keen to visit: the Valley of Balls in Kazakhstan[4]. If a third series is commissioned, surely some more fossil sites are on the cards?

Octonauts

Over on the more marine biological side of the programming output is *Octonauts*, with their NOAA-endorsed mission to Explore, Rescue, Protect[5]. Although yet to see fossils featuring directly, I've encountered plenty of taxa that, as a lover of marine invertebrate oddballs, I never thought would appear in primetime children's entertainment. Episode 2 of Series 3 was all about tardigrades; episode 12 of series 4 starred bomber worms (*Swima bombiviridis*, I think), and episode 2 of series 5 is apparently going to centre around the unbeatable scaly-foot snail (Chen *et al.*, 2015), which appears to have an excellent Wikipedia page[6]. If that wasn't enough, the operational structure of the Octonauts is very similar to that of the current PalAss Council, with the figurehead being a wise *Grimpoteuthis* called Professor Inkling.

Hey Duggee

One of my favourite children's TV shows, but sadly not currently one of my daughter's, is *Hey Duggee*. It is centred around The Squirrel Club, a rather scout-like enterprise whose operational structure is very similar to that of the current PalAss Council, in that it features a diverse array of enthusiastic young tetrapods overseen by an avuncular, onomatopoeic, award-dispensing brown dog.

The subject matters of *Hey Duggee* episodes are extremely varied, so I didn't anticipate being able to include it in this review, but then in episode 6 of series 2[7], the Squirrels (actually an octopus, a hippo, a crocodile, a rhino and a mouse) who feature in every episode are digging for treasure. One of them finds something. "Oh, it's just a rock," he complains. "But what's this squiggly bit? Let's ask Duggee, he'll know!" Ever-keen to educate his charges, and to enable them to claim their Fossil Badge, Duggee tells them it's a fossil, and then tries to explain what fossils are.

Perhaps accurately, this is a not entirely successful enterprise. Duggee does inform the Squirrels that, back in the mists of time, the only living creatures were in the sea, and that – in order to get fossilized – unusual events had to occur that caused said creatures to get 'stuck for a really, really long time'. However, though blizzards, volcanoes and sandstorms undoubtedly have fossilization potential, their impact on marine environments was not fully explained.

Of Duggee and the Squirrels' classification of fossils, though, I can definitely get behind a definition of dinosaurs as "big ones that walked", even if the remainder of the episode quite quickly digresses into a riff about cave-people and the invention of kitchens, windows and motor vehicles. Still, the Squirrels earn their Fossil Badge, and conclude correctly that 'fossils are amazing!' so that's the main thing.

[3] <**https://en.wikipedia.org/wiki/Go_Jetters**>.
[4] <**https://www.atlasobscura.com/places/valley-balls-rocks**>.
[5] <**https://www.zdnet.com/article/noaa-partners-with-captain-barnacles-and-the-octonauts/**>.
[6] <**https://en.wikipedia.org/wiki/Scaly-foot_gastropod**>.
[7] <**https://www.heyduggee.com/watch/series-2/**>.

Andy's Prehistoric Adventures (and Andy's Dinosaur Adventures)

Talking of the main thing, by far the most explicitly palaeontological shows I have come across feature a real person called Andy playing a character called Andy, who reminds me of no-one more strongly than a young Fatima Whitbread. The first show I became aware of was *Andy's Prehistoric Adventures* (2016), in which the titular gentleman introduces himself in a manner so familiar to anyone who's ever attended a PalAss Annual Address:

> "I'm Andy and I work here in the National Museum.
> We've got dinosaurs and Ice Age beasts – you should see 'em!
> Jen is my assistant, Mrs Pickles runs the show.
> Come on my adventures! Ready, steady, go!"

Having stretched my metaphor this far, I'm disappointed to report that the operational structure of the National Museum is *not* very similar to that of PalAss Council. Although Mrs Pickles evidently runs the show, and seems a generally pleasant and knowledgeable employer, she seems to demand that Andy and Jen do all their work at night, as every episode involves them hurrying to complete a display before she comes to critically inspect their efforts at 9am the following morning.

As a consequence of this, combined with some extremely clumsy cleaning contractors who seem hell-bent on destroying or disposing of key fossil specimens, Andy and Jen are under significant time pressure to produce their work. Somehow or other, Andy has discovered that the old museum clock is a time-travelling device that can take him back to any geological period (as long as it's not before the Permian), from which he can source the key specimen his display needs.

Now, why neither Jen nor Mrs Pickles are permitted to know this too, given their subject expertise, I can only speculate on (especially as the NHM website tells us that the clock provides free entry to anyone[8]). However, as Andy's palaeontological credentials – real or televisual – are not made clear, I conclude he is a chancer, or a charlatan.

This impression isn't helped by the fact that, at the end of each day, Andy takes in the 'Museum Open' sign from outside a building that is clearly the University of Bristol's Music Department[9], but when he walks back inside, he is now unquestionably in the Natural History Museum. Yet he doesn't notice.

Worse, I then discovered a 2014 series, *Andy's Dinosaur Adventures,* in which an excellent curator named Hattie is in charge of the National Museum's fossil galleries, and Andy is only an assistant, with no evident curatorial or palaeontological skills. Most worryingly, he brazenly steals Hattie's field equipment each time he wants to use the museum clock and travel back into the Mesozoic. As absolutely no mention is made of Hattie in the 2016 series, and Andy has mysteriously risen to being in charge of the prehistoric gallery, one dreads to think what skulduggery he must have enacted in 2015[10].

If you can overlook all these concerns, though (and my daughter seems blithely able to do so), the programmes are quite good fun. The reconstructions of the prehistoric creatures are impressive,

[8] <**http://www.nhm.ac.uk/events/andys-clock.html**>.

[9] <**https://en.wikipedia.org/wiki/Victoria_Rooms,_Bristol**>.

[10] I would heartily recommend reading the Mumsnet thread on the topic: <**https://www.mumsnet.com/Talk/am_i_being_unreasonable/2598230-About-Andys-prehistoric-adventures**>.

and the information provided is scientifically accurate, thanks to the show being produced by the BBC Natural History Unit. In a *Stegosaurus* episode, Andy even repeatedly employs the term 'thagomizer'[11], as approved by stegosaur expert Dr Susie Maidment of the Natural History Museum[12].

Conclusion

There's actually quite a lot of entertaining and educational material out there in television for the under-5s. Fossils fare reasonably well. I'd like to see more invertebrates, of course, and perhaps some *Horrible Histories*-type narratives rather than just cartoons and CGI, but what do I know? Anyway, now I've got all this spare time coming up in 2019, I'll just have to send the BBC my thoughts.

In the meantime, I'll leave you with the CBeebies guide to making a fossil: <**https://www.bbc.co.uk/cbeebies/makes/presenters-making-a-fossil**>. (WARNING: Do not eat the fossils. They won't taste very nice!)

Liam Herringshaw
University of Hull

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

[11] <**https://subsaga.com/bbc/childrens/andys-prehistoric-adventures/10-camptosaurus-and-call.html**>.
[12] <**https://twitter.com/Tweetisaurus/status/872932325646094337**>.

Geologists' Association Halstead Medal awarded to John Cope

Prof. John Cope has been awarded the Geologists' Association Halstead Medal for 2018, given for "work of outstanding merit, deemed to further the objectives of the Association and to promote geology". John's impressive research career has focused mainly, but not exclusively, on molluscs, and has spanned a great expanse of geological time, from the Precambrian to the Pleistocene. His early work focused on Jurassic ammonites with important applications to biostratigraphic and chronostratigraphic studies. Delving much deeper in time, his studies of Ordovician bivalves led to new ideas about early bivalve evolution. In the 1970s, John made the highly significant discovery of a Precambrian fauna in Carmarthenshire, extending the occurrence of Ediacaran fossils to another region of the UK. His interest in British stratigraphy and palaeogeography led to him acting as co-ordinating editor of the Geological Society's *Palaeogeographical Atlas*, and to his authorship of the Geologists' Association *Guide to the Geology of the Dorset Coast*. His teaching career was spent at the University of Swansea, and later Cardiff University, where he remains an Honorary Professor, in addition to being an Honorary Research Fellow at Amgueddfa Cymru—National Museum Wales. During John's career he has also devoted a very impressive amount of time to the PalAss Council, for which we are indebted.

Lucy McCobb
Amgueddfa Cymru—National Museum Wales

Palaeontographical Society Medal 2018 awarded to Bob Owens

Dr Bob Owens has been awarded the Palaeontographical Society Medal for 2018, in recognition of his outstanding contribution to our understanding of trilobites. This biannual award is given to recognize "a sustained and important series of contributions to taxonomic and systematic palaeontology". Bob spent his career at Amgueddfa Cymru—National Museum Wales, which he joined as Head of Palaeontology and Assistant Keeper of Geology in 1970. During a research

career spanning over 40 years (and still ongoing despite 'retirement'), Bob discovered more than 100 new species of trilobites and over 20 new genera. He also erected a new order, the Proetida, with Prof. Richard Fortey. Bob's trilobite work made important contributions to addressing biostratigraphical, palaeogeographical and palaeoecological questions, as well as exploring some key aspects of trilobite functional morphology, including their feeding habits and enrolment styles. Bob has been an active member of PalAss Council over the years and has further served our community as an editor for the Palaeontographical Society. Bob is always happy to share his knowledge and enthusiasm for trilobites with others, while being extremely modest and self-effacing about his achievements. He is a very worthy winner of the third Palaeontographical Society Medal.

Lucy McCobb
Amgueddfa Cymru—National Museum Wales

International Palaeontological Congress 6 (2022): call for proposals

After Sydney, Australia in 2002, Beijing, China in 2006, London, UK in 2010 and Mendoza, Argentina in 2014, the fifth International Palaeontological Congress (IPC5) took place in Paris, France in July 2018. It was a great success with a rich scientific programme of talks, posters and various pre- and post-congress field-trips, as well as enjoyable social and cultural activities. Delegates attended from over 60 different countries. The Council of the International Palaeontological Association (IPA) is now considering potential venues for IPC6 in 2022. Proposals are welcome and should be submitted no later than 31st December 2018. The proposals will be reviewed and a final decision on the location of IPC6 is expected by the end of January 2019. For more information please see the IPA website: <**www.ipa-assoc.org**>.

Sylvie Crasquin
President, International Palaeontological Association

Palaeontographical Society awards available

The Palaeontographical Society invites applications for two awards, the Edward Forbes Prize and the Richard Owen Research Fund. The Edward Forbes Prize aims to recognize outstanding contributions by early-career researchers in the field of taxonomic and systematic palaeontology and is awarded for publication excellence. The Prize comprises £250 and a one-year membership of the Society. The Richard Owen Research Fund is a small grant to assist palaeontological research (travel, visits to museums, fieldwork, *etc.*) within the Society's remit of describing the fossil fauna and flora of the British Isles. Two of these grants will normally be awarded each year of around £1,000 each, although the exact amount and the number of awards may vary at the discretion of the Council. Preference is given to applicants at the start of their careers or those without alternative sources of funding, and those engaged in the production of a monographic piece of work. The closing dates are 28th February each year. Full details of how to apply can be found on the website at <**www.palaeosoc.org**>.

Stephen K. Donovan
President, The Palaeontographical Society

BSA Award Lectures

The British Science Association (BSA) has been rewarding promising early career scientists for over 20 years, many of whom are now successful science communicators. Previous Award Lecturers include Brian Cox, Richard Wiseman and Maggie Aderin-Pocock. The Award Lectures aim to promote open and informed discussion on issues involving science, and actively encourage scientists to explore the social aspects of their research. The nominees should be active, early-career researchers who are skilled in communicating their research and who are able to present their Award Lecture during the British Science Festival in Coventry and Warwickshire in September 2019. Nominees should be based at a UK institution but can be of any nationality.

Nominations will be open for the 2019 Award Lectures in late 2018. See the BSA website for details: <**https://www.britishscienceassociation.org/award-lectures**>.

Jo Hellawell
Executive Officer

Help rebuilding the palaeontology collections of Brazil's National Museum

As you may know, the National Museum of Brazil in Rio de Janeiro was consumed almost entirely by fire on 3rd September 2018. The destroyed building included exhibit rooms and offices as well as palaeobotany, invertebrate palaeontology and vertebrate palaeontology collections that held a number of holotypes. The current director of the Museum, Dr Alexander Kellner, has been working hard to secure funding from the Brazilian government for a new building.

In order to make his case as strong as possible, Dr Kellner has requested help from fellow palaeontology colleagues and institutions. Notably, the National Museum is in desperate need of: (1) photographs and replicas of its own specimens that perished; and (2) donations of any number of replicas and fossils, including comparative specimens, from other institutions or individuals. Because the Museum's 3D printers luckily survived, 3D digital data (copyright permitting) can also be sent to the Museum. Individuals and institutions can help the National Museum by sending formal letters stating that they will make such donations.

At this point, it is not necessary to state the exact number of replicas and/or specimens to be donated, but simply the intent to make such donations. What is needed (and time-sensitive) are letters that demonstrate an international effort to help the National Museum to rebuild its palaeontology collections, which in turn can further justify the need for a place where replicas and specimens can be properly stored, curated, and open to visitation. Letters should be addressed to Dr Alexander Kellner (Museum Director) and sent via e-mail to <**direcao@mn.ufrj.br**>. It would be most effective if the letters can be sent to Dr Kellner by 30th November 2018, although the Museum will continue to welcome donation intent letters past that date.

Emily Rayfield
University of Bristol

Photo: Lu Brito.

Featured Article

Is bigger better? Body size was not a key trait determining archosauromorph extinction during the Triassic–Jurassic (T–J) crisis

It has been widely suggested that Earth has entered into a modern mass extinction phase because the rate at which species are now becoming extinct is comparable to those during Earth's greatest crises[1]. However, in both modern and ancient extinction scenarios, we still do not understand what pushes life over the edge, or even which traits make a species vulnerable to extinction. It has been suggested that for modern animals, size and life strategy matters: those at a higher trophic level (*e.g.* molluscs, crustaceans, fish) with higher metabolic rates might be at greater risk in a warming world[2,3] whilst their generally small population sizes and low reproductive rates also make them vulnerable to extinction[4]. In the ancient, this relationship is less clear: Clapham's (2017) analysis of Permian-through-Jurassic marine invertebrates revealed that organisms that were more active were significantly more likely to survive three of the four extinction events within that interval[5]. If you consider who would be more likely to outrun a pyroclastic flow out of Usain Bolt and me this seems reasonable.

A new study by Bethany Allen and colleagues[6], published in *Palaeontology*, examines the role of body size and other traits in patterns of extinction and survivorship in archosauromorphs (basal dinosaurs, crocodylomorphs and relatives) during the Triassic–Jurassic extinction, one of the least well understood of the "Big 5". Their study also evaluates a common assumption, that phylogenetic clustering of extinctions is a function of a given extinction driver acting on particular traits shared by closely related taxa[7] (*i.e.* whether species with certain traits were more or less likely to die out).

Allen *et al.* built several new archosauromorph maximum-likelihood supertrees, incorporating uncertainty in phylogenetic relationships. The supertrees were interrogated for a phylogenetic signal to extinction losses during the Triassic–Jurassic interval. Diet, posture, habitat, body size and palaeolatitude were all analysed as predictors for extinction. None of these proved significant in determining extinction or survival. Notably, Triassic archosauromorph body size is not linked to extinction, corroborating previous interpretations of the marine fossil record of the end-Devonian[8], end-Permian[9] and end-Cretaceous[10] extinctions. This contrasts with the popular view (albeit untested, phylogenetically) that the most famous extinct archosauromorph clade, the Dinosauria, died out at the end of the Cretaceous because they were large, whilst their relatives, birds and crocodiles, survived because they were small. Despite the lack of an obvious extinction-inducing trait in Allen *et al.*'s analyses, Triassic–Jurassic archosauromorph extinctions were phylogenetically clustered, suggesting a role for selection.

The fossil record is challenging to interpret, but studies such as Allen's are likely to prove

[1] Ceballos ***et al. 2015.***
[2] Gillooly *et al.* 2001.
[3] Brown *et al.* 2004.
[4] Cardillo *et al.* 2005.
[5] Clapham 2017.
[6] Allen *et al.* 2018.
[7] McKinney 1997.
[8] Sallan and Galimberti 2015.
[9] Puttick *et al.* 2017.
[10] Friedman 2009.

valuable for modern conservationists seeking to predict, understand and mitigate the impact of environmental change and habitat loss on modern biodiversity. It increasingly seems that past crises were indiscriminate with regard to the size of their victims, but if a close relative died out, things did not look good. Perhaps humans should look out for our own miners' canary, the bonobo (*Pan paniscus*), with whom we share 99.6% of our DNA[11] and many traits. Bonobo populations have been in decline for the past 30 years and the species is listed as Endangered on the IUCN Red List … worrying times indeed.

David Bond
University of Hull

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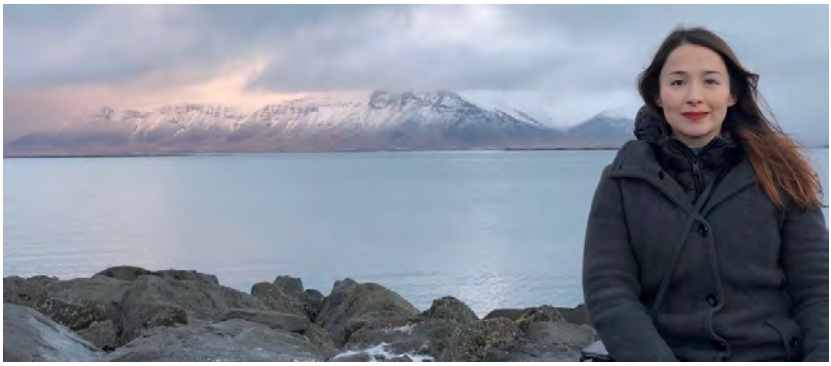
[11] Prüfer *et al.* 2012.

From our Correspondents

A Palaeontologist Abroad

Highlighting early career researchers who have taken posts outside their home country and the opportunities they used. This issue's palaeontologists are Dahiana Arcila, Katie Collins and Nicolás Mongiardino Koch.



Dahiana Arcila is a Colombian in the United States of America, employed as an NSF Postdoctoral Research Fellow at the University of Chicago, in the Department of Organismal Biology and Anatomy. She will begin a new academic appointment on January 2019 as Ichthyology Curator at the Sam Noble Oklahoma Museum of Natural History and Assistant Professor in Biology at the University of Oklahoma.

Q1: How did you end up in the United States of America?
I came for the first time funded by an NSF student exchange program (called "DeepFin") aimed for students to acquire training in molecular techniques and fish anatomy with Dr Guillermo Ortí and Dr Richard Vari. This exchange provided an invaluable opportunity that gave me an amazing introduction to the wonderful field of fish evolution and allowed me to pursue my doctoral degree at George Washington University. During my PhD, I was also lucky to work with great palaeontologists, including Drs James Tyler, Giorgio Carnavele and Alexander Bannikov. The combination of neontological and palaeontological approaches that we have used was initially bridged by the study of a charismatic group of fishes that includes the popular pufferfishes, boxfishes and molas (order Tetraodontiformes).

Q2: How is your position funded?
My position is currently funded by an NSF Postdoctoral Research Fellowship in Biology. For my project – "Morphological Evolution of Extant and Fossil Boxfishes, Pufferfishes and Allies" – I'm working under the supervision of Dr Mark Westneat at the University of Chicago and the Field Museum of Natural History. I was also supported during the past year working as a postdoc under an NSF-funded Tree of Life project – "FishLife: Genealogy and Traits of Living and Fossil Vertebrates that Never Left the Water" – under the tutelage of Dr Carole Baldwin at the Smithsonian National Museum of Natural History.

Q3: What is your project about?
Morphological diversity tends to increase within evolving lineages over time, but the relative role of abrupt shifts associated with extinction and speciation events due to palaeoclimate changes still remains poorly known for most groups of organisms. Despite great progress recently made into how morphology changes over time, the inclusion of fossils is still limited, affecting our understating of morphological evolution. In this project, we are using an integrative approach to study morphological evolution in extant and fossil pufferfishes, boxfishes, ocean sunfishes and allies and its link to palaeoclimate changes. Tetraodontiformes provide an excellent system for investigating morphological evolution as they include some of the most extreme body shapes in the fish tree of life from nearly square to globose, and spheroid to laterally compressed. The group also features one of the best-known fossil records in fishes.

Q4: What surprised you most about living in the United States of America?
The academic opportunities and support for research projects. I am also impressed with the large community of scientists from different countries who create a unique environment for scientific development. Culturally, I enjoy the respect for space, friendliness and coexistence rules found in most labs. There are also stunning natural parks encompassing a large diversity of landscapes and wilderness. As a tropical person who grew up in a region that has spring all year round, I was amazed by seasonal variations and I really enjoy them now.

Q5: Apart from friends and family what do you miss most about Colombia?
I miss conducting fieldwork in Colombia and experiencing the rapid change of landscape and temperatures in just minutes thanks to its location near the equator. Colombia is a beautiful country with an incredible undescribed biodiversity associated with jungles, mountains, valleys, lakes, rivers and oceans. I miss the food, especially the availability of almost all types of freshly squeezed juices, and its affordability.

Dahiana tweets at @arciladk and further information about her research can be found on her website, <**http://www.fishphylogeny.org/**>.

Katie Collins is a New Zealander in the United States of America, employed as a Postdoctoral Scholar at the University of Chicago on a grant made to her PI.

Q1: How did you end up in the United States of America?
I had been keeping my head above water working as a Teaching Assistant and a part-time curator at Victoria University of Wellington and GNS Science after I graduated, not having a lot of luck with funding applications in New Zealand, when my doctoral advisor forwarded me a job advert from PaleoNet for a position at Chicago in macroevolution working with Dave Jablonski – essentially my dream postdoc. I figured I didn't have much of a shot but it couldn't hurt to try, so I sent off the application and then set off on a volcanology field-trip with the VUW Student Geological Society – imagine my surprise when I groggily checked my

e-mail the day after climbing Mt. Tarawera to find out I'd been asked to interview. After spending the interview mostly babbling about the problems of quantifying *Spondylus* morphology, I was perhaps even more surprised (and definitely delighted) to be offered the job.

Q2: How is your position funded?
I'm employed under a grant awarded to my PI, Dave Jablonski. I had to get myself here, and I cover my own conference attendances, but my living expenses, my machine-time on the CT, and collections visits are all covered.

Q3: What is your project about?
I'm working on the morphological diversity of the Bivalvia. To do this, I'm micro-CT scanning shells loaned to us by collections around the world. So far we've made over 3,000 individual scans of ~2,000 species, covering 85 % of the genera of the Recent Bivalvia, and we're now beginning to incorporate fossil taxa too, starting with the Cretaceous. We are using this dataset (which we call "biv3D") to understand the evolution and spatial dynamics of bivalve morphological diversity around the globe. A lot of work goes on behind the scenes developing methods to pull information out of our scans, so my fellow postdoc Stewart Edie and I are problem-solving every day. He does most of the coding that underlies biv3D, while I mostly handle the specimens themselves. Two questions I'm working on right now using these scans are the latitudinal diversity of shell sculpture, and the repeated evolution of rock-boring ability, but we've barely begun to scratch the surface of what this dataset will let us do as we continue to add more species, living and dead.

Q4: What surprised you most about living in the United States of America?
The climate. Chicago goes from boiling hot summer to snow, neither of which I was particularly prepared for, coming from Wellington where we cruise a nice happy temperate medium.

Q5: Apart from friends and family what do you miss most about New Zealand?
The coffee. Sorry America, but your best cold-brew is just not a patch on an espresso from Enigma on Courtney Place! And the rocks – I miss my beautiful shelly limestones.

Katie tweets about molluscs and loud music at @spissatella.

Nicolás Mongiardino Koch is an Argentinian in the United States of America, doing a PhD at Yale University on a University Fellowship.

Q1: How did you end up in the United States of America?
I was taking one of the last courses of my degree, and the professor approached me and told me I should think about pursuing a PhD abroad. I honestly had never considered the option before, but she said it would be the best for my career. I took her word and applied for a few positions in the UK, but I was unable to secure funding as a non-EU student. The same professor then encouraged me to apply for a Fulbright scholarship to go the US, which I ended up obtaining.

Q2: How is your position funded?
My position is fully funded through a Yale University Fellowship. I was offered one upon acceptance even when I had already secured a Fulbright scholarship. Fulbright (quite logically) decided to use that money to send an extra person abroad through the programme.

Q3: What is your project about?
My PhD is on echinoid phylogenomics and macroevolution. I am working on combining genome-scale molecular information from extant sea urchins with the wealth of morphological data that can be obtained from the group's extraordinary fossil record. This will hopefully help me derive a solid phylogenetic framework for the clade with which to test hypotheses regarding its macroevolutionary dynamics.

Q4: What surprised you most about living in the United States of America?
I was very surprised by the diversity of people and cultures present on campus, as well as in the city in general. Living in such an international place has proven to be a hugely enriching experience.

Q5: Apart from friends and family what do you miss most about Argentina?
I definitely miss the more relaxed working culture. It was a shock to arrive at a place where people ate lunch alone and in front of their computers. I think in Argentina the work/life boundary is a lot blurrier, and I really miss the type of interactions that that allows for.

Nic (very rarely) tweets from @phyloprog, and all of his research is hosted on <**https://www.researchgate.net/profile/Nicolas_Mongiardino_Koch**>.

Legends of Rock

Gertrude Elles pioneering palaeontologist, geologist and woman of science

As reported in the last issue of *Palaeontology Newsletter*, the Association has introduced a new award for public engagement, which Council has decided should be named in honour of the pioneering palaeontologist Gertrude Elles (1872–1960). Principally known for her work on graptolites and Lower Palaeozoic stratigraphy, Elles was a pioneer in many respects. She was one of the first female lecturers at the University of Cambridge; the first female Reader at the University; a recipient of the Lyell Fund of the Geological Society in 1900; the first female recipient of the Murchison Medal of the Geological Society (1919); and the first female Council member of the Geological Society (1923–1927). Indeed, when awarded the Lyell Fund women were still not allowed to attend meetings of the Geological Society so she was unable to collect it in person and it had to be collected on her behalf by a man. Within twenty years, and a few months after being awarded the Murchison Medal, she was in the first group of twelve women admitted as Fellows of the Geological Society. Not restricting her activities to geology, she was the Red Cross commandant of a hospital for soldiers during World War One, for which she was

The Sedgwick Club in May 1897. Gertrude Elles, aged 24, is seated on the second row from the front, third from the left, holding a large hammer (image courtesy of the Sedgwick Museum of Earth Sciences 2018).

appointed an MBE in 1920. At Newnham College, Cambridge, she was successively Demonstrator, University Lecturer, Director of Natural Science, and Vice-Principal (1925–1936). Pertinently in relation to the Association's new award, Elles was President of the British Association for the Advancement of Science in 1923 (now the British Science Association).

Gertrude Elles was born in Wimbledon, then in Surrey, in October 1872. She went up to Cambridge in 1891 to read Natural Sciences, where she was influenced by the teaching of T. McKenny Hughes and J. E. Marr, graduating with First Class Honours in 1895. She stayed in Newnham College and began to undertake research on graptolites in the Woodwardian Museum. After a scholarship that enabled her to spend time in Lund, from 1895–1897, she began working with her Newnham friend Ethel Wood (later Dame Ethel Shakespear) and Charles Lapworth at the University of Birmingham on the graptolite faunas of the British Isles. Over twenty years of extensive fieldwork and painstaking descriptive effort by the team led to the production of the definitive monograph on British Graptolites (1901–1918). The work was encyclopaedic in its coverage of the group and beautifully illustrated, with Elles working on the text and Wood focusing on the illustrations. With the taxonomy standardized, a detailed biozonal scheme could be established and that, in turn, enabled the global correlation of Lower Palaeozoic rocks. The work, almost invariably referred to simply as 'Elles & Wood', continues to be a benchmark and standard reference tool a century later. In 1922, with the taxonomy stabilized, Elles followed up the monograph with an influential analysis of evolutionary patterns in graptolites – an early comprehensive treatment of an entire group. In common with her mentor Lapworth, Elles always considered fieldwork to be essential to being a good geologist and for understanding palaeontology. In late career she even undertook research on metamorphism in relation to the structure of the Scottish Highlands with C. E. Tilley.

Elles was an enthusiastic teacher and an influential supervisor of young researchers, many of them women, who took up the baton of producing an accurate global correlation of the Lower Palaeozoic. These included Dorothy Hill, who went on to become the first female professor at

an Australian university, and the first female fellow and first female president of the Australian Academy of Science; Betty Ripper, who worked on Australian graptolites and stromatoporoids; and Oliver Bulman, who became the Woodwardian Professor of Geology in Cambridge.

Gertrude Elles moved to Helensburgh, Scotland, in 1960 and died there a few months later in November of that year. She was not just a pioneering palaeontologist and geologist, but also had an influential position in the early twentieth century vanguard of women in science – the opening line of her obituary in *Nature* noted that she was the 'doyen of women geologists'. She never married, and her college obituary noted that her students and geology were her family. She was a strong supporter of the Sedgwick Club, the geological society in Cambridge, for all of her adult life, and the department in Cambridge retains a remarkable series of annual photographs of her from the young undergraduate of the 1890s through to the mature academic of the mid-twentieth century.

Gertrude Elles in the field. (image courtesy of the Sedgwick Museum of Earth Sciences 2018).

You can learn more about Gertrude Elles from her entry in the Oxford Dictionary of National Biography (<**https://doi.org/10.1093/ref:odnb/46414**>) and O. M. B. Bulman's biography of her in *Nature* (<**https://www.nature.com/articles/1881152a0.pdf**>).

Paul Smith
President

Mystery Fossil 26

Annette Schmid-Röhl (Leiterin Fossilienmuseum und Empfang, Holcim) sent us a request regarding a mystery fossil found by local collector Federico Fanzutti in the Lower Jurassic Angulatensandstein in SW Germany (Zollernalb area). See the two pictures below.

Please send suggestions to <**newsletter@palass.org**>.

The bones of Gaia

Be careful to whom you entrust a planet. Mother Earth, the normally appointed guardian, is usually shown these days as the nurturing type, flowers in her hair, her protective arms sheltering children and forest wilderness alike. In modern mythology, this goddess will invite you into her vine-clad house, be generous with tea, scones and sympathy – and wash the dishes afterwards, as you go on your now-more-enlightened way.

You would think twice, though, before asking the original, primordial Earth mother for sympathy, and – if you had any sense – you would send the scones off for testing in a forensics lab first. Gaia, or Gaea, in Greek mythology indeed personified the Earth, but she was distinctly robust in her nurturing style, as Hesiod related in his *Theogony*. Gaia had many children, for sure, but not, for the most part, of the kind that you would want your own tousle-haired moppets to play with. Among them, the Cyclops, not noted for delicate manners, and those distinctive triplets the Hecatoncheires, each with a hundred arms and fifty heads, all the better to fight the Titans with (as you might guess by now, this was strictly inter-family warfare). There was among the offspring the wily Cronos, too, a Titan who castrated his own father Uranus – being aided and abetted by Gaia herself, who conjured up an adamantine sickle for the purpose.

It is worth bearing this reality TV kind of behaviour in mind when thinking about the novelist William Golding's famous suggestion to James Lovelock that he borrow this ancient and bloodstained name to give to Lovelock's own idea, of how the life of a planet helps sustain itself, by helping regulate planetary conditions. The Gaia hypothesis has certainly led a life of its own since that time, attaining roughly equal measures of both fame and notoriety. Fame, as a concept that has spread far and wide, popular to many well beyond the academic sphere, and notoriety, being criticized by others for depicting the totality of life as some kind of regulatory superorganism. For yet others, the Gaia idea has been more midwife than mother, in contributing to the birth of a more scientifically sober and respectable entity, namely Earth System science, which treats our planet as a single, interconnected system that – without an anthropomorphic personification in sight – has its own dynamics and emergent properties and is greater than the sum of its parts.

As Earth System science has grown eloquent and strong, Gaia has lately often seemed to be fading away in counterpoint, in part a victim of the many faces she has acquired. As if stepped out of one of Venice's more mysterious masked balls, she has now been described, at one and the same time, a 'hypothesis, a testable theory, a summary of highly specific facts, a world view and a philosophy of nature all mixed together' – so, try to remove her mask, and another will appear in its place! The phrase, from a recent PhD thesis[1], is quoted in a joint exploration of the Gaia theory by the philosopher Bruno Latour and the Earth System scientist Tim Lenton[2]. The title includes the phrase 'why Gaia is so hard to understand', chiming with the protean nature of our enigmatic planetary goddess. The underlying message, though, is that Gaia may still be seen as usefully distinct from Earth System science, and not just as one of its more démodé and embarrassing ancestors.

[1] Dutreuil 2016.
[2] Latour and Lenton in press.

The discussion ranges widely, and often over unfamiliar terrain in which I need to inch my way across, but the punch line, once arrived at, couldn't be clearer. What distinguishes Earth System science from Gaia theory? It's a question I have sometimes puzzled over. Latour and Lenton, here, go to great lengths to say that Gaia *cannot* be easily pinned down, and is certainly not an organism or superorganism (something that Lynn Margulis, co-founder of the Gaia hypothesis with Lovelock, insisted on too), not least because it has no coherent inside or outside. Nevertheless, their distinction emerges as quite obvious, even strikingly so.

Thus the Earth and its System is a whole planet – a great big thing, mostly made of rock. Gaia, by contrast, is not a globe at all, they say, but 'a thin biofilm, a surface, a pellicle', which extends a little way up into the air, and a little way down into the ground. Barely less tenuous than a ghost at the scale of a rocky planet, this living skin nevertheless transforms matter and energy to make the planet a quite different body to one that has the same chemical and mineral components, but is devoid of life. Gaia as portrayed here is thus centrally a phenomenon of biology and the biosphere[3], one that makes the Earth much more complex than it would otherwise be, and keeps it firmly out of chemical equilibrium – the last of these qualities being one of Lovelock's own early key insights into the possibility of life on Mars (lifeless, he thought, as that mysterious planet is at chemical equilibrium at the surface). There's a lot more to it than that, of course, but at least there is something here that makes Gaia a little more *tangible*. And with something to get hold of, even a palaeontologist can begin to ask questions.

One of the questions is very simple, and one would normally hesitate to ask it for fear of appearing indelicate – except that it has recently been answered, so it behooves us to press on. How much does Gaia *weigh*? Hesiod's goddess would have bridled most ominously at such an inquiry, doubtless, but Yinon Bar-On and colleagues[4] recently cast caution to the winds, and had a go at calculating the total mass of life on Earth.

The error bars are big. We know there is a deep buried biosphere of *very* slowly metabolizing microbes, eking out a Methuselah-like existence up to a couple of kilometres below ground, for instance, but getting an idea of its scale is still very much work in progress. And even in the case of nearer-surface organisms, counting the likes of, say, terrestrial arthropods and amphibians is not straightforward. Still, with all of the ifs and buts laid out, a figure eventually emerged, of some half a trillion tons of carbon (550 billion tons was their figure, but a little rounding here would not come amiss). As life is more than just carbon, for our present purposes, we might add in the oxygen, hydrogen, nitrogen and such. We humans are about one-fifth carbon by mass. Let us say, then, that all life on Earth today, by extension, weighs some two and a half trillion tons. That is about 5 kilos of living stuff per square metre of the Earth – if grown as a single 'living pellicle', it would be half a centimetre thick. That's almost transparent, when wrapped around a planet-sized rock very roughly a billion times its mass – a ghost indeed.

The distribution is fascinating. Those romantic images of Mother Earth as leaf-bedecked tree-sprite are not so far off the mark. More than four-fifths of the Earth's life is made of plants, and almost all of those are on land. When life came on to land in mid-Palaeozoic times, therefore, to culminate in those Carboniferous coal forests, it not only extended its reach by an extra third of its area, but it also used this platform to gain greatly in mass. Gaia, thus, in eventually emerging

[3] … and thus with some relation to the biosphere *sensu* Vladimir Vernadsky, explored in PAN, vol. 84.
[4] Bar-On *et al.* in press.

from the Silurian oceans in late middle age, after three billion years sheltering in the oceans, grew perhaps five-fold to become – for the most part – a giant forest creature. (And as most trees are made out of wood, which is mostly inert if functional tissue, then perhaps our planet is not so much ghost-wrapped as very delicately wood-panelled.)

There is an earlier history of land plants, to be sure, although it is a spectre in its own fashion. The earliest and tenderest of shoots did not take kindly to fossilization, and it has taken some fancy footwork with molecular clocks[5] to suggest that they appeared some time in the Cambrian. As for the pre-shoot stage, there is a recent demonstration of spectacular antiquity, with terrestrial microbial mats way back in the Archaean, their remains discovered in 3.2-billion-year-old strata of the Moodies Group in South Africa. These latter were taken to be part of a 'thriving terrestrial biosphere' – although presumably non-photosynthetic – of those days. It's all fascinating and important stuff, but probably not *weighty* in an avoirdupois sense, as a tangle of liverworts or film of microbes is unlikely to have anything like the tonnage of a respectable forest.

Of the other fifth part of life measured by Bar-On and colleagues, that's mostly microbial (*sensu lato*: mostly bacteria, though also archaea, protists and viruses) – though that fifth is also the least well constrained. This ancient domain of life might be a lot larger, or smaller: the uncertainty is estimated as 'tenfold'. Fungi make up a couple of percent (and the uncertainty here is a mere 'threefold').

Animals, now, barely scrape into contention, amassing to some ten billion tons[6] or so, or less than half a percent. The uncertainty, surprisingly, is as much as five-fold, or four times as much as is allocated for plants in the study. This probably reflects the difficulty in making a census of those nematodes, cnidarians and hard-to-get-at arthropods which lurk in the crevices of the Earth's physiography. And it is the arthropods that emerge as top dogs[7] amid the animals, mostly in the oceans, at five billion tons or so, outweighing the fish of the world by about a third. As for the land animals … well, we'll deal with the land animals later. Something curious is happening to them – and, as a consequence, to Gaia too.

So, there is some reason for the Earth to be described, to a second approximation, as the 'planet of the arthropods' by any aliens that chance to visit from outer space. I had always thought that the microbes would take the first approximation spot, but before this study, hadn't realized that they would be so emphatically beaten to it, sometime in the mid-Palaeozoic, by the trees. The aliens, one would hope, would tumble to this central truth more quickly – especially if they happened to be photosynthetic.

For therein lies one of the key characteristics of Gaia, as so thought-provokingly outlined by Latour and Lenton. It[8] is photautotrophic, making itself out of inorganic materials, making use, rather inefficiently[9], of a fraction of the power of the sunlight that pours down on Earth. This,

[5] Morris *et al.* 2018.

[6] Two billion tons of carbon was the amount calculated. I'm roughly converting to whole-tissue again, which I'll do throughout.

[7] Or, alternatively, have the lion's share.

[8] It is terribly hard to resist the temptation to be anthropomorphic here, so the third person singular feminine form of the pronoun was only avoided by a whisker…

[9] Thankfully so. Goodness knows what the world would be like if photosynthesis could capture a large part of the incoming solar energy, instead of a small one. Nisbet and Nisbet (2008) indeed have gone some way down this thought experiment and argued that the key enzyme, rubisco, that controls CO_2 capture, was fine-tuned early in the Precambrian to its 'inefficient' state, consistent with a habitable balance between carbon dioxide and oxygen in the atmosphere.

naturally, is the Gaia of a little under the last three billion years, a Gaia-morph that developed some time in the late Archean, when photosynthesis began to leak free oxygen into the ocean/atmosphere system. The original Gaia, prior to that, would have been chemoautotrophic, unlocking the energy present within rocks and sediments without the help of sunlight, as would be the case for any Gaia-relatives that might be present under the ice of the Jovian and Saturnian moons – or buried deep below Martian permafrost. The step to being powered by sunlight was more a long march, given that the 'Great Oxidation Event' of early Proterozoic times took place the best part of half a billion years later.

The next iteration of Gaia is generally held to be the great turning point, and more clearly a step than a long slog, with the Cambrian explosion[10], for the most part accomplished in a mere thirty million years, unleashing a cornucopia of animals, wriggling, swimming, crawling, and evolving claws and armour as they sought to eat their neighbours and avoid being eaten by them. All of the resultant complicated morphology and activity (and sentience, too, a further string to Gaia's bow) is always in prime focus in a palaeontologist's field of view – the beginning of the geological eon we still live in, and all that. But, the calculations of Bar-On and colleagues suggest that we are dealing here with the re-engineering of but a small part of the Earth's biomass, and the question of whether this in turn was essentially mass-neutral at the expense of a fraction of those microbes or substantially added to the weight of the Earth's living freight is one that would need quite a large pot of tea to muse through.

The marine plants at the base of the food chain would have been crucial to the whole process, but likely did not bulk large: Bar-On *et al*. note that the total biomass of today's oceans is only about 30 billion tons, or two orders of magnitude less than that on land, even though the oceans have an area twice that of land – and this *definitely* gives pause for thought to those who have spent a good deal of their lives hammering fossils out of early Palaeozoic strata. Moreover, the food pyramid of the oceans is inverted, with only about five billion tons of plant material – which therefore has to grow quickly and be eaten quickly to keep all those marine animals going.

It's efficient cycling – and that again is taken as a key character of Gaia as interpreted by Latour and Lenton: this idea of an almost perfectly closed system, constantly recycling matter. But again, they note that, this holds true depending which of Gaia's masks happens to be on show. For the Gaia that works on long time scales, living matter is converted to dead matter that is buried in strata. The classic case is carbon, of which less than a percent typically leaks out of the biological cycle to wind up as coal, oil and gas underground. A little spookily, we have burnt a touch over one contemporary Gaia's worth of carbon since the Industrial Revolution – a bit more than half a trillion tons. Quite a few more such amounts, of course, still lie underground.

Overall, though, the efficient cycling works well for bodies, as the organic carbon that once animated them begins the journey into other bodies. The situation is more complicated for skeletons – for shells, bones, teeth, that is, for those things which are a palaeontologist's stock-in-trade. More solid than flesh, they can outweigh it too. Our own skeletons are modest in this respect: we are about 15% bone by mass. Other animals are more skeleton-heavy. Cookery websites discuss the proportions of shell to edible tissue in different molluscs (mussels range from about half to three-quarters shell), while a study of arthropod metabolism did the same thing for crabs and shrimps (which weighed in at a quarter to over half skeleton by mass). These are the

[10] Or, the Cambrian eruption, as Preston Cloud put it, on the grounds that it didn't make a noise.

parts of Gaia's mortal remains that have the most direct path out of the recycling loop, and into immortality through petrifaction.

They can add up. Let us take, for an example, the Cocos-Keeling islands, which were walked and jumped[11] on by Darwin, as he pondered (and solved) the mystery of how coral atolls formed. The southern and bigger of these two atolls is mostly a stretch of very shallow sea some 10 kilometres across, where part of the living matter, amounting to perhaps just a few thousand tons, is busy making skeletons and so adding to the atoll's mass. That mass is some two kilometres thick and thus would weigh in at over half a trillion tons, a skeletal mass of limestone that rivals in bulk all living biomass, beneath just a tiny speck in the wide Indian Ocean. Such a coral reef is a prime example of a gateway from a delicately tenuous living world into a gigantic underworld of the dead. It's amazing what a few million years can do.

This huge skeleton trail takes husks of Gaia back into the past – and by doing so has slowly shaped the Gaia of the present. But other, much newer things are modifying Gaia too. Bar-On and colleagues, amid their calculations, include one that suggests that the sum of planetary life is now about half the mass that it used to be before humans began to set about the world with spears and axes. The spears are probably nugatory in this particular respect, given the trivial mass contribution of animals to the stuff of the Earth's life. The axes, though, have allowed humans to cut down an awful lot of trees, and to diminish life as a whole in the most basic way (while expanding their own share in the process, to become a third or more of terrestrial vertebrate biomass).

This purposeful deforestation, and all that stemmed from it, are symptoms that led Lenton and Latour[12] to the further suggestion that the Earth, after nearly four billion years in a mode where its regulation of surface conditions was unconscious and unplanned – they call this Gaia 1.0 – is now in a different state. In the Gaia 2.0 of the present, they say, the combination of human powers, technology-augmented and evolving hyper-rapidly, and human self-awareness, is now driving the system. Ideally, they say, the self-awareness part should be brought into full play to find means to maintain Gaia in life-supportive mode, and to keep her[13] more murderous impulses at bay. We are, they note, a little way from that happy state. Helping rather than dismantling Earth's self-regulation processes will need thinking deeply on how matter, energy and life are evolving from past to present to future. Part of that story, of course, lies petrified in the rocks – but it may need musing on from new perspectives. High time to reboot to Palaeontology 2.0, perhaps?

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[11] With a home-made 'leaping pole' – he was a young man, then, and very keen to get to the edge of the coral growth zone at the edge of the sea.

[12] Lenton and Latour 2018.

[13] The third person singular feminine form finally breaks through. Hesiod would surely, here, allow no other.

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Wardie: Stan Wood and a challenging Edinburgh fossil site

Stan Wood began his remarkable fossil-hunting career in 1969 at Wardie, an Early Carboniferous locality on the southern shore of the Firth of Forth in the northern outskirts of Edinburgh. For two years he searched in vain in the black shales exposed by the falling tides until eventually he learned that the fossils collected in the past had been found in the hard ironstone concretions within the shales and not in the softer rocks. After that there was no stopping him, and over the next few years Stan assembled a large collection of actinopterygians, acanthodians and chondrichthyans which he subsequently sold to National Museums Scotland (NMS) and the Natural History Museum, London (NHM). The new chondrichthyans formed the basis of John Dick's PhD research (*e.g.* Dick 1978) and revealed a hitherto unknown shark biota, but the actinopterygians and acanthodians were, until recently, largely overlooked. Now, the application of new technologies, most notably micro CT scanning, are uncovering the detailed anatomy of these fishes for the first time and shed new light on Wardie as a middle Mississippian Lagerstätte that preserves a remarkable fauna of vertebrates that formed part of the foundations of the modern vertebrate fauna.

Wardie was a significant fossil site during the late nineteenth century with Hugh Miller among the many who collected there. It yielded numerous new taxa, some of which were named and described by the great Scottish palaeoichthyologist Ramsay H Traquair. The site was largely neglected during the first half of the twentieth century, but Stan championed its significance. He kept detailed records of his discoveries and these formed the basis of his first paper (Wood 1975). In this he identified a total of seven fish beds, which he characterized by the different concretions they contained. Of the 14 fish taxa previously described from Wardie, Stan found 13 but in addition discovered two new un-named chondrichthyans and the first record of

Elonichthys striatulus at the site. He tabulated the relative abundance of fish taxa in the different beds, noting that the chondrichthyans were comparatively common and may have been overlooked by previous collectors. Stan followed this with a privately published memoir (Wood 1992) entitled *A Challenging Edinburgh Fossil Site* (Figure 1). It was part field guide and part review, in which he outlined the history of the locality. He discussed the un-salubrious environment of the shoreline when he began collecting, before a new treatment works removed the need to pump raw sewage into the Forth at Wardie. He also described his technique for preparing the concretions to expose the fossils, which included boiling them first to make them safe to handle. He included a summary of its geology and vertebrate fauna. It has an excellent bibliography and is a good place to begin for anyone wanting to find out about Wardie. The memoir has been out of print for many years and in the UK was only available at the National Library of Scotland and the NHM, London. Recently however, with the aid of a generous donation from The Palaeontological Association, it has now been made available through the Biodiversity Heritage Library (BHL) at: <**https://doi.org/10.5962/bhl.title.150534**>.

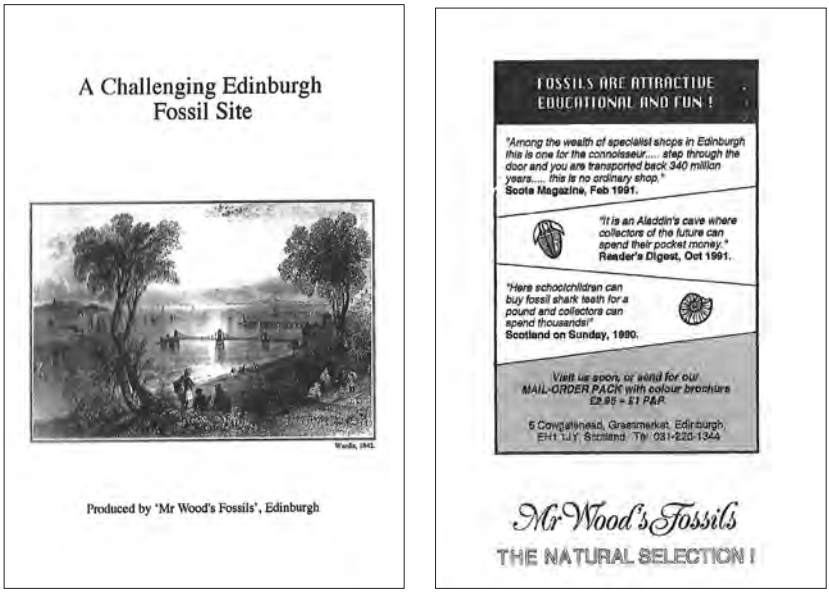

Figure 1: Front and back covers of Stan Wood's 1992 memoir on Wardie recently made available by the Biological Heritage Library at <**https://doi.org/10.5962/bhl.title.150534**>.

Stan's pioneering work at Wardie was briefly described by Smithson and Rolfe (2018) in one of a collection of papers published earlier this year in tribute to Stan entitled *A legacy in fossils* (Fraser *et al.* 2018). It also records many of his other significant discoveries at Dora, Bearsden, East Kirkton, Mumbie, Whitrope Burn and Willie's Hole. In the same volume, Coates and Tietjen (2018) gave a detailed account of the braincase of one of the earliest elasmobranchs *Tristychius,* based on micro CT scans of Wardie specimens collected by Stan (Figure 2). This revealed for the first time the true proportions of the cranium, details of the jaw suspension, and, internally, the form of the otic labyrinth with implications about its hearing capability.

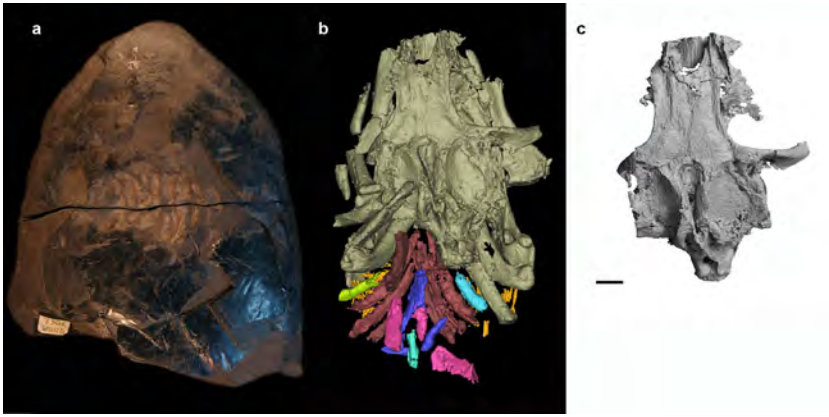

Figure 2: Tristychius arcuatus*, National Museums Scotland specimen G 1974.23.20, collected by Stan Wood. a. Wardie nodule unprepared. b. Rendered CT scan data revealing cranial cartilages, including braincase, jaws, hyoid arch (dull olive), gill arches (brown, green, pink, blue) and gill rays (yellow). c. Completed rendering of neurocranium, dorsal view (Coates and Tietjen 2018, adapted from Fig. 6). Scale bar 10 mm.*

One of the early collectors at Wardie, much admired by Stan, was Thomas Stock. After a brief period working with Traquair at the Museum of Science and Arts in Edinburgh (later to become the NMS), Stock emigrated to America and took his fossil collection with him, eventually selling it to the Museum of Comparative Zoology, Harvard. Among these specimens is the only tetrapod to have been found at Wardie, an elongate, limbless form, *Lethiscus stocki* (Wellstead 1982). This was the first Wardie specimen to be investigated using X-ray techniques (Wellstead 1982), and the most recent study using micro CT (Pardo *et al.* 2017) revealed new details of the skull and braincase and demonstrated the efficacy of this technique on ironstone concretions. More recently, another of Stock's specimens, containing the actinopterygian *Eurynotus*, has been CT scanned, and delivered details of the braincase, jaws and toothplate dentition (Friedman *et al.* in press).

Wardie's time in the spotlight has come. This important middle Mississippian Lagerstätte, with its taxonomically diverse and morphologically disparate fauna of actinopterygians, chondrichthyans, rhizodonts, undescribed lungfish and a tetrapod, is one of the earliest known glimpses of vertebrate diversity following the end-Devonian extinctions. Micro CT scanning is finally releasing the data long thought to be locked within the fossils from this "challenging" site (Wood 1992) and has proved effective on tetrapod, shark and ray-finned fish specimens. It is anticipated that over the next few years our understanding of this critical time in the evolution of the early members of the modern vertebrate fauna will be much enhanced through the study of the considerable body of material collected by Stan Wood.

Tim Smithson
University Museum of Zoology, Cambridge

Nick Fraser
National Museums Scotland, Edinburgh

Mike Coates
University of Chicago

Acknowledgements

We thank Maggie Wood and Matt Dale, proprietor of Mr Wood's Fossils, for allowing Stan's memoir *A Challenging Edinburgh Fossil Site* to be made available by the Biodiversity Heritage Library, Bianca Crowley at the BHL for her help and advice, and Jo Hellawell and the Palaeontological Association for their support and encouragement.

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

Linnean Society Palaeobotany and Palynology Specialist Group Meetings
Burlington House, London, UK *21 – 22 November 2018*

The 2018 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**>) or Barry Lomax (e-mail <**barry.lomax@nottingham.ac.uk**>), respectively.

1st Palaeontological Virtual Congress
Virtual environment *1 – 15 December 2018*

The emergence of new applications and technologies opens a wide range of possibilities regarding new forms of communication in the scientific world. The 1st Palaeontological Virtual Congress is being convened with the purpose of spreading the most recent scientific advances in palaeontology worldwide in a fast, easy and economical way.

This Congress is a first for palaeontology, being exclusively developed in a virtual environment. Oral communications and posters about any palaeontological field will be presented through an online platform. The simplicity of this new format allows for low-cost registration fees and saves travel and other expenses. Consequently, this initiative aims to give international projection to the palaeontological research carried out by groups with limited economic resources, and promotes participation of palaeontologists from developing countries.

The 1st Palaeontological Virtual Congress combines the benefits of traditional meetings (*i.e.* providing a forum for discussion, including guest lectures or the production of an abstract book among other things) with the advantages of the online platform, allowing a higher number of researches around the world to benefit. Online congresses can also enable the creation and management of new thematic workshops by the participants. The organizers are seeking workshop proposals dealing with any palaeontological topics.

Please see the website for further details: <**http://palaeovc.uv.es/**>.

GCG Winter Seminar and AGM
Amgueddfa Cymru – National Museum Cardiff, UK *4 – 5 December 2018*

The topic is “Inspiring Volunteers” and will be hosted in Wales. The organizers are keen to involve as many of our museum colleagues as possible, be they waged or unwaged, so as well as ensuring the costs for the seminar are as affordable as possible, the committee is investigating the possibility of

offering a series of travel/attendance bursaries. Further details will be announced on our website as they become available: <**https://www.geocurator.org/agm2018**>.

If you are interested in submitting an abstract for a talk or workshop relating to the theme of the conference, please get in touch with Zoë Hughes (<**events@geocurator.org**>) or Cindy Howells (<**membership@geocurator.org**>).

JK2018
Muséum d'histoire naturelle, Geneva, Switzerland *5 – 7 December 2018*

The aim of JK2018, the International Meeting around the Jurassic–Cretaceous Boundary, is to discuss eustatic, biological, physiographical, geochemical *etc*. events at/near the boundary (*i.e.* over an interval of time spanning the Kimmeridgian to the Hauterivian, with a special focus on Tithonian to Valanginian strata). Registration is now open.

Please check the website for updates: <**http://php5.univ-brest.fr/conference/ocs/index.php/JK2018/JK2018**>.

The past is a foreign country: how much can the fossil record actually inform conservation?
London, UK *28 – 29 January 2019*

This meeting, to be held at the Royal Society in London, aims to bring together researchers from the fields of deep-time palaeontology, Quaternary science, historical ecology and conservation biology to provide expert-based interdisciplinary assessment of the potential opportunities for using different long-term biodiversity archives to inform conservation and environmental management, and critical evaluation of the potential limitations of using past data to understand the present and predict the future. This scientific discussion meeting is organized by Dr Samuel Turvey and Associate Professor Erin Saupe. Participants of the meeting will be able to present a poster. If you would like to apply to present a poster please submit your proposed abstract to the Scientific Programmes team no later than Friday 26th October 2018 (see website for details). Please note that places are limited and abstracts will be selected at the scientific organizers' discretion.

Register online at <**https://royalsociety.org/science-events-and-lectures/2019/01/the-past-is-a-foreign-country/**>.

4th International Meeting of Early-Stage Researchers In Palaeontology (IMERP)
Castilla-La Mancha Paleontology Museum, Cuenca, Spain *12 – 14 June 2019*

The IMERP is aimed at early-stage palaeontologists, from undergraduate students to recent post-doctoral researchers. Geologists, biologists or any scientist with research topics related to

palaeontology, as well as palaeoartists, are also welcome. The IMERP has two main objectives: to provide a friendly environment for early-stage researchers to present their research and follow each other's progress; and to share new methods and useful ideas in palaeontology. Another aim is to develop the skills of the attendees with the help of invited expert speakers. The IMERP is held in villages or towns located close to areas of geological interest. A field-trip in this palaeontological and geological heritage area will be offered.

Abstract submission is now open and ends on ends on 1st February 2019; registration closes on 1st March. For more details please see the website: <**www.imerp2019.weebly.com**>.

18th International Bryozoology Association Conference (IBA)
Technical University of Liberec, Czech Republic *16 – 22 June 2019*

The IBA 2019 focuses on bringing together researchers and students to exchange and share experiences and research results on all aspects of bryozoan life. IBA offers a burgeoning field of study as it consists of diverse scientific topics including, but not limited to, taxonomy and systematics of fossil and living bryozoans, their ecology, evolution, response to climatic changes and the history of research. The Conference is the premiere forum for the presentation of new advances and research results in all fields of bryozoan studies.

Please see the website for more information: <**http://18iba.tul.cz/**>.

Lyell Meeting 2019: Carbon: geochemical and palaeobiological perspectives
Geological Society of London, Burlington House, UK *28 June 2019*

The 2019 Lyell Meeting seeks to foster conversation between disparate scientific communities to facilitate a more holistic approach to considering carbon, and how it cycles between Earth's organic and inorganic reservoirs.

The fundamental building block of life as we know it, carbon is critical to the Earth system. Traditionally biological and chemical approaches to understanding carbon dynamics in the geological past have been considered in relative isolation.

The 2019 Lyell Meeting aims to bring together a broad spectrum of scientists that address the big picture of carbon in the Earth system, drawing on expertise in palaeontology, geochemistry, palaeobotany, atmospheric processes, deep-Earth processes and anthropogenic impacts.

Oral and poster abstract submissions for the meeting are now invited. These should be sent in a Word document to Rhianna Mclean (e-mail <**rhianna.mclean@geolsoc.org.uk**>) by 4th February 2019. For more details see the website <**https://www.geolsoc.org.uk/lyell19**>.

Registration rates for the Lyell Meeting are reduced for PalAss members.

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 a second held in Graz (Austria) in 2015, the 3rd International Congress on Stratigraphy will be held in Italy. The Congress venue is Milan, in the historic buildings of the University, with pre- and post-congress field-trips to the Alps, Appennines, and the Italian islands.

STRATI 2019 is organized by the Commissione Italiana di Stratigrafia, Servizio Geologico d'Italia, Società Geologica Italiana, Società Paleontologica Italiana, Associazione Italiana per lo studio del Quaternario, and Università degli Studi di Milano.

For more information see the website: <**http://www.strati2019.it/**>.

5th International Symposium on Palaeohistology (ISPH)
University of Cape Town, South Africa *31 July – 4 August 2019*

The 5th International Symposium on Palaeohistology will be hosted by the Palaeobiology Research Group of the University of Cape Town at the River Club, between 31st July and 4th August 2019.

This international meeting brings together researchers at all levels (postgraduates, postdocs, established researchers) investigating the histology of mineralized tissues of extant and extinct animals.

The deadline for abstract submissions is 31st January 2019. Please see the website for more details: <**http://www.isph2019.co.za/**>.

13th International Symposium on Fossil Cnidaria and Porifera
University of Modena and Reggio Emilia, Italy *3 – 6 September 2019*

The 13th International Symposium on Fossil Cnidaria and Porifera is the traditional meeting of the International Association for the Study of Fossil Cnidaria and Porifera. Symposia are organized every four years and take place around the globe. In 2019 the Symposium will be in Italy for the first time and aims to bring together participants from all over the world to discuss and share the most recent advances in studies of fossil corals and sponges, coral reefs and associated biota. The importance of the fossil archives will be highlighted with regard to understanding responses of the biosphere to long term environmental perturbations. The Symposium will aim to promote interdisciplinary approaches from a body of interested palaeontologists and biologists, but also scholars in other disciplines.

Please see the website for more details: <**http://www.13thfossilcnidaria.unimore.it/**>.

3rd International Conference of Continental Ichnology (ICCI 2019)
Martin Luther University of Halle-Wittenberg, Halle, Germany
23 – 29 September 2019

The 3rd International Conference of Continental Ichnology with take place at the Central Natural Science Collections (ZNS) of the Martin-Luther-University in Halle (Saale) from 23rd to 29th September. Please save the date!

This Conference will include all aspects of extant and fossil continental ichnology. Suggestions for possible symposia are welcome.

We expect to send out the first circular towards the end of 2018.

We are already planning several ichnological field-trips including many classic and world-famous German fossil ichnosites from the Permian (*e.g.* Bromacker Quarry), Triassic (*Chirotherium* sites in Thuringia), and Cretaceous (Obernkirchen and Münchehagen).

For more information, see the website: <**https://sites.google.com/view/3rd-icci-2019/**>.

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

Zoë Hughes
Natural History Museum, London

Meeting REPORTS

Des journées de rencontre autour du patrimoine minier de la Corniche Angevine (JRPM 2018)
Maine-et-Loire, France *4 – 7 June 2018*

Anjou is a historical region in the west of France that corresponds broadly to the modern department of Maine-et-Loire and has Angers as its capital. During the middle of the nineteenth century the co-development of the carboniferous coal mine industry took place alongside that of the lime kiln industry – the main consumer of the coal. Important industrial remains of these heritage sites still exist in the town of Montjean-sur-Loire, 30 km from Angers, now classified as 'French Historic Monuments'. Among these remains is one of the largest mining headframes (32.29 m high) built in stone that can still be seen in France. Coal rising to the surface from this headframe was transported to seven neighbouring lime kilns at the time of mining operations.

Another historic mining area is in the 'Corniche Angevine', *c.* 15 km to the east of Montjean around the towns of Chalonnes-sur-Loire and Chaudefonds-sur-Layon. It comprises the remains of a mining village. Parts of it (*e.g.* the house of the director, the school, some miners' houses) are now private, but the other parts are owned by the local towns. Partial preservation of these publicly-owned geoheritage sites has started to be carried out: in particular, the miners' church – the Chapelle Sainte Barbe des Mines – and the over-ground remains of the deep coal mine 'Les Malécots 2' that closed in 1964.

Numerous fossil plants have been collected from the mines of the Corniche Angevine during the nineteenth and twentieth centuries and are now housed in the collections of regional museums as well as in the Muséum national d'Histoire naturelle, Paris. Previously they have mainly been studied by the well-known palaeobotanists E. Bureau and A. Carpentier. We (Christine Strullu-Derrien, Alan Spencer and Christopher Cleal) are currently reinvestigating this flora with a paper in preparation.

Next to the Carboniferous coal mine of Les Malécots lies a disused roadstone quarry. This important site, known as the 'Tranchée des Malécots', provides a unique window into the Namurian (326.4–315 Ma) flora of the region. The site consists of bedded 'pierres carrées' or square stones and volcanoclastic ash deposits, interspersed with *in-situ* and *ex-situ* plant remains, which are preserved as either carbonized adpressions or three-dimensional moulds/casts; prior to the meeting a 3D digital record of this fossiliferous site was undertaken.

A project for the valorization of the mine heritage

Des journées de rencontre autour du patrimoine minier de la Corniche Angevine was the first meeting organized in this historic mining area, and had the aims of highlighting the geological and palaeobotanical mining heritage, and educating the wider public in the geographic region. It focused around a scientific meeting and had numerous public outreach events (which included 13 local primary schools). These events were located in and around Chalonnes-sur-Loire, and the historic Chapelle Sainte Barbe des Mines, a stone's throw away from the city of Angers.

The meeting was organized by Christine Strullu-Derrien (Natural History Museum, London) and Sylvain Marcais (l'Association Ste Barbe des Mines), in collaboration with Christopher Cleal (Amgueddfa Cymru—National Museum Wales), José Bienvenido Diez Ferrer (University of Vigo), Alan Spencer (Imperial College London), Fabrice Redois (University of Angers), Céline Ducassou (University of Rennes) and Philippe Cayla (University of Angers). It received its main support from the town of Chalonnes-sur Loire, the region Pays de la Loire, the tourist office of Chalonnes and the Palaeontological Association (Grant-in-aid, grant number PA-GA201803). Other contributors were Mécènes et Loire (a French foundation), towns around Chalonnes, the museums of Nantes and Angers and local advertisers.

The Q&A session for local schools and exhibition of their artworks. Photo by Alan Spencer.

The range of activities at the meeting was particularly diverse. Over the first two days, 14 scientific talks were directed to a large audience, among whom members of local councils, focused on: 1) the geology and history of the mine sites; 2) some examples of valorization and tourism attractions linked to the mines and; 3) Carboniferous fossil plants of the area. Throughout the days an exhibition of fossil plants from the area was also presented to the public. On the third day, despite cold torrential rain (very bad weather for the season!), there was a field-trip visiting numerous historic mine sites. This was successfully led by Fabrice Redois, Céline Ducassou and Philippe Cayla. It was well attended with *c.* 50 people, and was appreciated by very enthusiastic participants. On the last day of the meeting artwork produced by local schools was exhibited, and a question-and-answer session with the palaeobotanists took place. During the day 293 school children, ranging from 8 to 11 years in age, and their teachers presented pictures, paintings and models on the theme of Carboniferous forests. Prior to the meeting Christine Strullu-Derrien had gone around to the local schools to present and explain to the students what fossil plants had been historically collected from this area and posed the question "What was a Carboniferous forest?" They were then asked to imagine the forest and, with the help of their teachers, to create artworks. Professional artists joined us for this part of the project and prepared a collective exhibition, open to the public in the local tourist office, around the mine heritage of the "Corniche Angevine".

The meeting was well perceived by local people and members of local councils. A plan is now afoot to use the momentum created during the meeting to work towards building a centre of interpretation based around the mining heritage. We warmly thank the Palaeontological Association for its support that enabled European palaeobotanists to participate to this meeting.

More information and photos of the meeting can be found on the website at <**jrpm2018.eu**>.

Looking at fossil plants in the 'Tranchée des Malécots' during the field-trip. Photo by Christine Strullu-Derrien.

Christine Strullu-Derrien
Natural History Museum, London

Alan Spencer
Imperial College London

15th Larwood Symposium
Cardiff, UK *6 – 8 June 2018*

Amgueddfa Cymru—National Museum Wales hosted the 15th Larwood Symposium, a meeting for both palaeontologists and biologists with an interest in bryozoans, with the chance to interact and exchange ideas on both fossil and living animals. It was the 20th anniversary of the first Larwood Symposium, named after palaeontologist Gilbert Larwood from Durham University, which took place in Bristol in 1998. There was a minor scare a couple of months before the 2018 Symposium, when participants noticed that the cost of hotels in Cardiff had tripled in price for the days of the meeting. This was not the demand by bryozoologists pushing up the price but the announcement that Beyoncé and Jay-Z would be playing at the Principality Stadium in Cardiff on the first evening of the meeting. Luckily everyone managed to find somewhere to stay.

The meeting lasted for three days, the first day and a half filled with scientific presentations and poster sessions. It began with **Paul Taylor** (NHM, London) looking at whether the greater thickness of the cuticle in cheilostome bryozoans was an advantage compared with cyclostome cuticles. This was followed by talks on the phylogeny of the ctenostomes (**Andrea Waeschenbach**, NHM, London, plus a large international group) and the evolutionary history of cheilostomes (**Helen Jenkins** and **Silviu Martha**, NHM, London). Bryozoans from the Ordovician to Pleistocene were examined including a presentation by **Mark Wilson** (Wooster College) who proposed a new term 'Bryoimmuration' describing how encrusting bryozoans were very important in preserving Ordovician aragonitic faunas.

Abby Smith (Otago University) opened the second day of talks, discussing the effect of sample preparation and the storage of biomineral carbonate on geochemistry. Fresh water bryozoans were highlighted by **Beth Okamura** and **Paolo Ruggeri** (NHM, London), and the final talk of the meeting was by **Lee Hsiang Liow** (University of Oslo) looking at competitive overgrowth outcomes for encrusting cheilostome bryozoan species.

The support offered via the Palaeontological Association Grant-in-aid (grant number PA-GA201710) enabled awards to be made for the best talk and poster by an early career bryozoologist. **Arthur Porto** (University of Oslo) won the best talk award for his presentation on 'High-throughput phenotyping of Bryozoan specimens using machine learning: a Cheilostome case study', and the poster prize went to **Mali Hamre Ramsfjell** (University of Oslo) for 'Cheilostome bryozoan diversity in the Pleistocene Tewkesbury Formation, New Zealand'.

On the afternoon of the second day, **Lesley Cherns** (Cardiff University) joined us to lead a field-trip to the Glamorgan coast, first to Ogmore-by-Sea to look at the Carboniferous–Triassic–Jurassic section. Bryozoans are not common in the Carboniferous Limestone at this locality but as you might have guessed, members of this party managed to find them. The second stop was at an Upper Triassic section along the coast at The Bendricks, where there were no bryozoans but participants got to see 220 million-year-old dinosaur footprints.

Delegates on the field-trip at Ogmore-by-Sea. Photo courtesy of Mark Wilson.

On the final day there were tours around the curatorial areas at Amgueddfa Cymru—National Museum Wales, looking at the palaeontological, marine and Mollusca collections. This was followed by a trip to Big Pit National Coal Museum. Located in Blaenafon, the Museum still retains many features of its former life as a coal mine. Everyone took the underground tour and went 90 m down the mine, entertained by our tour guide, a former miner.

Caroline Buttler
Amgueddfa Cymru—National Museum Wales

Progressive Palaeontology 2018
Manchester, UK *7 – 9 June 2018*

This year's *Progressive Palaeontology*, the student conference of the Palaeontological Association, was held jointly between the University of Manchester and Manchester Metropolitan University, and hosted in Manchester Metropolitan University's Sandra Burslem Building.

Prior to the plenary talks, two great workshops took place at the University of Manchester Williamson Building on "Visualizing CT Data" and "Biomechanics in Palaeontology" gratefully led by **Dan Sykes** and **William Sellers**, respectively, followed by an open panel discussion chaired by **Elspeth Wallace** on careers in palaeontology. The outstanding Fossil Gallery of Manchester Museum then played host to the conference icebreaker, which is always a fantastic opportunity to reconnect with and expand one's palaeontological career network, and what better location than in the shadow of Stan the *T. rex*?

The plenary was attended this year by an international cohort of some 90 delegates heralding from institutes all over Britain and Ireland, with collective research spanning the Protero- and Phanerozoic and all disciplines of the macro- and micropalaeontological realm. The 27 talks which were presented were once again kindly live-streamed by Palaeocast and are available to re-watch on their website (<**http://www.palaeocast.com**>).

The talks were structured into four sessions which consisted of a number of 12 minute "full" talks, followed by 4 minute "lightning" talks which allows researchers in any stage of projects to present their work. The well-deserved prize-winning oral presentations this year went to **Orla Bath Enright** for her full talk on 'Spinning the truth out of worms: Investigating the impacts of decay and transport on palaeocommunity fidelity of the Burgess Shale', and **James Chester** for his lightning talk on 'A Total Evidence Approach to Scorpion Evolution.'

Between sessions, tea, coffee and lunch breaks provided a great opportunity to take a look at the 28 research posters that further demonstrated the diversity of exciting research topics which are being worked on by the younger palaeontological community.

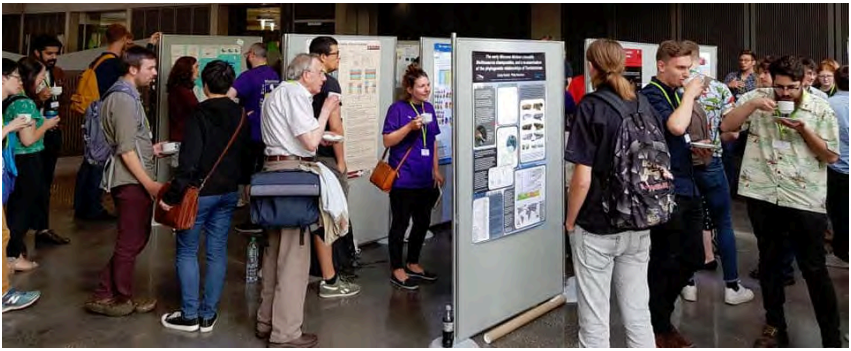


Photo: Adam Woodhouse.

With so many fantastic posters it was difficult to pick a favourite, however **Nuria Melisa Morales Garcia**'s poster '2D extruded Finite Element Analysis: a new biomechanical approach to the study of Mesozoic mammals' demonstrated terrific presentation of a novel analytical technique. Prior

to reconvening after lunch, we were able to hear from the President of The Palaeontological Association, **Paul Smith**, who demonstrated the great work that PalAss is doing towards ensuring that all demographics are equally represented in our discipline.

Following from the concluding remarks, the delegates took part in a slow saunter along Manchester's famous "Curry Mile" for a hearty conference meal at the award-winning Indian restaurant Lal Qila, followed by the annual ProgPal palaeo-auction run by the committee. This saw delegates battling for all kinds of palaeontological artefacts under the hammer, which is always met with much merriment.

Photo: Adam Woodhouse.

Photo: ProgPal Organizing Committee.

Saturday morning provided fantastic weather for a field-trip into the Peak District to explore the local exposures on and around Mam Tor to find fossils and take in the stunning scenery.

Another brilliant turnout for Progressive Palaeontology thanks to the painstaking work of the committee and organizers at the University of Manchester and Manchester Metropolitan University. We hope to see lots of familiar faces next year at the University of Birmingham, as well as lots of new faces eager to discuss evermore exciting palaeontological research topics.

Adam Woodhouse
University of Leeds

The International Symposium on Foraminifera (FORAMS 2018) – Foraminifera in a changing world

Edinburgh and St Andrews, UK *17 – 24 June 2018*

The International Symposium on Foraminifera, FORAMS 2018, was held in Edinburgh, the Scottish capital, thanks to the involvement and support of the School of GeoSciences at the University of Edinburgh and the School of Geography and Sustainable Development at the University of St Andrews. The Symposium brought together professionals, students and academics from 48 countries to communicate their advances in foraminiferal research. With over 600 abstracts submitted, the scientific programme was diverse, with 18 technical sessions taking place during the meeting, ranging from foraminiferal biology, evolution and population dynamics to geochemistry and molecular works on single-cell and environmental genomics. Particular attention was given to contributions discussing the impact of our changing world on foraminiferal responses to multi-stressor events and biogeographical perturbations.

The Symposium welcomed delegates at the opening ceremony with speeches by the Lord Provost of the City of Edinburgh and the Regius Professor of Geology Dick Kroon, followed by an icebreaker reception held at the Playfair Library in the Old College, University of Edinburgh. This provided an excellent occasion to catch up with friends and colleagues as well as an opportunity for introductions, all while enjoying a glass of wine and the beauty of the surrounding architecture.

Day One started with a plenary session hosting keynote talks by **Jennifer Fehrenbacher**, **Elisabeth Alve** and **Tine Lander Rasmussen**. These highlighted current mainstream research approaches as well as advances in the fields of geochemistry, biomonitoring, and the development of environmental proxies. A set of parallel talk and poster sessions followed, giving delegates the possibility of choosing between discussions on foraminiferal biomineralization and geochemistry, biomonitoring, ecological and evolutionary dynamics in deep time, as well as Quaternary research.

Day Two saw the keynote talks of **Bruce Hayward**, **Valeriya Mikhalevich** and **Raphael Morard** during the plenary session. These introduced the main topics of the day: foraminifera as tools to bridge the gap between past and present, the history of foraminiferal research (how the past can inform the future) and genomics of foraminifera. Additionally, presentations on planktonic foraminiferal ecology and population dynamics, as well as on evolution, stratigraphy and geological crises, took place in the morning and afternoon. The day concluded with the Cushman Foundation reception and a ceilidh, which had the delegates testing themselves with Scottish traditional dancing.

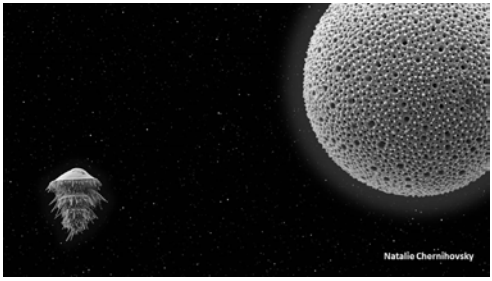
Day Three was dedicated to field-trips exploring the geology and history of Edinburgh and elsewhere in Scotland. Six excursions were planned by the organizing committee, and groups headed off to the Isle of May, Siccar Point, Arthur's Seat, the Royal Yacht or Edinburgh Castle. The whisky tasting held in the evening could not have been missed while attending a symposium held in Scotland!

Day Four had the delegates back at the John McIntyre Conference Centre to attend keynote talks from **Bridget Wade** celebrating 50 years of ocean drilling, **Mike Simmons** using applied micropalaeontology to tie together industrial and academic research, and **Anna Weinmann** exploring foraminiferal biology in times of global change. The day concluded with the Symposium Dinner at the Assembly Rooms where delegates enjoyed an excellent meal and speeches by **Jere Lipps**, **Helena Filipsson** and Symposium hosts **Bill Austin** and **Kate Darling**.

One of the groups enjoying Hutton's unconformity at Siccar Point: see the unconformity, be the unconformity; horizontal Devonian, vertical Silurian. Photo courtesy of Elena Lo Giudice Cappelli.

The last day of FORAMS 2018 saw the keynote talks of **Hidetaka Nomaki**, **Laia Alegret** and **Maria Rose Petrizzo** opening discussions on foraminiferal experimental studies, deep time records of climate change impacts, and ocean drilling and foraminifera. Talks and posters on larger benthic foraminifera as historical archives of deep time changes followed the plenary session, together with The Micropalaeontological Society Spring Meeting. The Symposium ended with the closing ceremony, during which three poster prizes were awarded to international students and the bidding for the next symposium host took place. We are looking forward to FORAMS 2022 in Perugia, Italy!

Throughout the whole Symposium SHELLSCAPES took place, an interdisciplinary art and science project that saw delegates, museums and start-ups joining forces to contribute images and art inspired by foraminifera.



A contribution by Natalie Chernihovsky submitted to the art exhibition SHELLSCAPES, hosted during the Symposium.

Workshops at the University of St Andrews followed the Symposium, providing a unique platform to bring together the world-leading experts in the field of foraminiferal research and early career scientists, in a more specialized context than at the main symposium. The workshops offered hands-on training opportunities on foraminiferal biomonitoring and applied biostratigraphy normally unavailable at the participants' home institutions. This gave early career scientists from around the globe the chance to meet and discuss with the current leaders in their field of research, expand their horizons and set up new collaborations.

The organizers are grateful to the PalAss for enabling the participation of early-career scientists with limited funding through travel grants via the Grant-in-aid programme (grant number PA-GA201712).

Elena Lo Giudice Cappelli
University of St Andrews

The Fossil Week: The 5th International Palaeontoloigcal Congress
Sorbonne University, Paris, France *9 – 13 July 2018*

The fifth International Palaeontological Congress took place in Paris, organized by the International Palaeontological Association (IPA). It is the largest international palaeontology conference and is organized every four years. This year 956 people from 60 countries attended, giving 745 talks and presenting 286 posters, in 42 symposium sessions and an additional open session. The meeting took place at the Pierre and Marie Curie Campus (Sorbonne Universities) and an amphitheatre of the Jardin des Plantes. A large array of topics were presented, covering many aspects of palaeontology. In this report I will present the events organized as well as the range of sessions – including those I attended.

The *Fossil Week* started with invited talks by **Marion Bamford** on fossil woods of Gondwana, **Diego Pol** on the evolution of gigantic dinosaurs, and **Andrew Knoll** on the Proterozoic–Phanerozoic global state changes.

The first session I attended was S04, 'Big Data in Palaeontology' which focused on ways for sharing knowledge and data. It included talks on methodology databases (**Jérémie Bardin**) and the use of inapplicable characters for investigating disparity (**Melanie Hopkins**).

Session 06, 'Biominerals through time' included an interesting talk by **Julie Aufort** on controlled diagenesis experiments on bones, where new experimental procedures were used in order to better understand apatite transformation. Various aspects of macroecology were covered in session 24, 'Macroecology and the fossil record'. **Jere Lipps** presented the Signor-Lipps Effect and its relatios to macroecology, where it is important for the correct estimation of biodiversity before and after an extinction event. In the same session, the talk 'Macroevolution through mass extinctions' by **Mark Puttick** tested theories on the impact of extinction events on macroevolution using a novel approach. Simulations were carried out with a new R package in order to measure disparity before and after extinction events.

Another session I attended was 17, 'Fossils & Recent, molecules & morphology'. As its name suggests, the session concerned links between fossil and Recent data with a keynote talk by **Gregory Edgecombe** on fossil and molecular data and the terrestrialisation of arthropods. A nice demonstration of combining molecular and palaeontological data was presented by **Malcolm Sanders** through the example of frog shells (Bursidae) for retracing their characters and evolution through time. Session 28 explored new trends in biostratigraphy where **Gloria Franceschetti** used a multidisciplinary approach to revisit a Bartonian Stage section from the UK.

Session 10, 'Conservation Palaeobiology and Historical Ecology' included talks on using palaeontological approaches in the study of historic variations in order to find baseline environmental conditions. The keynote speech by **Jeremy Jackson** was very inspiring and brought out the link between palaeontology, palaeoecology and modern environmental conditions. **Catalina Pimiento** showed the fate of marine megafauna from the Pliocene to the Anthropocene in relation to functional richness, and **Paolo Albano** investigated changes in composition of marine mollusc assemblages in the Mediterranean Sea during historical time in order to assess the impact of invasive species migrating from the Red Sea.

Jeremy Jackson presenting the important role of palaeontology in conservation efforts. Photo CR2P IPC5.

Finally, session 05, 'Biodiversity changes through times examined crises and radiations' explored various topics such as mid-Triassic ostracods from Romania and the emergence of Triassic taxa after the end-Permian mass extinction (**Marie-Béatrice Forel**). The ecological impacts of mass extinctions were addressed by **Lydia Tackett** with an example of brachiopod sculpture as a response to the diversification of predators during the Late Triassic. Lastly, **Alycia Stigall** tested a conceptual model for investigating Biotic Immigration Events and assessing α-, β-, and γ-diversity.

The closing ceremony included a talk by **Tatsuo Oji** on the Ediacaran, presenting animal activity in western Mongolia, which included an interesting way to visualize infaunal animals in three dimensions. **Anjali Goswami** presented a very interesting part of the ongoing research of her team on macroevolutionary consequences of phenotypic variation. This research focuses on the analysis of cranial modularity of tetrapods, and uses a large number of specimens from across the clade.

Tatsuo Oji, who just got to Paris in time for his speech at the closing ceremony, made a brief introduction of his presentation in French. Photo CR2P IPC5.

Anjali Goswami describing her exciting research during the closing ceremony. Photo CR2P IPC5.

An illustration contest took place for both professional and amateur illustrators and reconstructors; the winning images can be found on the Conference website. Three workshops took place on

11th July, on the Geobiodiversity Database (**Fan Junxuan**), on Palaeontology and Databases (**Adeline Kerner**) and one short course on Scientific Illustration (**Sophie Fernandez**).

Grande Galerie de l'Évolution: preparing for the group photo. Photo CR2P IPC5.

For a more detailed overview of the topics of the Conference, please visit the conference website at <**https://ipc5.sciencesconf.org/**>.

Danae Thivaiou
National and Kapodistrian University of Athens

Palaeontological excavations in an exceptional fossil site: the diversity of life 125 million years ago
Cuenca, Spain *13 – 28 July 2018*

In July this year, the fourth presentation of the course on palaeontological excavations organized by the Department of Biology at the Universidad Autónoma de Madrid took place in Cuenca. Eleven undergraduate and graduate students from different Spanish and foreign universities participated in this sixteen-day-long course packed full of activities. For many of the students it was their first real experience of digging for fossils. The course started with an introductory talk on the ecological reconstruction of Las Hoyas, the fossil site where we were going to do fieldwork, by **Ángela Delgado Buscalioni**, director of the research project on this locality. Las Hoyas is an Early Cretaceous (upper Barremian) Konservat-Lagerstätte that represents the first well-documented wetland from the fossil record, very much like the modern day Everglades National Park in Florida, USA. Once everyone was really hyped, we packed up our kit and made our trip to the World Heritage city of Cuenca, where we would spend the first half of the course.

That same day in the afternoon we visited the Museum of Palaeontology of Cuenca (MUPA), where we were offered a very entertaining guided tour through the exhibitions of the remarkably rich palaeontological heritage of the region. After that, we had our first session of seminars devoted to the evolution and relevance of natural history museums in education, and to the reconstruction of plant biomes in the palaeowetland of Las Hoyas. It is worth highlighting how this second seminar in particular was a great formative experience, not only for the students, but also for **Candela Blanco Moreno**, the PhD student who moderated the seminar, who was able to share part of her own research on palaeobotany with the students, other palaeontologists, and the general public who attended the event. After such a stimulating first day, everyone was happy to enjoy a night out in the beautiful city of Cuenca.

On our second day, we ventured on an exciting nature route led by **Irene Prieto Saiz**, local geologist and palaeontologist, and CEO of GeoDiscover, who showed us gorgeous geological structures and landscapes, enabling us to understand the geological configuration of the palaeowetland during the Early Cretaceous. In the afternoon we went back to the MUPA for our second session of seminars. On this occasion we discussed conservation of the palaeontological heritage, and we learned about conchostracans (with **Oscar Gallego** from Argentina), the evolution of fish assemblages during the Mesozoic, and the palaeoecological interpretation of coprolites. Once again, this last seminar was moderated by a PhD student, **Sandra Barrios de Pedro**, who amazed everybody with how much information about the environment can be drawn from the morphological and chemical study of coprolites. As befits a Saturday evening, we finished the day conducting our own particular research on the rich gastronomical heritage of the province.

On the third day we moved on to what everyone was really looking forward to: the fieldwork. We spent the next five days excavating the thin laminated limestones of Las Hoyas. The students learned digging techniques, field data collection following a layer-by-layer excavation, scientific photography, and other curatorial procedures. Students were also able to learn how to identify different fossil taxa; the most common groups found in this year's campaign were aquatic angiosperms and ferns, bivalves, decapod crustaceans, a diverse array of insects and small primitive teleostean fish.

Students excavating the laminated limestones of Las Hoyas locality. Photo courtesy of Hugo Martín Abad.

Every year the excavation campaigns at Las Hoyas attract regional and national media who are aware of the exceptional scientific relevance of this unique fossil site, especially since it was declared a Site of Cultural Interest in 2016. Not being an exception, this year we were visited by a team of newspaper journalists, a national radio show, and two teams of TV news reporters, all of them interested not only in the scientific development of the fieldwork, but also on the educative aspect of the excavations as a course. They interviewed several of the students, who were very happy to make an appearance on TV!

After the five days of fieldwork at Cuenca we moved to Buenache de la Sierra, a small locality in the middle of the Castilian mountain ranges. We stayed in a rural house for the next ten days while we explored the area for new fossil sites. Led by **Jesús Marugán Lobón**, the students acquired the experience of prospecting for unknown outcrops and were thrilled to be the first generation ever to dig at these new sites. The people of Buenache were very excited to have us staying among them, and were flabbergasted to find that their territory was hiding such wonderful fossils. They were so involved in the project that one night they even prepared a party for us! Townspeople and students alike clearly understood the relevance of the fossil sites for the potential development of this rural region.

One of the most enriching aspects of the course is that for the duration the students lived together with researchers and PhD students from around the world as well as amateur palaeontologists, who were all available to answer questions, to help solve problems in and out of the field, and in particular to share their experiences and passion for palaeontology. In this sense, students were able to appreciate what it means to be a palaeontologist apart from just doing research.

Finally, after sixteen long days, we made our trip back to Madrid, all of us exhausted but very satisfied with our achievements during the course. This course was partially funded by the Government of Castilla-La Mancha (project 180354-P1), but it would not have been possible without the help from the Palaeontological Association. PalAss funding covered part of the lodging, food and transportation expenses of the students via its Grant-in-aid programme (grant number PA-GA201804). On behalf of the students, professors and all the people involved in the course, thank you very much PalAss!

Participants of the course during the geological tour around the Serranía of Cuenca. Photo courtesy of Hugo Martín Abad.

Hugo Martín Abad
Universidad Autónoma de Madrid

10th European Palaeobotany & Palynology Conference (EPPC)
University College Dublin, Ireland *12 – 17 August 2018*

The historical city of Dublin was the setting for EPPC 2018, the auspicious 10th European Palaeobotany and Palynology Conference. It was co-hosted by Trinity College Dublin, University College Dublin (UCD), the National Botanic Gardens and the National Museum of Ireland. With the theme 'A Multidisciplinary Science', the Conference aimed at highlighting the integrative and multidisciplinary nature of palaeobotanical and palynological research, as well as demonstrating the strong history of partnership with disciplines beyond the core areas of research.

On Sunday evening before the Conference delegates were welcomed to a reception in the atmospheric *c.* 250-year-old dining hall of Trinity College in the heart of Dublin City, where there was an opportunity to get to know one-another, greet old friends and 'settle in' before the serious conference business began. EPPC 2018 kicked off in earnest early on Monday morning, 13th August, in the O'Reilly Theatre on the UCD campus, the venue for the five-day event. **Jenny McElwain**, chair of the EPPC organizing committee, delivered the opening address, focusing delegates on the conference theme and introducing an exciting week of special sessions and presentations. Three diverse and fascinating plenary talks followed: **Jane Stout** shared her perspective on palynology as a pollination biologist working with bees, **Pete Coxon** described his research on the Tertiary and Quaternary vegetation history of Ireland, and **Caroline Stromberg** presented insights into her work on grasses and grassland evolution. After coffee, three highly engaging keynote talks were delivered by **Leyla Seyfullah** on the wonderful world of amber, **Benjamin Bomfleur** who enthralled us with his expeditions to the Antarctic, and **Claire Belcher** who presented fascinating work on fire-feedbacks of the earth system for managing our future Earth. Over the following five days 401 delegates from 45 countries around the world attended 29 special sessions under the banners of Palynology/Stratigraphy, Palaeobotany/Biogeography, Evolution/Extinction and Palaeoenvironment/Palaeoecology/Palaeoclimate – a total of 472 individual presentations and poster exhibitions.

A special session celebrating the remarkable career of the late Professor William (Bill) Chaloner was held in UCD's O'Brien Centre for Science on the Tuesday, to present some of the ongoing research stemming from his work. **Jenny McElwain**, Bill's last PhD student, dedicated her presentation to the legacy of his pioneering work in the fields of palaeotraits and palaeoproxies and their use in reconstructing palaeoclimate; she shared her experience of his simple, innovative and memorable approaches to teaching. Seventeen other speakers reminded us of Bill's many and varied interests. His major contributions to palaeobotany were through developing new experimental approaches and methods of study, such as the early use of SEM on plant fossils and the use of morphological variation in extant *Ginkgo* leaves to discuss implications for species concepts in fossils.

Highlighting the career of another sadly late and distinguished palaeobotanist, there was a second dedicated memorial session on the Thursday, entitled *Transformative Palaeobotany: Commemorating the life and legacy of Thomas N. Taylor*, to celebrate his outstanding contribution to the field of fossil fungi evolution. The session included many fascinating talks on the subject and at the end of the session a book celebrating Tom's research career, entitled *Fossil Fungi*, was presented to his fellow research palaeobotanist and wife, Prof. Edith Taylor.

There were many, many fascinating and thought-provoking talks during the Conference, including two stand-out presentations by PhD students **Kelly Matsunaga** from University of Michigan on "fossil palm reading", illustrating the utility of palm reproductive structures to identify fossil palms, and **Mario Coiro** from University of Zurich about his work on an exciting new phylogenetic framework for the Cycadales using improved fossil and molecular phylogeny integration. Other memorable presentations included advances in the non-invasive X-ray micro-computed tomography (microCT) tool to study fossil plants by **Selena Smith** during the special session on experimental palaeobotany, as well as some really exciting presentations on the novel applications of 'geochemical and molecular proxies from fossil plants and palynomorphs' during that session.

Of course, a week-long conference like this is a wonderful opportunity to get to know fellow scientists and make new friends during social events. Three informal poster sessions provided a more relaxed chance to discuss ongoing projects and promising new work over a beer or two. A mid-conference break on the Wednesday afternoon offered delegates the opportunity to take one of the organized tours of the beautiful National Botanic Gardens and herbarium on Dublin's north side, visit sites of glaciation and palaeoecology in the Wicklow Mountains, or walk through the historical Dublin streets to soak up their unique atmosphere and Viking heritage.

A group enjoying the 'UCD Evolution of Land Plants' garden during a sunny coffee break. The garden is an outdoor classroom designed for teaching land plant evolution. It first showcased at Bloom in the Park 2016, the Irish version of Chelsea Flower Show, where it won a gold medal and Best Concept Garden, before being installed at UCD. The concept was conceived by Prof. Paul McCabe, Head of Botany at UCD. It was designed and created by lecturer Dr Caroline Elliott-Kingston and architect Nicola Haines. Photo courtesy of Jo Hellawell.

On the Thursday evening a gala dinner was held in the world-famous home of Guinness at St James's Gate, where we were treated to a pre-dinner pint of the colloquially known "black stuff", some great food and of course traditional Irish music and dancing, all making for great 'craic' (pronounced 'crack' and meaning fun in Irish)! After dinner a number of awards were made to some truly inspiring and deserving recipients. The Jongmans Medal was presented to **Johanna "Han" van Konijnenburg–van Cittert** by Hans Kerp for her unique contribution to palaeobotany

Busy coffee break in the O'Brien Centre for Science, UCD. Photo courtesy of Jo Hellawell.

The Burren excursion group in front of the limestone hill of Mullaghmore. Photo courtesy of Jenny McElwain.

spanning more than fifty years. The International Organisation of Palaeobotany (IOP) also took that opportunity, and at the closing session on Friday, to present two IOP Honorary Membership awards and certificates to **Zlatko Kvaček** (Prague) and **Gar Rothwell** (Athens, OH) for their lifelong contributions to palaeobotanical science and teaching.

At the closing session after lunch on the Friday we were treated to a 'preview' of the 11th EPPC gathering planned by the organizing committee of host country Sweden in 2022, which, for some, will be a real opportunity to get to know our Viking roots! Finally, after closing remarks and before final farewells, all were invited to remain in the auditorium to enjoy a most remarkable presentation of computed tomographic animations from the research of artist and academic **Anita Milroy** and **Andrew Rozefelds** of Queensland Museum. This took the form of visually stunning 3D images of preserved Cenozoic fruits and seeds from Queensland augmented with original music called *Deep Time*, further highlighting innovations in art and science and the multidisciplinary theme of the Conference. Those of us lucky to witness it were treated to a unique experience and an inspiring close to a wonderful week of palaeobotanical and palynological discourse.

For those staying on to make the most of their visit, some interesting cultural activities and field excursions were organized to explore the botanical, archaeological and geological richness Ireland offers. These included the famous karst landscapes and flora of the Burren National Park on the Atlantic seaboard of County Clare and the UNESCO World Heritage site of major archaeological interest and natural beauty, Skellig Michael, an island in the Atlantic Ocean off the south-west County Kerry coast and film location for "Star Wars: The Last Jedi" movie. We now eagerly look forward to EPPC 2022!

Michelle Murray
Trinity College Dublin

Crossing the Palaeontological – Ecological Gap (CPEG)
University of Leeds, UK *30 – 31 August 2018*

This integrative conference exceeded its nominal goal to bridge the gap between palaeontology and ecology, spanning in addition the divisions between empirical work and theory, micro- and macro-evolution, and population demographics and species responses. Three palaeobiologists based in the UK organized the event: **Alex Dunhill** (University of Leeds), **Emily Mitchell** (University of Cambridge) and **Erin Saupe** (University of Oxford); the School of Earth and Environment at the University of Leeds provided the venue. The Palaeontological Association and British Ecological Society generously supported the endeavour; PalAss enabled prestigious plenary speakers to attend from far afield thanks to Grant-in-aid (grant number PA-GA201802). Attendees delivered more than 40 talks, including nine lightning reports and five plenary lectures. Presentations addressed questions at every level of spatial, temporal and evolutionary hierarchies. Attendees were from 43 institutions in ten different countries, with Europe, Asia, North America and Australia represented. Enthusiasm abounded to convene the meeting again in future years, with an interest in rotating among European countries.

A session on biogeography led off the Conference. **Axelle Zacaï** summarised results from a recent *Palaeontology* paper (published just the day before) that inferred a regionally specific signal of Rapoport's rule in Early Jurassic ammonites. **Lewis Jones** combined fossil and modern data to detect and predict poleward range shifts in zooxanthellate corals under global warming simulations. Also in the marine realm but across the whole Phanerozoic, **Gwen Antell** tested for ecological release and competitive exclusion in brachiopod and bivalve species. Drawing attention back to the present day, **Oliver Wilson** captivated the crowd with the natural history of the Araucaria forests endemic to southern Brazil. **Rowan Whittle** took a comparative approach with isocrinoid communities to demonstrate the delay of the Marine Mesozoic Revolution in the Southern Hemisphere. **Nuss Raja** then tracked latitudinal ranges to infer evolution of temperature tolerances. Concluding the session, invited speaker **Andrew Beckerman** soliloquized on the power of matrix representations for a variety of ecological phenomena.

Axelle Zacaï presenting her work on Jurassic ammonites, published the day before in Palaeontology *(<***https://doi.org/10.1111/pala.12389***>). The paper is open access as part of the prize received for the Best Paper Award 2016, see details on the PalAss website. Photo courtesy of the CPEG organizing committee.*

Extinction garnered more attention than any other topic in the conference. **Bryony Caswell** opened the first of the sessions dedicated to research on extinction, investigating community trait changes during early Toarcian ocean anoxic events. Next, **Sergei Petrovskii** sobered the audience with mathematical models that predict phytoplankton net oxygen production collapse as global warming shifts modern oceans beyond a critical threshold for sustainability. Returning to empirical work, **Catherine Mascord** outlined a project to combine observations of Precambrian bioturbation with laboratory experiments on living burrows. **Amy Tims** also synthesized disparate types of data, inferring missing fossil traits from a phylogeny to study extinction patterns in freshwater fish. Linking physiology to environmental stress, meanwhile, **Veronica Piazza** provided evidence from

two sections before the Jurassic anoxic events where brachiopod and bivalve body sizes evolved differently. Continuing the extinction session the next day, **Carl Reddin** attempted to tease apart the relative contributions of several temperature-related stressors in marine extinctions. **Mark Puttick** developed a theoretical framework to test phylogenetic null models of mass extinction survivorship patterns. Finally, **Frederik Saltre** found evidence for a two-part driver of Australian megafaunal extinctions: aridification compounded by human hunting.

The first three speakers on community ecology were challenged to concentrate their message into only five minutes. **Emma Dunne** questioned conventional hypotheses that aimed to explain Triassic distributions of three tetrapod clades. Also focusing on the Triassic, **Vanessa Roden** calculated species turnover and nestedness in reef assemblages. **Elspeth Wallace** cautioned interpretation of Morrison Formation fossil counts, noting the difficulty of separating or controlling the signal of taphonomic bias. In the second plenary talk, **Karen Bacon** reminded researchers of the merits of the plant fossil record, and discussed the nuances of palaeobotanical interpretation. On the second day, **Isabel Fenton** and **Gregg Milligan** modelled community dynamics from high-temporal-resolution Cenozoic microfossils. **Malcolm Hart** had prepared a talk about community composition in the time-averaged Oxford Clay formation, and **Kelsey Lorberau** reviewed the use of metabarcoding plant fossils from lacustrine deposits. Plenary speaker **Thomas Halliday** mapped the Paleocene mammal radiation in ecospace, morphospace and geographic space.

Shifting topic to biotic interactions, **Pnina Cohen** plied genetic analyses to trace the modern fire ant invasion to a small number of founding populations. **Thomas Guillerme** tested the hypothesis of escalation by comparing armouring and predator-prey body size ratios in fish. **Fiona Pye** and **Emma Randle** also discussed predator-prey dynamics in marine animals, while **Joshua Tyler** talked about the effect of competition and facilitation on bovid morphology. **Andrew Clarke** regaled attendees with a plenary talk to end the session, giving a review of physiological responses to the many environmental variables that vary with temperature.

Perhaps the most daunting gap that presenters attempted to cross at the Conference was the separation between palaeontology and conservation biology. Nevertheless, **Tracy Aze** evaluated current criteria for conservation against the fossil record, and **Jennifer Crees** used historical ecology data to contextualise ecologists' definition of 'native' species. **Catalina Pimiento** drew on Quaternary data to implicate coastal habitat loss as a primary driver of marine extinction. Pooling historical and modern Asian mammal occurrences, **Samuel Turvey**'s research struck a hopeful note that some species restricted to mountaintops may have a larger environmental tolerance, and hence lessened extinction risk under warming, than modern data alone would predict. **Virginia Harvey** compiled historic baseline estimates for Baltic fishery populations, which also differ from estimates derived without historic data. In contrast, **Melanie Tietje**'s fossil-calibrated model of amphibian extinction risk agreed well with assessments based on modern data. **Jennifer Dunne** delivered the penultimate plenary talk and awed the crowd with visually striking – and laboriously reconstructed – fossil food webs.

Delving into behavioural ecology, **Kalyan Halder** and **Aaron Hunter** pored over specimens to unravel the complexities of obligate monogamous oyster pairs and pseudoplanktonic megarafts, respectively. Three lightning talks on functional ecology, by **George Harrison**, **Neil Adams** and **Travis Park**, all used cranial morphology to infer behaviour in vertebrate species.

Palaeontologists and ecologists enjoying the coffee and posters at CPEG in Leeds. Photo courtesy of the CPEG organizing committee.

Posters displayed results from nearly 20 projects, with topics as varied as morphology, feedbacks between biotic and abiotic systems, and diversity gradients, decimations and explosions. Authors drew data from a menagerie of microfossils, invertebrates and vertebrates (living, extinct and virtual). Celebrating the posters with libations of wine, attendees debated the tribulations of crossing disciplinary gaps. Ecologists noted palaeontologists' fondness for acronyms and silhouette images of animals. In turn, palaeontologists pointed out the assumptions in ecology that have gone untested by omission of deep-time data. Beyond these superficial discords, however, the Conference cultivated a spirit of camaraderie that will enable future collaborations to continue crossing the palaeontological–ecological gap.

Gwen Antell
University of Oxford

The 66th Symposium of Vertebrate Palaeontology and Comparative Anatomy and 27th meeting of the Symposium of Palaeontological Preparation and Conservation
Universities of Manchester and Salford *5 – 8 September 2018*

Being a newcomer to the palaeontology world (having jumped ships from Ocean Sciences), I was eager to learn more about the field. The SVPCA meeting was first mentioned to me by my supervisor **Per Ahlberg**, and as fate would have it the conference timed perfectly with fieldwork we had planned in Ireland.

I had signed up to the Bayesian phylogenetics workshop on the Tuesday morning not having high expectations as it is a topic that I had read a lot about, and still could not get my head around. However, I think everyone who attended the workshop would agree that **Robin Beck** did a fantastic

job – he gave a well-pitched explanation on Bayesian phylogeny along with a helpful computer exercise. Time will tell whether I have mastered the art of Bayesian phylogeny, but I definitely feel a lot more confident about it. We all then gathered in the afternoon to attend a special Symposium on 'Advances in the Vertebrate Tree of Life', starting off with a talk from **Mike Coates** on the puzzling topic of early chondrichthyans and their origins. **Sam Giles** gave us a tantalising insight into the conundrum of the origin and diversification of osteichthyans, and how CT scanning is proving a vital tool in increasing our understanding of this group. After the Symposium, we convened at the fossil galleries at Manchester Museum, where we all received our own Palaeo Aleo. (Who says scientists aren't cool?)

Photo: Emma Louise Nicholls.

The fish session began the next morning, starting with a talk from **Per Ahlberg** on an unusual Devonian tetrapod skull from North Timan, Russia. Unusual because this skull is only 31 mm in size, revolutionising our perception of early tetrapods being around 1-2m in length. After the tea break, we received great talks on macroevolution and palaeobiogeography spanning the Phanerozoic. The afternoon kicked off with exploring the applications of molecular biology in bettering our understanding of phylogenies, a great example of interdisciplinary science. The day finished with talks on sauropsid phylogeny, which contained the equally scientific and entertaining talk by **Paul Barrett** on scales being the primitive state for Dinosauria, however if we found three hypothetical feathered ancestors this could all change.

Then came the poster session. I was presenting a poster on modelling the contents of a coprolite from the Devonian–Carboniferous boundary of Greenland so I did not get to see many of the posters, but I have been told that they were all of great interest. It also helped that we were supplied with an array of beverages along with the Northern delicacy of pork pies. Finally, the best of the day was saved for last, the annual auction. Hosted by the wonderful **Jeff Liston**, I found myself progressively willing to part ways with my money through the impressive auctioneering skills of Jeff and his team of enthusiastic displayers, though I lost out in my bid for an adorable looking toy dinosaur.


Photo: Liz Martin-Silverstone.

The last day began with a continuation of the dinosaur theme, this time looking at archosaur anatomy. After the tea break, we received talks on sauropsid crania, which to my delight included talks on marine organisms by **Ray Chatterji** and **Dean Lomax**. After the lunch break, the session was on biomechanics and functional morphology, which included some pretty clever modelling techniques – my particular favourite talk was by **Pernille Troelsen** who tested different plesiosaur neck morphologies in a hydrodynamics model to explore what was the most likely state. To

finish the Conference, we had talks on taphonomy and mammals, and it seemed I was not the only imposter in our midst; **Thomas Clements**, who usually looks at the fossilization of insects, presented a great talk on vertebrate taphonomy of the Mazon Creek Lagerstätte. The conference closed with an intriguing talk from **Stephan Lautenschlager**, who used sophisticated modelling techniques to examine morphological convergence and function diversification of sabre-toothed vertebrates. I had noticed throughout the conference that, despite the vast span of subject areas, nearly everyone attended all the talks and were genuinely intrigued by each other's work.

After three days of fantastic talks and posters, we all descended upon Yang Sing for the conference dinner. As we wined and dined, **Thomas Kemp** as the oldest attendee gave a speech on his summary of the meeting and how SVPCA has developed over the years into the flourishing conference it is today. Some final words were added by **Rob Sansom**, who did an incredible job hosting this year's conference, and the winners of the student talk and poster were announced – **Thomas Clements** and myself! Not bad for a couple of imposters.

Photo: Cindy Howells.

Having attended a few conferences now, SVPCA 2018 was by far my favourite. The enthusiasm and kindness of everyone was palpable, it felt like one big family. Thanks again to Rob Sansom and helpers for such a wonderful meeting and I'm very much looking forward to SVPCA 2019 on the Isle of Wight.

Hannah Byrne
Uppsala University

Yorkshire Fossil Festival
Hull, UK *15 – 16 September 2018*

After several highly successful years in Scarborough, the PalAss-sponsored Yorkshire Fossil Festival made the brave, and potentially treacherous, decision to up sticks and move slightly south to the wonderfully industrial city of Hull – the UK's current City of Culture. So it was, on the 15th and 16th of September, that a bunch of hardy palaeontologists from the Palaeontological Association, consisting of **Jo Hellawell**, **Liam Herringshaw**, **Lucy McCobb**, **James McKay**, **Maria McNamara**, **Tom Raven** and **Emily Roberts**, joined several other exhibitors at the University of Hull to provide entertainment for

Photo: Jo Hellawell.

budding fossil enthusiasts from across the north of England and beyond. Some familiar organizations were present, including the Oxford University Museum of Natural History, Dinosaur Isle Museum, the Geological Society, the Yorkshire Museum and the Yorkshire and Hull geological societies, as well as a strong contingent of local universities with representatives from Hull, Leeds, Leicester and Sheffield. In contrast to previous years, the Festival was part of the Hull Science Festival, which itself had followed the British Science Festival, so we were all entering new, unchartered territory.

Photo: Jo Hellawell.

The PalAss stand had a familiar feel to it, with the ever-popular diorama of the Jurassic oceans returning along with the 'Fossilization Frenzy' board game (a slightly sadistic version of snakes and ladders where the aim of the game is to die and become a fossil in a museum). Visitors also had the chance to make their own trace fossil using either fossil shells or a toy dinosaur's foot – this activity proved very popular again, and for the trace fossil enthusiasts reading this, clay pots were much better than the salt dough pots of previous years. And once again, James McKay's palaeoartistic skills were in high demand, with a seemingly endless queue of small children (and a few adults) drawing their own fossil chimeras, which in turn James would paint to create amazing, and often quite bizarre, lifelike restorations of the imaginary animals. In a new addition for this year, on the Saturday afternoon the lead organizer of this year's Festival, Liam Herringshaw (University of Hull), decided to add a bit of spice to the proceedings with a stand-up comedy show STUFF – 'Stand Up for Fossils'. This was an especially nerdy affair and, although great fun, the jokes were far too cringeworthy to be reproduced here.

The Festival once again proved to be highly successful, with thousands of people attending over the two days, cementing its position as a highlight in the palaeontological calendar in the north of England. Next year the Yorkshire Fossil Festival will be returning to its spiritual home of Scarborough on 13–15 September 2019.

Tom Raven
Natural History Museum, London

Research Grant REPORT

The Lilliput effect: growth rate or longevity?

Brett Metcalfe
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Introduction

Over the past 550 million years, environmental perturbations of such magnitude have occurred that have preceded, caused, or relate to five mass extinction level events. The documentation of species preceding, surviving and evolving in the aftermath of an extinction event has enabled researchers to recognise several similarities for events that are driven by and/or caused by radically different triggers (*e.g.*, bolide impact; volcanism). One such similarity is that species in the immediate (<1 million years) aftermath (Fraiser *et al.* 2011) of (mass) extinction events can be smaller than those preceding the (mass) extinction event (Urbanek 1993), such size change occurring across clades and families. This phenomenon is referred to as the 'Lilliput effect', a reference to *Gulliver's Travels* in which Gulliver (our 'reference specimen') finds himself in the land of Lilliput populated by people considerably smaller than himself (thus giving us a relative size-change); the effect relates to a reduction in species body size following an extinction event (Urbanek 1993; Twitchett 2007; Morten and Twitchett 2009; Metcalfe *et al.* 2011). The cause of this effect remains enigmatic, whether it reflects some intrinsic species response to environmental change (Garilli *et al.* 2015); the post-event ecosystem reorganization that may have had a detrimental impact upon species that survive, or new species that evolve in the aftermath (Twitchett 2007); or a taphonomic effect brought about by a loss of larger, rare, individuals has been debated (Brayard *et al.* 2010, 2011; Fraiser *et al.* 2011).

Microvolume analysis of $\delta^{18}O$

One such way to estimate the environment during and throughout the ontogeny of a shelled organism is to measure the shell's geochemical properties. The ratio of heavy to light isotopes of oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) within carbonates has been used as a palaeotemperature approximation (Urey *et al.* 1951) and an indicator of the carbon cycle (Shackleton 1977; Harries and Little 1999; Zachos *et al.* 2008; Hönisch *et al.* 2012). The quantity of carbonate required for a routine stable isotope analysis is between 100 µg and 200 µg which, for diminutive forms, can prove problematic, more so if the aim is to measure along the growth axis of an organism, as this can severely reduce the number of measurements per sample. A number of papers have thus used other species' $\delta^{18}O$ values to approximate the seawater temperature during the period of size change, *e.g.* García Joral *et al.* (2018). However, it is possible through modification of both the protocol and adaptation of the mass spectrometer's preparation device (Spötl and Vennemann 2003; Fiebig *et al.* 2005; Breitenbach and Bernasconi 2011) to considerably reduce the amount of CO_2 (Figure 1 A), and thus $CaCO_3$ required (>10 µg), for a single analysis (Ganssen *et al.* 2011; Feldmeijer *et al.* 2015; Metcalfe *et al.* 2015; Lougheed *et al.* 2018) with only a minor impact upon the precision and reproducibility of a single measurement (external reproducibility 1σ <0.12 ‰ for $\delta^{18}O$ and $\delta^{13}C$ of international standards).

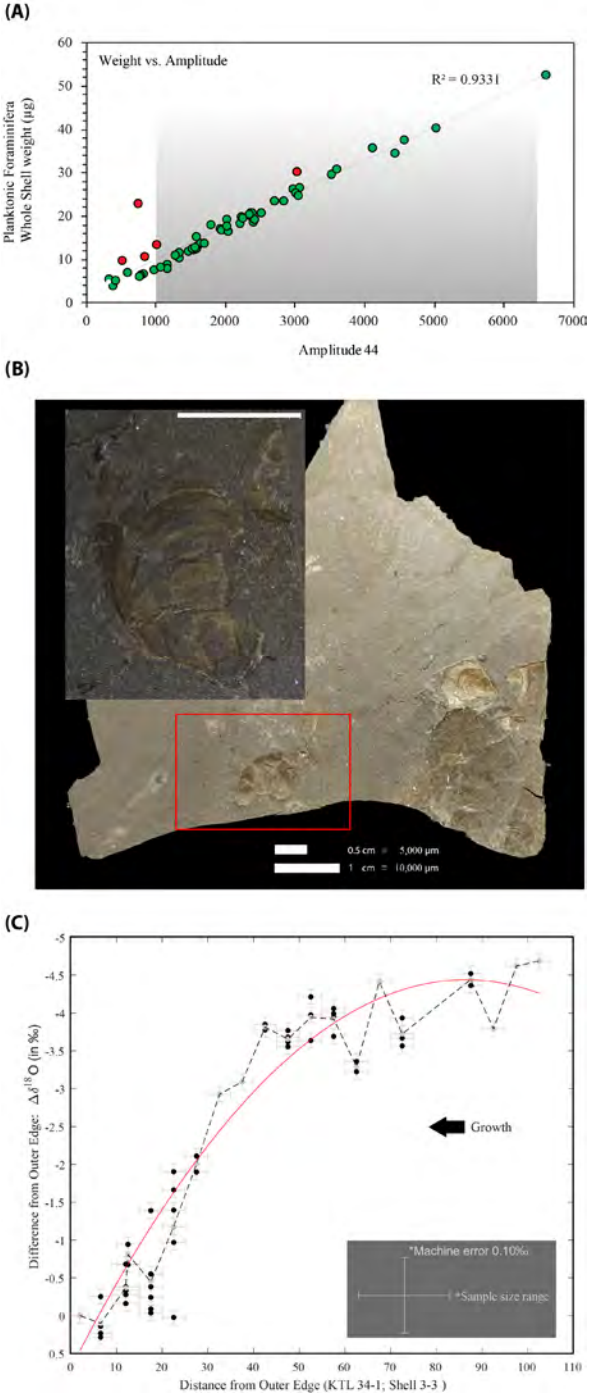

Figure 1. (A) The amplitude of the resultant CO_2 produced from the temperature-controlled reaction of carbonate with phosphoric acid, was calibrated with the weighed (precision 0.1 µg) single shells of modern planktonic foraminifera (Metcalfe et al. *2015). Red circles denote foraminifera that were partially dissolved. (B) A slab obtained from a bed at Kettleness, North Yorkshire. Red rectangle denotes specimen measured in (C), inset a higher magnified image of the shell (Inset picture scale bar is 5,000 µm). (C) Measured $\delta^{18}O$ values in ‰ V-PDB have been normalized to the outer edge value ($\Delta\delta^{18}O$). Individual values are represented by black dots; grey dots represent the average values of replicates, the dashed black line is fitted through these average values, and the red line is a polynomial fit. The direction of growth of the shell is indicated.*

Pliensbachian–Toarcian extinction event

This project sought to perform stable isotope analyses on brachiopods and bivalves from a mass extinction event to determine if the diminutive-sized forms have a reduced growth rate or a reduced longevity. The supposition is as follows: assuming the shell records a seasonal cycle, if the Lilliput effect is primarily related to the growth rate then the distance along the shell between recorded seasonal cycles should be small. Whereas, if the Lilliput effect relates to longevity then fewer seasonal cycles should be recorded in the shell. Samples were selected from the marine siliclastic sediments of the Cleveland Basin of North Yorkshire, UK, that cover the Pliensbachian–Toarcian extinction event that occurred 187 million years ago (Little 1996). The sections at Staithes, Kettleness, Whitby and Ravenscar have been partitioned into background, extinction, survival and recovery intervals (Morten and Twitchett 2009), following the definition of Harries and Little (1999).

Once a specimen is selected three procedures exist to measure growth lines: micromilling of specimens polished and cut into thin sections; drilling of growth lines with a handheld etcher's drill; and/or careful removal under the microscope via scalpel (Lougheed *et al.* 2018; Pracht *et al.* 2018). Ideally, micromilling or an etching drill would be utilized, however the shell material from these Yorkshire sections was 'flaky', easily breaking apart under mechanical stress, as evidenced by incomplete shells (Figure 1 B). The delicate nature of the shells therefore required the use of a scalpel and a calibrated microscope ocular to remove parts of the shell at discrete intervals, as has been done with foraminiferal chambers previously (Lougheed *et al.* 2018; Pracht *et al.* 2018). Several specimens from the different intervals were successfully sampled and measured in this way for their stable isotope composition. As an example, the results of a single specimen of *Pseudomytiloides dubius* from the Kettleness KTL 34-1 bed of Morten and Twitchett (2009) are presented (Figure 1 C). The KTL 34-1 bed is within the *Harpoceras exaratum* ammonite subzone, considered to be within the survival interval of the Pliensbachian–Toarcian extinction event. For this single specimen 54 discrete oxygen isotope measurements were made, despite the relatively small size, and these shell values have been normalized to the value of the terminal portion of the shell ($\Delta\delta^{18}O$). With this approach it was also possible to make replicate measurements, not only on the same shell but on the same shell increment.

Longevity or growth rate?

The measurement of specimens from the different pre- and post-extinction intervals (Harries and Little 1999) shows that a number of specimens have a similar large range in $\delta^{18}O$ between the youngest and oldest part of the shells to the one presented here ($\Delta\delta^{18}O$: ~4.5 ‰; Figure 1 C). It is possible that this large range represents a single seasonal cycle, yet the seasonality (or lack of seasonality) during this time period is not well defined. Whilst potential taphonomic effects across the shell have not been definitively ruled out, measurements of the $\delta^{18}O$ of single foraminiferal shells from geologically recent sediments (Ganssen *et al.* 2011; Metcalfe *et al.* 2015; Pracht *et al.* 2018) highlight that a large $\delta^{18}O$ interannual range can exist ($\Delta\delta^{18}O$: ~3 ‰). However, the large range in $\delta^{18}O$ could potentially represent a long-term signal, if the growth rate of a specimen is slow enough.

Conclusion

This project has shown that it is possible to make multiple geochemical measurements on diminutive forms. Applying this approach to multiple extinction events and background intervals could expand the knowledge of large-scale environmental perturbations. As well to test whether

the cause of the Lilliput effect is constant through time. To refine this approach further, future work could include a combined modelling study to determine both the potential $\delta^{18}O$ values and range.

Acknowledgements

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Undergraduate Bursary REPORTS

Reconstructing the limbs and girdles of the ichthyosaurs of Strawberry Bank, Somerset

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Introduction

Ichthyosaurs (members of the clade Ichthyopterygia) were an extremely successful group of marine reptiles and a major component of the marine macrofauna from their origin in the Early Triassic to their mid-Cretaceous demise (Motani 2009). A comparatively good fossil record and an iconic status has resulted in numerous studies that cover the evolution (Motani 2017; Fisher *et al*. 2016), ecology (Dick and Maxwell 2015) and ontogeny (Dick *et al*. 2016) of the group. However, studies focusing on the locomotion of ichthyosaurs are scarcer. Many of these studies have made comparisons based on the morphological convergence of ichthyosaurs with dolphins, for example in assuming that they swam using primarily the tail for propulsion and the forelimbs solely for steering. Further, very few studies have considered the morphology and musculature of the pectoral girdle and forelimb (Johnson 1979).

We aim to determine the role of the pectoral girdle in the locomotion of ichthyosaurs: whether its function was propulsive or stabilizing. The importance of soft tissue when inferring function requires the reconstruction of both skeleton and musculature of this region (Witmer 1995). Here, the pectoral and brachial osteology of two species of Early Jurassic ichthyosaur are digitally reconstructed and extant phylogenetic bracketing is used to infer the musculature of the pectoral girdle.

Materials and Methods

Two species of Early Jurassic ichthyosaur were used in this study: *Hauffiopteryx typicus* (von Huene, 1931) and *Stenopterygius triscissus* (Quenstedt, 1856). The specimens were collected in the 1850s from the now inaccessible Strawberry Bank Lagerstätte at Ilminster, south Somerset, UK, and are currently held in the museum of the Bath Royal Literary and Scientific Institution (BRLSI). The site preserved a diverse Toarcian marine fauna, including ichthyosaurs, marine crocodiles, bony fish and insects (Williams *et al.* 2015). The fossils were deposited in nearshore facies and, importantly, vertebrate fossils are three-dimensionally preserved and articulated due to rapid burial and the formation of carbonate concretions around the fossil material (Caine and Benton 2011).

The specimens were CT scanned at the University of Bristol, and the osteological elements of the pectoral girdle and forelimb were segmented using Amira Avizo. The components were subsequently rearticulated using published information on ichthyosaur pectoral anatomy (Johnson 1979; Moon and Kirton 2016) in the Blender software program. Once realigned, muscles were added using the segmentation feature on Amira Avizo following Lautenschlager (2013), which

involved creating two to three point-to-point contacts using the interpolation feature and then increasing these isometrically to meet one another, without intersecting other muscles and bone.

To infer the position of muscles, previous work was consulted (*e.g.* Johnson 1979), but as this is not particularly extensive, an extant phylogenetic bracket approach was used to infer the positions of the major muscles of the pectoral girdle. The current phylogenetic position of ichthyosaurs within reptiles is debated, but it is widely accepted that ichthyosaurs have lepidosauromorph affinities (Motani *et al.* 1998). Assuming such affinities, the bracket consisted of a lepidosaur, *Iguana iguana,* and an archosaur, *Alligator mississippiensis*, and if the position of muscles differed within these taxa, the form of *I. iguana* was used due to greater phylogenetic proximity.

Skeletal reconstruction

The *H. typicus* specimen (BRLSI M1399) preserved all the major components of the pectoral girdle (Figure 1), although the humeral shaft was damaged, while the *S. triscissus* specimen (BRLSI M1409) lacked an interclavicle, distal humerus and paddle. The individual bones realigned readily in Blender, though care was taken with some elements, particularly the humerus of *H. typicus,* which was damaged and therefore more challenging to differentiate the ventral and dorsal sides. One important consideration was the fact that both specimens were juveniles (Caine and Benton 2011), which means that ossification was incomplete, and each element did not fit as closely as might be expected in adults. Ontogeny also had an effect upon the quality of the skeletal material, as some of the elements were still cartilaginous bone precursors, and they had not been preserved so were difficult to segment, particularly for the proximal and distal regions of elongate elements (*e.g.* scapula and humerus).

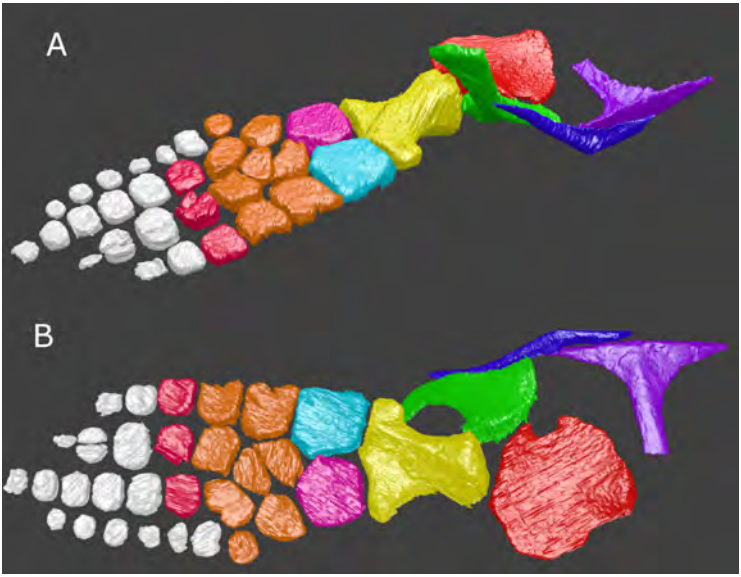

Figure 1. The osteological elements of the pectoral girdle of the early Jurassic Ichthyosaur, Hauffiopteryx typicus*, in A, anterolateral view and B, ventral view. A complete pectoral girdle and near-complete (missing terminal phalanges) brachium exist for this specimen. The Lagerstätte-type preservation of these specimens allows for the muscle attachment sites to be readily identified.*

Muscular reconstruction

Muscle reconstruction relied heavily upon the extant phylogenetic bracket due to the comparatively poor condition of the proximal humerus in both specimens, which is the site of the greatest concentration of muscle attachment. The general position of most muscles was conserved across the Reptilia, but the number of muscular bodies and their relative positions frequently diverged. An example is the *M. supracoracoideus,* which exists as a single muscle with coracoidal origins in *I. iguana,* but as a muscular complex with both coracoidal and scapular origins in *A. mississippiensis* (Meers 2003; Russel and Bauer 2008).

Currently, only the ventral musculature has been fully modelled, consisting of five muscles (Figure 2).

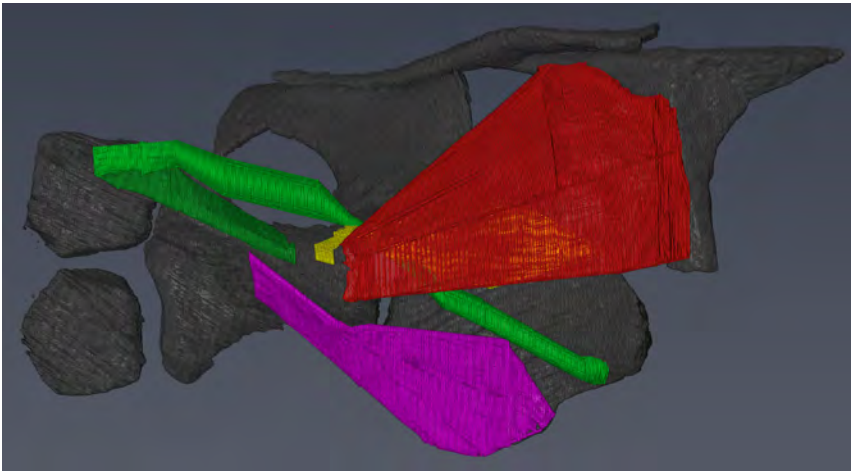

Figure 2. The ventral musculature of Hauffiopteryx typicus*. Red,* M. pectoralis*; yellow,* M. supracoracoideus*; pink,* M. costocoracoideus*; light green,* M. biceps brachii*; dark green,* M. brachialis*. These muscles appear short and stocky and appear to 'hug' the bone to a large degree, suggesting they served primarily as stabilisers.*

The *M. supracoracoideus* and *M. coracobrachialis* are relatively short compared to the bracketing taxa and appear to 'hug' the bones. This suggests that the primary function of these muscles was to provide stability to the forelimb. The *M. pectoralis* sports the usual fan-shaped morphology, overlying the other muscles of the ventral girdle. However, this muscle likely had origins from the unpreserved cartilaginous sternum, so it cannot be fully reconstructed; this has implications when estimating the mass of other muscles (especially the *M. coracobrachialis* (Figure 2)), as the *M. pectoralis* confines the size of the underlying muscles. The *M. biceps brachii*, an important flexor of the antebrachium in the bracketing taxa, has been the most problematic muscle to reconstruct. This muscle has a complex topology, sits in an exterior position for a large part of its length, has a small and poorly defined origin, and the location of insertion (on the radial tuberosity in the bracketing taxa) is highly derived in ichthyosaurs. Comparison with morphologically and functionally convergent taxa, such as cetaceans, will hopefully improve the reconstruction of this muscle (Figure 2). In comparison, the *M. brachialis* was far easier to reconstruct, though its position is different to previous authors (*e.g.* Johnson 1979) who recorded it as originating from the distal humerus. This was unsupported by the bracket, which suggested an origin from the

proximal ventral process of the humerus extending onto the anterior humeral shaft; this has been reconstructed here.

Through comparison of the gross morphology and the location of muscle attachment sites on the bones of both species, we conclude that the muscular morphology was very similar in both *H. typicus* and *S. triscissus*. As the pectoral girdle is similar across post-Triassic ichthyosaurs, it is likely the musculature is the same or similar to that of later ichthyosaurs such as *Ophthalmosaurus*, though this would require further research to verify.

Further Work

Modelling the dorsal musculature is the current priority and this should be completed in the next few weeks, following which a thorough comparison of retractors and protractors will allow the hypothesis that the forelimbs were capable of producing a power stroke to be tested. Alternatively, testing whether the ichthyosaurian forelimb was used in sharp manoeuvres may be done by comparing the relative sizes of rotator muscles *(e.g. M. costocoracoideus)* to, for example, modern cetaceans. The overall findings of this project will be published in due course.

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Regionalization of cervical vertebrae in plesiosaurs

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Introduction

Vertebral regionalization of the axial column into cervical, dorsal, sacral and caudal regions has been fundamental to vertebrate locomotion and biomechanics. Governed by Hox genes these four regions are constant among all vertebrate species. Using geometric morphometric (GMM) analysis, research has found secondary regions within the larger primary vertebral regions. Using these methods along with anatomical descriptions, recent work has found cervical regions in extant archosaurs (Böhmer *et al*. 2015). These species have changed their Hox gene regulation over time to allow the development of additional regions within the cervical column. Avian taxa appear to possess cervical regions with variable boundaries between species (Marek *et al*. in prep.). Subsequently, this work allows insights into neck elongation and axial evolution in vertebrate classifications (Böhmer *et al*. 2015, Buchholtz and Stepien, 2009).

Plesiosaurs are an extinct group of marine reptiles that had hugely elongated necks. Homeotic influences have facilitated the disparity in cervical counts between plesiosaurs, with the Elasmosaurid *Albertonectes vanderveldei* possessing 76 cervical vertebrae (Soul and Benson 2017; Kubo *et al*. 2012), while the Cryptoclidid *Muraenosaurus leedsii* possessed just 42 cervical vertebrae (Andrews 1910). Research into the cervical regionalization of plesiosaurs could aid the understanding of the evolution of neck elongation in the clade. Using *M. leedsii* (NHMUK R2863), this study used GMM, anatomical description and comparative analysis of extant taxa to uncover the number of cervical regions in plesiosaurs.

Methods

Digital models of cervical vertebrae were either created using photogrammetry (*M. leedsii* NHMUK R2863) or accessed from digital repositories (Crocbase: *Crocodylus moreletii*, *Crocodylus niloticus*; Morphosource: *Alligator mississippiensis, Bronchocela cristatella*) and colleagues (*Fregata aquila, Anhinga anhinga, Alectoris rufa*). GMM analysis was carried out (MorphoJ and Landmark 3.0) using

homologous landmarks established in previous studies (see Böhmer *et al*. 2015). Regionalization was assessed using Principal Coordinate Analysis and cluster analysis using Procrustes coordinates from the GMM output combined with qualitative characters from Böhmer *et al*. (2015). Qualitative characteristics were not used for *B. cristatella* due to lack of definitive characters among vertebrae, nor for *M. leedsii* due to the lack of preservation of vertebrae. Reduced landmark points were used in *M. leedsi* due to lack of fossil preservation.

Results

The results from the cluster graph (Figure 1) and principal coordinates suggest *F. aqulia* (Figure 1C) possess five cervical regions and *A. mississippiensis* possess four (Figure 1D), agreeing with previous work on these taxa, although *A. mississippiensis* shows minor differences (Böhmer *et al*. 2015). Principal coordinates and cluster analyses suggest a basal three regions in *B. cristatella,* (Figure 1B). Shape changes occurring along the first principal coordinate (PC1) appear to be overall cervical vertebrae height and neural spine height, PC2 is associated with cervical length and neural spine length. Principal coordinates and cluster analyses of *M.leedsi* suggest four cervical regions are present, namely C2, C3-C6, C7-C37 and C38-C42 (Figure 1A). PC1 represents changes in centrum length while PC2 represents changes in centrum height.

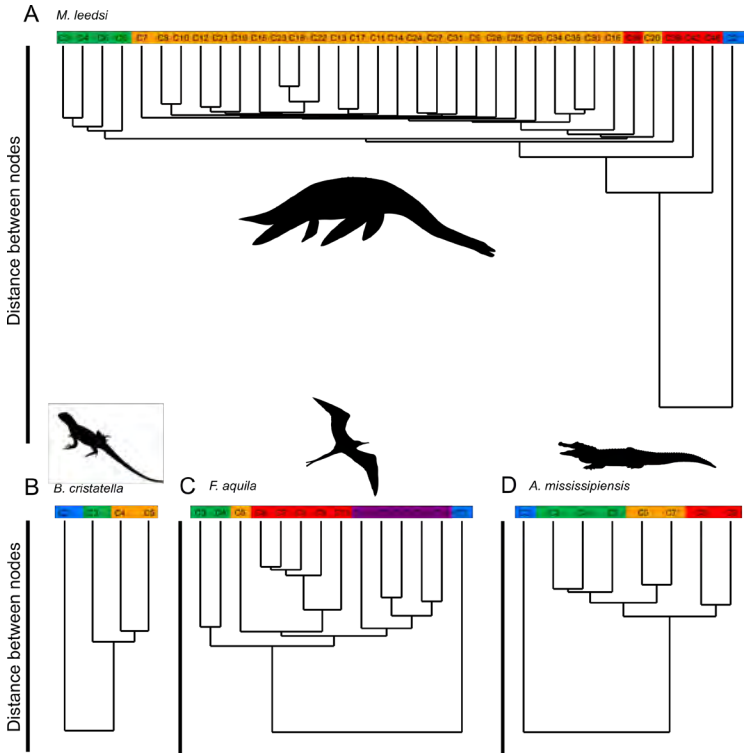

Figure 1. Cluster analysis graphs showing the region delineations in four different taxa. Colour bars represent the different regions: blue, region 1; green, region 2; orange, region 3; red, region 4; purple, region 5. The figure does not suggest homology between species.

Avian species show increased vertebral height and decreased vertebral length at the anterior vertebrae, decreased height and increased length in the middle vertebrae, and an increase in height and decreased length of the posterior vertebrae. Similarities are seen in the vertebrae of *A. mississippiens*is and the anterior vertebrae of *M. leedsii,* as vertebral height increases posteriorly. The middle cervical vertebrae of *B. cristatella* are tallest, and centrum length increases posteriorly. Region 4 of *M. leedsi* and *A. mississippiensis* show vertebrae with a prominent increase in neural spine height as well as more laterally facing articulate facets. Shape changes between regions can be seen in the neural spines of *M. leedsii*, and region 3 displays vertebrae with more rounded prezygophysis.

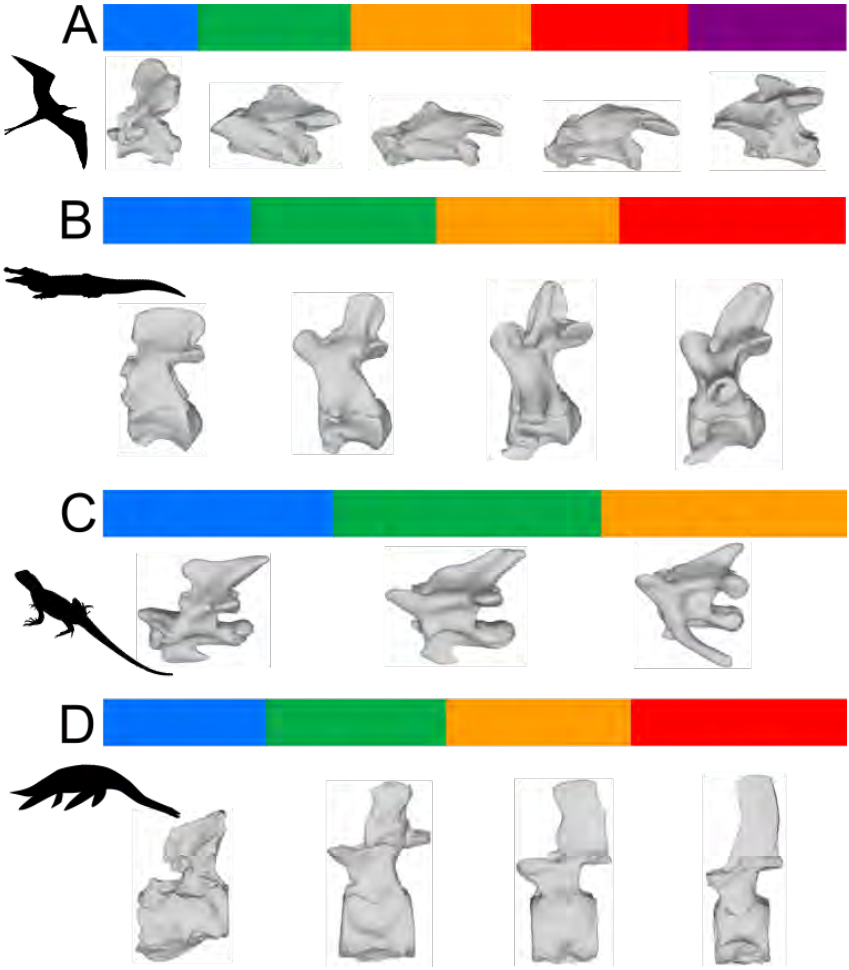

Figure 2. Anatomical difference seen between the different regions in each species. Colour bars represent the different regions: blue, region 1; green, region 2; orange, region 3; red, region 4; purple, region 5. Image does not suggest homology between species.

Discussion

This study suggests that the plesiosaur *M. leedsi* possessed four cervical regions, one more region than the basal cervical format. Much of the neck elongation occurs in region 3, although without genetic data of extant outgroups and analyses of additional species it cannot be confirmed which region is novel to plesiosaurs. Plesiosaurs show a disparate cervical vertebral count between species. Therefore, we might expect to see variable regions between plesiosaur species, which change position along the cervical column, the same way in which avian species show a disparate number of cervical vertebrae within a given region dependant on the biomechanical factors of the species. The shorter regions of the neck (region 1, 2 and 4) likely allowed less movement, while the extensive region 3 was likely more flexible. A large plesiosaur using four-limbed propulsion for locomotion (Muscutt *et al*. 2017) may have depended on a long neck with a broad spectrum of movement to seize prey whilst propelling through the water. Though cervical regionalization is significant to understanding the evolution of plesiosaur species, the evidence is rudimentary. This work sets the foundations for future research; a larger sample size along with GMM and an in-depth study of cervical anatomy could give evidence for regionalization in the plesiosaur clade.

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The grit problem: environmental signals in tooth microwear and implications

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Introduction

When an animal eats, food and teeth interact and this creates scratches and pits on the tooth's surface. This is known as dental microwear. The texture that is produced is directly related to the physical properties of the food/diet of that animal. Analysis of animals with known diets allows the relationship between diet and microwear to be determined, and this relationship allows microwear texture analysis to be used as a tool for dietary reconstruction in extinct animals. Although the method is widely used, there is an ongoing debate about whether extraneous sediment or 'grit' particles contained in food have an effect in producing microwear and thus obscure or even override dietary signals (Lucas *et al.* 2013; Merceron *et al.* 2016). Previous research on the "grit problem" has focused on herbivores, but we have used moles as a natural experimental system to test the hypothesis that the 'grit' content (sand and silt grade silicates) of soils has an overriding influence on the generation of tooth microwear. Moles feed underground, and their food, mainly earthworms and insect larvae, also contains and is coated by soil that the moles ingest. Mole diets exhibit little variation (Beolchini and Loy 2003), so differences in sand and silt content of soils should, if it has any effect on tooth microwear, be detected by analysis of mole tooth surfaces. This makes moles ideal for investigating whether or not sand and silt particles obscure dietary signals.

Methodology

Soil analysis: 26 moles were sourced from Norfolk, and soil samples were taken from mole collection sites. The soil samples were sieved to remove particles larger than 2mm and the remaining material was subsampled. The subsamples were then sieved into their sand and silt fractions and clay was removed. Loss-on-ignition (LOI) was used to remove organics and carbonates, allowing the sand and silt grade silicate content of the soil to be calculated.

Stomach and microwear analysis: The stomachs of the moles were dissected and the contents removed. Brief notes on the main constituents (*e.g.* worms, larvae *etc.*) were made and the particle size and silicate content of the mole stomachs were determined using the same methods as for the soil. The lower jaws were removed and the left lower second molars (Figure 1) were isolated for microwear analysis. 3D surface texture data were captured using focus variation microscopy (Alicona IFM G4) and data were processed to generate scale limited surfaces (Figure 2) and ISO 25178 texture parameters. Statistical tests, including correlations and ANOVA, were carried out to test the null hypothesis of no relationship between the sand and silt content of soils and the microwear textures of the moles, represented by the ISO parameters.

Preliminary results

There is no correlation between the sand and silt grade silicate content of the soils and microwear texture parameters. Analyses of variance comparing the moles from soils with the highest silicate sand and silt with moles from the soils with the lowest values also fail to find significant differences. We are thus unable to reject the null hypothesis that silicate sand and silt content of soils has no effect on microwear in moles. This provides strong support for the results of other analyses,

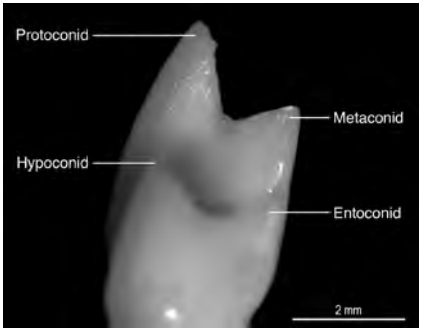

Figure 1. Left lower second molar of a mole. Data for our study were acquired from the protoconid facet.

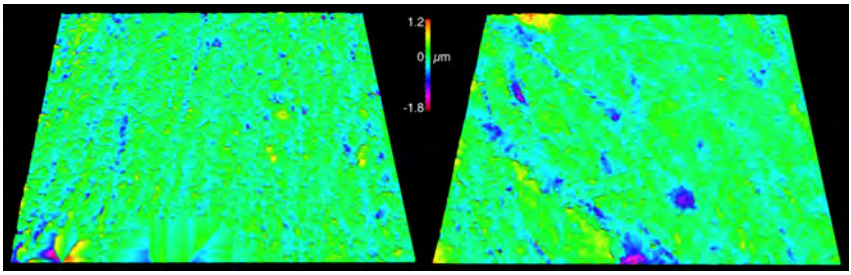

Figure 2. Examples of scale-limited surfaces generated by focus variation microscopy showing the microwear textures of two moles. The left image relates to a mole that lived in soil with the lowest total silicate content and the right image relates to a mole that lived in soil with the highest total silicate content. Fields of view are approximately 140 x 110 µm.

in herbivores (*e.g.* Merceron *et al*. 2016), which found that although 'grit' has an effect on tooth microwear, the magnitude of this effect is not great enough to obscure dietary signals.

Acknowledgements

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A new crocodylomorph from the early Late Cretaceous Kem Kem beds of Morocco

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Introduction

Unusually for crocodylomorphs, notosuchians exhibit considerable morphological and ecological diversity (Pol and Apesteguia 2005), and were abundant and diverse during the mid to Late Cretaceous of Gondwana (Sereno and Larsson 2009). Most of this diversity is found in South America (*e.g.* Marinho and Carvalho 2009; Iori *et al.* 2018), where over 70 % of known notosuchians have been discovered (Pol and Leardi 2015). However, the Cretaceous crocodylomorph record of Africa, Madagascar (Turner 2006) and Indo-Pakistan (Prasad and de Lapparent de Broin 2002) are poorly sampled, hampering our understanding of large-scale patterns.

During the mid-Cretaceous, Africa became isolated from the rest of Gondwana; understanding the African fossil record is therefore vital for ascertaining the timing of Gondwanan fragmentation (Upchurch 2008). As fully terrestrial animals, notosuchians are well-suited to testing palaeobiogeographic hypotheses of continental break up, given their likely requirement for land bridges (Gheerbrant and Rage 2006). Here, we present a description of a new notosuchian specimen (NHMUK PV R36829) from the early Late Cretaceous Kem Kem beds of Morocco. We test the phylogenetic position of this species in a comprehensive framework, and will use this information to provide new insights into notosuchian evolution and the Cretaceous palaeobiogeographic history of Africa.

Geological setting

This specimen is housed in the Natural History Museum, London and was obtained commercially after being recovered from the fossiliferous Kem Kem beds of southeastern Morocco. The Kem Kem beds comprise continental red sandstones of Albian to Cenomanian age (Cavin *et al.* 2010) and are part of the Continental Intercalaire, consisting of Paleozoic and Mesozoic sediments that extend across North Africa. They have yielded abundant, predominantly disarticulated, skeletal remains of highly diverse assemblages of reptiles and fish (Cavin *et al.* 2010).

Description: Mandible

The mandible is generally well preserved and comprises the dentary, splenial and left angular ramus (Figure 1). The right lateral dentary ramus is truncated at the posterior margin of the symphysis and the right lateral dentary ramus is truncated at the dorsal end of the dentary posterodorsal process where it would branch into the surangular ramus. Beneath the mandibular fenestra, the angular ramus is truncated at the angular ventrolateral flange. The mandible is sculptured by vermiform grooves and punctuated by approximately < 4.1 mm dentary neurovascular foramina. In dorsal view, the mandibular symphysis is relatively wide and posteriorly extends to the level of the eleventh tooth. The left and right tooth row along mandibular symphysis are well separated from each other by a broad dorsal surface of the symphysis. The presence of concave notch posterior to tooth 6 appears to be an autapomorphy. In dorsal view, the splenials participate in the symphysis, occupying approximately 38 % of the symphyseal length as well as extending anteriorly

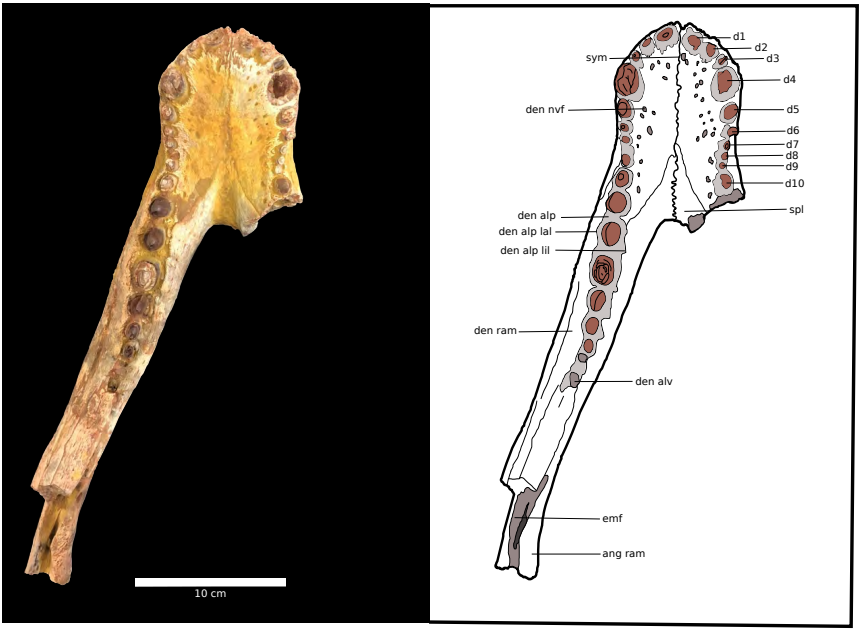

Figure 1. Schematic drawing of the mandible of NHMUK PV R36829 in dorsal view. **Ang ram**, *angular ramus;* **d1-d10**, *teeth of the dentary;* **den alg**, *dentary alveolar groove;* **den alp lal**, *dentary alveolar process labial lamina;* **den alp lil**, *dentary alveolar process lingual lamina;* **den alp**, *dentary alveolar process;* **den alv**, *dentary alveolus;* **den ram**, *dentary ramus;* **den nvf**, *dentary neurovascular foramina;* **emf**, *external mandibular fenestra;* **spl**, *splenial;* **sym**, *mandibular symphysis.*

to the level of the eighth alveolus, contrasting with extension to the sixth alveolus in *Gasparinisuchus peirosauroides* (Martinelli *et al*. 2012). The splenials are high, covering the inner surface of the mandibular ramus from the lower edge of the dentaries to the alveolar groove.

Description: Dentition

The dentition consists of 18 mandibular teeth which are single cusp, conical to sub-conical, with convex labial and lingual surfaces. Most crowns are broken or damaged; the seventeenth and eighteenth teeth in the series are not preserved. Teeth 11, 12, 14 and 15 are covered by a thick layer of red-brown coloured enamel. When preserved, the crowns exhibit finely denticulate anterior and posterior carina. In these teeth, the striations are evident around the entire crown from the crown base to the apex. The teeth are closely arranged, without diastemas. There is no cingulum, as is often the case in advanced notosuchians, with the exceptions of cingulate tooth crowns in *Morrinhosuchus*, *Malawisuchus* and *Candidodon* (Montefeltro *et al*. 2009; Iori *et al*. 2018).

There are two procumbent teeth on each anterior region of the mandibular symphysis. The lower incisiviforms are implanted in separate alveoli. The fourth tooth, whilst only partially preserved, is sub-conical and hypertrophied. Procumbent anterior teeth are also exhibited in *Montealtosuchus, Mariliasuchus* and *Labidiosuchus* and at a larger size in *Yacarerani* (Novas *et al*. 2009). Similar hypertrophied teeth are seen in *Araripesuchus, Candidodon*, and *Gasparinisuchus*, (Martinelli *et al*.

2012). Posterior to this anterior most part, the series of dentary teeth 6 to 10 are upright and arranged in a straight line from tooth 11 to 18. The teeth decrease in size in both the anterior and posterior direction from tooth 13, and are closely spaced within the dentary alveolar groove.

Phylogenetic Analysis

We are still in the process of preparing a manuscript fully analysing the significance of this new species. However, preliminary phylogenetic analysis using TNT v1.5 and an existing phylogenetic matrix from Pol *et al.* (2014) has indicated this is a new species and belongs within a polytomy with several notosuchians. Currently, we are updating the matrix by Pol *et al*. (2014), which we hope will produce a better resolved tree and accurately place NHMUK PV R36829. Ultimately, this research has enabled the taxonomic affinities of NHMUK PV R36829 to be determined, and it will be placed in both a regional and a global context, adding an important new data point to our understanding of crocodylomorph evolution and Gondwanan palaeobiogeography in the mid-Cretaceous.

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Macroevolutionary patterns of tetrapod evolution during the Carboniferous–Permian transition: evidence from fossil footprints

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Introduction

The late Carboniferous–early Permian (Bashkirian–Kungurian) was a significant time in Earth history. Pangaea had recently assembled, and terrestrial ecosystems underwent significant change as rainforests disappeared due to increasing aridification brought about by the concentration of the terrestrial realm into one landmass (Hilton and Cleal 2007). This interval was an important one in tetrapod evolution, with the evolution and diversification of amniotes, including reptiles, and evidence from body fossils suggests an important role for environmental changes in driving macroevolutionary patterns (*e.g.* Sahney *et al.* 2010; Dunne *et al.* 2018). However, a clear understanding of tetrapod evolution through this interval is limited by the sparse fossil record. The tetrapod ichnofossil record is more extensive and has the potential to enrich interpretations based on the body fossil record. This project aimed to use the tetrapod ichnofossil record to: quantify changes in ichnodiversity; understand tetrapod community structure (particularly the proportion of amniotes versus amphibians); and quantify morphofunctional diversity (ichnodisparity).

Methods

A comprehensive literature review was conducted of tetrapod ichnofossils (footprints and trackways) from the Bashkirian–Kungurian, and an occurrence dataset compiled in Microsoft Excel. The dataset contained information pertaining to the locality, latitude and longitude (precise coordinates were estimated using Google Earth), stratigraphic age, lithology and palaeoenvironment of the ichnofossil occurrence. The statistical environment R was used to analyse and plot data. A series of 28 discrete morphological characters (*e.g.* ratios of manus length to pes length, total digit divarification, pace angulation and one absolute measurement of pes length to represent overall body size) were identified and scored for each ichnogenus. The package Claddis was then used to estimate disparity using weighted mean pairwise dissimilarity for stage-level time bins.

Results

An overall increase in maximum numbers of ichnogenera is observed through the time interval (Figure 1). However, considerable fluctuations occur. The numbers of localities and formations sampled are strongly correlated with the number of ichnogenera (Spearman's Rank Correlation; p value <0.05), suggesting a potential sampling bias. The observed fluctuations in ichnodiversity may therefore reflect variation in sampling effort rather than real biological changes.

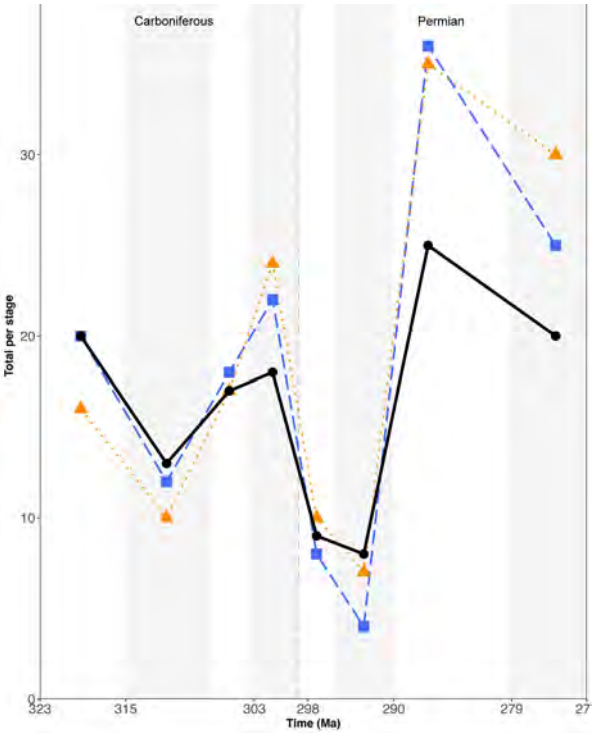

Figure 1. Changes in numbers of ichnogenera (black line), sampled formations (orange line) and localities (blue line) from the Bashkirian–Kungurian.

An increase in the proportion of amniotes relative to amphibians is seen through the time interval studied (Figure 2), although a number of fluctuations are observed. The Carboniferous rainforest collapse (CRC) is proposed to have occurred through the late Carboniferous (Dunne *et al*. 2018); however, the sharp decrease in the number of amphibian ichnogenera occurs only in the earliest Permian (Asselian). This suggests that the CRC may have been a prolonged event spanning several million years. Amniote ichnogenera are much more abundant than amphibians in the Artinskian and Kungurian. This may be because they could lay eggs on land and were likely more tolerant to arid conditions (*e.g.* Sahney *et al.* 2010; Dunne *et al*. 2018).

This study represents the first attempt to quantify ichnodisparity from tetrapod ichnofossils. No significant change in ichnodisparity occurs through the time interval (Figure 3). This is perhaps unexpected given that substantial changes occurred in the total number of ichnogenera and

faunal composition (Figures 1 and 2). This may suggest that locomotor function and diversity of tetrapods did not change substantially during the interval, and that changes in taxonomic richness estimated from body fossil data (Dunne *et al*. 2018) are not underpinned by evolutionary innovation in locomotion. However, this signal may not reflect patterns of overall morphological diversity: footprints are a poor representation of the entire skeleton (especially for the large trackmakers of ichnogenera such as *Alabamasauripes*). Extramorphological variation, such as in the form of digit impressions missing from footprints, was recorded for the majority of occurrences; this is most likely due to preservational biases, *e.g.* tidal flats (Hunt *et al.* 2005). Sedimentological processes may therefore have distorted data collection.

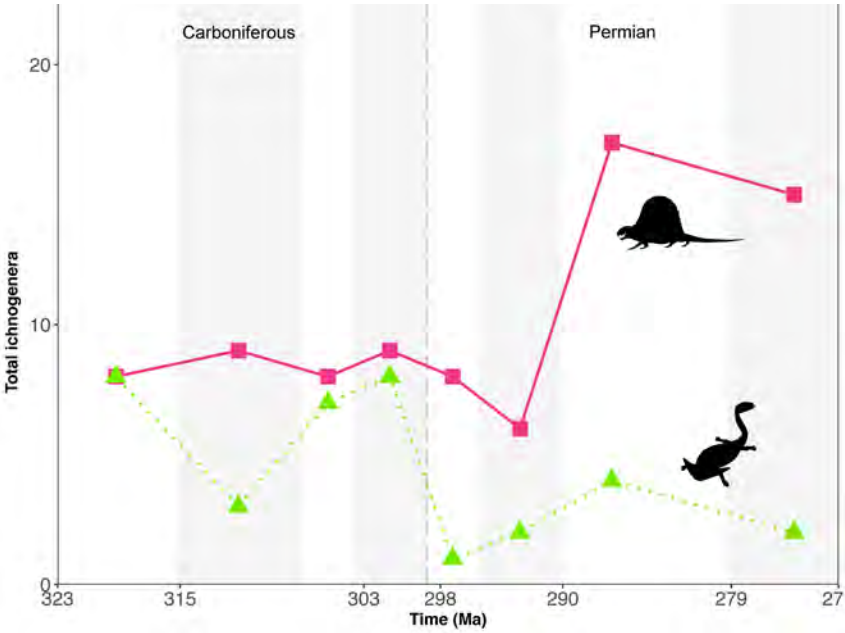

Figure 2. Number of amniote ichnogenera (pink line) versus amphibian ichnogenera (green line) from the Bashkirian–Kungurian. Silhouettes of Dimetrodon *(amniote) and* Diplocaulus *(amphibian) from* <**www.phylopic.org**> *and created by Dmitry Bogdanov and Gareth Monger.*

No significant increase in mean tetrapod size (estimated using manus stride length and glenoacetabular distance, measured from images in publications using the software ImageJ) occurred through the interval. This appears to be inconsistent with Cope's Rule, which postulates that animals evolve to larger sizes over time and has been suggested to occur in early tetrapods (Laurin 2004). However, different patterns might be recognized if data from the earlier Carboniferous were integrated in subsequent analyses. There was an increase in the maximum body size obtained by tetrapods throughout the interval.

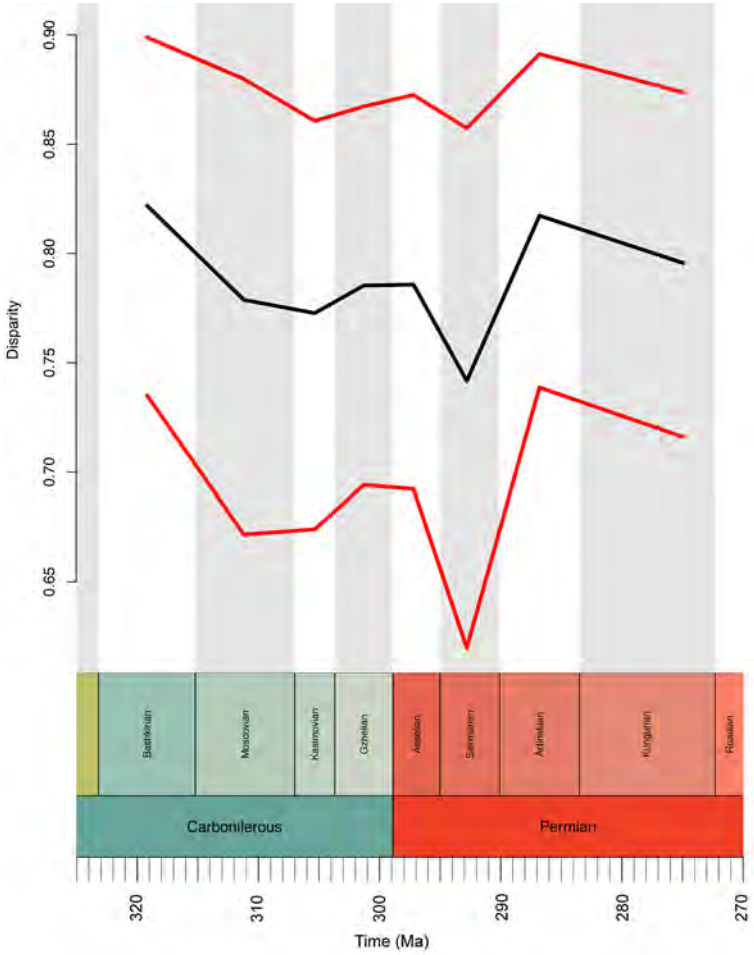

Figure 3. Estimate of ichnodisparity (weighted mean pairwise dissimilarity: WMPD) from the Bashkirian–Kungurian. Black line represents WMPD for each time interval, and red lines indicate 95 % confidence intervals. Note the absence of significant changes in disparity through time.

Conclusions

The ichnofossil occurrence data complement the body fossil record from this interval and provide additional evidence of substantial sampling biases. The proportion of amniotes increased whilst the proportion of amphibians fell, but there was no overall change in ichnodisparity. One of the most significant outcomes of the project was the construction of a large database of ichnofossils; it contains a wide range of information that can be analysed in the future (*e.g.* through plotting data on palaeogeographic maps to examine changes in the biogeographical distribution of tetrapods over time). We also intend that the data will eventually be integrated into the Paleobiology Database.

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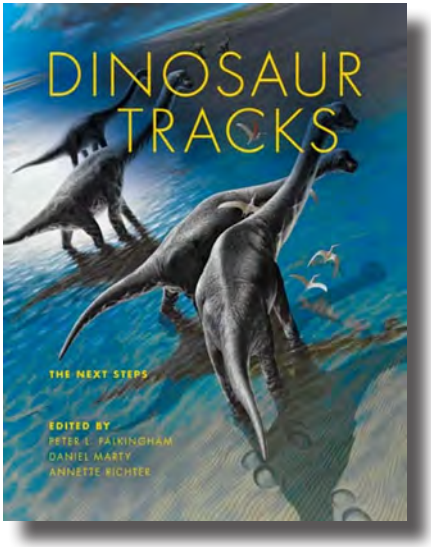
Book Reviews

Dinosaur Tracks: The Next Steps

Peter L. Falkingham, Daniel Marty and Annette Richter (editors). 2016. 428 pp. 177 illustrations. Indiana University Press. £67.00 (print, also available as eBook). ISBN 978-0-253-02102-1.



Modern invertebrate ichnology was first summarized by Abel (1935) but essentially had its roots in the 19th century. However, it was not recognized as mainstream science until the works of Seilacher and Schäfer in the 1950s and 1960s. During this time the transition was made from pure taxonomical treatment of trace fossils towards interpretive behaviour and ultimately their use in palaeoenvironmental reconstructions or even in applied geosciences, *e.g.* petroleum geology. Vertebrate ichnology, on the other hand, was and still is behind, although fossil vertebrate tracks have been recognized, described and interpreted as one of the first fossils in human history (see *e.g.* Seilacher, 2007). The scientific focus in vertebrate tracks was mainly on their taxonomy and only very few modern studies were conducted (*e.g.* track-tracemaker pairings by Soergel 1925). Modernization of vertebrate ichnology had already started about 30 years ago (Lockley 1991, 1998; Lockley & Gillette 1987) and the present book sets out to push it even further by interlinking it with biological and geological disciplines, such as biomechanics, taphonomy, sedimentology and stratigraphy.

In the present book 20 articles are compiled dealing with this new approach to dinosaur ichnology, most of them presented as talks and posters during the international symposium 'Dinosaur Tracks 2011' in Obernkirchen (Germany) in April 2011. These contributions are broadly grouped by subject into four parts. An introduction acquaints the reader with the basics and also provides a brief historical overview of vertebrate ichnology.

In the first of the aforementioned parts ('Approaches and techniques for studying dinosaur tracks'), modern techniques and methods are explained for extracting all imaginable information from vertebrate tracks. Milàn and Falkingham highlight the importance of actuopalaeontological studies and experiments under laboratory conditions in order to confidently interpret track morphology by subtracting the influences a certain sediment and its specific consistency may have on a surface track and its undertracks. Matthews *et al.* describe an inexpensive and easy way of documenting and (digitally) preserving dinosaur track sites. Wings *et al.* investigate the shape variation of tridactyl

dinosaur tracks over the course of a more than 25 m long section of a trackway using three-dimensional photogrammetric models. As a result, suggestions are made for the ranking of some ichnotaxobases. Furthermore, the authors propose a system to determine sediment loss between true tracks and natural casts during excavations of track sites. Falkingham discusses the most problematic challenge that vertebrate ichnotaxonomists face: the reliability of outline drawings of tracks. Even when three-dimensional models are created, no objective outline of an individual track can be defined (as already pointed out by Sarjeant 1975). Although Falkingham suggests that maximum and minimum outlines are communicated ('best guess and bracketing') instead of an interpreted outline, he favours sharing of full three-dimensional data of tracks by scientists.

Gatesy and Ellis provide a closer look at track ichnogeny (*sensu* Belaústegui *et al.* 2016) by distinguishing foot-sediment and sediment-sediment interactions (how sediment particles move). In invertebrate ichnology, *e.g.* ontogeny of burrows may reflect different ontogenetic stages of the tracemaker and are therefore important for possible tracemaker assignments (Seilacher, 1967). In vertebrate ichnology, track ichnogeny could provide valuable supplementary data in order to understand the origin and possible variability of track morphology. Belvedere and Farlow present exactly that. It should allow ichnologists to consider only the best-preserved tracks for ichnotaxonomy. The system is based on the occurrence or lack of morphological details. At the end of the first part, Alcalá *et al.* raise awareness of what could happen with a newly discovered tracksite. The proposed criteria for evaluation, apart from its scientific importance, are aesthetics, tourism, pedagogic value, erosional protection, *etc*. In my opinion, these criteria should probably not be addressed in scientific publications but certainly must be considered before talking to municipality or other officials to protect and make a tracksite publicly accessible.

The second part of the book, 'Paleobiology and evolution from tracks', is opened by Castanera *et al.* on Iberian sauropod tracks through time. The Iberian Peninsula has about a hundred sauropod tracksites ranging from the Middle Jurassic to the Late Cretaceous. The authors observed morphological changes in both manus and pes imprints revealing a changing tracemaker fauna. Hall *et al.* assess the hypothesis that sauropod pedal ungual flexion increased the friction between sediment and foot to prevent miring. This hypothesis is disproved and the authors see in the ungual flexion an adaptation to digging or scratching. Milner and Lockley study the morphological characteristics and the context of natichnia. The differentiation between theropod and other archosaur tracemakers leads the authors to refine the terrestrial vertebrate ichnofacies model. Lockley *et al.* review all 16 occurrences of didactyl tracks worldwide with respect to sample size, quality of preservation, morphology, ichnotaxonomy and tracemaker identification. The Cretaceous occurrences are compared with two earlier didactyl ichnogenera (*Evazoum* and *Paravipes*). *Evazoum* is regarded as made by tracemakers having convergent morphology to raptors, and *Paravipes* is reinterpreted as a swimming trace.

Hornung *et al.* attempt to identify the causes of morphological variation in iguanodontian tracks by applying multivariate homologous two-dimensional landmark analysis. They conclude that ichnotaxa should be based on qualitative characters (presence or absence of elements) rather than size relations, because the first method allows recognition of ontogenetic development of the tracemakers. Stevens *et al.* investigate the data provided by trackways about its tracemaker. Their analysis of limb phase and stride length in relation to the trackmaker's size reveals interdependence amongst these parameters. The software Cadence (a so-called passive solver) visualizes a given

trackway by animating the two locators of each manus and pes over time, reconstructing acceleration, deceleration, hesitation or pauses. Cobos *et al.* shed light on foot and distal limb kinematics by interpreting bioglyphs such as scale impressions or their scratching structures formed at the sides of the track, created during the impression of the extremity into the sediment ('4-D').

Part three ('Ichnotaxonomy and trackmaker identification') only includes two papers. Buckley *et al.* test whether established avian and theropod ichnogenera actually belong to established ichnofamilies. According to their statistical data evaluation, all the Cretaceous avian ichnotaxa are valid and most of these ichnofamilies are redefined. Hübner carefully examines possible ornithischian tracks that, owing to their variable morphology, are often mistaken for less well-preserved theropod tracks. Although derived from a rather small data source, promising potential in differentiating seems to lie in a weaker mesaxony, wider divarication angles, stronger symmetry, broader digits and a rounder, more consistent metatarsal imprint.

The fourth and last part of the book ('Depositional environments and their influence on the track record') begins with a description and interpretation of the highly diverse 'Chicken Yard' of Northern Germany by Richter and Böhme. They highlight the problems faced during investigations of such heavily trampled surfaces and recommend possible solutions. Loope and Milàn raise and try to answer the question of why dinosaurs wandered around in dune fields, and why their tracks were not erased by the next wind or storm to shift the loose aeolian sands. Schanz *et al.* emphasize that a thorough analysis of soil desiccation structures may provide information about track formation, track preservation and the interpretation of the palaeoenvironment. They report on intrinsic state properties of the soil and the boundary where the cracks form by utilizing data derived both from experiments and from numerical simulations (mathematical modelling). Soil stiffness during production of the tracks can be estimated with their method, also allowing reconstructions for tracks preserved in natural casts whose original surface already has been eroded. D'Orazi Porchetti *et al.* evaluate 131 papers published between 1917 and 2013 on 212 dinosaur tracksites in shallow marine carbonate beaches. Their database for the Jurassic and Cretaceous revealed an abundance of saurischian tracks and a relative paucity of ornithischian tracks. If this decline of ornithischian tracks reflects an evolutionary trend, the authors suggest studying data from siliciclastic environments in the future.

Four colour plates with beautiful artwork by Frederik Spindler depict scenes from the Obernkirchen (Bückeberge) and Münchehagen tracksites in Lower Saxony (Germany). Short explanations of these scenes are given by Hornung and colleagues.

A glossary of terms and an index to subjects complete the book. These two sections make *Dinosaur Tracks* suitable and its content easily accessible not only for specialists but also for students and laypeople. Invertebrate ichnologists will find it interesting as it shows how much the same term has changed meaning by crossing the border between the sister fields of invertebrate and vertebrate ichnology.

Regrettably, the term "mark" occurs repeatedly in the book, often as "claw marks" or "scratch marks". These combinations are flawed because the term "mark" is restricted to sedimentary structures produced exclusively by physical forces or chemical reactions (Seilacher, 1953; Jacobsen & Bromley, 2009; Vallon *et al.*, 2015). Sedimentary structures actively caused by organisms must be called traces.

Altogether, the book is outstanding, not only because of its content, but also because of its high quality in printing and binding, two important aspects that, unfortunately, are increasingly neglected by publishers. Its paper is thick and semi-glossy, all figures are in colour and everything is firmly bound together. The book's price to performance ratio is also fantastic if you should choose the electronic version. Publication in this manner was probably only realizable owing to the financial support of two German state authorities. Students and other beginners in vertebrate ichnology can therefore easily purchase a copy in order to take their next steps as well as experienced scientists in the field of *Dinosaur Tracks*.

Lothar H. Vallon
Faxe (Denmark)

[Lothar wishes to acknowledge Andrew K. Rindsberg (Livingston, Alabama, USA) for help improving the language of this review.]

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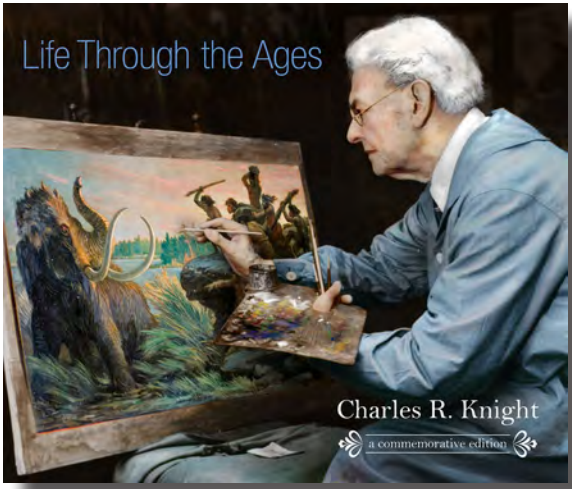
Life Through the Ages – A Commemorative Edition

Charles R. Knight. New Foreword by Stephen Jay Gould, Introduction by Philip J. Currie. 2017. 96pp. Indiana University Press. £13.99 paperback. ISBN-10: 9780253028822.

There is no doubt that Charles R. Knight (1974–1953) was one of the most influential palaeo-illustrators of all time. His stunning ability to bring prehistoric animals to life captured the imagination of a whole generation and shaped their perception of how the life of prehistoric Earth looked. His works can be admired as large-sized murals at museums, and his vivid colourful



illustrations have been used in numerous books and articles for several decades. This is a commemorative edition of Knight´s classic book, *Life Through the Ages*, from 1946. This was originally a black and white book with charcoal sketches of many of his later colourful and famous illustrations, with a page of text accompanying each sketch.

When I read the advertisement for the book several things immediately intrigued me. First the cover shows a colour picture of Knight working on his famous painting of ice age hunters attacking a woolly mammoth. This together with the text saying that for this edition several of Knight's original paintings had been re-photographed, led me to believe that this might be an updated full-colour version of the book. The more puzzling thing with the advertising text was the highlighting of a foreword by Stephen Jay Gould – who sadly passed away in 2002. I know that the spirit of Gould is still strong among us in the palaeontological community, but writing a foreword for a new book must be considered out of his current reach. It could, however, be the case that the publishing house reused a foreword from a previous edition. More interesting was the promise of a new introduction by Phil Currie that brings the reader up to date with current research and puts Knight´s work in perspective. Well, after reading the foreword it becomes clear that it was written around 2000, and by looking into the small print on the inner sleeve, it becomes clear that this edition of the book is in fact not a new edition, but the direct unaltered reissue of the 2001 edition. I cannot help but feel that this publication is a bit of a lost chance to make a great relevant reprint of an old classic.

So should you buy this book? If you are interested in a classic piece of palaeo-illustration which this book really is, and you don't mind that the "new" introduction is in fact 17 years old, then it's the book for you. But if you want a book showcasing the immense talent of Charles R. Knight and already have a large selection of his best works in full colour to marvel on, you should buy Richard Milner's 2012 book *Charles R. Knight: The Artist Who Saw Through Time* instead.

Jesper Milàn
Geomuseum Faxe

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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.

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- Acrocanthosaurus *Inside and Out*, by Kenneth Carpenter.
- *Across the Bridge*, by Henry Gee.
- *Fossil Frogs and Toads of North America*, by J. Alan Holman.
- *The Tyrannosaur Chronicles*, by David Hone.
- *Trilobites of the British Isles*, by Robert Kennedy and Sinclair Stammers.
- *Fossilien im Alpstein: Kreide und Eozän der Nordostschweiz*, by Peter Kürsteiner and Christian Klug.
- *Dinosaurs: The Textbook*. (6th Edition), by Spencer G. Lucas.
- *Burning Planet*, by Andrew Scott.
- *Smilodon: The Iconic Sabertooth*, edited by Lars Werdelin, H. Gregory McDonald and Christopher A. Shaw.
- *The Palaeoartist's Handbook: Recreating Prehistoric Animals in Art*, by Mark P. Witton.

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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.

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