The Palaeontology Newsletter

89

Contents

Reminder: The deadline for copy for Issue no 90 is 12th October 2015.

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Editorial

Here in London summer is under way, although it is difficult to tell just by looking out of the window; once you step outside, however, the high pollen counts are the main giveaway. It is largely the sort of 'summer' weather that confuses foreign tourists, makes a mud bath out of music festivals and stops play at Wimbledon. The perfect sort of weather to leave Britain behind and jet off to sunnier climes for a nice long field campaign: as I wistfully gaze at the grey skies I wish I were packing my notebook and field gear ready for departure.

Those of you who are setting out for fieldwork during this Northern Hemisphere summer will probably be aware that it is not a walk in the park, as my initial rose-tinted memories lead me to believe. Delving deeper into the memory banks I recall arriving in Wyoming, USA, at the end of June one year to snow and freezing conditions, followed by thunderstorms and then some of the hottest temperatures I have ever experienced (described by the local cowboys as "hotter than hell"), all in the space of a few weeks. Then there's the added responsibility of managing everything prior to travel, making sure necessary forms have been filled, arrangements made and all vital equipment packed, not to mention the pressure of making a success of the limited time at the field site. Fieldwork is often the start of a project, the remainder of which can rely on the outcome of those few weeks.

Putting the downsides to one side, fieldwork represents some of the best times of my life, getting away from it all and focusing on fossils in the great outdoors. I've found some fantastic specimens (and some not so much), made firm friendships and enjoyed a fair few post-field G&Ts. Perhaps it's this triumph in the face of potential adversity that makes fieldwork so special. For those of you who are going away this year, please share your experiences so that we poor creatures stuck doing office work or collections-based research can live vicariously through you. It would be great to see photos of you at your field localities and catch a glimpse of the exciting discoveries that you're making (including nice stratigraphy, micropalaeontologists!). Please submit your photographs on Twitter, Facebook, Instagram, or anywhere else, adding the hashtag #fossilsinthefield, or if you're not a fan of social media then e-mail your photographs directly to me. For those of you with field sites in the Southern Hemisphere, please join in and post photos from your most recent fieldwork. We will collate the best and feature them in the next Newsletter; there are some great examples already on Twitter and we'd love to see lots more.

In the meantime I hope that the rest of this Newsletter brings a little ray of sunshine into your lives. We've had some great contributions this time and I'd like to thank everybody for their hard work.

Jo Hellawell
Newsletter Editor
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@ThePalAss

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

Association Business

Annual Meeting 2015

Notification is given of the 59th Annual General Meeting

This will be held at Cardiff University, UK, on 15th December 2015, following the scientific sessions.

AGENDA

1. Apologies for absence
2. Minutes of the 58th AGM, University of Leeds
3. Trustees Annual Report for 2014
4. Accounts and Balance Sheet for 2014
5. Election of Council and vote of thanks to retiring members
6. Report on Council Awards
7. Annual address

DRAFT AGM MINUTES 2014

Minutes of the Annual General Meeting held on Wednesday, 17th December 2014 at the University of Leeds, UK.

1. **Apologies for absence.** Dr M. Sutton, Dr R. Owens, Dr M. Ruta.

2. **Minutes.** Proposed by Prof. G. Sevastopulo and seconded by Mr D. Ward, the minutes of the 2013 AGM were agreed a true record by unanimous vote.

3. **Trustees Annual Report for 2013.** Proposed by Dr A. B. Smith and seconded by Prof. D. A. T. Harper, the report was agreed by unanimous vote of the meeting. The small year-on-year decline in membership numbers was discussed and, although not considered significant at present, a small drop in the number of student members was noted.

4. **Accounts and Balance Sheet for 2013.** Proposed by Dr C. T. S. Little and seconded by Dr P. W. Skelton, the accounts were agreed by unanimous vote of the meeting. A question concerning the high spend on the Designated Funds was raised and the Treasurer confirmed that Council regularly monitors the situation and that the Designated Funds are periodically topped up from General Funds.

5. **Election of Council and vote of thanks to retiring members.** Prof. M. J. Benton extended a vote of thanks to the following members of Council who were retiring from their positions this year: Dr C. Jeffrey-Abt, Dr A. McGowan and Dr R. Owens. The following members were elected to serve on Council: President: Prof. D. A. T. Harper; Vice Presidents: Dr M. Sutton and Mr D. J. Ward; Treasurer: Mr P. Winrow; Secretary: Prof R. J. Twitchett; Editor-in-Chief: Dr A. B. Smith; Editor Trustees: Prof C. H. Wellman, Dr M. Ruta; Newsletter Editor: Dr J. Hellawell; Book Review Editor:

Dr T. Challands; Publicity Officer: Dr L. Herringshaw; Education Officer: Dr C. Buttler; Outreach Officer: Dr F. Gill; Internet Officer: Mr A. R. T. Spencer; Meetings Coordinator: Dr T. Vandenbroucke; Ordinary Members: Dr R. J. Butler, Dr C. T. S. Little, Dr M. McNamara, Dr M. Munt, and Dr I. Rahman. Dr C. Buttler will organise the Annual Meeting in 2015 at the University of Cardiff and National Museum of Wales, UK.

6. **Association Awards.** The following awards were announced:

Lapworth Medal to Prof. R. A. Fortey (The Natural History Museum, London).

President's Medal to Prof. P. C. J. Donoghue (University of Bristol).

Hodson Award to Dr. M. E. McNamara (University of Cork).

Mary Anning award to Dr Christoph Bartels.

The President's Award was made to D. Button (University of Bristol and The Natural History Museum, London).

The Council Poster Prize was presented to Jennifer Hoyal Cuthill (University of Cambridge) and Edine Pape (University of Leeds).

Undergraduate Research Bursaries were awarded to: Mr N. Adams, Royal Holloway, supervised by Prof. M. Collinson; Ms H. Betts, University of Bristol, supervised by Prof. P. Donoghue; Mr C. Bracher, Plymouth University, supervised by Dr C. Smart; Mr A. Hudson, University of Southampton, supervised by Dr I. Harding; Mr J. Bestwick, University of Leeds, supervised by Dr C. Little; Ms R. Hodge, University of Nottingham, supervised by Dr B. Lomax; Mr I. Smith, Plymouth University, supervised by Dr K. Page; Mr L. Schröer, Ghent University, supervised by Dr Thijs Vandenbroucke; Mr F. Smithwick, University of Bristol, supervised by Prof. M. Benton; and Mr J. Teoh, University of Bristol, supervised by Dr J. Vinther.

Research Grants were awarded to: Dr Adiël Klompmaker: *Comparative experimental taphonomy of marine crustaceans: clues to their fossil record*; Dr Alejandro Otero, *Phylogeny of basal sauropodomorphs: insights on the early radiation of the group and the transition to Sauropoda*; and Dr Olev Vinn, *Evolution of biofouling and bioerosion in the early Palaeozoic of Baltica*.

Under the Small Grants Scheme, the following awards were announced: Sylvester-Bradley Awards to Mr J. Huang: *Middle Triassic conodont apparatus reconstruction from China;* Dr B. MacGabhann: *Community ecology of Cambrian deep marine scratch-circles;* Ms E. Martin: *Pterosaur body mass, pneumaticity, and flight mechanics;* Mr L. Parry: *Fossil polychaetes from the Palaeozoic of North America;* and Ms N. Stone: *Biomechanical impact of skull sutures in Palaeognathae;* The Callomon Award to Mr W. Foster: *Evolution of the oldest Mesozoic platform margin reef*; Stan Wood Awards to Ms K. Richards: *Tournaisian chondrichthyans from the Scottish Borders;* and Mr D. Foffa: *Ecology and evolution of British Jurassic marine reptiles*; and The Whittington Award to Dr A. Daley: *What is the Cambrian "muscle worm"?*

9. **Annual Address:** The Annual Address entitled "Understanding ancient Earth climates and environments using models and data" was given by Prof. A. Haywood (University of Leeds).

Trustees Annual Report 2014

1. Objectives and Activities

1.1 Aims and Objectives: The aim of the Association is to promote research in Palaeontology and its allied sciences by (a) holding public meetings for the reading of original papers and the delivery of lectures, (b) demonstration and publication, and (c) by such other means as the Council may determine. In order to meet these objectives, the Association continues to increase its range and investment in public outreach and other charitable activities, whilst continuing to support research, publications, and student and speaker attendance at national and international meetings including our flagship Annual Meeting.

1.2 Grants–in-aid for meetings and workshops: The Association provided funds to support the following meetings and workshops: A Geological Society of America Annual Meeting 2014 symposium entitled 'Mass extinctions: volcanism, impacts and catastrophic environmental changes' (Dr. D. Bond, Hull University); a European Geosciences Union General Assembly 2015 session on Stratigraphic Palaeobiology (Dr. S. Danise, Plymouth University); the 13th meeting of Early Stage Researchers in Palaeontology (EJIP), Cercedilla, Spain (Dr S. Domingo, University of Madrid); Echinoderm Palaeobiology Conference, Zaragoza, Spain (Dr S. Zamora, Spanish Geological Survey); a meeting entitled 'Moray geology: past, present, future' (Dr S. Beardmore, Elgin Museum).

1.3 Public meetings: Four public meetings were held in 2014, and the Association extends its thanks to the organisers and host institutions of these meetings.

a. *58th Annual Meeting*. This was held on 16th–19th December at University of Leeds, UK. Dr C. T. S. Little and Dr F. Gill, with local support from colleagues and PhD students, organised the meeting, which included a symposium on 'The photosynthesis revolution: how plants and photosynthetic micro-organisms have bioengineered the planet,' and comprised a programme of internationally recognised speakers. There were 274 attendees. The Annual Address was entitled 'Understanding ancient Earth climates and environments using models and data' and was given by Prof. Alan Haywood (University of Leeds). The President's Prize for best oral presentation from an early career researcher was made to David Button (University of Bristol). The Council Poster Prize was presented to Edine Pape (University of Leeds) and Jennifer Hoyal Cuthill (University of Cambridge).

b. *British Science Festival, Palaeontological Association Symposium*. This is an annual forum for presentations to the public and general scientists. The Symposium 'Virtual Palaeontology' was held at the Lapworth Museum and organised by Dr R. J. Butler (Birmingham). Funds supported presentations by Dr R. Garwood (University of Manchester) and Dr I. Rahman (University of Bristol).

c. *Progressive Palaeontology*. The annual open meeting for presentations by research students was organised by Ms J. Lawrence and a team of colleagues, and was held at the University of Southampton.

d. *Lyell Meeting*. The Association is one of the joint co-organisers of this annual meeting. The 2014 Lyell Meeting was held in March at Burlington House, London, on the topic of 'Deep Sea Chemosynthetic Ecosystems' organised by Dr S. Danise (University of Plymouth) and Dr C. T. S. Little (University of Leeds).

1.4 Publications: Publication of *Palaeontology* and *Special Papers in Palaeontology* is managed by Wiley Blackwell. During 2014, the following volumes were published: *Palaeontology* **57**, comprising six issues; *Special Papers in Palaeontology* **91**, 'The Late Ordovician brachiopods of southern Pembrokeshire and adjacent south-western Wales', by L. R. M. Cocks; and *Special Papers in Palaeontology* **92**, 'Trilobites from Silurian reefs in North Greenland', by H. E. Hughes and A. T. Thomas. During 2014, the decision was made to cease production of *Special Papers* and to replace it with a new journal entitled *Papers in Palaeontology*. The Association is grateful to the National Museum of Wales and the Lapworth Museum (University of Birmingham) for providing storage facilities for publication back-stock and archives. Council thanks Meg and Nick Stroud for assistance with the publication and distribution of the Palaeontological Association *Newsletter*.

1.5 Publicity, Outreach and Engagement: The Association continues to promote palaeontology and its allied sciences through press releases to the national media, radio and television. The Association had stands at the Lyme Regis Fossil Festival and at the Yorkshire Fossil Festival, which were staffed by members of Council, the Executive Officer and volunteers. Council approved a budget of £30,000 to be spent exclusively on Outreach activities. A payment of £1,000 was made to J. McKay for artwork associated with four dioramas to be used at the fossil festivals, and during outreach visits to schools.

1.6 Research Grants: Six applications for Palaeontological Association Research Grants were received. Three were recommended for funding in 2014, totalling £14,784, and were awarded to: Dr Adiël Klompmaker, Florida Museum of Natural History, 'Comparative experimental taphonomy of marine crustaceans: clues to their fossil record'; Dr Alejandro Otero, La Plata University, 'Phylogeny of basal sauropodomorphs: insights on the early radiation of the group and the transition to Sauropoda'; Dr Olev Vinn, University of Tartu, 'Evolution of biofouling and bioerosion in the early Palaeozoic of Baltica'.

1.7 Small Grants Scheme: The scheme received 20 applications. Nine were recommended for funding in 2015, totalling £11,943. Sylvester-Bradley Awards were made to Jinyuan Huang (Chengdu Institute of Geology and Mineral Resources); Dr Breandán MacGabhann (Edge Hill University); Elizabeth Martin (University of Southampton); Luke Parry (University of Bristol), and Nicola Stone (University of Bristol). The Callomon Award was awarded to William Foster (Plymouth University); the Whittington Award to Dr Allison Daley (Oxford University); and inaugural Stan Wood awards to Kelly Richards (University of Cambridge) and Davide Foffa (University of Edinburgh).

1.8 Undergraduate Research Bursaries: In its inaugural year, the Palaeontological Association Undergraduate Research Bursary Scheme attracted 20 applications. Ten were recommended for funding in 2014, totalling £15,000, and were awarded to the following: Neil Adams, Royal Holloway, supervised by Prof. M. Collinson; Holly Betts, University of Bristol, supervised by Prof. P. C. J. Donoghue; Curtis Bracher, Plymouth University, supervised by Dr C. W. Smart; Alex Hudson, University of Southampton, supervised by Dr I. Harding; Jordan Bestwick, University of Leeds, supervised by Dr C. T. S. Little; Ruth Hodge, University of Nottingham, supervised by Dr B. Lomax; Ian Smith, Plymouth University, supervised by Dr K. N. Page; Laurenz Schröer, Ghent University, supervised by Dr T. Vandenbroucke; Fiann Smithwick, University of Bristol, supervised by Prof. M. J. Benton; James Teoh, University of Bristol, supervised by Dr J. Vinther.

1.9 Online activities: The online activities of the Association continue to expand with greater emphasis on Social Media (Facebook, Twitter). The Association continues to be the sole host for the online-only journal *Palaeontologia Electronica*, as well as continuing to host websites for other societies (The Palaeontographical Society; International Organisation of Palaeobotany), palaeontological online resources (EDNA fossil insect database; the Kent Fossil Database), and online outreach projects (Palaeontology [Online]). The Association Twitter account, **@ThePalAss**, had ~1,150 followers by the end of 2014, an increase of ~650 (130%) on the numbers at the end of 2013.

1.10 Awards: The Lapworth Medal, awarded to people who have made a significant contribution to the science by means of a substantial body of research, was presented to Prof. R. A. Fortey (Natural History Museum). The President's Medal, awarded to a palaeontologist within 15 to 25 years of their PhD in recognition of outstanding contributions in their earlier career, coupled with an expectation that they will continue to contribute significantly to the subject in their further work, was presented to Prof. P. C. J. Donoghue (University of Bristol). The Hodson Award, for a palaeontologist within ten years of award of their PhD who has made an outstanding contribution to the science through a portfolio of original published research, was awarded to Dr M. McNamara (University of Cork). The Mary Anning award, for an outstanding contribution by an amateur palaeontologist, was made to Dr Cristoph Bartels (Bochum, Germany). Council also awards an undergraduate prize to each UK and Irish university department in which palaeontology is taught beyond Level 1.

1.11 Forthcoming plans: From 2015, members will have the option of paying a lower subscription and receiving publications only online. The Association will continue to make substantial donations from General and Designated funds to promote the charitable aims of the Association. Resources will be made available to continue a similar programme of grants, meetings, outreach and public engagement activities. Funds will be made available to further develop the website with the aim of encouraging outreach and to support other outreach, education and publicity initiatives. *Special Papers in Palaeontology* will be discontinued, and will be replaced by a new journal: *Papers in Palaeontology*. Volume 58 of *Palaeontology* will be published. The 59th Annual Meeting will be held jointly at the National Museum of Wales and University of Cardiff. Progressive Palaeontology will be held at the University of Bristol.

2. Achievements and Performance

2.1 Meetings support: During 2014, the Association agreed to support a total of 11 palaeontological meetings, symposia or workshops worldwide (in UK, USA, Spain and Austria). This support enabled the worldwide dissemination of research to the benefit of the global palaeontological community.

2.2 Publications: During 2014, 110 papers were submitted to *Palaeontology*. Of these, 71 (65%) were considered suitable by the Editorial Board and 48 (44%) were subsequently accepted after peer review. Of these, 39 papers were accepted for *Palaeontology* and a further nine for *Papers in Palaeontology*. By comparison, 108 papers were submitted during 2013, of which 46 (42%) were approved for peer review by the Editorial Board, and 33 (30%) were subsequently accepted. Increases in approval and acceptance rates in 2014 are due in part to launching the new journal *Papers in Palaeontology*. For *Palaeontology*, the average production time from acceptance to first publication was 49 days in 2014, which represents a substantial reduction from an average of 84

days during the previous year. This increased efficiency in production has benefited authors and the wider research community and is due in part to changes in ICZN rules that have allowed online publication of new taxonomic names.

2.3 Support for Research: In 2014 the Association agreed to fund the research activities of 22 individuals from six countries (UK, USA, Argentina, Estonia, Belgium and China), most of whom were early career researchers. This represents a substantial increase on previous years due to an additional ten awards made as part of the new Undergraduate Research Bursary Scheme and two awards made under the new Small Grant award in memory of Mr Stan Wood. Three of the undergraduate awardees presented their work at the 2014 Annual Meeting. Apart from directly benefiting the career development of the individuals concerned, the Association's funds enabled more palaeontological research to be undertaken worldwide than would otherwise have been the case. Compared to 2013, applications to the Research Grants scheme (6) and success rates (50%) remained the same. For the Small Grants, applications increased (from 11 to 20) and success rates fell (from 64% to 45%).

2.4 Outreach, Education and Public Engagement: During 2014, the Association supported the two major UK Fossil Festivals, at Lyme Regis and Scarborough, which attracted respectively an estimated 12,000 and 4,000 members of the general public of all ages. Secondary school students were particular beneficiaries of the Association's outreach and education activities. During 2014, we established a new, competitive Outreach and Engagement Fund to support individuals in developing new activities that promote palaeontology and its allied sciences. Continued use of social media, in particular the Association's Twitter account, has enabled the rapid and regular dissemination of research news, including of new publications, meetings and other information, to a growing audience.

3. Financial Review

3.1 Reserves: As of 31st December, The Association holds reserves of £743,997 in General Funds, which enable the Association to generate additional revenue through investments, and thus to keep subscriptions to individuals at a low level, whilst still permitting a full programme of meetings to be held, publications to be produced and the award of research grants and grants-in-aid. They also act as a buffer to enable the normal programme to be followed in years in which expenditure exceeds income, and new initiatives to be pursued. The Association holds £123,797 in Designated Funds which contribute interest towards the funding of the Sylvester-Bradley, Hodson, Callomon, Whittington and Stan Wood awards and towards the Jones Fenleigh fund. £40,000 has been transferred from General Funds into the Sylvester Bradley Fund to meet demands due early in 2015. Total funds carried forward to 2015 totalled £867,774.

3.2 Summary of Expenditure: Total charitable expenditure, through grants to support research, scientific meetings and workshops in 2014, was £337,053. Governance costs were £20,115. Total resources expended were £386,799. The Association continues its membership of the International Palaeontological Association and remains a Tier 1 sponsor of *Palaeontologia Electronica*, and the *Treatise on Invertebrate Paleontology*.

4. Structure, Governance and Management

4.1 Nature of the Governing document: The governing document of the Palaeontological Association is the Constitution adopted on 27th February 1957, amended on subsequent occasions as recorded in the Council and AGM Minutes.

4.2 Management: The Association is managed by a Council of up to twenty Trustees, which is led by the President. The Association employs an Executive Officer and a Publications Officer. The Trustees are elected by vote of the Membership at the Annual General Meeting, following guidelines laid down in the Constitution.

4.3 Trustees: The following members were elected at the AGM on 14th December 2013 to serve as trustees in 2014: President: Prof. M. J. Benton; Vice Presidents: Dr A. B. Smith and Dr M. Sutton; Treasurer: Mr P. Winrow; Secretary: Prof. R. J. Twitchett; Editor-in-Chief: Dr A. B. Smith; Editor Trustees: Dr M. Ruta, Prof. C. H. Wellman; Newsletter Editor: Dr A. McGowan; Book Review Editor: Dr C. Jeffrey-Abt; Internet Officer: Mr A. R. T. Spencer; Publicity Officer: Dr L. Herringshaw; Education Officer: Dr C. Buttler; Outreach Officer: Dr F. Gill; Meetings Coordinator: Dr T. Vandenbroucke; Ordinary Members: Dr R. J. Butler, Dr C. T. S. Little, Dr M. Munt, Dr R. Owens, Mr D. J. Ward. The Executive Officer Dr T. J. Palmer and the Publications Officer Dr S. Thomas serve on Council but are not Trustees. Prof. M. J. Benton and Prof. R. J. Twitchett represented the Association on the Joint Committee for Palaeontology.

4.4 Membership: Membership on 31st December 2014 totalled 1,071 (1,163 at end 2013). Of these 613 were Ordinary Members, 141 Retired Members, 16 Honorary Members, 261 Student Members and 40 Institutional Members. There were 69 institutional subscribers to *Special Papers in Palaeontology*. Wiley Blackwell also separately manage further Institutional subscribers and distribute publications to these Institutional Members on behalf of the Association.

4.5 Risk. The Association is in a sound financial position. Succession planning for the Executive Officer will be considered as part of the Annual Review of Officers in 2015.

5. Reference and Administration

5.1 Name and Charity Number: The Palaeontological Association is a Charity registered in England and Wales, Charity Number 276369.

5.2 Address: The contact address of the Association is c/o The Executive Officer, Dr T. J. Palmer, Institute of Geography and Earth Sciences, University of Aberystwyth, Aberystwyth, SY23 3DB, Wales, UK.

5.3 Professional Services: The Association's Bankers are NatWest Bank, 42 High Street, Sheffield, S1 1QF. The Association's Independent Examiner is G. R. Powell BSc FCA, Nether House, Great Bowden, Market Harborough, Leicestershire LE16 7HF. The Association's investment portfolio was managed by Quilter, St Helen's, 1 Undershaft, London EC3A 8BB.

THE PALAEONTOLOGICAL ASSOCIATION Registered Charity No 276369

STATEMENT OF FINANCIAL ACTIVITIES FOR THE YEAR ENDING 31st DECEMBER 2014

			General Funds	Designated Funds	TOTAL 2014	TOTAL 2013
Incoming Resources						
Generated Funds						
Voluntary income	Subscriptions	53,841			53,841	55,744
	Donations	0		32,220	32,220	4,561
			53,841	32,220	86,061	60,305
Charitable activities						
Sales	*Palaeontology*	255,074				
	Special Papers	8,378				
	Offprints	775				
	Newsletter	250				
	Field Guides	3,933				
	Distribution	250				
			268,660		268,660	278,828
Investment income			13,413	174	13,587	14,007
TOTAL INCOMING RESOURCES			335,914	32,394	368,308	353,140
Resources expended						
Costs of generating funds						
…for voluntary income	Admin.	25,977				26,514
Investment management	S'broker fees	3,654				3,537
			29,631	0	29,631	30,051
Charitable activities						
Publications	*Palaeontology*	62,935				
	Special Papers	3,994				
	Offprints	930				
	Field Guides	27				
	Newsletters	16,100				
	Distribution	1,035				
	Marketing	2,330				
	Publication costs	64,464				
	Editorial costs	37,103				
	Total Publications	188,918			188,918	206,107
Scientific Meetings & Costs			47,141		47,141	26,591
Grants and Awards			32,398	12,843	45,241	15,409
Research Grants			14,932		14,932	5,685
Administration of charitable activities			40,821		40,821	41,664
			324,210		337,053	295,456
Governance costs	Trustee expenses	12,143				
	Administration	7,422				
	Examiner's fee	550				
			20,115	0	20,115	16,158
TOTAL RESOURCES EXPENDED			373,956	12,843	386,799	341,665
NET INCOMING RESOURCES			-38,042	19,551	-18,491	11,475
INVESTMENT GAINS/LOSSES	Realised gain	2,607				
	Unrealised gain	28,747				
			31,354		31,354	61,215
DEFICIT/(SURPLUS) FOR THE YEAR			-6,688	19,551	12,863	72,690
TRANSFERS BETWEEN FUNDS			-40,000	40,000	0	0
			-46,688	59,551	12,863	72,690
FUNDS BROUGHT FORWARD			790,665	64,246	854,911	782,221
FUNDS CARRIED FORWARD			743,977	123,797	867,774	854,911

THE PALAEONTOLOGICAL ASSOCIATION
Registered Charity No. 276369

BALANCE SHEET as at 31st DECEMBER 2014

2013 £			Note			2014 £
		INVESTMENTS				
	594,639	At market value	**1.6**			626,180
		CURRENT ASSETS				
162,483		Cash at Banks		174,448		
128,438		Sundry Debtors	**6**	132,249		
290,921		Total Current Assets			306,697	
		CURRENT LIABILITIES				
21,010		Subscriptions in Advance		25,496		
9,639		Sundry Creditors	**7**	39,607		
30,649		Total Current Liabilities			65,103	
	260,272	NET CURRENT ASSETS				241,594
	854,911	TOTAL ASSETS				867,774
		Represented by:				
	790,665	GENERAL FUNDS				743,977
		DESIGNATED FUNDS	**8**			
5,052		Sylvester-Bradley Fund			36,815	
23,720		Jones-Fenleigh Fund			24,362	
9,152		Hodson Fund			8,172	
7,573		Callomon Fund			6,500	
18,749		Whittington Fund			17,415	
0		Stan Wood Fund			30,533	
	64,246					123,797
	854,911					867,774

Approved by the Board of Trustees on 6th May 2015.

THE PALAEONTOLOGICAL ASSOCIATION Registered Charity No. 276369

DESIGNATED FUNDS, Year ended 31st December 2014. Note 8 to the Accounts

	Sylvester-Bradley	Jones-Fenleigh	Hodson	Callomon	Whittington	Stan Wood	TOTAL 2014	TOTAL 2013
Donations	210	1,090	0	210	210	30,500	32,220	1,340
Interest Received	11	52	20	17	41	33	174	75
TOTAL INCOMING RESOURCES	221	1,142	20	227	251	30,533	32,394	1,415
Grants made	8,458	500	1,000	1,300	1,585	0	12,843	9,506
NET SURPLUS/(DEFICIT)	-8,237	642	-980	-1,073	-1,334	30,533	19,551	-8,091
TRANSFERS BETWEEN FUNDS	40,000	0	0	0	0	0	40,000	0
SURPLUS/(DEFICIT) FOR THE YEAR	31,763	642	-980	-1,073	-1,334	30,533	59,551	-8,091
FUNDS BROUGHT FORWARD	5,052	23,720	9,152	7,573	18,749	0	64,246	72,337
FUNDS CARRIED FORWARD	36,815	24,362	8,172	6,500	17,415	30,533	123,797	64,246

Notes to the Financial Statements for the year ended 31st December 2014

1. Accounting Policies

The principal accounting policies adopted in the preparation of the financial statements are set out below and have remained unchanged from the previous year and also have been consistently applied within the same financial statements.

1.1 Basis of preparation of financial statements
The accounts have been prepared in accordance with the Statement of Recommended Practice issued by the Charity Commission in 2011 and cover all the charity's operations, all of which are continuing.

The effect of events relating to the year ended 2014 which occurred before the date of approval of the statements by Council have been included to the extent required to show a true and fair state of affairs at 31st December 2014 and the results for the year ended on that date.

1.2 Fund Accounting
General Funds are unrestricted funds which are available for use at the discretion of the Council in furtherance of the general objectives of the charity and which have not been designated for other purposes.

Designated funds comprise unrestricted funds that have been set aside by Council for particular purposes. The aim of each designated fund is as follows:

- Sylvester-Bradley Fund: Grants made to permit palaeontological research.
- Jones-Fenleigh Fund: Grants to permit one or more students annually to attend the meeting of the Society of Vertebrate Palaeontology and Comparative Anatomy (SVPCA).
- Hodson Fund: Awards made in recognition of the palaeontological achievements of a worker under the age of 35.
- Callomon Fund: Grants made to permit palaeontological research with a fieldwork element.
- Whittington Fund: Grants made to permit palaeontological research with an element of study in museum collections.
- Stan Wood Fund: For Small Grants in the area of vertebrate palaeontology received as generous donations in memory of the Scottish fossil collector Mr Stan Wood.

1.3 Incoming Resources
The charity's income principally comprises subscriptions from individuals and institutions which relate to the period under review, and sales of scientific publications which are brought into account when due.

1.4 Resources Expended
All expenditure is accounted for on an accruals basis and has been classified under the appropriate headings.

Charitable expenditure is that which is incurred in furtherance of the charity's objectives.

Administrative costs have been allocated to the various cost headings based on estimates of the time and costs spent thereon.

1.5 Investments
Investments are stated at market value at the balance sheet date. The statement of financial activities includes net gains and losses arising on revaluations and disposals throughout the year both of investments and of foreign cash balances.

1.6 SCHEDULE OF INVESTMENTS (per analysis sheet)

2. Analysis of Financial Resources Expended

	Staff costs	Other costs	Total 2014	Total 2013
	£	£	£	£
Generating Funds	17,488	12,143	29,631	30,051
Charitable activities	63,574	273,479	337,053	295,456
Governance	4,997	15,118	20,115	16,158
	86,059	300,740	386,799	341,665

3. Staff Costs

	Salary	National Insurance	Pension Contributions	Total 2014	Total 2013
	£	£	£	£	£
Publications: 1 employee (2013: 1)	30,850	2,167	3,075	36,092	34,152
Administration: 1 employee (2013: 1)	32,167	2,338	15,462	49,967	50,387
	63,017	4,505	18,537	86,059	84,539

4. Trustees Remuneration and Expenses

Members of Council neither received nor waived any emoluments during the year (2013 – nil).

The total travelling expenses reimbursed to 19 Members of Council was £12,143 (2013 – £8,083).

5. Costs of Independent Examiner

	2014 (£)	2013 (£)
Examination of the accounts	550	500
Accountancy and payroll services	1,600	1,500
	2,150	2,000

6. Debtors

	2014 (£)	2013 (£)
Accrued income – receivable within one year	132,248	128,438

7. Creditors – falling due within one year

	2014 (£)	2013 (£)
Social Services costs	1,679	1,796
Accrued expenditure	37,928	7,843
	39,607	9,639

8. Designated Funds (per anaysis sheet)

Independent Examiner's Report

on the Accounts of The Palaeontological Association

for the year ended 31st December 2014

Respective resonsibilities of trustees and examiner

The charity's trustees are responsible for the preparation of the accounts. The charity's trustees consider that an audit is not required for this year under section 144 of the Charities Act 2011 (the Charities Act) and that an independent examination is needed.

It is my responsibility to:

- examine the accounts under section 145 of the Charities Act,
- follow the procedures laid down in the general Directions given by the Charity Commissioners (under section 145(5)(b) of the Charities Act, and
- to state whether particular matters have come to my attention.

Basis of independent examiner's statement

My examination was carried out in accordance with the general Directions given by the Charity Commissioners. An examination includes a review of the accounting records kept by the charity and a comparison of the accounts presented with those records. It also includes consideration of any unusual items or disclosures in the accounts and seeking explanations from the trustees concerning such matters. The procedures undertaken do not provide all the evidence that would be required in an audit, and consequently no opinion is given as to whether the accounts present a "true and fair" view and the report is limited to those matters set out in the statement below.

Independent examiner's statement

In connection with my examination, no matter has come to my attention:

(1) which gives me reasonable cause to believe that in any material respect the requirements:

to keep accounting records in accordance with section 130 of the Charities Act;

to prepare accounts which accord with the accounting records and comply with the accounting requirements of the Charities Act

have not been met; or

(2) to which, in my opinion, attention should be drawn in order to enable a proper understanding of the accounts to be reached.

Dated: 4th June 2015

G R Powell F.C.A.

Nether House, Nether Green,
Great Bowden,
Market Harborough
Leicestershire
LE16 7HF

Palaeontological Association year ended 31 December 2014.

Nominal	Holding	Cost (bought pre 2014) £	Value end 2013 £
£18,000	UK 4.75% Stock 07/03/20 GBP 100	18,145.87	20,813.00
£20,000	UK 4.5% Gilt 07/03/19 GBP 0.01	20,092.99	22,688.00
804	Royal Dutch Shell B shares	12,432.00	18,331.00
1,425	BP Ord 25c shares	5,047.35	6,955.00
600	BHP Billiton $0.5 shares	4,341.48	11,214.00
500	BG Group Ordinary 10p shares	3,977.95	6,488.00
1,465	HSBC Holdings Ordinary 0.5 US Dollar shares	4,425.44	9,704.00
2,250	Barclays 25p Ord shares	4,867.00	6,119.00
1,200	Great Portland Estates Ord		
1,500	Jupiter Ord 2p		
105	Next Ord 10p shares	4,648.88	5,723.00
1,150	Tesco Ord GBP 0.05	4,583.22	3,845.00
850	Tesco Ord GBP 0.05		
437	IMI Ord 25p shares	4,267.00	6,664.00
63	IMI Ord 25p shares	638.57	961.00
175	Carnival Plc Ord USD 1.66	3,996.49	4,377.00
650	Glaxo Smithkline Ordinary 25p shares	10,232.42	10,475.00
170	Astrozeneca Ord 25c		
220	Shire Ord 5p shares	4,986.29	6,274.00
2,499	Bluecrest Allblue Ord Npv GBP shares	3,020.28	4,378.00
300	Morgan Stanley		
550	Amec ord 50P	6,133.62	5,984.00
1,861	Melrose Indust Ord 0.1p	5,936.00	5,688.00
339	Melrose Indust Ord 0.1p	1,103.88	1,037.00
2,277	Vodaphone Group Ord USD 0.11428571	3,434.00	5,397.00
109	Verizon Communications	2,600.20	4,498.00
2,150	BT Group Ordinary 5p shares	7,787.53	8,157.00
300	Diageo Ord		
300	Unilever PLC Ord GBP 0.031111	4,326.21	7,446.00
460	Pearson Ordinary 25p shares	8,069.00	6,169.00
490	Serco Group Ord 2P	3,005.01	2,446.00
700	National Grid Ord GBP 0.113953	3,648.26	5,516.00
420	Experian Ord 10C	3,444.95	4,679.00
670	Blackrock World Mining Ord 5P	4,019.09	3,116.00
400	Persimmon Ord 10p	5,035.71	4,956.00
650	RIT Capital Partners Ordinary £1 shares	4,903.90	8,190.00
4,400	TR Property Ord 25p shares	7,560.85	9,966.00
1,000	Balfour Beatty 50P	2,913.17	2,869.00
1,225	Brown Advisory US Equity Value £B	14,789.62	19,931.00
1,500	British Empire Sec & Gen Trust Ordinary 10p shares	5,005.61	7,275.00
425	Findlay Park Partners US Smaller Companies	6,158.47	18,322.00
2,825	Ishares S&P 500 GBP	20,319.63	31,358.00
900	JPMorgan Am UK Ltd Emerging Markets I Instl	5,043.10	4,946.00
425	Fidelity EUR Value Ordinary 25P shares	4,059.07	6,481.00
3,900	Edinburgh Dragon Trust Ordinary £0.20 shares	4,478.10	9,543.00
160	GLG Japan Corealpha Equity IT Acc	11,330.79	17,104.00
5,194	Aberdeen Investment Property Trust B	4,681.00	4,780.00
26	Veritas Asset Mgmt Veritas Asian A GBP	8,182.27	8,192.00
65	Roche Hldgs Ag Genusscheine Nvp	7,226.55	10,994.00
6,600	Henderson Gbl Invs European Special Sits I Inc	7,037.91	10,006.00
1,283.80	COIF Charities Investment Fund Acc Units	75,000.00	133,747.44
£64,176.46	COIF Charities Fixed Interest Fund	85,000.00	80,836.67
	Total	441,936.73	594,639.11

Schedule of Investments (Note 1.6 to the Accounts)

Proceeds (sold in 2014) £	Cost (bought in 2014) £	Gain realised during 2014 £	Gain unrealised during 2014 £	Value end 2014 £
			636.00	21,449.00
			432.00	23,120.00
			-378.00	17,953.00
			-1,098.00	5,857.00
			-2,883.00	8,331.00
			-2,163.00	4,325.00
			-788.00	8,916.00
			-640.00	5,479.00
	8,503.14		352.86	8,856.00
	6,065.93		-591.93	5,474.00
6,758.66		1,035.66		
			-1,671.50	2,173.50
	1,642.56		-36.06	1,606.50
			-1,145.00	5,519.00
1,007.75		46.75		
			731.00	5,108.00
			-1,531.00	8,944.00
	8,144.94		-400.94	7,744.00
10,445.32		4,171.32		
			275.00	4,653.00
	9,958.08		-40.08	9,918.00
5,626.91		-357.09		
			-723.00	4,965.00
1,035.64		-1.36		
			-327.00	5,070.00
4,200.77		-297.23		
			475.00	8,632.00
	5,825.54		-279.54	5,546.00
			438.00	7,884.00
			-695.00	5,474.00
843.38		-1,602.62		
			911.00	6,427.00
			-109.00	4,570.00
			-1,037.00	2,079.00
280.00			1,636.00	6,312.00
			891.00	9,081.00
			2,552.00	12,518.00
1,464.71		-1,404.29		
			2,217.00	22,148.00
7,736.04		461.04		
			3,298.00	21,620.00
			6,264.00	37,622.00
			250.00	5,196.00
			425.00	6,906.00
			1,109.00	10,652.00
			1,557.00	18,661.00
			440.00	5,220.00
			1,261.00	9,453.00
			327.00	11,321.00
			-113.00	9,893.00
			12,155.27	145,902.71
			6,764.20	87,600.87
39,399.18	40,140.19	2,052.18	28,747.28	626,179.58

Nominations for Council

At the AGM in December 2015, the following vacancies will occur on Council:

• President Elect • Vice-President • Treasurer

Nominations are now invited for these posts. Please note that each candidate must be proposed by at least two members of the Association and that any individual may not propose more than two candidates. Nominations must be accompanied by the candidate's written agreement to stand for election and a short paragraph describing their interests.

All potential Council Members are asked to consider that:

> 'Each Council Member needs to be aware that, since the Palaeontological Association is a Registered Charity, in the eyes of the law he/she becomes a Trustee of that Charity. Under the terms of the Charities Act 1992, legal responsibility for the proper management of the Palaeontological Association lies with each Member of Council'. Responsibilities of Trustees can be obtained from <**secretary@palass.or g**>.

The closing date for nominations is 7th October 2015. They should be sent to the Secretary: Prof. Richard J. Twitchett, Department of Earth Sciences, Natural History Museum, Cromwell Road, London SW7 5BD, UK; e-mail: <**secretary@palass.or g**>.

Council's nominations are as follows:

President Elect: Prof. M. P. Smith

Vice President: Dr E. Rayfield

Treasurer: Mr P. Winrow (2nd term)

Council vacancies: 'job descriptions':

President (two-year term)

The President is usually a senior member of the palaeontological community, with wide experience of the Association, its Council and committees. The President represents the Association externally and is responsible for the overall management of Council and its many activities.

Vice-President (two-year term)

The Vice-President is one of the more loosely defined Council offices. Vice-Presidents are normally long-serving Council members who have previously held one of the other offices. They have no formal portfolio or duties other than to deputize for the President if and when required, but are present on Council to provide independent input on all matters, backed up by experience arising from their long service. They are also expected to lead or at least participate in important sub-committees, particularly those tasked with making recommendations for the awards of grants.

Treasurer (five-year term)

You might think the Treasurer looks after Council's money but thankfully that task is undertaken by the Executive Officer and an independent accountant. The Treasurer's main role is to act as a sounding board for the Executive Officer and Council on financial matters, along with practical things like counter-signing large cheques and signing the Association's accounts on behalf of Council, having reviewed the accounts prior to their approval. The Treasurer also meets with the Association's investment managers once a year to discuss our investment portfolio, receives the investment reports, and sits on sub-committees and working groups as required, *e.g.* reviewing grant applications.

Awards and Prizes

The Palaeontological Association recognises 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 summarises the candidate's career, and further supported by a brief statement from the two nominating members. 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.

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.or g**> by **31st March**.

The Lapworth Medal is announced at the AGM and 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 summarises the candidate's career, and further supported by a brief statement from the two nominating members. 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.or g**> by **31st March**.

The President's Medal is announced at the AGM and 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 nominating members. 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 purposes, this should be highlighted.

The academic case, statements of support and publication list should be attached in MS Word or PDF format.

Nominations should be sent to <**secretary@palass.or g**> 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 in palaeontology but who have made an outstanding contribution to the subject. Such contributions may range from the compilation of fossil collections, and their care and conservation, to published studies in recognised 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 and should include the full contact details of the candidate.

Nominations should be sent to <**secretary@palass.or g**> by **31st March**.

The award comprises a cash prize of £200 plus a framed scroll, and 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

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 stage researchers within one year of award of a higher degree (PhD or MSc), excluding periods of parental or other leave, are eligible for consideration for this award, which consists of a cash prize of £200. The prize is announced at the end of the Annual Meeting.

Annual Meeting Council Poster Prize

Awarded for the best poster at the Annual Meeting. All student members of the Palaeontological Association, and all members of the Association who are early career stage researchers, *i.e.* those 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, which consists of a cash prize of £200. The prize is announced at the end of the Annual Meeting.

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 loans or grants from the organisers 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 organiser(s) of the meeting using the online application form (see website). Such requests will be considered by Council at the March and October Council Meetings each year. If the application is successful, we will require that the support of the Association is acknowledged, preferably with reproduction of the Association's logo, in the meeting/workshop/short course literature and other media. Enquiries may be made to the Secretary (<**secretary@palass.org**>).

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

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

Note: If funds are requested to support one or more keynote speakers, then full details of their names, affiliations and titles of presentations should be included. The application will be strengthened if 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.

Outreach and Engagement Grants

Awards are made to encourage educational outreach, public engagement, and related initiatives in palaeontological themes. Normally, the budget for an individual grant would be less than £5,000. However, 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. The principal applicant must be a member of the Association. Preference will normally be given to candidates who have not previously received a grant.

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

For more information please contact the Association's Outreach Officer, Dr Fiona Gill, School of Earth and Environment, University of Leeds, Leeds LS2 9JT; e-mail: <**outreach@palass.org**>.

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

Small Grants Scheme

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

- **Sylvester-Bradley Awards** : Multiple awards up to £1,500 each, for palaeontological research.
- **Callomon Award** : An award up to £1,500 for a project which is normally field-based.
- **Whittington Award** : An award up to £1,500 for a project which is normally based on museum collections.
- **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 Palaeontological Association *Newsletter* when the award is made.

Successful applicants will be required to produce a final project report that will be published in the Palaeontological Association *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. Enquiries may be made to the Secretary (<**secretary@palass.or g**>).

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 Bursary

The Palaeontological Association Undergraduate Research Bursaries are aimed at giving undergraduate students the opportunity to acquire research skills and experience that will significantly transform their academic career. The bursaries will support projects co-designed by students and their supervisor(s) that give students registered for an undergraduate degree their first experience of undertaking a palaeontological research project. The bursaries provide a stipend for the student of £200 per week for up to eight weeks. The scheme is not intended to fund students to undertake routine work for the supervisor(s) and the Association expects the supervisor(s) to provide significant personal mentoring of successful student applicants.

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

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

After completion of the work, successful students are required to produce a short report of the findings suitable for publication in the *Newsletter*. This report should be submitted to <**palass@palass.org**> within eight weeks of the stated end date of the project. Successful candidates are requested to prioritise 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. Enquiries may be made to the Secretary (<**secretary@palass.org**>).

The deadline is **24th February** each year.

Successful applicants will be notified by the middle of May and funds will normally be available from 1st June. A full list of awards will be announced at the AGM.

Research Grants

Awards are made to assist palaeontological research up to a maximum value of £15,000, 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 the elements shown over the page:

- 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 Palaeontological Association *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. Enquiries may be made to the Secretary (<**secretary@palass.or g**>).

The deadline is **1st March** each year. Funds will normally be available from 1st June, and the awards will be announced at the AGM.

Palaeontological Association Undergraduate Prize Scheme

We are making some changes to the way that this scheme is operated because our current practice of writing to individual British and Irish departments in May is not as inclusive as we would like.

The scheme annually invites all departments where a palaeontology course 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 free membership of the Association for the rest of the year in question, plus the following year. It provides electronic access to both our journals, paper copies of the *Newsletter*, and all the other advantages of membership. Receipt of the award also looks good on a recipient's CV.

The award scheme will continue and, from this year, will be extended to undergraduate students in other countries, but we shall no longer send out invitations to individual departments. They are invited to contact us at <**palass@palass.org**> with a nomination (name, address and e-mail) and we will then sign up the student as a member and let them know. 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.

If you are a staff member who is involved with exam assessment at UK and Irish universities you will know about the scheme and be familiar with the selection process. Please ask your department to carry on making recommendations to us in the normal way. If you are a teacher of palaeontology, and a PalAss member, in a university further afield who is unfamiliar with the scheme, then we invite you to join the scheme and tell people in your department about it. The award is available to only one person per year in any one institution, who should be an undergraduate student, not a postgraduate, when they are selected.

We will repeat this *Newsletter* announcement periodically as a reminder.

Tim Palmer
Executive Officer

Vacancy for PalAss Executive Officer

The Palaeontological Association is seeking applications for a new Executive Officer. The Executive Officer plays a critical role in facilitating the smooth running of the Association by assisting the Council with delivery of its key aims and strategy. The role covers the full breadth of the Association's activities and requires interaction with a range of key stakeholders including the members, publishers, grant applicants and awardees, investment brokers, accountants, and members of the general public. The Executive Officer's role is important for maintaining and enhancing the reputation of the Association. Duties are varied and include aspects of finance, sales, meetings organisation and logistics, public engagement and outreach, and website maintenance. Although location is flexible, the Executive Officer is required to attend Council and other meetings (held mainly in the UK), as well as UK-based outreach events. The role is full-time, initially for a fixed-term period of three years. Salary is in the range £35,000 to £42,000 per annum.

What we're looking for: To be considered for the role, it is essential to have an understanding of palaeontology and its relationship to the wider scientific community and the public; excellent communication skills, both written and oral, together with some experience of financial and/or budget management; and the ability and willingness to work outside normal office hours, including weekends, and to travel throughout the UK and overseas, with notice, as required.

Further particulars and details of how to apply can be found at <**www.palass.org**>.

Informal enquiries should be directed to <**applications@palass.org**>.

Closing date: 5pm UK time, **21st August 2015**.

Interviews: to be held in London between 7th and 18th September 2015.

Start date: 1st December 2015.

ASSOCIATION MEETINGS

59th Annual Meeting of the Palaeontological Association
Cardiff, Wales, UK *14 – 17 December 2015*

The Annual Meeting of the Palaeontological Association will be held at Cardiff University and Amgueddfa Cymru – National Museum Wales, organised by Caroline Buttler (<**Caroline.Buttler@museumwales.ac.u k**>), Lesley Cherns (<**cherns@cardiff.ac.u k**>) and Lucy McCobb (<**Lucy.McCobb@museumwales.ac.u k**>).

Monday 14th December: Symposium and reception

The meeting will begin with a symposium in the afternoon of Monday 14th December in the Reardon Smith Lecture Theatre at Amgueddfa Cymru – National Museum Wales.

The theme of the Annual Symposium is 'Palaeobiotic interactions':

13.00 – 13.15	Welcome
13.15 – 13.55	Dr Paul Taylor (Natural History Museum): Competition and symbiosis on hard substrates in the marine fossil record
13.55 – 14.35	Dr Paul Wright (National Museum Wales) & Dr Lesley Cherns (Cardiff University): Leaving no stone unturned: the feedback between biotic diversity and early diagenesis
14.35 – 15.15	Prof. Rosmarie Honegger (University of Zurich): Fossil lichens
15.15 -15.45	Break
15.45 – 16.25	Dr Liz Harper (University of Cambridge): Something ate my fossil: from anecdote to testing hypotheses
16.25 – 17.05	Dr Chris Berry (Cardiff University) & Prof. Bill Stein (Binghamton University): Rooting in the earliest trees: new insights from Devonian cladoxylopsids
17.05 – 17.45	Dr Cris Little (University of Leeds): Animal–animal and animal–microbial ecological interactions in ancient methane seep communities
18.00 – 20-00	Icebreaker reception in the Main Hall of Amgueddfa Cymru – National Museum Wales, with the opportunity to look around the Evolution of Wales galleries and the William Smith Exhibition.

Tuesday 15th December: Conference, AGM, Annual Address and Dinner

The conference will be held at Cardiff University and will commence on Tuesday 15th December with a full day of talks and posters.

The Association AGM will take place before the Annual Address.

The Annual Address will be given by Prof. John Hutchinson (Royal Veterinary College) prior to the evening reception, and will be entitled 'Computer modelling and simulation of extinct organisms: its utility and limitations for reconstructing the evolution of locomotor behaviour'.

In the evening there will be a reception and the Annual Dinner at Cardiff City Hall.

Wednesday 16th December: Conference

A full day of talks in parallel sessions (depending on demand) and posters. Talks, on both days, will be allocated 15 minutes including questions.

Thursday 17th December: Field-trip

In the morning, the field-trip will visit classic Silurian carbonates of the Usk Inlier, and we will then take you to Blaenavon, a World Heritage Site. Lunch will be at Big Pit National Coal Museum with the opportunity to go 300 feet (91 m) underground with a miner-guide. We will aim to be back in Cardiff by 5.30pm and will stop at the train station.

Venue and travel

All conference venues, including the Annual Dinner, are within 5–10 minutes' walk of each other, located in Cardiff city centre. The train station is a *c.* 20 minute walk from the venues.

Accommodation is available within walking distance of the University and the city centre.

Getting to Cardiff

By Train
Cardiff Central railway station is a *c.* 20 minute walk from the conference venues and close to many hotels. Booking early will get the best rail ticket prices, especially from London Paddington station. From Cardiff Central station, there is also a frequent train service which stops at Cathays station (located on the Cathays Park Cardiff University campus).

Rail services connect Cardiff with London, Bristol, Birmingham, Southampton, Manchester and Liverpool, as well as many other cities and towns.

By Coach
Cardiff is served by regular coach services from towns and cities across the UK; these are often cheaper than trains. For information, see National Express Coaches (<**www.nationalexpress.co m**>) and Megabus (<**www.uk.megabus.co m**>).

Local bus services also operate from Cardiff Central station.

By Car
There is limited parking around the University, and almost none on campus, so driving to meeting venues is not the best option. There is 'pay and display' car parking available on Park Place and in the civic centre (along College Road, City Hall Road, King Edward VII Avenue and Museum Avenue) but this fills up very quickly, especially just prior to Christmas. This typically costs around £6 per day, payment is by coin or debit/credit card. Charges for city centre multi-storey car parks vary considerably, up to £12 per day.

By Plane
Cardiff Airport is approximately 12 miles (19 km) from the city centre. There are bus and train links to Cardiff city centre, as well as a taxi service (taxi fare to Cardiff city centre approximately £31). There are rail and bus links to Cardiff from other airports such as Bristol, Heathrow and Gatwick.

Taxis
Taxis can be found at the front of Cardiff Central station and a number of other locations around the city centre.

Registration and booking

Registration, abstract submission and booking (including payment by credit card) commences on Monday 13th July 2015. Abstract submission closes at midnight on Friday 18th September 2015; abstracts submitted after this date will not be considered. Registration payments made after Friday 2nd October 2015 will incur an additional administration charge of £25.00. The final deadline for registration is Friday 13th November 2015. Registrations and bookings will be taken on a strictly first come, first served basis. No refunds will be available after the final deadline.

Registration, abstract submission, booking and payment (by credit card) will be through online forms available on the Palaeontological Association website (<**http://www.palass.org /**>). Please note that all of these transactions will be in sterling (£ GBP). Accommodation must be booked separately (see below). The cost of registration is the same as last year. Early registration is £90.00 for ordinary and retired members; £60.00 for students; and £120.00 for non-members. Registration costs include the icebreaker reception on the Monday evening, sandwich lunches on Tuesday and Wednesday, full registration package and tea/coffee from Monday through to Wednesday.

Oral presentations

All speakers (apart from the symposium speakers) will be allocated 15 minutes. You should therefore prepare a 12 minute talk to allow time for questions and switching between presenters. We will have a number of parallel sessions in adjacent theatres so timing will be especially important. All the lecture theatres will have a single A/V projector linked to a large screen. All presentations should be submitted and checked the day before they are scheduled. Cardiff University is PC-based, so Mac-based presentations may cause problems, particularly if animations are included. If you are using a Mac, please make sure your presentation is PC-compatible before you leave your institution. If we are oversubscribed with oral presentations, you will be offered the opportunity to present your work as a poster presentation. Preference will normally go to those in the early stages of their career.

Poster presentations

Poster boards will accommodate an A0-sized poster presented in portrait format. The boards will not be suitable for posters of this size in landscape format. Materials to fix the poster to the boards will be available at the meeting.

Accommodation

This needs to be booked separately. Cardiff has a wide variety of hotels, hostels and guest-houses at a range of prices, which can be booked through the usual online resources. Most of the well-known hotel companies are represented. It is recommended that delegates look for reviews and ratings such as those at <**www.tripadvisor.co.u k**> to decide which would suit them best. <**visitcardiff.co m**> also lists a number of providers of accommodation, from budget to luxury.

City centre hotel examples:

- The Parc Hotel (Park Place)
- Hilton (Kingsway)
- Park Plaza (Greyfriars Road)
- Premier Inn Cardiff City Centre (Churchill Way)
- Best Western PLUS Maldron Hotel (St Mary Street)
- Holiday Inn (Castle Street)
- Angel Hotel (Castle Street)
- Travelodge (Queen's Street)
- Radison Blue (Meridian Gate, Bute Terrace)

Bed & Breakfast accommodation:

There are large numbers of B&Bs on Cathedral Road near Cardiff Castle. You are advised to check their ratings on Trip Advisor or other review websites as standards do vary.

- Lincoln House Hotel (Cathedral Road)
- Jolyon's at No. 10 (Cathedral Road)
- Number 62 (Cathedral Rd)
- Church Guest House (Cathedral Road)

Budget accommodation:

A brand new YHA Youth Hostel has opened in Cardiff city centre with parking and private rooms, close to the rail and coach stations: <**www.yha.org.uk/hostel/cardiff-centra l**>. This is approximately a 30 minute walk from the conference venues. It has dorm rooms and en-suite double and family rooms starting from £16.

There are four backpacker hostels in the City, details available at <**visitcardiff.co m**>:

- Bunkhouse Hostel (St Mary Street)
- Nomad Backpacker (Roath)
- The River House Backpackers (Riverside)
- NosDa Studio Hostel (Riverside)

Travel grants to student members

The Palaeontological Association runs a programme of travel grants to assist student members (doctoral and earlier) to attend the Annual Meeting, in order to present a talk or a poster. For the Cardiff 2015 meeting, grants of less than £100 (or the € equivalent) will be available to student presenters who are travelling from outside the UK. The actual amount available will depend on the number of applicants and the distance travelled. Payment of these awards is given as a disbursement at the Meeting, not as an advance payment. Students interested in applying for a PalAss travel grant should contact the Executive Officer, Dr Tim Palmer (<**palass@palass.org**>), once the organisers have confirmed that their presentation is accepted, and before 1st December 2015. Entitle the e-mail "Travel Grant Request". No awards can be made to those who have not followed this procedure.

Cardiff

Cardiff is the capital city of Wales with many cultural and entertainment attractions (see <**http://www.visitcardiff.com /**>). During the Conference, there will be a Christmas market in the centre of the city and ice-skating outside City Hall. There are many restaurants and bars in the city centre.

We look forward to seeing you in Cardiff in December.

Towards a revival of Palaeontology at EGU?

The EGU General Assembly is the premier Geosciences meeting in Europe, attracting thousands of scientists (over 11,800 in 2015!) from across the world. The next meeting is scheduled for 17th–22nd April 2016 in Vienna.

In EGU's Division on Stratigraphy, Sedimentology and Palaeontology (SSP <**http://www.egu.eu/ss p**>), there is a strong desire to see more palaeontology represented in sessions at the General Assembly. Over the last few years, Council has set aside a number of dedicated postgraduate travel grants for EGU and has also sponsored a few keynote speakers. This year, two of the Association's Council members have been appointed 'Palaeontology science officers' for EGU/SSP, underscoring EGU's and the PalAss' continued drive to increase the presence of palaeontology and palaeontologists at the Vienna meetings.

We now need *your* help! One way to work towards our goals is to try to ensure that more, quality palaeontology sessions are proposed, filled and actually run. Even though relatively few palaeontology sessions are currently convened at the EGU they are amongst the most popular. Recent examples include sessions on taphonomy and palaeoecology, Mesozoic stratigraphy and bioevents. We are now actively seeking suggestions from the membership for topical sessions that *you* would like to attend or be willing to convene at the meeting. Over the next few years, the Association will increase its sponsorship at EGU and is committing significant funding to support one or more sessions per year, covering the costs of conveners and keynote speakers, through our regular grants-in-aid scheme. Members interested in this opportunity are strongly encouraged to contact the Meetings Coordinator or the Secretary at their earliest convenience, providing a brief description of the proposed session, and a list of potential invited speakers. We hope to receive many suggestions!

Thijs Vandenbroucke
PalAss Meetings Coordinator and *SSP science officer*
<meetings@palass.or g>

Richard Twitchett
PalAss Secretary and *SSP science officer*
<secretary@palass.or g>

news

New impact factor

The 2015 Thomson Reuters Journal Citation Reports® have been released, with new impact factors announced based on citations for the calendar year to December 2014. *Palaeontology* has done exceptionally well with a new impact factor of 2.24, a significant jump from the previous 1.804. This moves the journal up six places in the Journal Citation Reports Ranking (Paleontology) to 6th out of 49 journals. This is a measure of our citation influence on the broader literature and reflects the increasingly high standard of submissions to the journal. A massive thank you to all of our authors for choosing to publish with *Palaeontology*, and long may this success continue!

Find *Palaeontology* online at <**http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1475-498 3**>, with full access available via the Members' Area of the PalAss website.

For he's a jolly good Fellow

Phil Donoghue has been elected Fellow of the Royal Society, a major honour bestowed upon the most outstanding scientists and engineers from the UK and the Commonwealth. Candidates are nominated for election by existing Fellows, and their case is judged on the basis of scientific excellence. Phil was recognised for his world-leading research in the emerging field of molecular palaeontology. His work has explored the relationship between evolution and development, as well as the role of fossils in reconstructing phylogeny and evolutionary history. Howard Armstrong wrote an excellent summary of Phil's research in *Newsletter* **88**, following the award of the President's Medal. So what advice does Phil have for budding Fellows?

Photo: Mandy Donoghue.

> "My advice would be to do research that you are proud of. If people choose to recognise it with bells and whistles, medals and titles, that's nice. If not, you've done research that you are proud of. What more could you want?"

Phil joins other eminent palaeontology-flavoured Fellows, including Mike Benton, Derek Briggs, Bill Chalenor, Jenny Clack, Simon Conway Morris, Peter Crane, Dianne Edwards and Richard Fortey. For a full list see <**https://royalsociety.org/about-us/fellowship/fellows /**>. In addition, Andy Knoll has been elected as a Foreign Member this year.

Imran Rahman
University of Bristol

Paleontological Society Medal awarded

Photo: Jakob Vinther.

Derek Briggs, former President of the Palaeontological Association (2002–2004) and current G. Evelyn Hutchinson Professor at Yale University and Curator in Charge of Invertebrate Paleontology of Yale Peabody Museum, has been awarded the Paleontological Society Medal for 2015, the most prestigious honour bestowed by the Society. Derek's career-long work on Burgess Shale-type faunas and the Cambrian radiation, on exceptionally preserved biotas throughout the stratigraphic record, and on the taphonomic lens through which we view the fossil record, have earned him numerous accolades to which he can now add this prestigious award. Perhaps his most lasting impact on the field, though, will result from his outstanding efforts as a mentor at Bristol and Yale, with over 30 graduate students and post-doctoral researchers completing their training with him since his re-invigoration of the invertebrate palaeontology programme at Yale.

Erik Sperling
Harvard University

SET for Britain

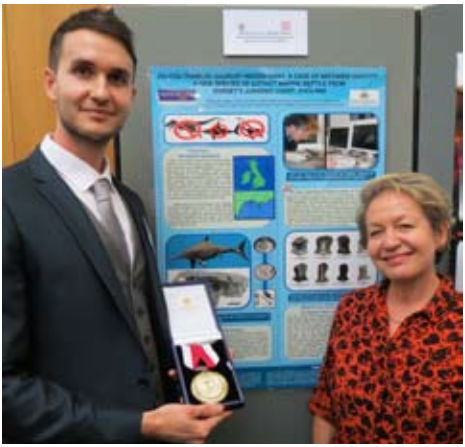


Photo: Dean Lomax

Dean with Rosie Winterton, M.P. for Doncaster Central.

Recently, early-career researchers presented posters of ground-breaking and frontier UK research to Members of Parliament at Westminster, with the aim of enlightening politicians on current science and engineering topics. I was selected from hundreds of applicants to present my research on a new species of ichthyosaur; taking part in this competition is an achievement, and getting to the final stage was a great accomplishment. The only palaeontologist in the Biological and Biomedical Sciences category with 59 other researchers, I came first and won the prestigious Gold Medal (G J Mendel Award) for excellence in science. I think this is a real win for British palaeontology and would encourage other UK-based researchers to apply in the future; for more details visit <**http://www.setforbritain.org.uk** />.

Dean Lomax
University of Manchester/Doncaster Museum and Art Gallery

Palaeontology *in the news*

The last quarter has been an active one for palaeontology news, with various papers published by the Association attracting international attention. In late March, the mayhem lobster – *Yawunik kootenayi* to its friends – crawled out of the Burgess Shale and into view (Alia *et al.* – <**http://onlinelibrary.wiley.com/doi/10.1111/pala.12161/abstrac t**>), with the press release featuring an animation of the creature. In some online coverage, this was accompanied by extremely funky music (*e.g.* <**https://www.youtube.com/watch?v=OTOdilvB Ex4**>), which was presumably the prelude to a Cambrian kootenanny. In their coverage, *National Geographic* sounded a bit jaded about the Burgess Shale, describing poor *Yawunik* as 'yet another Cambrian weirdo' (<**http://phenomena.nationalgeographic.com/2015/04/01/scientists-uncover-yet-another-cambrian-weirdo /**>). The *Daily Mirror* wasn't very complimentary either. "This weird, giant, shrimp-like predator prowled our oceans long before the dinosaurs arrived", it announced (<**http://www.mirror.co.uk/news/technology-science/science/weird-giant-shrimp-like-predator-prowled-5413918**>). Their headline also reminded us that, if we really want to engage with the media, palaeontologists should abandon the Palaeozoic, Mesozoic and Cenozoic and just go for the 'pre-dinosaur', 'dinosaur', and 'post-dinosaur' eras. The article did at least mention giant killer newts though, and informed its readers that silverfish eat clothing and wallpaper, so not all was lost.

In the UK, you know you've hit the big time when your work attracts the attention of the *Daily Mail*. In particular, featuring on its hugely successful website will see your work interrogated by the brains trust that is the *Daily Mail* online comments section. In the case of the *Palaeontology* authors (<**http://www.dailymail.co.uk/sciencetech/article-3011373/Ancient-lobster-six-claws-FOUR-eyes-unearthed-Fossil-reveals-predator-prowled-oceans-500-million-years-ago.htm l**>), they got off relatively lightly, assured only that *Yawunik* would have been delicious fried in garlic butter.

In early April, we learned from Field *et al*. (<**http://onlinelibrary.wiley.com/doi/10.1111/pala.12165/abstrac t**>) that mosasaurs gave birth to live young. The *Register* – 'biting the hand that feeds IT' – offered a facetious angle on the story, running a piece with the title "Ancient JUMBO MARINE LIZARD pushed out sprogs in open ocean" and the subheading "Mosasaurs DIDN'T give birth near shore, bone boffins claim" (<**http://www.theregister.co.uk/2015/04/11/mosasaurs_gave_birth_in_open_ocean_boffins_claim /**>).

In more serious quarters, such as *National Geographic*, the story merited much more thoughtful analysis. Brian Switek reminded his readers that careful reappraisal of historic collections can lead to dramatic new interpretations of the biology of ancient creatures (<**http://phenomena.nationalgeographic.com/2015/04/20/baby-mosasaurs-were-born-out-at-sea /**>). The story also led to some quite fabulous palaeoart, such as the accompanying illustration by Julius Csotonyi (<**http://cdn4.sci-news.com/images/enlarge/image_2687e-Newborn-Mosasaurs.jp g**).

Perhaps less appealing to reconstructors was the invertebrate fossil that appeared in early May: the cheese-grater penis worm! More properly described as the Cambrian priapulid *Ottoia* (Smith *et al*. – <**http://onlinelibrary.wiley.com/doi/10.1111/pala.12168/abstrac t**>), such an uncomfortable-sounding beast inevitably caught the eye of the press:

"Flesh-eating 'cannibal' penis worms had tooth-lined throats," hollered the *Leicester Mercury*: <**http://www.leicestermercury.co.uk/Flesh-eating-cannibal-penis-worms-tooth-lined/story-26447933-detail/story.htm l**>.

"Ancient flesh-eating 'penis worm' dragged itself around by teeth," declared the *Daily Telegraph*: <**http://www.telegraph.co.uk/news/uknews/11582988/Ancient-flesh-eating-penis-worm-dragged-itself-around-by-teeth.htm l**>.

"This ancient flesh-eating 'penis worm' had teeth in its THROAT," boomed the *Daily Mirror*: <**http://www.mirror.co.uk/news/technology-science/science/ancient-flesh-eating-penis-worm-teeth-5643171**>.

"The prehistoric penis worm with TEETH," capitalized the *Daily Mail*, last but not least: <**http://www.dailymail.co.uk/sciencetech/article-3069412/Ancient-fossils-shed-light-life-shaped-Cambrian-explosion.htm l**>. Again, its comments section was the place to go for people speaking their brains. My favourite was from 'rangiwahia' who declared that modern scientists were a "sex-crazed generation of moonbats".

And on that bombshell, I will stop. Who knows what palaeontological media treats await us over the summer…

Liam Herringshaw
Publicity Officer

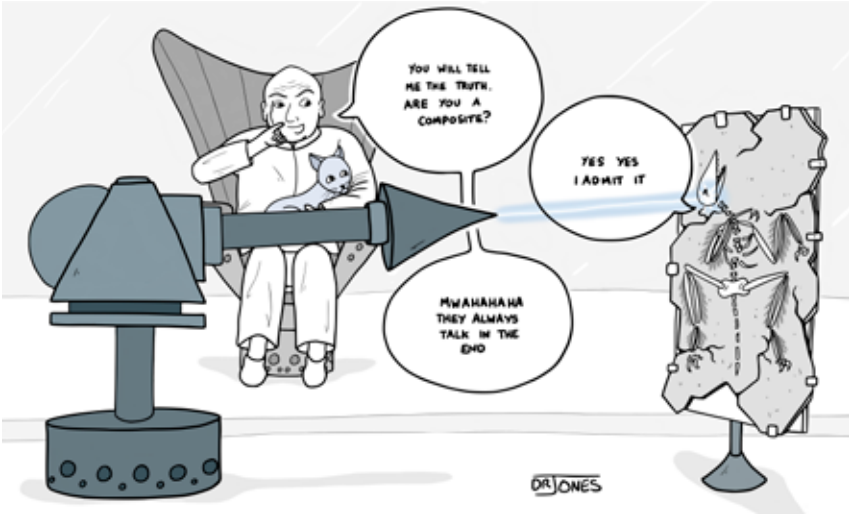
Featured article

Are you stuck in palaeontology's preparatory bottleneck? Writing in *PLoS One*, Thomas Kaye and co-authors present one solution – a "next generation" imaging tool, laser-stimulated fluorescence (LSF), with wide applications in both macro- and micropalaeontology. LSF doesn't just excite me, it concentrates extremely high flux rates both at the macroscopic and microscopic levels to excite the electrons in rocks and, where present, fossils. Specimens react by fluorescing in ways that the traditional UV bulb technique just cannot induce. Even subtly varying mineral compositions suddenly become easily distinguishable from each other. The authors present several beautifully-illustrated case studies that demonstrate LSF's uses in *e.g.* silhouette illumination of carbon films (in this case a feather from the Green River Formation); microscopic imaging of specimens fluorescing beneath the sample surface (revealing fish teeth and scales hidden beneath the surface of a Liaoning rock slab); and portable, non-invasive *in situ* imaging (of the bracelet worn by a mid-Holocene human skeleton). LSF can even be automated, offering huge time savings, particularly for micropalaeontological preparation. Kaye *et al*. (2015) built a prototype automated microfossil picker in which a stream of matrix passes under the laser while a camera watches out for particles of the requisite size and brightness. Fluorescing fossils are guided down a tube into a tray by a puff of compressed air. Think about it micropalaeos: no more picking… just be sure to wear protective glasses!

Finally, LSF can bust "fake fossils". Ever since George Waterhouse and Richard Owen paid Karl Häberlein £700 (a lot of money in 1862!) for his *Archaeopteryx* and 1,756 accompanying Solnhofen specimens, fossils have been traded like any other commodity. Love it or loathe it (and I know people of both persuasions even within the PalAss), the international fossil industry is big business, and it should be no surprise that there are many fakes on the market. Fakes extend beyond those intended for mere collectors – Archaeoraptor even fooled the experts at *National Geographic* magazine. Kaye *et al*. used LSF to test a Chinese *Microraptor* with a suspicious break in the skull, barely perceptible under white light. Upon exposure to LSF, the little feathered fiend starts to reveal its true colours – literally: a variable mineral composition manifests as varied fluorescence either side of the break, suggesting this particular *Microraptor* might be a composite. When entire careers and scientific theories can be built on fake fossils, the advent of cheap LSF-sleuthery should be welcomed by our community. Nobody wants another Piltdown Man – the orangutan-jaw-welded-to-human-cranium-fraud-of-the-century, even if it was a good ruse.

Recent reductions in the cost of medium-power short-wavelength lasers mean that the entire LSF set-up, consisting of the laser and appropriate filters mounted to a stereo-microscope (or a motor and custom-built scanning plate for large specimens), is within reach of most interested university departments and research groups. This new technique is a welcome addition to the palaeontologist's tool cupboard.

David Bond
University of Hull



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

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KAYE, T. G., FALK, A. R., PITTMAN, M., SERENO, P. C., MARTIN, L. D., BURNHAM, D. A., GONG, E., XU, X. and WANG, Y. 2015. Laser-Stimulated Fluorescence in Paleontology. *PLoS ONE* **10**, e0125923.

PBDB hackathon

Since its creation in 1998, the Paleobiology Database (<**paleobiodb.org**>) has grown to include 1.25 million occurrences of over 320,000 taxa. The database was built with integrated tools for data analysis, such as mapping functions and diversity curve generators created by John Alroy. Those analytical tools, now hosted at <**www.fossilworks.org**>, continue to be indispensable for a wide variety of research. In parallel, the Paleobiology Database programming team at the University of Wisconsin, Madison, has been working to provide more flexible access to the data through an application program interface (API), available at <**https://paleobiodb.org/data1.1**>. With this functionality, anyone with programming skills can write web applications, R packages, or other interfaces that request data directly from the server to analyse or visualise the information in novel ways.

To introduce the API and spur development of new applications, the Paleobiology Database recently held a hackathon at the University of California, Santa Cruz. This event brought together 11 researchers from universities and museums across the United States for some programming by the beach. Participants worked on web applications, R packages, and GIS tools for phylogenetic analysis, paleogeography, among other topics. For example, Andréa Matsunaga (University of Florida) created a web application (<**http://phylojive.acis.ufl.edu/PhyloJive/OtPbdb.jsp**>) that integrates Paleobiology Database species names with phylogenetic trees from the Open Tree of Life, generating distribution maps using specimen data from iDigBio. David Bapst (South Dakota School of Mines) updated his paleotree R package (<**http://cran.r-project.org/web/packages/paleotree**>) to create time-scaled phylogenetic trees using Paleobiology Database data.

The API and underlying data are available for anyone to use under a Creative Commons CC-BY licence, and we enthusiastically welcome any developments! Members of the Executive Committee are happy to answer questions or help you navigate the API – just e-mail <**info@paleobiodb.org**>. If you want to contribute fossil occurrences or taxonomic data, new members are also welcomed (e-mail <**sec@paleobiodb.org**>). We look forward to seeing the exciting tools created by you, the community!

Matthew Clapham
University of California, Santa Cruz

Photo: Matthew Clapham.

Hackathon participants at the UCSC coastal campus.

Introducing Fossil Hunter Lottie

Fossil Hunter Lottie itching to excavate some of the NHM's fossil shark teeth. © Victoria Herridge/NHM London.

Victoria Herridge

Natural History Museum, London

TrowelBlazers (<**www.trowelblazers.co m**>) – an online project to highlight the pioneering contributions of women to the trowel-wielding fields of palaeontology, geology and archaeology – have collaborated with toy company Arklu to design Fossil Hunter Lottie, a doll aimed at encouraging 3-9 year-old kids to become amateur palaeontologists. Fossil Hunter Lottie comes with her own geological hammer, hand lens and trowel, all of which fit nicely into her backpack alongside her ammonite fossils and handy Mary Anning fact cards. The box is inspired by De la Beche's *Duria Antiquior*, and there's a child-friendly fact sheet about fossils with an-easy-to-follow set of rules for safe and responsible fossil collecting. You can buy Fossil Hunter Lottie online at <**http://uk.lottie.com/collections/all/products/fossil-hunter-lottie-dol l**>; for every doll bought via this website £1 is donated to the Jurassic Coast Trust. Lottie is also available in the NHM shop.

Jurassic FossilBlitz

As part of NERC's 50th anniversary celebrations in the UK, a number of public engagement activities will take place over the summer to showcase recent and ongoing research it has funded. One of these events is a 'Jurassic FossilBlitz' that will take place at Lyme Regis on Saturday 1st August. Based on the popular bioblitz concept, members of the public will get the chance to take part in a race against the tide to help count and document the different types of fossils visible on the exposed bedding plane surfaces of the Blue Lias Formation at Monmouth Beach and Pinhay Bay. Assisted by local experts from the Jurassic Coast World Heritage site team and Natural England, as well as palaeontologists from the Natural History Museum, British Antarctic Survey and University of Leeds, the fossils will be identified and added to a growing, open access database. We believe this will be the first such event of its type held in the UK.

Richard Twitchett

Natural History Museum, London

PalAss comes to Yorkshire

The British Science Festival comes to Bradford this September, and the Association will be represented by David Button, PhD student at the University of Bristol and the Natural History Museum, London. David, the President's Prize-winner at the 2014 Annual Meeting in Leeds, will give a presentation on sauropods, those popular behemoths of the Mesozoic world. The aim of the talk is to give a fun, interactive overview of the latest sauropod science, focusing especially on their feeding habits, and David is an excellent speaker so it should be a great event. Visit the website for more details: <**http://www.britishscienceassociation.org/british-science-festiva l**>.

After a very successful and enjoyable debut last September, the Yorkshire Fossil Festival is returning to the Rotunda Museum in Scarborough from the 18th to the 20th of September. With the Museum being the brainchild of one William Smith, this will be a bicentennial celebration of his work, Yorkshire geology and all things palaeontological and stratigraphical. Horace the Travelling Pliosaur Cinema will be making his second appearance, there will be geological sand-sculpting on the beach, and Saturday night will see the first 'Stand Up For Fossils' event, in which palaeontologists will tell their best jokes and silliest scientific stories. You might also get to hunt for legendary local, Alan the Whitby sauropod! If you're interested in taking part in any capacity, I'd be delighted to hear from you (e-mail <**publicity@palass.or g**>).

Liam Herringshaw

University of Hull

The Palaeontological Association Funding and Information for PhD students

The Palaeontological Association is an international charity that exists to promote the study of palaeontology and allied sciences through publications, sponsorship of meetings, provision of web resources, and a programme of annual awards and grants.

Membership is open to all, but subsidised for students, for whom it costs only £15 per year. In return, you will receive the Association's Newsletter, online access to the Association journals *Palaeontology* and *Papers in Palaeontology*, a discount on other publications (*e.g.* field-guides), and eligibility for Association awards and grant schemes. The Association provides particular support for postgraduate students through:

Small Grants Scheme
Grants of up to £1,500 are available to students wishing to undertake clearly defined research projects. These may be used to augment PhD studies, although a case for why funding cannot be obtained from existing project monies must be made. The deadline is 1st November.

Postgraduate Travel Fund
Grants of up to £200 are offered to postgraduate student members for travel to international meetings not directly supported by the Association. Apply online at least two months before the meeting.

Progressive Palaeontology
Progressive Palaeontology is an annual Association-supported conference run by PhD students for PhD students. It provides a forum for postgraduates in palaeontology to meet their peer-group, obtain experience with presentations, and discuss their projects with the community. Progressive Palaeontology normally takes place in April or May, and registration is free.

Subsidy of Other Meetings
The Association subsidises international palaeontological meetings which postgraduate students are likely to attend; these subsidies are often used to reduce student registration or accommodation costs.

Outreach Events
The Association participates actively in many outreach activities (*e.g.* the Lyme Regis Fossil Festival and British Science Festival); there are many opportunities for student involvement in these events.

Annual Meeting and Prizes
The Association's flagship Annual Meeting is a major international conference in December with several hundred delegates. Registration is subsidised for students, and contributions to travel costs may be made for students giving a presentation who are based overseas. Presentations are given by palaeontologists at all career-stages, but postgraduate students wishing to present talks and/or posters are prioritised. The President's Prize (best presentation) and Poster Prize are awarded to PhD students or early-career postdoctoral researchers at each meeting; these prizes provide peer-recognition and a cash sum of £200.

See <**www.palass.org**> for further information. including details of and eligibility for grants and awards.

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From our Correspondents

Legends of Rock

Sir Roderick I. Murchison – The King of Siluria

"God made the world, Sir Roderick arranged it."

– Leopold von Buch (Stafford 1990, p.202)

Sir Roderick Impey Murchison, 1st Baronet, Director of the Geological Survey of Great Britain 1855–71. © The Trustees of the Natural History Museum, London.

Most of us have heard the name Murchison, but what do we know about this geo-superstar? He was one of the first to fully appreciate the importance of fossils in stratigraphy. He gave us the Silurian and his legacy extends from the Scottish Highlands to the Australian outback. He hung out with Darwin, Buckland and Lyell, and unpicked the baffling complexity of the European Alps. Murchison explored Palaeozoic palaeontology in Wales, England and Scotland – as well as the rest of the British Empire – earning him a knighthood, the title of Baronet, and enough letters after his name to generate some nifty anagrams[1]. He had a marmite personality (not to everyone's taste), was opinionated and relentlessly argumentative. This overpowering combination made him an excellent scientist, but would cost him many friends and allies over the course of his lifetime.

Roderick Impey Murchison was the son of a wealthy doctor, born on 22nd February 1792 in a quiet little Scottish village named Muir of Ord, nestled in rich farmland below the isolated bulk of Ben Wyvis. Although Murchison was born there, his father died when he was only four years old, so the little boy was packed off to the prestigious English boarding school, Durham School. From there he trained for the army, and served for eight years before marrying Charlotte Hugonin, the daughter of a General, and returning to Durham.

Like many young, wealthy men of his time, Roderick passed his time hunting, shooting and spending money. He and Charlotte moved to several different residences in England before settling in London. It was here that he began attending scientific lectures at the Royal Institution.

[1] KCB DCL FRS FRSE FLS PRGS PBA MRIA – tweet your anagrams to @gsciencelady

His friend, the chemist Sir Humphry Davy, suggested that perhaps science would be a better focus for his energy, and soon Murchison became one of the Geological Society of London's most active members.

In the 1820s Murchison travelled the Scottish Highlands with geologist Adam Sedgwick, who converted him to catastrophist geology. Alongside equally famous geologist Charles Lyell, he spent time in the European Alps unravelling the geology of the region. His wife accompanied them in France, and was a very capable fossil collector and artist (and close friend of Mary Anning). Murchison would later extend his European work into the Ural Mountains of Russia, alongside French Palaeozoic palaeontologist Édouard de Verneuil and German natural-science polymath Alexander Keyserling.

Murchison's best-known contribution to palaeontology and geology was his description and naming of the Silurian, based predominantly on detailed work on fossils in greywacke rocks on the Welsh–English border. The name Silurian comes from the Welsh Celtic tribe the *Silures* – likewise the Ordovician was named for the *Ordovices* tribe by Charles Lapworth, and the Cambrian after the Celtic name for Wales, by Adam Sedgwick.

Murchison published his findings in *The Silurian System* (1839), subsequently republished as *Siluria*. In it he described 350 species that defined the Silurian – some beautifully illustrated by his wife Charlotte – using the principles of biostratigraphy to outline the definition of his new geological period:

> *Are any of the crustaceans, so numerous and well-defined throughout the Silurian rocks, also found in the Carboniferous strata? I venture to reply, not one… such evidences are … supports of the important truth which geology has already established; that each great period of change, during which the surface of the planet was essentially modified, was also marked by the successive production and obliteration of certain races.* (Murchison 1839, p.582)

He drew on the work of many other palaeontologists and added his own study of "crustaceans" to his Silurian description. He noted the lack of plant material in his Silurian strata, the first recognition that terrestrial plants were only just evolving at this time. Sedgwick and Murchison went on to define the Devonian the next year (Sedgwick and Murchison 1840), and Murchison subsequently defined the Permian in Russia (1841), describing many new fossils including those of early reptiles.

Murchison had a talent for seeing the big picture, and his greatest achievements were based on this ability to incorporate the geology of whole landscapes, even inter-continentally. He drew on palaeontology from "the very antipodes" of the world in his description of the Silurian; including fossils brought back from the Falklands by Charles Darwin. The flip-side of this broad-vision was a tendency to overlook fine details. This became apparent when his beloved Silurian clashed with Sedgwick's Cambrian, and Murchison's tireless advocacy for his own opinion irreparably destroyed their friendship. Murchison's approach also proved unhelpful in his later explorations of the Scottish Highlands, where he and geologist Archibald Geikie mistakenly identified Moine Schists as being metamorphosed Silurian rock.

Founding member and many time president of the Royal Geographical Society, Murchison belonged to most of the great Societies in the UK and abroad, receiving medals from the Royal Society, the Geological Society, and the Royal Society of Edinburgh. He also received honorary degrees from Oxford, Cambridge, and Dublin. His view of empire was truly Victorian: as Director General of the Geological Survey he argued that colonial expansion was good for science and was often in favour of annexing territory for Great Britain. While the imperialism does not ring true for us today, it fed his appreciation of the global interconnectedness of geology and distribution of fossils both temporally and geographically.

Although he developed many rivalries and heated feuds with other respected scientists of his time, Murchison was progressive in his attitude towards women in science thanks to his intellectual wife, who not only supported and encouraged his scientific endeavours, but nursed plenty of her own. He argued for the awarding of Geographic Society medals to Lady Franklin and Mary Somerville, and gave his voice in approval of letting women into scientific societies. He donated, bequeathed and gifted money to the University of Edinburgh and the Geological and Geographical Societies, including the establishment of the Murchison Medal and Murchison Fund, awarded annually by the Geological Society. Murchison's reach extends well beyond his own country: there are mountains, rivers and islands named in his honour, from Australia and Antarctica, to Russia and Uganda. He even has his own crater on the moon.

The Murchison Medal, obverse and reverse. The fossils are: trilobites Encrinurus punctatus *and* Ampyx nudus*; brachiopod* Pentamerus Knighti*; and gastropod* Euomphalus rugosus. *Reproduced by permission of the Geological Society of London.*

He died on 22nd October 1871 and is buried in Brompton Cemetery, London. With his name scattered across the globe (and beyond), we are unlikely to forget Murchison any time soon. His greatest contribution is surely the appreciation of the use of fossils in stratigraphy, not just in the UK, but globally. Without him, our understanding of species distribution through time would be much the poorer.

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Behind the Scenes at the Museum

A history of Elgin Museum, UK, and its fossil collection

Elgin Museum, the oldest independent Museum in Scotland, houses a Scottish Government Recognised Collection of Devonian fish, Permian and Triassic reptiles, and Permian trackway fossils. These were excavated from sandstones, mainly in the early- to mid-nineteenth century, from coastal, riverside and quarry localities in Moray and adjacent Nairn. The fossils were initially collected at such a rate that storage soon became a problem. Local collectors filled their houses and the early Elgin collection moved between a jail, free of charge, a Mason's Hall, at some cost, and 55 High Street, the charge for which is unknown. In 1836, a group of men from Elgin, Provost John Lawson, Patrick Duff, Rev. Dr George Gordon, Isaac Forsyth and John Martin, founded the Elgin and Morayshire Literary and Scientific Association (now the Moray Society). Their task was to manage the design and construction of a more suitable and permanent museum building, resulting in the current Elgin Museum building (Figure 1); this was finished in 1842 and opened in 1843.

The collection includes a number of Permian dicynodont fossils, such as *Geikia elginensis* and various species of *Gordonia* (Kammerer *et al*. 2011), remains of one of the earliest and most diverse tetrapod assemblages from the Devonian (Ahlberg 1998; 2005), the well-travelled specimen of *Rhynchodipterus elginensis*, found to the west of Elgin and taken to the University of Chicago to be MRI-scanned (Friedman 2007a; 2007b), and a single specimen of *Saltopus* once thought to be the earliest dinosaur in the UK but now considered one of a number of dinosauriformes that radiated across the globe before dinosaurs, in the strictest sense, appeared (Benton and Walker 2010). These and numerous other studies led to the designation in 2008

Figure 1. The Italianate Elgin Museum. Photo by Sue Beardmore.

of the Devonian, Permian and Triassic fossils and associated archive as a Scottish Government Recognised Collection, defined as a collection of treasures that demonstrate the nation's diversity.

Recently, there have been a number of growing concerns, as one would expect in a collection present for over 170 years, regarding access to the specimens and their current storage conditions. In the 1980s for example, the West (geology) Store – the location of the collection for several decades – was photographed as an example of how not to keep geological specimens, mainly for the wide skylights allowing strong natural light to pour in, and the limited insulation. The most recent development, besides blocking the skylights, has been a year-long project, funded by the Recognition Fund, to catalogue and organise the collection by employing a curatorial assistant. Access to the West Store was quickly improved by moving a large sandstone block containing a Triassic *Stagonolepis* reptile that had long prevented the door from being fully opened, and several Asian statues that were bulky as well as heavy, to a more relevant store. Other storage issues were addressed by transferring specimens from open wooden drawers and ripped cardboard boxes to archival-grade plastic containers, and providing cardboard containers and acid-free paper to prevent damage.

On completion of the project, in February 2015, every specimen had been photographed and listed in a new catalogue database. The majority of the 1,500 Recognised fossils are Devonian fish (approximately 786), with 242 reptile and 15 trackway fossils also recorded. A further 69 plants, 258 invertebrates and more than 62 rocks and minerals form an additional non-Recognised collection. The fish include examples of heterostrachans (*Psammosteus*), partly armoured placoderms (*Coccosteus*, *Dickosteus*, *Asterolepis*, *Bothriolepis*, *Pterichthyodes*), ray-finned actinopterygians (*Cheirolepis*), spiny acanthodians (*Diplacanthus*, *Cheirocanthus*, *Mesacanthus*) and lobe-finned sarcopterygians (*Glyptolepis*, *Glyptopomus*, *Gyroptychius*, *Holoptychius*, *Osteolepis*)

including several Dipnoi (*Rhynchodipterus*, *Dipterus*, *Phaneropleuron*, *Conchodus*). Most are preserved in carbonate nodules as scattered scales or as skull elements that possess a vaguely recognisable outline. Sizes are variable, from *Mesacanthus* measuring a few centimetres to the large isolated scales, some up to 12 cm, of *Holoptychius*. My favourite specimen (yes I did pick one) is an *Asterolepis maxima* preserved in three parts (ELGNM 1978.143.64a-c; Figure 2). The first part is a three-dimensional body approximately 10 cm long with a definite head end, clearly showing the plates of the head and dermal body armour. The latter is moulded onto the second and third pieces along with the rod-like pectoral fins that were present but little use for swimming.

Figure 2. The three-part specimen of Asterolepis maxima *(ELGNM 1978.143.63a-c). Photo by Sue Beardmore, used with permission of Elgin Museum.*

The list of reptiles is equally impressive. Most recognisable is the Triassic *Stagonolepis robertsoni* preserved as natural casts of long-gone disarticulated limb bones, vertebrae and crocodile-like scutes. The preservation of other Triassic reptiles, like *Brachyrhinodon*, *Leptopleuron* and *Saltopus,* is similar. In contrast, the bones of *Hyperodapedon* tend to be present as a white mineral against the grey-brown sandstone matrix, as seen in the near-complete and articulated skeleton in dorsal view on display (Figure 3). Body fossils from the Permian are limited to a few scattered bones of *Elginia mirabilis*.

That these fossils came to light at all is down to a number of local figures, notably the above mentioned Rev. Dr George Gordon and Patrick Duff; Dr John Grant Malcolmson, discoverer of Tynet Burn, Dipple Brae and Lethen; Lady Eliza Gordon Cumming, who helped Malcolmson collect fish from his sites and produced sketches that appeared in prominent scientific publications of the day; William Taylor, who collected enough Devonian fish fossils with Rev. Dr George Gordon during his retirement to become a world expert. These local figures also promoted the fossils they collected, successfully attracting the interest of many eminent early

geologists, such as Roderick Murchison, who devoted a decade of his life to Scottish geology; Hugh Miller, collector of Devonian fossil fish in Cromarty which were exchanged for similar-aged fish from Moray; Louis Agassiz, the Swiss palaeontologist who included fish from Moray in his studies; Thomas Henry Huxley, an English anatomist known for his strong support of Darwin's theory of evolution; Richard Owen, who described the Elgin reptile *Leptopleuron* but remains more famous for his naming of the 'Dinosauria'. Between them, these workers resolved several ongoing scientific arguments, an example being the true affinities of *Stagonolepis robertsoni* originally thought to be a scaly fish on discovery in 1844, but described more correctly in 1859 as a crocodile-like reptile. This correction, in turn, led to some consensus on the age of the Moray Sandstones, originally considered entirely Devonian by Murchison and Sedgwick among others, based on the presence of fish fossils, but, with the finding of definite reptiles, was divided into the Old Red (Devonian) and New Red (Permo–Triassic) sandstones.

Put into context, the fossils of the Recognised Collection demonstrate the progression across Moray from a fluvial setting on the shores of the vast Lake Orcadie some 380 Myr ago, to an altogether hotter, drier, desert with large sand dunes occasionally subjected to flash flooding 250 Myr ago. The latter persisted into the Triassic, until 220 Ma.

Figure 3. The Triassic Hyperodapedon *reptile on display (ELGNM 1886.3Ai). Photo by Sue Beardmore, used with permission of Elgin Museum.*

Being in the centre of Moray, Elgin Museum is the obvious starting point for learning about the fossils and rocks in the local area. Future developments are planned, notably the addition of permanent cabinets and drawers in the West Store to more adequately accommodate the Recognised, and non-Recognised, collection, and to further improve access. The problem is that, as an independent museum, Elgin Museum relies entirely on donations to remain open and, like many institutions, is struggling financially. The work force comprises approximately 50 volunteers in management, admin, front of house, shop and guide roles, but with the completion of the

re-organisation project there is no longer a member of staff dedicated to management of the Recognised Collection, adding further responsibilities to the workload of the volunteers. It is hoped that with continued promotion of the fossils among the public and scientific communities, the most recent example being the Moray Geology conference in March, we can ensure that the Museum and its collection have a stable future.

Sue Beardmore
Elgin Museum

Elgin Museum is open Monday to Friday 10am–5pm and Saturday 11am–4pm. Please see the Museum website at <**www.elginmuseum.org.u k**> for more details.

Facebook: <**https://www.facebook.com/ ElginMuseu m**>

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Buffon's Gang

If you want to encircle the world, it's good to have friends to give a helping hand. Darwin, on the *Beagle*, had the support of the remarkable, if troubled, Captain Fitzroy[1]. Humboldt, in his extraordinary South American adventures, had the constant company of the botanist Aimé Bonpland. The Comte du Buffon, now, of the preceding generation, spent his long working life with the ingrained habits of the most conservative of civil servants. Summer at his country residence of Montbard, shunning even the provincial delights of Dijon, while Winter was spent in Paris, working for his employer, King Louis XVI, as – if one is being prosaic about it – keeper of his gardens. If, from either end of such a narrow, metronomic path, you want to understand the world – really understand it, in the round, from beginning to end, as Buffon attempted in his *Les Époques de la Nature*, in the mid- to late-eighteenth century – then you need a means to reach much wider than your eyes can see or your legs can carry you. A circle of correspondents and friends (and adversaries too) was a *sine qua non* for the savant of that day (it's still pretty handy nowadays, of course, though the Internet is a good friend too). For Buffon, an insight into these connections can be gained among the 'Notes Justificatives' that provide a good deal of the spadework for Buffon's whole-Earth history. Much more than footnotes, these are a succession of essays that chew over a more or less random assortment of topics which together amount to a four-dimensional vision of the world.

There are some pretty characterful characters among these Notes. For instance, among the Notes on the Second Epoch, there appears the name of 'M. le Baron d'Olbac', in a passage giving chapter and verse on the nature and arrangement of veins of different metal ores and of coal seams within mountains, as worked out by that 'celebrated chemist' Johann Gottlob Lehmann. Lehmann deserves some words of his own one day, but D'Olbac should now have our attention as part of the intellectual landscape within which Buffon lived. Metal ores and coal seams were by no means D'Olbac's usual territory, but in those days it was not unusual to be multidisciplinary, not least because the disciplines that bind us today had mostly not been invented. He put a small but not insignificant portion of his considerable energies into translating Lehmann's work into French – and so bringing it within Buffon's orbit. Today, the name is more commonly spelt Baron d'Holbach or, in full, Paul Henri Thiry d'Holbach. Born in the Rhineland, he had the good fortune to be raised by a maternal uncle who played the Paris Stock Exchange with an assured hand, to highly profitable effect, and this in effect set up d'Holbach for life[2]. He studied, travelled, and then settled in France where, like Buffon, he was based in Paris for the Winter and a country estate in the Summer. In Paris, he used his wealth to set up one of the more opulent *salons*[3] where, every Thursday and every Sunday, some of the most enlightened and forward-thinking spirits[4] of the French Enlightenment used to meet for fine cuisine and intellectual conversation.

[1] The support was, of course, mutual. Darwin was on the ship as shelter from loneliness and mental stress for Fitzroy on the long voyage, and proved his worth.

[2] So it is not so much ironic as almost inevitable that d'Holbach's writings would later have considerable influence on Karl Marx.

[3] In the Rue Royale – where else?

[4] Males only; the Enlightenment was a slow process.

One can use the last term entirely without irony. These would be heavyweights in any age: Denis Diderot, Jean-Jacques Rousseau, Condorcet, Helvétius – and, when they were in town, Adam Smith, David Hume, Edward Gibbon and (it seems) Benjamin Franklin. And Buffon, too. The *coterie hobachique* (as Rousseau termed it) probably had no little influence on what was to happen in France in later years. They played with dangerous ideas, and they knew it. The radicalism is hard to discern from outward appearances[5]. There is a portrait of Buffon, used, indeed as the cover of the Fayard edition of Jacques Roger's magnificent biography of him, and it bears extraordinary similarity to a portrait of d'Holbach: both (clearly) well-fed, finely dressed and bewigged, sitting on plushly upholstered chairs, gazing into the middle distance against a sylvan landscape (which in Buffon's case includes a lion, camel and elephant, while behind him an ornate globe stands on a table). The portraits, unsurprisingly, were by the same artist, Carmontelle, who painted others of the *coterie holbachique*, too. A journeyman's reproduction of identikit savant-aristocrats? It seems not: reports from the day speak of being able to recognize Camontelle's subjects in the street, from having previously seen their portrait alone.

There was more than physical similarity in common between d'Holbach, essentially a man of letters who had trained as a lawyer, and that self-made professional scientist, Buffon. Firstly, they both worked on dangerous ideas, which they knew would offend powerful forces of the day – although they developed very different styles of dealing with it. D'Holbach is now best known for being one of the most trenchant and outspoken atheists of the day, not just anti-deist but anti-clerical, too, and indeed not a great admirer of the contemporary authority in general. Religion, he said, is the art of intoxicating men to turn their minds from the ills that the government foists upon them. Worse (to some), he was a fatalist, too, arguing that humans are effectively born into a destiny determined by their material setting with little that they could do about it – except perhaps to pursue a path of enlightened self-interest. How did he get away with it? The books in which he espoused these inflammatory ideas, such as *The System of Nature* and *The Holy Contagion* (aka *The Natural History of Superstition*) were duly received with horror by the establishment of the day[6]. They were, indeed, officially condemned by Parliament, and copies were ceremonially burnt at the foot of the palace steps. How did d'Holbach, rich as he was, escape the same fate? Simple. He published the offending works abroad, under assumed names (including that of Jean-Baptiste de Mirabaud, a member of the French Academy who had been dead ten years – a neat touch, that), and presumably was looking skywards with an expression of beatific innocence on his face as the scandal blew around him. It wasn't until the next century that it became commonly known that he was the author.

Buffon's technique was quite different. In writing a history of the Earth that was in essence entirely materialist, with that time-scale of 75 000 years an order of magnitude greater than the Biblical one, he was sailing close to the wind, as this was a context not at all designed to appeal to the theological establishment, the Sorbonne. He was not doing this out of political radicalism, which was at least in spirit a powerful strand in d'Holbach's thought: Buffon was a social conservative who enjoyed – and used – the powers and privileges that he had risen to. He was simply being a scientist, trying to think clearly how the world worked. So, he used diplomacy to levels that are more usually called hypocrisy, and laid it on thick with a ten-foot trowel. He was outwardly pious, a regular churchgoer, and in his 'First Discourse' to *Les Époques* he said that his

[5] Or from the excellent cuisine and fine wines, of course.

[6] Even these days, there are many establishments that don't much like these ideas.

own feeble thoughts could never, but absolutely not, compete with the absolute authority of the Scriptures, repeating this until the meaning would be *quite* clear to even the most suspicious potential inquisitor … and then – with that out of the way – just got on with the job of working through his new-found Earth history. Unlike Darwin a century later, he seemed not to agonise internally over any potential science-faith conflict, simply taking great care to keep himself out of the firing-line. None of his writings attempt to usurp religion in exchange for a natural universe, so it's not certain whether he was a deist or not, and it's even been suggested that the 'seven epochs' are modelled on the seven days of creation. He was probably an atheist, said Jacques Roger, who probably got as close to understanding him as anyone in recent times, and so sincere *homage* to an Old Testament timescale also seems doubtful.

D'Holbach and Buffon were also engaged in wider endeavours – monumental assemblies of the knowledge of the day. D'Holbach was an assiduous contributor to the *Encyclopédie*, a huge multi-author enterprise to put together knowledge of the sciences, the arts and the 'mechanical arts' (agriculture, crafts and so on). Orchestrated by Diderot (and on the mathematical side by Jean le Rond D'Alembert), this was an ambitious attempt to gather together all the knowledge, then, of the world – a direct ancestor to the subsequent compendia such as the *Encyclopaedia Britannica*. The *Encyclopédie* was certainly produced on a grand scale: over seventy thousand articles by hundreds of contributors, with in excess of 3,000 illustrations, published in 28 volumes between 1751 and 1772. D'Holbach contributed some 400[7] of these articles, including on mineralogy, as befits a polymath of the *ancien régime*. The *Encyclopédie* itself didn't have a smooth passage, as some of the passages put in by Diderot (a co-conspirator in D'Holbach's anticlerical pamphlets, it seems) and by D'Alembert could be construed as politically radical[8]. Nevertheless, it survived to and through publication, not least because of friends in the most unlikely of places. From within the heart of the aristocracy, the *Encylopédie* received the support – the active, thoughtful support – of Madame de Pompadour, no less, King Louis IV's official mistress, and this helped prevent its suppression.

No one, then, was closer to the King, in a way that makes all the obvious jokes about this relationship seem trite. Her name, to us now, seems the essence of the empty artifice of the ancient regime. In reality, she was tough and smart enough to negotiate the complex etiquette and vicious politics of the court – and showed kindness, too, in establishing cordial relations with the King's wife, poor Marie Leszcynska, something that the other royal mistresses did not deign to do. She brokered political deals and was a very proactive patron of the arts – and of Enlightenment science and philosophy, becoming a supporter of the cautious Buffon as well as of the more daring Diderot. Reincarnated today, she would make one hell of a good chair of a major scientific grants panel.

Buffon did not contribute to the *Encyclopédie*. He had encyclopaedic plans of his own, which were on a different plane, in the most fundamental way, to that of Diderot and D'Alembert's brainchild. This was his *Histoire Naturelle*, which *Les Époques* was nested in, and which weighed

[7] Not bad going – but nothing by the standards of Louis de Jaucourt, who wrote over 17,000 articles for it in six years, at an average rate of eight a day.

[8] Easily construed, indeed – try this by Diderot himself on wealth: *If exclusive privileges were not granted, and if the financial system would not tend to concentrate wealth, there would be few great fortunes and no quick wealth. When the means of growing rich is divided between a greater number of citizens, wealth will also be more evenly distributed; extreme poverty and extreme wealth would be also rare.*

in at 36 quarto volumes[9]. It was no multi-author compendium, but a personal vision; his own extended exploration of the natural world. He did not want to systematically catalogue the variety of life then known – a variety that even then, by the efforts of earlier naturalists and the new views opened up by such technological developments as the microscope, was seen to be both wildly diverse and insanely complex. Indeed he poured scorn on the piling up of fact after fact, detail after detail that was then in vogue, and on the new classification of Linnaeus, which he judged too rigid and too one-dimensional to encompass the subtlety and richness of the natural world. It was a world he wanted to explain – to provide a working model for, and so he stepped high, wide and handsome as his big ideas evolved. And taking those big steps, he could of course tread on toes. The owner of perhaps the most delicate and intellectually aristocratic toes flattened in one stage of Buffon's exploration isn't mentioned in the Notes Justificatives of *Les Époques*. Not overtly or deliberately, but because the loud sounds of hurt from the bruised pedal extremities hadn't yet made it across the Atlantic to Paris. It was to become something of a legend, in cartoon version at least, a duel between the aristocratic French savant, routed by a palaeontologically savvy soon-to-be American President. But it wasn't quite like that.

Thomas Jefferson is the missing name here. His reputation has been systematically burnished down the years, not least by John F. Kennedy's delicately placed observation to a group of Nobel laureates invited to a gathering at the White House, telling them that the House had *never* seen such a brilliant gathering … 'except perhaps when Jefferson dined alone'. Be that as it may, Jefferson was certainly deeply interested in, and wrote on, the natural history and palaeontology of his corner of the new continent. And Buffon was, quite unconsciously, to act as the small barrel of gunpowder that was to propel him into redoubled activity in this field. There were two main points of contention, one general, and one specific. First, there were the Americas as victim of one of Buffon's early models to explain the history of the Earth. Buffon's history – generalizing wildly – involved a cooling of the Earth, and a concomitant shrinking and enfeebling of the biosphere[10] from the early age of energetic giants, to one of rather slothful pygmies. All the Americas originally fell into a category of biological late arrivals, and hence punier and feebler than the denizens of the Old World. Buffon meant no particular slight to the new world – it was simply an outcome of his evolving world-view. Jefferson, then a young man, was incensed, though, at this slur upon Americans – both two- and four-legged – by the established and famous French savant, and worked strenuously to emphasize the burliness and muscularity of the North American fauna. He went so far as to send to Buffon the bones and skin of a large moose in a crate (by all accounts, highly odoriferous and not at all in good shape by the time it arrived, though the reaction of Buffon is not recorded).

Buffon, by the time of *Les Époques*, had moved on, noting the reports of large quadrupeds in North America (now, he reserved the status of a different, 'late-formed' fauna to South America to explain the emerging, and very real differences, between the faunas of the two continents). Among the most spectacular of these quadrupeds was to greatly exercise both him and Jefferson. This was what was to be called the mastodon, a generation later, by Cuvier. In the mid to late eighteenth century, though, there was simply a jumble of gigantic bones, pulled out from the ground, notably from swamplands near the river Ohio. There were enormous tusks, as from some mighty elephant; and there were monstrous teeth, looking very much like the molars

[9] In his lifetime; more were published after his death.
[10] A term not yet invented, of course.

of a hippopotamus, but of something like four times the mass. There were thigh bones, too, comfortably big enough to fit three adults across to sit down for lunch. Buffon had been sent reports and examples of these bones and teeth (to grace the *Cabinet du Roi* in Paris) and was greatly intrigued by them, devoting one of his longest 'Notes Justificatives' to them. What were they? Buffon, here, an ocean away from the evidence, was unsure how to piece the puzzle together. He supposed that there were large elephants formerly trampling across North America, together with some mysterious unknown beast, the possessor of the hyper-hippopotamus teeth – *which no longer existed*. He was quite clear in this last assertion: had there been something living of that scale, it would by then have been found. It was another extinct creature to add to the others – the belemnites, the 'horns of Ammon', and so on – that he recognized as relics of worlds now thoroughly gone.

Jefferson, the man on the ground, was clearer in associating the tusks and the teeth into one creature – and even made a little fun of the mighty Buffon, wondering how elephants might come to a particular spot to leave their tusks, and the über-hippopotami arrive at the very same place to leave their grinding teeth behind. His intuitions on the current whereabouts of the mystery animal, though, were to prove not so acute, in hindsight. A deeply religious man, he did not believe that animals divinely created would be just cast aside by Providence. He considered the bones as bones, not as fossils, and imagined that somewhere in the poorly explored far regions of the new continent, the mastodons-to-be-yet-named still roamed, peacefully isolated from the encroaching human tide. The quarrel between Jefferson and Buffon seems to have been exaggerated. The young American seems to have genuinely respected the French savant (and it was perhaps this sense of the older man's reputation and influence that made him work so hard to make his points). When Jefferson spent some years in Paris as Benjamin Franklin's successor as United States ambassador, the two men met, and dined, it seems amicably. Buffon, then an old man, could afford to be gracious to the young pretender.

Buffon's acquaintance with the mastodon was via other of the North American pioneers. Two names appear in this respect in the Notes – most directly that of an 'M. Collinson'. This is Peter Collinson, a man who spanned the worlds of trade and science. His main passion lay rather lower down the food chain, for he was a trader who transformed the upmarket English garden (and the global biosphere, too, for that matter) in supercharging the transatlantic and transglobal market in plants. If you think of the rhododendrum (*maximum*), azalea (*nudiflora*), clematis (*reticulata*), hydrangea (*arborescens*) and yucca (five different species, no less) … well, here is the man who brought them across[11]. An enthusiast for the underlying science (and member of the Royal Society), he was a great 'facilitator', corresponding or meeting with the likes of Linnaeus, Benjamin Franklin[12], Hans Sloan – and Buffon. In this case, he acted as link between a great finder of mastodons, George Croghan, and Buffon. Now, Croghan really should not have had the time for this kind of thing. Among the larger-than-life characters who cast the new world in their mould, he was a true original. Dublin-born, and nominally a fur-trapper by trade in mid-eighteenth century Ohio County, by force of character he became a power-broker in that region rivalling (and for most of the time out-muscling) George Washington for the best part of three

[11] All this has been carefully documented by John Living and Roddy Braithwaite of the Mill Hill Preservation Society.

[12] He seems to have been the man who introduced Benjamin Franklin to the idea of electricity. The rest is, as they say, history.

decades. As if the colonial interests, French and British (not to mention the 'rebel' American ones), were not complex enough, he also lived and worked more or less successfully with the Native Americans, learning at least two of their languages and marrying a Mohawk woman. Balancing the bloody power struggles between these competing interests, and trying as best he could to keep the peace, he amassed wealth and power and a very large amount of land – so what on earth was he doing risking his life on a quest for fossil bones?

Goodness knows. It is, whatever else it might be, testament to the fascination exerted by the true monsters that once roamed this world. In 1765, Croghan led an expedition to 'Big Bone Lick' on the Ohio River, and found many large bones, only to lose them all – and almost his life (his thick skull, he said, saved him from a hatchet blow) – as the party was ambushed by Native Americans. Undaunted, a year later he was back again. This time he got, and kept, the bones, and from there they travelled, to arrive in the hands of Benjamin Franklin, and also into those of 'Mylord Sherborne' in London. Buffon, clearly fascinated by the remains of this vanished monster, noted all of this, via his correspondence with the assiduous M. Collinson.

There's much more of note in the 'Notes'. There is Buffon collating reports of bones of human giants, and being half-sceptical, half-open on which among these feverished accounts might represent some reality. There are accounts of him wondering about whether the kingdom of ice was tightening its grip, both in the Alps and in choking off the navigability of the waters north of Siberia. There is material, too, on how life might survive in hot springs. Whatever this is, it goes well beyond whatever stratigraphy might have been starting as then. Baron D'Holbach's translation of Lehmann, that we started with, was quoted as a useful account of the structure of mountains – with ancient cores covered by younger, more coherent strata. These are insights comparable to, and independent of, those of Giovanni Arduino, whose letters describing the internal structure of Valdagno, in the southern Italian Alps, are generally seen as one of the origins of rock stratigraphy, with his recognition of Primary, Secondary and Tertiary (and implicitly, Quaternary) units, ranging from older and more complex to younger and simpler. Arduino's letters, a correspondence in two parts published by the much-impressed Professor Vallisnieri of Padua, were soon translated into both German and French, and his ideas spread widely throughout Europe[13]. Buffon, with his wide reading and extensive correspondence, would very likely have been aware of them, just as the less academically aristocratic Arduino was aware of Buffon's earlier geological ideas. Why not cite them too?

Perhaps he thought Lehmann's intuitions sufficient – after all, they ran along generally similar lines. Perhaps, too, he regarded these broad principles of what was to become stratigraphy, as self-evident. After all, he was clear that Earth's 'primary' rocks crystallised from a once-incandescent and cooling melt, and had no trouble recognising the superposition of the main lithological units in the countryside around his chateau (and probed yet more complicated geometrical rock relationships in exploiting – very successfully – the iron ores on his property).

Buffon's ambitions ranged wider. His main aim in *Les Époques* was not so much to detail the nature of the rock succession, as did Lehmann and Arduino (and Fuchsel, too) but to explain the nature of things. Just as the *Histoire Naturelle* as a whole focused on the big questions regarding life, so *Les Époques* tried to get under the skin of an active and evolving Earth. The numbered

[13] But they have only been translated in full into English relatively recently, by Theodore Ell – and fascinating reading they make. To be mused on anon, methinks.

epochs are units of time and history (inferred, true, from the physical evidence of the rocks and fossils) – but they are there not as a time-based catalogue, but as the framework upon which to present a four-dimensional evidence-based working model of the Earth. Ambitious? Of course, but that was something that Buffon had in spades. The scale of the enterprise grows with hindsight, given the tools he had to work with. Buffon was working, remember, before Lavoisier took his giant steps towards building a functional chemistry, so the elements to him were not iron and carbon and nitrogen (let alone considering their cycles), but earth and air and fire and water. None of the observations then made in biology were remotely capable of allowing sensible insight into the large mysteries of the day, such as how organisms could reproduce and grow. Even the spheres that were then well developed could not give him a sure foothold. He was an excellent mathematician in his youth, but grew to distrust mathematics: more a product of human logic than an inbuilt part of the universe, he suspected.

Still, with all these caveats, things had to be explainable in relation to each other. Some of these relations may appear ludicrous today, such as an epoch of volcanism as a direct result of sea level fall (itself the product of the collapse of giant blisters developed on the cooling Earth), this having the effect – he proposed – of triggering exothermic air/water/rock interactions in the newly exposed crust to generate the heat to generate the lava and ash. Wrong, we now know – but internally consistent with the knowledge at his disposal, and it was the kind of all-inclusive reasoning that he followed right up to the present, seventh, epoch, where he proposed local climate change followed on from the conversion of forests (cold, humid) to farmland and town (warmer, drier). This seems to be rather more on the line to what we could call today 'Earth systems science', than to organized stratigraphy. Or perhaps it was just a premonition of this new multi-discipline, that was left more as a fossilised trace than as a living lineage. Whatever it was, it was this kind of ferment that could light an intellectual fire in a future president of the United States of America. Our science does not make quite the same kind of waves today.

A generation later, Humboldt was to create his own Earth system, one that certainly went on to make waves that still lap around us today. Buffon's star fell as Cuvier's rose, *après la Deluge*, and his kind of thinking in the round did not, say, later cross the channel to infect the newly-formed Geological Society of London, where the accent was on gathering and recording data from the rocks, without necessarily being too concerned about the greater worldview.

Still, Buffon got surprisingly far, with a little help from his friends.

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R for palaeontologists
4. Statistical tests Part 2 – Regression

Introduction

In the previous article I discussed the basics of statistical tests and how to implement a series of descriptive and inferential tests ranging from single-sample tests (testing for normality of a sample) and two-sample tests (comparing the variances of two samples). In this and the following article or so I will cover what is a wide area of data exploration, that of statistical modelling. Here I will focus on one of the most commonly applied statistical models: linear regression.

Statistical modelling and its uses in palaeontology

In simple terms a statistical model is an estimation of the relationship between one dependent variable and one or more independent variables. Specifically, in the cases of the models I will discuss in this and the following few articles, a statistical model asks how much of the variation in the dependent variable is explained by the variation in the independent variable(s). For example, on a standard bivariate graph the dependent variable is placed on the y-axis and the independent variable on the x-axis. I should just briefly mention that there are a number of synonyms for the dependent and independent variables (Table 1) and while they do have subtle differences and specific uses you may see them used interchangeably in the literature.

Table 1. Some of the commonly used synonyms for the x-axis and y-axis variables in statistical modelling.

independent (x-axis)	**dependent (y-axis)**
predictor	response
regressor	regressand
controlled	measured
manipulated	responding
explanatory	explained
input	output

In the previous article I discussed how to correlate two variables, and while from the description above it could be confused with a regression – specifically a linear regression – there are some similarities that I should just briefly discuss. Firstly, they are similar in that they both provide a correlation coefficient, *i.e.* a measure of correlation between two variables. Also, neither provides an answer to whether there is causality between the variables, in that you still don't know whether changes in one variable cause changes in the other, merely that they are related. However, they differ in that a regression provides more information that just a correlation coefficient; specifically, using the equation of the line of best fit we can infer values for the dependent variable based on values for the independent variable. Typically though when researchers are illustrating the results of such an analysis they will include on the scatter plot both a line of best fit (regression line) along with a measure of correlation (typically a combination of R^2 and p-value).

As you can imagine, the results of any statistical modelling analysis is just that, a model of the relationship between these two (or more) variables, and as such there could be another model that better fits the data. This is the reason why this is such a wide selection of models, as there are many different ways in which a model may be fitted to your data. Also the model you choose to apply depends greatly on the nature of your data: for example, are all of your independent variables continuous (usually something that can assume fractional values, *e.g.* height or mass), ordinal or nominal/categorical (*e.g.* gender), or a mixture of both?

In palaeontology the uses of statistical modelling are many and varied, ranging from examinations of ontogenetic variation within species to examinations of the interactions of organisms and the surrounding environment. One example of a technique I intend to cover later is the use of generalized linear models (GLMs), which have been used to compare several different combinations of sampling and geological variables against diversity to see which combination best fits geological variations in diversity (Benson and Mannion 2012).

Although different to the kinds of methods I am discussing here, modelling techniques are now extremely common in examining phenotypic trends such as body size through geological time. A number of packages developed for R, such as geiger and paleoTS, allow researchers to compare several models of evolution against their phenotypic data to determine which of these best fits their data (Bell and Braddy 2012; Benson *et al.* 2014).

Linear regression

One of the most basic hypotheses we can have about two continuous variables, and the one that most people are familiar with from school, is that of a linear relationship whereby both variables follow a straight line. The equation of this line is as follows:

$$y = mx + c$$

where y is the dependent variable, x is the independent variable, m is the gradient of the line (the change in y divided by the change in x) and c is the intercept (the value of y when $x = 0$). The test we use to determine the equation of this best fit line is a linear regression, which is defined as the line that minimizes the sum of the squares of the residuals. The null hypothesis (H_0) of a linear regression is as follows:

H_0 = there is no relationship between the dependent and independent variables

As with all statistical analyses there is a set of assumptions that must be obeyed prior to carrying out that test or applying that model. For a regression the ones that apply here are as follows, the first two of which we can deal with before conducting the analysis, whereas we will have to check the others (iii – v) once the model has been fitted:

[i] The data must be normally distributed.

[ii] The relationship between the independent and dependent variables must be linear.

[iii] The error of the model (residuals) must be normally distributed.

[iv] The variability of the residuals should be the same across the range of the fitted values (heteroscedasticity).

[v] There should be no points that assert a high amount of leverage on the model.

In order to demonstrate we will use the *extrinsic* dataset I've been using throughout this series to examine the relationship between two variables. First we will load the file into the R environment (see Article 1 if you are unsure how to load in files):

```
extrinsic <- read.table(file="extrinsic.txt", header=TRUE)
```

In this example we will ask the question of whether there is a relationship between a measure of diversity, here we will use Shareholder Quorum Subsampling (SQS), and a measure of ecological evenness; *i.e.* is there a decreasing or increasing trend or none at all? To make the code presented here easier to follow, although this is not necessary, I will assign the data to two new variables:

```
diversity <- extrinsic[,"SQS"]

evenness <- extrinsic[,"evenness"]
```

The initial stage of such an analysis is to check the assumptions of the method we intend to use. The first of these as I outlined above [i] is that the data are normally distributed. As covered in the previous article this can be done either graphically, by plotting a histogram, or statistically, using the Shapiro-Wilk test. If we perform the latter on the two variables we can see that while the evenness variable is not significantly different from a normal distribution the same is not true of the diversity variable that has a p-value of less than 0.05:

```
shapiro.test(diversity)$p.value
[1]         0.0008012931
shapiro.test(evenness)$p.value
[1]         0.7050528
```

So, given that the diversity dataset is not normally distributed we can log transform this variable using the function **log**:

```
diversity <- log(diversity, 10)
```

The next step is to check that a linear model is appropriate for the data that we have (point [ii] above). We can do this graphically using the **plot** function (Figure 1):

```
plot(evenness, diversity)
```

This is an important step for any analysis as even by eye we can get a good idea of the nature of the data and whether there are any issues that have to be dealt with, such as outliers. In this case we can see that a linear model is appropriate as it appears there is likely to be at least a positive linear relationship between our two variables, in that they are increasing together.

Calculating a linear regression

In a linear regression this line is called a least squares regression line, that is the line that minimizes the sum of the squares of the residuals. Before I show you how to implement a linear regression in R I want to walk you through how the slope (m) and intercept (c) are calculated for a simple bivariate dataset. The first step to determining the equation for the least squares regression line is to calculate the slope (or gradient) of the line (m), for which we need to know two things: the sum of squares for y (SSX), which is the sum of the difference between the observed values, and the mean value of x squared. So the equation for SSX is as follows:

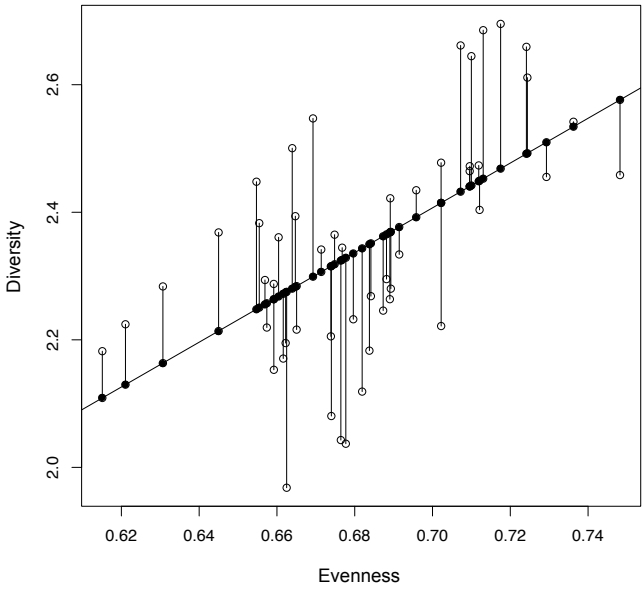

Figure 1. Plot of diversity against evenness (SQS) from the extrinsic dataset (open circles) along with a fitted least squares regression line. The fitted values are shown as filled circles and the residuals by vertical lines.

(1) SSX = ∑(observed value of x - mean of x)²

In R we can calculate this using the following code and store it in the new variable called **ssx**:

```
ssx <- sum((evenness - mean(evenness))^2)
```

However, care must be taken when writing such functions: the placement of brackets is important, as this determines the order of operations. In this example we want to first calculate the difference between each and every evenness value and the mean of evenness, then square each of these values, then finally sum all of these numbers together – not to calculate the squared value of the sum of the differences. If you were to do this then you will get zero as an answer:

```
sum((evenness - mean(evenness)))^2
[1]          0
```

Next we need to calculate the sum of products (SSXY) that is represented by equation 2 below.

(2) SSXY = ∑(observed value of y - mean value of y) * (observed value of x - mean of x)

In R we can calculate it as follows and store the value in the variable **ssxy**:

```
ssxy <- sum((diversity - mean(diversity)) * (evenness - mean(evenness)))
```

So now we have both SSX and SSXY we can calculate of the slope (*m*), which is simply the sum of products (SSXY) divided by the sum of squares of *x* (SSX) (equation 3).

(3) slope (*m*) = SSXY / SSX

We can store this ratio as the variable slope:

slope <- ssxy / ssx

If we now call for **slope** we will get the following result:

[1] 3.511038

This confirms what we saw by plotting the data, that there is a positive slope between our two variables of interest and that as the evenness value increases, so does diversity. Now we have the slope of the best fit line we need to calculate the value for the intercept (*c*) which is calculated using the following formula (equation 4):

(4) intercept (*c*) = mean of *y* - (slope * mean of *x*)

And in R we can calculate the value and store it in the variable **intercept**:

intercept <- mean(diversity) - (slope * mean(evenness))

Now if we call for **intercept** we will get the value:

[1] -0.05080294

So finally we have both of the values we need, the slope of the line and the intercept, so we can add this regression line onto our original plot (Figure 1) using the function **abline**, where the arguments **a** and **b** represent the intercept and slope respectively (see **help(abline)** for more details):

plot(evenness, diversity)

abline(a=intercept,b=slope)

It stands to reason that you don't need to go through all of these steps to calculate a linear regression and that there is an inbuilt function for this method. In R the function you need is called **lm**, for linear model, the syntax for which is as follows:

(5) lm(dependent variable ~ independent variable)

A quick note here that while in plots and correlations the independent variable (x-axis) typically comes before the dependent variable (y-axis), this is reversed for all model formulae within the R environment and the two variables are separated by a 'tilde' (**~**) which means "is modelled as a function of". So to run a linear regression we can use the following code, storing the result in the variable **lm.mod**:

lm.mod <- lm(diversity ~ evenness)

If we now call for **lm.mod** we will get the following output:

```
Call:
lm(formula = diversity ~ evenness)
Coefficients:
(Intercept) evenness
-0.0508 3.5110
```

This provides the formula that has been given (passed) as input to **lm** as well as the intercept and slope values respectively. You can see that these values match the ones that you previously calculated. Now you can add this line to your existing plot using the same function we used previously, **abline**; however, we can just specify the variable that contains the linear model rather than using the arguments **a** and **b** as before. Plotting this line with a different colour using **col="red"** you can see that it plots directly on top of the line you calculated manually:

```
abline(lm.mod,col="red")
```

There is more information held in **lm.mod** than just the coefficients of the least squares line, and we can see the names of the elements of **lm.mod** by using either the functions **names** or **ls**:

```
ls(lm.mod)
```

This will return the following:

```
[1] "coefficients" "residuals" "effects" "rank" "fitted.values"
[6] "assign" "qr" "df.residual" "xlevels" "call"
[11] "terms" "model"
```

Of this list I need to mention **fitted.values** and residuals. The fitted values, which can be called using **lm.mod$fitted.values**, represent the values for the dependent variable (y-axis) for the regression line. We can see these if we plot them against our independent variable (Figure 1) using the argument **pch** to draw them in a different way:

```
points(evenness, lm.mod$fitted.values, pch=19)
```

Secondly, as you will see in Figure 1, the data do not lie perfectly on the regression line and there are deviations from the model (**fitted.values**). The differences between the fitted values and the original data points are called residual values as in:

```
lm.mod$residuals
```

You will see that you have a range of positive and negative values, as some of the data points lie above and some below the regression line. We can show the residuals graphically by joining them to the fitted values using the function **segments**, which is useful for adding lines to plots (Figure 1):

```
segments(evenness, lm.mod$fitted.values, evenness, diversity)
```

Now just fitting a line to the data is not enough to prove that there is a relationship, as no matter what data you provide to **lm** it will provide a least squares regression line. So we also want to know how significant this model is from random data, and whether we can therefore reject the null hypothesis. The function **summary** can be used to show all of the information stored in **lm.mod** in a meaningful way:

```
summary(lm.mod)
```

At the bottom of this you will see the 'Multiple R squared' and 'Adjusted R squared' values; these tell you how well your model fits the data. Below this is the test statistic (F-statistic) and the associated '*p*-value' that tells you how significant the model is. In this case, with a *p*-value of <0.001, we can reject the null hypothesis that there is no relationship between our two variables; however, the adjusted R-squared value is 0.3078 which tells us that our independent variable (diversity) is only explaining around 31% of the variation of our dependent variable (evenness).

Checking the model

So we are now at a stage where we have fitted one model to our dataset. However, we are not yet ready to move on and either declare the job finished or try another model for comparison. Next we have to ask a few questions: does the model correctly describe the data and does this agree with the assumptions of a linear regression I discussed earlier, specifically statements [iii] to [v] above? There are three different plots that are useful in showing how well our model is doing and we can show these by simply plotting **lm.mod**, resulting in four different plots being shown:

```
par(mfrow=c(2,2)) # Allows for four plots to be included in one window
plot(lm.mod)
```

The first assumption we need to test is that the residuals show a normal distribution. We can plot the distribution of the residual values as a q-q plot (see Article 3) (Figure 2 top right). Additionally we could plot these values as a histogram or use a Shapiro-Wilk test to test the null hypothesis that the distribution is taken from a normal distribution:

```
hist(lm.mod$residuals)
shapiro.test(lm.mod$residuals)
```

Using any of these methods we can see that here the residuals display a normal distribution so at the moment there are no issues that we need to worry about.

The second assumption is that there is a uniform variance of residuals compared to the fitted values (the values that the model has calculated for the dependent variable). So we can plot the fitted values against the residual values (Figure 2 top and bottom left):

```
plot(lm.mod$fitted.values, lm.mod$residuals)
```

There are a couple of things we are looking out for here; firstly we want to see something like Figure 3a, a distribution lacking in any patterns or trends, as this may suggest that the model we have chosen is not the most appropriate. More concerning though, is that we really don't want a case where the variance increases as the fitted values also increase; this will result in the distinctive fan shape in this plot (Figure 3b), a pattern with the great name of heteroscedasticity.

Finally, we don't want any outliers in the data as these can have a large influence, or leverage, on the model. The bottom right plot of Figure 2 shows a plot of the leverage of each point against the standardized residuals; what we don't want to see are any points lying outside the Cook's distance line (marked as a dashed red line). In this case, none of the points are outside of the Cook's line so there are not any points with a high leverage on the model. With all of these comparisons completed for this dataset, none of the assumptions of a linear regression have been violated, so we can say that this is an appropriate model for comparing these two variables.

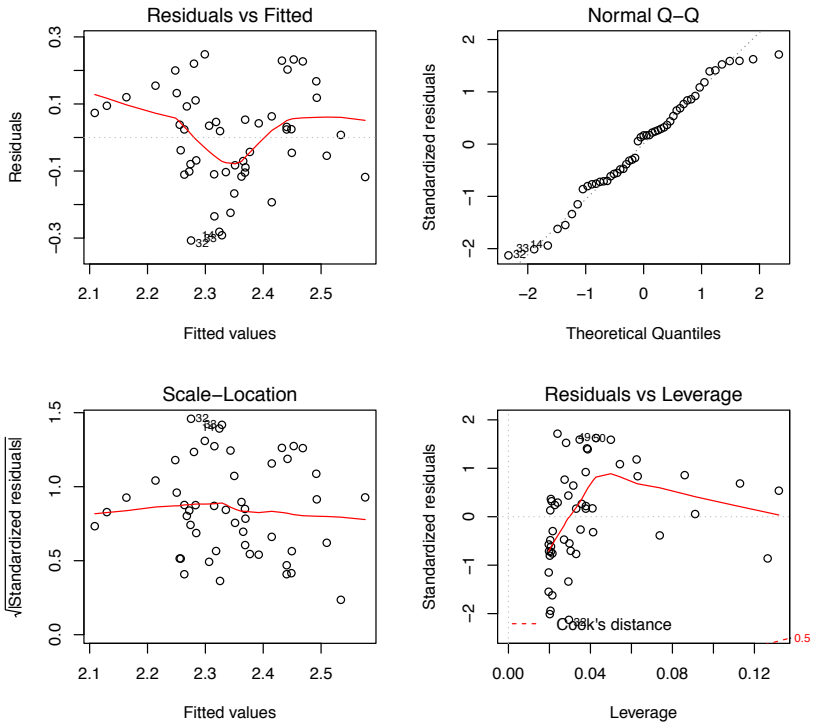

Figure 2. The four model-checking plots for **lm.mod**.

Fitting linear models to non-linear data

One of the commonest errors in statistical modelling is applying an inappropriate model to your data. As I mentioned at the beginning, in the case of a linear regression one of the assumptions is that there is a linear trend between the dependent and independent variables. This is where visualizing your data is very important, as even if all of your data fit the assumption of being normally distributed there may be a nonlinear component to the data that should be accounted for. Figure 4 shows a range of nonlinear trends that could occur in your data, ranging from a complete absence of any relationship (Figure 4a) to data described by logarithmic, quadratic or cubic functions (Figures b-d).

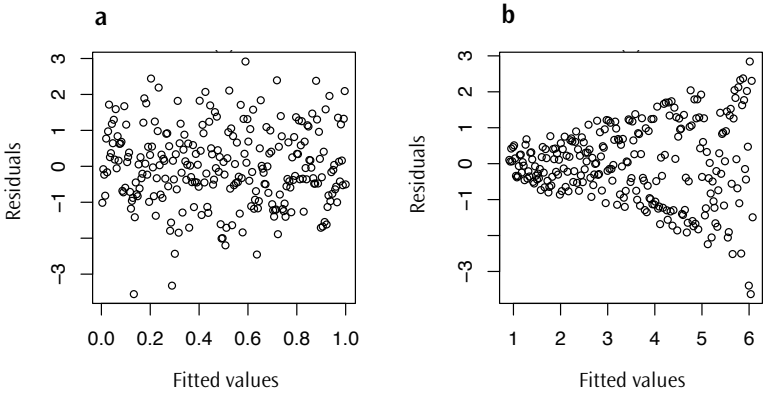

Figure 3. Plots of the residual values against the fitted values for **lm.mod***: a) a typical plot with no visible trend and b) an example of residuals displaying heteroscedasticity.*

Summary

As I mentioned at the outset this is an incredibly diverse and complex subject and, while I won't be able to cover every kind of modelling technique in this and the following articles, my intention here is to provide an insight into the range of techniques available and how to apply them in the R environment. Here, I have covered one example of a technique for a continuous independent variable, the linear regression. In the following article(s) on statistical modelling I intend to cover a technique used when your independent variable is categorical (ANOVA) as well as other nonlinear regression techniques, and variations on these such as generalised linear models (GLMs).

In addition, I hope that I have shown here that these are not complex tests to perform, requiring only a few lines of code in each case. In my experience, one of the most annoying and fiddly stages to any analysis is getting the data into the correct format so that they can be either read by R (especially as error warnings in R are not often that enlightening) or inputted into the function(s) you want to use. Trust me, once you have passed this stage life becomes a lot easier.

Mark A. Bell
University College London
<mark.bell521@gmail.com>

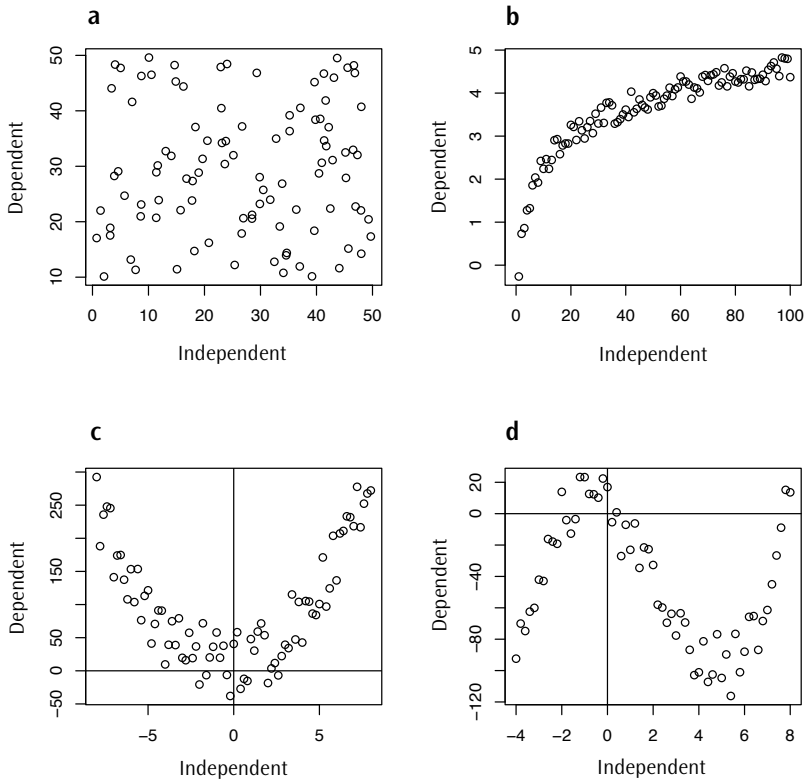

Figure 4. Examples of non-linear data for which fitting a linear model would be inappropriate: a) random data, no trend; b) logarithmic data; c) quadratic data; d) cubic data.

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FURTHER READING

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PalAss press releases

I can waffle for Britain, but I also realise that short, simple messages can have the most impact. This is something I've become increasingly aware of since becoming PalAss Publicity Officer and getting to inspect all sorts of papers, press releases and palaeontological information aimed at public consumption.

One of the standout observations I can make is that many of the 100-word summaries we get at PalAss Towers are inadequate for publicity purposes. You might not really care about trying to get in the news, but if you want your research to reach out to a wide audience (and this is something more and more institutions are being encouraged to achieve), your summary has to be comprehensible to a non-specialist. Quite often we receive dense chunks of text filled with technical terms, making them very difficult to use. A summary needs to be a glass crocodile: clear but snappy.

Similarly, though you might regard Facebook or Twitter with disdain (or obliviousness), these are two extremely successful means by which to bring your research findings to a new and bigger audience. Twitter is a particularly interesting medium: can you condense your research findings into a single 140-character message? In my experience with @ThePalAss account, this is often a real challenge, particularly when the titles of some papers are more than 140 characters long (indeed, I'd argue that we shouldn't permit any presentations at the Annual Meeting that have a title too long to be tweeted). Trying to condense a research paper into an eye-catching snippet can be an enjoyable task, though, and – if done well – may lead to some great new interactions, especially if there's a striking image to accompany the story.

I'm always happy to chat with authors about possible publicity in advance of a paper coming out, so if you'd like to talk about Twitter, foment about Facebook, or simply discuss a summary, just drop me a line.

Liam Herringshaw
Publicity Officer

The Blaschka glass models of marine invertebrates at the NHM, London

The Treasures Gallery at the Natural History Museum (NHM), London, UK, features some amazing glass models of marine invertebrates (radiolarians, jellyfish, siphonophores, squid, octopi) made by Leopold Blaschka (1822–1895) and his son Rudolf (1857–1939) in their workshop in Dresden, Germany. The models, made between 1866 and 1889, were acquired by the NHM to show features of marine invertebrates that were not possible to show via spirit collections or because, like the radiolarians, they were microscopic. They show a snapshot of late 19th century scientific thinking at a time when evolutionary theory was in its infancy and Ernst Haeckel was formulating his ideas about ontogeny.

Examples from the Natural History Museum collection of 185 Blaschka models.
© The Trustees of the Natural History Museum, London.

The father and son partnership is most famous for creating glass flowers that are on display at the Harvard Museum of Natural History, USA, <**http://hmnh.harvard.edu/glass-flowers**>, an exclusive contract from the Ware family that brought them a constant income from the early 1890s until the 1930s. Before the exclusive contract they ran a business making marine invertebrate models on demand, mainly for museums in Europe and North America but also had orders from as far away as New Zealand. Catalogues listing models available from the Blaschkas were published by North American Natural History dealer Henry Augustus Ward who acted as their North American agent; orders were taken and distributed to European clients via agent Robert Damon. Around the British Isles today, examples of Blaschka glass models of marine invertebrates can be seen in the galleries of Amgueddfa Cymru – National Museum Wales, Cardiff <**https://www.museumwales.ac.uk/rhagor/galleries/blaschka/**>, the National Museum of Ireland, Dublin <**http://www.museum.ie/en/collection/blaschkamodels.aspx**>, and the National Museum of Scotland <**http://www.nms.ac.uk/explore/collections-stories/natural-sciences/blaschka-models/**>, among others. A list of worldwide Blaschka collections is available at <**http://www.ucd.ie/blaschka/worldwide.htm**>.

The Blaschkas were fascinated by natural history and drew inspiration from direct observation of marine invertebrates. Leopold, on a transatlantic trip, observed jellyfish while marooned in

The Treasures Gallery at the Natural History Museum with radiolarian model of Aulosphaera elegantissima *Haeckel, 1862 appearing prominently in the first case you see as you enter the room.* © *The Trustees of the Natural History Museum, London.*

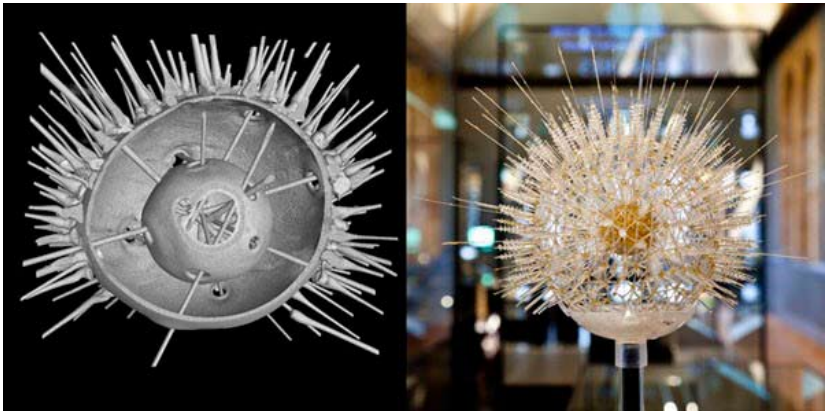
the Azores, and they were known to have ordered live specimens from the Zoological Station in Naples so they could observe them in their own aquarium (Reiling 1998). They knew famous scientists of the time and borrowed books from famous evolutionary biologist Ernst Haeckel (1834–1919), gaining inspiration from illustrations from his famous monograph on the radiolarians published in 1862. They also provided models of ontogenetic series of jellyfishes to illustrate Ernst Haeckel's theory of ontogeny that has now been disproved. Illustrations from books such as Gosse's *Actinologia Britannica* were also used as inspirations for some of the anemone models in the NHM collection.

It is not known exactly how the models were made. Evidence exists in a letter from Mary Ware who described a visit to their workshop outlining how they had many individual parts in their workshop waiting to be assembled (Ware 1961). Models show a variety of media such as parchment, wire and surface treatments that were used to form and decorate the glass. CT scans (see Brierley 2009) have shown inner features that continue to amaze and create wonder as to how they could have manipulated the glass on their glass working tables into concentric shapes. Analytical methods such as inductively coupled plasma mass spectroscopy (ICP-MS) have provided details of glass colouring strategies, differences in glass composition of various anatomical parts, evidence of surface coatings and surface degradation of glass (Bertini *et al*. submitted).

The Blaschka order books in the archives at the Corning Museum of Glass in New York, USA, show that models appear to have been purchased mainly by museums for display purposes. The form and features of macroscopic marine invertebrates are much better illustrated in glass than by spirit collections, while the models of radiolarians and other microscopic organisms such as

amoebas are excellent methods for illustrating the biology and morphology of these microscopic organisms. Evidence from the archive at the NHM shows that there was some correspondence between the Museum and the Blaschkas, first of all to complain about some models that arrived broken and then to requisition a model of *Amphioxus* (Miller and Lowe 2008). This type of model was never subsequently made or offered in their catalogues. Orders of the NHM models can be clearly linked to the research interests of various members of staff and the Blaschkas offered models of sponges to the museum sponge curator. These were never purchased, perhaps because they were the most expensive ever offered by the Blaschkas. Some Blaschka sponge models are on display at the National Museum of Ireland.

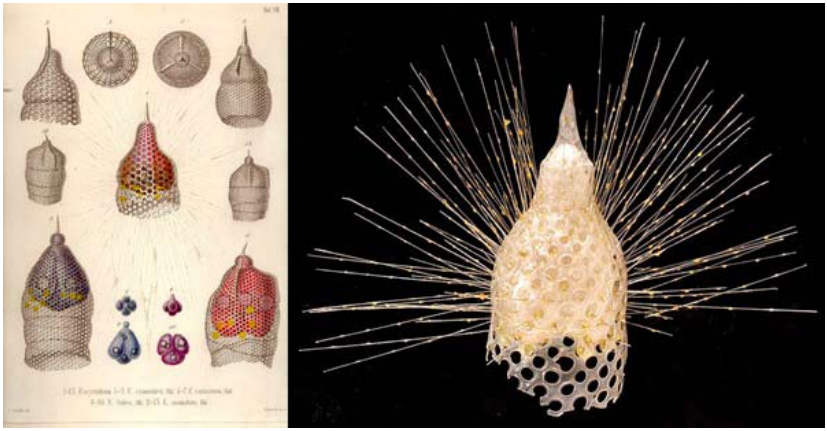
Some octopus and squid models that arrived at the NHM broken show evidence of presumably 19th century repair in the form of brown, discoloured adhesives used to glue tentacles and other features back on cephalopod specimens. More recent attempts to conserve the NHM Blaschka specimens have included Brierley (2009) who cleaned two radiolarian specimens with fine brushes and industrial methylated spirit and reattached broken fine filaments representing the protoplasm. This method has also been employed to conserve other specimens that have subsequently been displayed in the Treasures Gallery off the main hall of the Museum. CT scans have been used to 3D-print cups mirroring the underside of displayed specimens, allowing them to be displayed and handled more easily when the display is changed every six months.



A CT-scan showing the inside of one of three Aulosphaera *radiolarian models that are displayed on a six-monthly rotation.*

Details of the large team who enabled the NHM Blaschka models to go from cardboard box to museum treasure can be found in this blog post: <**http://www.nhm.ac.uk/natureplus/blogs/micropalaeo/2012/11/30/how-a-specimen-got-from-cardboard-box-to-museum-treasure**>. If you are ever in London, seek them out in the Treasures Gallery or visit another UK museum holding Blaschkas if you can. Otherwise you can find out more in this short Blaschka YouTube clip: <**https://www.youtube.com/watch?v=aI83KEkUrTE**>.

Giles Miller
Curator of Micropalaeontology, Natural History Museum, London



A plate from Haeckel's 1862 monograph on the radiolarians and the NHM Blaschka model based on the central illustration. © *The Trustees of the Natural History Museum, London.*

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Sourcing the Ring Master – a crowdsourcing adventure

Crowdsourcing is a way of soliciting the expertise of a wider range of people than one would normally come into contact with. Say someone collides with your car "hit and run" style while you are out thank-you-present shopping for the stalwart soon-to-be-former PalAss Executive Officer, and leaves behind only a fragment of their bumper. Post a picture of that bumper fragment on the web on the right website, and you increase the possibility of learning something about the identity of that bumper and the car that it belonged to. For example, some fanatic may be able to tell you that it was from a 1985 MGB, and through that you can identify the culprit as a member of your institution's law faculty…

Crowdsourcing need not apply only to questions to which there is a definitive answer, and we recently had fun applying it to a geological puzzle. Fine-scale alternation between layers of mudstone and sandstone characterise the 492 Myr old St Lawrence Formation that outcrops in southwestern Wisconsin. At one quarry, several interfaces between such laminae preserve a curious set of ring-like circular structures on the surfaces of the layers. The rings have sharply defined walls that are a few mm thick, with the diameter of each ring commonly several cm across, and with rings commonly approaching a perfectly circular shape. They are strikingly curious structures that have stimulated speculation among both amateur and professional palaeontologists for some years. I first came across them in 1986 when beginning my PhD fieldwork in the area, where my introduction to the field was through local amateur Jerry Gunderson who, along with his school buddy Ron Meyer, has been collecting fossils in the state for nearly 65 years and generously interacting with professionals throughout much of that time. Ron owns a movie production firm in Colorado where he makes natural history documentaries.

Both surfaces of a slab, revealing mirror images of the rings on the upper and lower surface. The slab at the bottom represents the original seafloor. Photo courtesy of Nigel Hughes.

Given the combination of Ron's profession and status as co-discoverer of the rings, I thought I might be able to inveigle him into making a couple of short videos that explained something about the rings to the web audience, and that gave the world a shot at providing plausible science-based explanations for the rings that we would then judge as a competition. So last October, Ron and his son Joel kindly came to Riverside, on an uncharacteristically rainy day, to shoot a couple of videos that both explained the key features of the rings that my students, undergraduate Ashelle Tyler and PhD student Matt Knauss, and I thought most relevant for constraining their possible origins.

The videos provided information on the ring structures, including a simulation of their form, and this was paralleled and expanded on the associated website with a list of "constraining observations" that were intended to guide people's interpretations. Entries were submitted via a Reddit site, which our colleagues in Computer Engineering, led by Eamonn Keogh, set up with us. We offered a $500 prize for the best natural explanation and the Reditt site solicited entries for about three weeks, before a member of the Reddit editorial team expressed concern that entering the competition might encourage people to give up their intellectual property and closed entries to the site, which we felt rather missed the point of encouraging people to experience the pleasure and excitement of scientific thought.

Statistics on the hits to the site suggested that we got the word distributed around the world quite effectively and, indeed, one of the joint winning entries was from Kolkata, India. The site attracted a fair number of hits during the three week window of the competition (~7,000), but not as many as I had anticipated. Media coverage included the local branch of National Public Radio, and a science blog in *Scientific American*, but the competition did not "go viral" in a significant sense. Perhaps this was because getting a clear picture of the structures and then constructing a reasoned explanation was quite demanding.

We had about 80 serious entries (and a very small number of additional entries that were flippant), and these ranged through the wide gambit of explanations that we had previously considered. While no ideas were totally new to us, several of the proposed explanations provided thinking that was novel, and certainly led to literature and images that we would not likely have come across otherwise. The committee favoured two explanations, which are available on the website below.

As a research exercise the project was, I think, quite successful, both in providing novel ideas and information, and in reassuring us that we were not missing the obvious. We are planning to write up the rings in the coming months and to discuss the crowdsourcing adventure in the article, but please feel free to check out <**http://ringmaster.cs.ucr.edu/Rings.html**> and to send any thoughts on the origins of the structures that you might yet have!

Nigel Hughes
University of California, Riverside

Underwhelming Fossil Fish of the Month, or how to get some use out of your useless fossils

It is probably a fair assumption that if you're reading this you know the value of the multimillion strong collection of fossils in museums, universities and other scientific institutions. If pushed you would no doubt espouse that fossil collections are the unique collected history of life on Earth and their accessibility, study and scrutiny informs us about evolution, the location of fossil fuels, extinction, climate change, adaptation, engineering and architecture. Without palaeontology civilisation wouldn't be the way it is today. This is why fossil collections are important and should be maintained, supported and added to. Cue rapturous applause…

A niggling truth

However, for those of us who manage palaeontological collections there's a niggling truth: all of the above is true for probably <1% of palaeontological collections. Yes the mammal, reptile, Lagerstätte and type collections may see a steady flow of researchers year on year. Of course, there's a tiny fraction of collections on display in museums (arranged geographically and chronologically of course) and there may be a boxful of ammonites and trilobites in teaching and handling collections. But it's a drop in the ocean. The rest of the material, the stratigraphic series – the endless drawers of gastropods, echinoderms, fish and ammonites *etc*. – remain largely unused.

Of course, charged with preservation for perpetuity we shouldn't take the short term view, but how many of these fossils haven't been accessed in the last two years? The last five? The last 20? The last 100?! Their lot is unlikely to improve either. Charged with managing hundreds of thousands or millions of fossil specimens, a high proportion of which were collected before modern museum information management standards, most museums have a huge documentation backlog. It isn't sensible to use tight museum resources on documenting hundreds of drawers of graptolites in the speculative hope that 'if you document it, they will come,' and with the pressure to prove impact with every funding grant it's better to focus resources on the specimens that are in high demand. So the cycle continues, the unused material isn't documented because it isn't used and it isn't used because it isn't documented and is therefore inaccessible.

The world needs another dinosaur researcher

Occasionally, a once-in-a-generation salmon swimming upstream will decide to specialise in an understudied group, invertebrates if they're particularly career-averse, and for a small time the 'useless' specimens become the most important specimens in the world, if they can be located in the first place. The media love a 'discovered in a dusty drawer' story, inadvertently highlighting a history of curatorial neglect, then the celebrated specimen is destined to return to a drawer for another hundred years of obscurity. There's also the sad fact that most stored fossil collections just aren't very interesting. The three-dimensionally preserved, complete, soft tissue specimens associated with an important name are cherry-picked for public display. The majority of fossils

in institutions, however, are the dregs; partial pygidia, a section of shell, an isolated whorl, half a head shield and countless drawers of 'vertebrate ribs'.

I've had the great privilege of going around many amazing museum storerooms, but even my eyes start to glaze over at the fifth drawer of brachiopods. These aren't the fossils that will sell exhibition tickets, shift lunch boxes or make headlines. Lastly there are then the dregs of the dregs: the specimens with no data. With a strictly myopic scientific view these specimens are useless. At best they might be put to a couple of years use in a handling collection. At worst they're destined straight for the bin during the next downsize, not passing through proper museum disposal procedures because that's a time-absorbing exercise and they 'aren't accessioned anyway'.

The power to underwhelm

It was with these thoughts in mind that I approached the fossil collections in my care at the Grant Museum of Zoology at UCL. The Grant Museum isn't a huge collection, but it has a history of using recent and fossil specimens in teaching and research. The largest portion of the fossil collection at the Grant Museum is the fossil fish collection of former curator and vertebrate palaeontologist David Meredith Seares Watson. Although Watson quite literally wrote the book on fossil fish, the collection is particularly unexceptional, with the better specimens having been transferred to other institutions and the majority of the remainder likely to be found in any other fossil fish collection. In recent years a handful of researchers have requested access to the collection, in particular an important group of *Millerosteus* specimens, but how could this collection be exploited in between rare research visits and with virtually no potential for display? This is when I turned the usual museum notion of celebrating collections on its head. These fossil fish aren't particularly interesting and that's what is uniquely interesting about them. This was the birth of the monthly blog series on UCL Museums and Collections blog, *Underwhelming Fossil Fish of the Month*. Rather than try to directly evangelise about fossils which, at best, are of very very niche interest, the attempt was to make fossil fish engaging to a wider audience by having a bit of fun emphasising how uninteresting they are, questioning why museums have row after row of material like this and not neglecting to slip some science content in there at the same time.

The format is simple, each month I search the collection for an especially unremarkable specimen and then write about its preservation, research value and impact upon society (or lack thereof across the board). Often in the process I need to identify, document and digitise the specimen, improving the catalogue information about it, which at a rate of twelve specimens a year isn't exactly making a dent in the backlog but it's progress nonetheless. Many of the species featured are otherwise invisible on the Internet. These aren't the fish with beautiful artistic reconstructions, verified entries in taxonomic databases or even a Wikipedia stub page. Almost without fail, though, I find a surprising titbit about the specimen itself or the history of palaeontologists who have worked on the group that wouldn't have been associated with these specimens otherwise.

At the time of writing there have been 31 underwhelming fossil fish of the month, including such highlights as: a specimen of *Diplacanthus striatus* that D.M.S. Watson may have looked at once (<**https://blogs.ucl.ac.uk/museums/2012/12/13/underwhelming-fossil-fish-of-the-month-december/**>); the interesting fact that *Psammodus rugosus* teeth resemble paving slabs

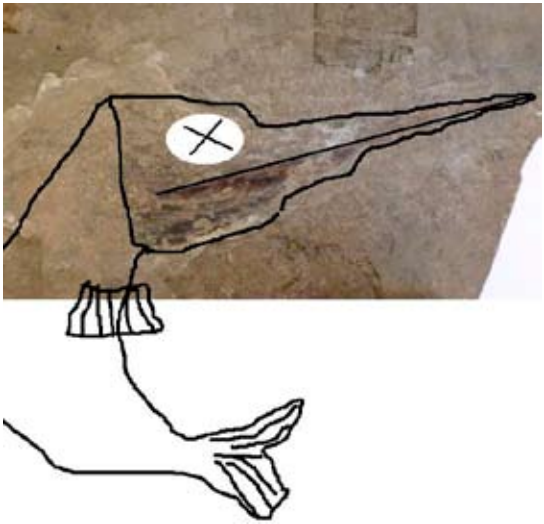
(<**https://blogs.ucl.ac.uk/museums/2013/07/30/underwhelming-fossil-fish-of-the-month-july/**>); the struggle of James Murray, the primary editor of the Oxford English Dictionary to keep *Ceratodus* in the dictionary (<**https://blogs.ucl.ac.uk/museums/2013/11/22/underwhelming-fossil-fish-of-the-month-november-2013/**>); a particularly special specimen of *Cheiracanthus* that resembled a Rorschach inkblot after some photo manipulation (<**https://blogs.ucl.ac.uk/museums/2014/01/30/underwhelming-fossil-fish-of-the-month-january-2014/**>); and this specimen of *Dapedium* which bears a striking resemblance to Godzilla.

Uncanny isn't it? On the left we have the beast, the legend, the scourge of Tokyo, GODZILLA! On the right we have, ahem… LDUCZ-V1508 Dapedium *sp.*
Photo by Mark Carnall, used with permission of Grant Museum of Zoology.
Image from <**photobucket.com**>.

Often it is hard to generate enough content from the scientific literature so there are a range of special features and formats to try to keep the reader awake, such as: find the fossil fish (inspired by spot the ball competitions), the ever popular what does the back of this specimen look like?, what's in the box?, why was there Sellotape here? and highly popular low-resolution close-ups of interesting areas taken with a perpetually disappointing but affordably inexpensive USB microscope (recently back by popular demand). Other filler content includes commentary on poor fossil documentation practice like writing a now-outdated identification in permanent black marker on the front of the specimen as well as fan fiction about the heydays of fossil fish research at the 1950s Stockholm School and even full screenplays such as *Rhamphodopsis: The little ptyctodontid that almost made* it, reproduced here in full:

> ***Rhamphodopsis: The little ptyctodontid that almost made it***
>
> Lewis Carroll sits opposite his editor who is finishing reading through the manuscript of *Alice's Adventures in Wonderland.* Everyone is smoking. Lewis Carroll's editor looks up from the manuscript, takes off his glasses and addresses Lewis: "It's good Lewis but this *Rhamphodopsis* character…"
>
> "Yes it's bloody awful, I'll change it to a dodo or something" Lewis offers casually.
>
> "Yes. That's a good idea" reflects his editor.
>
> **THE END**

Many of the fossil fish featured are incomplete specimens of species which don't have off-the-shelf reconstructions to help bring the animals to life. Fortunately, I have help from an up-and-coming young palaeoartist who is a wizard with computer-generated graphics to bring the fish off the page, such as this reconstruction of *Acidorhynchus acutus* superimposed over the specimen of the head and snout:



A very poorly-realised reconstruction of fossil fish specimen LDUCZ-V1523, Acidorhynchus acutus*. These expert reconstructions have been really popular with the readers and the palaeoartist involved now receives a number of commissions for Hollywood film work. Photo by Mark Carnall, used with permission of Grant Museum of Zoology.*

Feedback

The blog series receives a good number of hits, with over 20,000 page views to date, and regularly features as one of UCL Museums and Collections blogs' top-read blogs per quarter. Feedback from readers has been overwhelmingly positive and generated the kind of interactions you'd be hard pressed to generate from the usual specimen-based content celebrating the first, oldest, biggest, newest animals and specimens. On one particularly handsome specimen of *Hoplopteryx lewesiensis* a reader was moved to comment "It's so far from underwhelming that I am considering returning from Hanoi simply to throw my knickers at it, screaming". It was preserved in 2.5 dimensions so it's an understandable reaction and a low in the series in the underwhelming stakes. Another comment I've cherry-picked to quote is "I'd just like to say that this underwhelming series is, by a long way, the best thing I read on the Internet each month and fills me with joy. Good work. And MORE!!!". Why stop there? Here's more anecdata: "…this is basically the best idea for a museum blog I've ever seen. I can't wait to be underwhelmed again next month!!". However, the last word on a positive reception and fulfilling the aims of this blog series to inspire people about fossil fish must be left to commenter *Anon* who responded to the challenge to make a word rhyme with the porolepiform genus *Glyptolepis:*

Of *Glyptolepis leptopterus*
Nobody ever made a fuss.
That long-gone porolepiform
Endured a myriad ancient storms.
Compared with Devonian Scottish sea
How dreary now its death must be.
A nodule as its crypt of sleep is.
Pity poor old *Glyptolepis*.

UFFotM: The Stage Show

The influence of the blog as a method for using collections in museum social media has been far and wide and well beyond the palaeontology or natural history museum communities. Various museum blogs, including the National Archives blog, point to underwhelming fossil fish as a successful way of creating collections-focused content, especially around lesser known parts of collections (<**http://blog.nationalarchives.gov.uk/blog/please-do-not-boil-the-archives/**>). The blog also gets mentioned a lot at various conferences on museums and social media, with twitter notifications and web hits spiking whenever it gets a name check. There have also been a number of indirect uses of the blog series. Unbeknown to the Grant Museum staff at the time, underwhelming fossil fish of the month had been set as a case study for UCL Geography students to comment on in science communication coursework, and I was asked to do a stand-up set on underwhelming fossil fish for open mic night Museums Showoff as part of the Bloomsbury Festival. I've received a number of offers to write underwhelming content for other websites and glossy magazines, and most recently I was asked to write this article for the PalAss *Newsletter*. There are rumours of an Official Underwhelming Fossil Fish of the Month Calendar and the format is only a few entries away from having enough content for a full Top Trumps deck.

Overall, the series has been very successful at creating a buzz and an interest around fossil collections which traditionally would have been seen as useless or unusable for public engagement or science communication, a factor that's particularly pressing as museums and other institutions are once again under pressure to justify their space and resources and some collections don't come out well in terms of having a 'wow factor'.

I was very pleased to be asked to write for the Palaeontological Association, as the seed of this idea has its roots in when I first became a member. Many years ago, when I first joined, members were sent a pack of palaeontological postcards featuring brachiopods, bivalves and coral. The postcards, which I still have, are so brilliant and at the same time so very dull, but it's here that the origins of underwhelming fossil fish lie and this poem taken from October 2014's blog post is in honour of the inspiration:

Fragments of My Fossil Drawer
The long bits could be ribs
The square bits could be skull
As an assortment with a number
These fragments are quite dull

Mark Carnall
Grant Museum of Zoology

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

XIII Annual Meeting of the European Association of Vertebrate Palaeontologists
Opole, Poland *8 – 12 July 2015*

This meeting will follow the general objectives of the Association to promote and encourage communication and collaboration, as well as to bring together the vertebrate palaeontology community of Europe through the organisation of such a meeting in a different country every year. Delegates are invited to provide oral and poster presentations that cover all aspects of vertebrate palaeontology.

For further information please see the conference website at <**http://www.eavp2015.uni.opole.pl/**>.

12th International Symposium of Antarctic Earth Sciences (ISAES)
Goa, India *13 – 17 July 2015*

The International Symposium of Antarctic Earth Sciences (ISAES) in Goa, India, has several sessions relevant to palaeontologists. In particular, session 20 “Break up of Gondwana and Vertebrate evolution” and session 21 “Key drivers of Antarctic biodiversity through the Cenozoic: the influence of climate, oceanography and tectonics”.

For further information please see the conference programme: <**www.isaes2015goa.in/program.php**>.

STRATI2015: 2nd International Congress on Stratigraphy
Graz, Austria *19 – 23 July 2015*

The Congress is open to all topics in stratigraphy. The technical programme will range from the Archean to the Holocene, cover all techniques and applications of stratigraphy, and discuss discoveries that the stratigraphical record reveals about the Earth system. In addition, it will serve as the primary venue for International Union of Geological Sciences (IUGS) business, for International Congress on Stratigraphy (ICS) sub-commissions, and for the award of ICS stratigraphy prizes.

There will be a range of pre- and post-conference field-trips and a variety of social activities will be offered. Funds will be available to support travel expenses for students. Application information will be posted on the Congress website.

Please see the website for more details where registration is now open: <**http://strati2015.uni-graz.at**>.

5th Polar Marine Diatom Workshop
Salamanca, Spain *19 – 24 July 2015*

The Polar Marine Diatom Taxonomy and Ecology Workshops represent a community-led initiative to provide international polar diatom researchers with an opportunity to interact and discuss topical issues and new results that bear on recent and future research activities in the polar regions. Workshops have a strong focus on the Neogene to Recent time period and on taxonomic issues toward standardization of terminology and identifications. Workshops are interactive with dedicated microscope-based taxonomy sessions.

Workshops allow students and early career researchers to interact with, and receive training and advice from, leaders in the field and, as such, researchers at all stages of their careers are encouraged to attend.

Please check the website for updates (<**www.polarmarinediatomworkshop.org**>) or e-mail María Angeles Bárcena for more information (<**mbarcena@usal.es**>).

12th Symposium on Mesozoic Terrestrial Ecosystems
Shenyang, China *16 – 20 August 2015*

This Symposium will focus on a series of scientific sessions presenting research progress on Mesozoic terrestrial ecosystems. Besides the usually fantastic MTE meeting, this is a great opportunity to see the field sites of the spectacular Early Cretaceous Jehol biota and Jurassic Yanliao biota. Field-trips will go to western Liaoning, including Beipiao (sites of *Sinosauripteryx* and the earliest known angiosperm *Archaefructus*) and Jianchang (*Anchiornis* site).

Please see the website for more information: <**http://www.pmol.org.cn/MTE-12/**>.

Systematics Association Biennial Meeting
University of Oxford, UK *26 – 28 August 2015*

This three-day meeting will take place in The University Museum of Natural History and the Department of Zoology, with accommodation available in historic Christ Church College.

There is an exciting programme including both plenaries and thematic symposia, as well as contributed sessions. Scheduled symposia include:

- The value of long-term monitoring plots for plant systematics and ecology in the tropics
- Comparative approaches to the origin of biodiversity
- Accelerating the pace of taxonomy
- Rooted in deep time: Palaeontological contributions to systematics

Abstract submissions for contributed talks and posters are open until 1st July 2015.

Please check the Systematics Association website at <**http://systass.org/biennial2015/**> for updates.

Flugsaurier 2015, The International Meeting of Pterosaurology
University of Portsmouth, UK *26 – 28 August 2015*

In 2015, Flugsaurier, the International Meeting of Pterosaurology, will be held in the UK for the first time. Flugsaurier 2015 will be held at the University of Portsmouth in conjunction with the Symposium of Vertebrate Palaeontology and Comparative Anatomy to be held afterwards in Southampton. A pre-conference field-trip is planned for 25th August to the Isle of Wight, including the Dinosaur Isle Museum.

Please see the meeting website for more information: <**http://flugsaurier2015.com/home.html**>.

The Annual Symposium of Vertebrate Palaeontology and Comparative Anatomy & Symposium of Palaeontological Preparation and Conservation with the Geological Curators' Group (SVPCA and SPPC/GCG)
National Oceanography Centre, Southampton *31 August – 4 September 2015*

Registration for the 2015 SVPCA and SPPC/GCG is now open. The deadline for registration and abstract submission is Friday 24th July.

The meeting will be preceded by Flugsaurier 2015 (to be held in Portsmouth). Pre-conference field-trips are planned, in conjunction with Flugsaurier, to visit the famous Jurassic coast in Dorset on 29th August. A post-conference field-trip on 4th September to the Isle of Wight will follow the formal SVPCA sessions, with visits to key Wealden localities including Brook Bay.

Please visit the SVPCA website for updates and to register for either, or both, of the symposia, at <**http://svpca.org/years/2015_southampton/index.php**>.

Climate impacts, ecosystems and evolution – from deep time to the future
Durham University, UK *3 – 6 September 2015*

This multidisciplinary conference will be both inclusive and substantive, involving biologists, geologists, geographers and palaeontologists, addressing research questions over different timescales – decadal, multi-decadal, millennial or tens of millennia to millions of years in deep time.

The Conference will provide a unique platform to present a range of research cultures and topics linked to the common challenges of understanding the impact of climate change on ecosystems throughout geological time.

The Conference is held in association with the Climate Impacts Research Centre and will be hosted at Van Mildert College, Durham University.

Registration is now open, please visit <**www.dur.ac.uk/circ**>.

21st International Cave Bear Symposium
Leiden, Hellevoetsluis & Rotterdam, The Netherlands *9 – 13 September 2015*

The focus of this Symposium is on all aspects of Pleistocene carnivores, from anatomy and taxonomy to ancient DNA and isotopes. The Symposium includes a field-trip and visits to several important collections.

Please see the website for further information: <**http://icbs2015.pleistocenemammals.com/**>.

Advanced Course in Jurassic–Cretaceous–Cenozoic Organic-Walled Dinoflagellate Cysts
Heidelberg, Germany *13 – 19 September 2015*

The course will focus on morphology, stratigraphy and palaeoecology. An excursion will take you to the UNESCO World Heritage site at Lake Messel quarry, an Eocene lake deposit. Following the course there will be a special workshop in which the latest developments on Arctic and Nordic dinocyst biostratigraphy will be presented.

Please see the website for further information: <**www.lpp-foundation.nl**>.

For pre-registration e-mail your name and affiliation to <**info@lpp-foundation.nl**>.

The Interaction of Fire and Mankind – a Royal Society discussion meeting
London, UK *14 – 15 September 2015*

The complex interrelationships between fire and mankind transcend international borders and disciplinary boundaries. The spectre of climate change highlights the need to improve our understanding of these relationships across space and time. This meeting will examine historical, evolutionary and biophysical tensions inherent in the fire-climate-society nexus to advance the international, interdisciplinary science necessary to address contemporary and future fire challenges.

The meeting is free but registration is essential, at <**https://royalsociety.org/events/2015/09/fire-and-mankind/**>.

For any other information, please e-mail <**discussion.meetings@royalsociety.org**>.

RALI 2015: an international conference on the Rise of Animal Life: Cambrian and Ordovician biodiversification events
Marrakesh, Morocco *5 – 9 October 2015*

More than 500 million years ago the emergence of animals marked a turning point in the evolution of life on Earth, giving rise to present-day biodiversity and ecosystems. This international conference will focus on this crucial event, especially its timing, possible processes and causes, with special emphasis on the relationships between the Cambrian Explosion and the subsequent Great Ordovician Biodiversification Event.

The Conference will be held in the captivating city of Marrakesh, offering an ideal setting for this scientific gathering. A special symposium dedicated to aspects of promoting geological heritage will be held in conjunction with the Conference and will highlight associated educational, cultural and socio-economic issues.

A post-conference field-trip offers participants the opportunity to visit fossil localities near Zagora, where the Lower Ordovician Fezouata Biota was discovered.

For more information see <**http://www.fstg-marrakech.ac.ma/rali2015/**>.

SVP 75th Annual Meeting
Dallas, USA *14 – 17 October 2015*

The 75th anniversary meeting of the Society of Vertebrate Paleontology will be held in Dallas, Texas, USA. The Conference will cover all areas of vertebrate palaeontology, including fish, tetrapods, amphibians and many more related topics.

Registration is now open, see <**http://vertpaleo.org/Annual-Meeting/Home.aspx**> for details.

7th International Conference on Fossil Insects, Arthropods and Amber
National Museum of Scotland, Edinburgh *26 April – 1 May 2016*

Registration is now open for this Conference on the scientific study of non-marine arthropods and amber. The Conference is usually held every three years and this is the first time that it will be held in the UK. It comprises a Reception at the Royal Society of Edinburgh, three days of lectures at the National Museum of Scotland (Edinburgh) and two optional days of field-work to Palaeozoic non-marine arthropod sites.

To be added to the mailing list and receive the Second Circular with instructions on how to register, please e-mail Dr Andrew Ross (<**a.ross@nms.ac.uk**>).

4th International Congress on Ichnology (Ichnia 2016)
Idanha-a-Nova, Portugal *6 – 9 May 2016*

Ichnia 2016 is jointly organised by the International Ichnological Association, the Geopark Naturtejo da Meseta Meridional, UNESCO Global Geopark, and the National Museum of Natural History and Science of the University of Lisbon. Pre-, intra- and post-congress field-trips are proposed to ichnosites throughout the Iberian Peninsula.

Oral and poster presentations are both welcome! Ichnia 2016 call for abstracts opens on 15th August 2015; for details see <**http://ichnia2016.org/**>.

6th Symposium on Mesozoic and Cenozoic Decapod Crustaceans
Villers-sur-Mer, France *14 – 18 June 2016*

The Symposium will be held at the Paleospace-l'Odyssee, Museum of Palaeontology and the cinema, both located in the centre of Villers-sur-Mer. Poster and oral presentations will be followed by field-trips to the Callovian–Oxfordian cliffs of the "Vaches Noirs", Bajocian stratotype and Bathonian Confessionnaux; parts of the Normandy landings locations, a trip to the Cenomanian hard-grounds of Petreval, and the Etretat cliffs which attracted Courbet and Monet. English and French will be the official languages of the Conference. Talks will be 30 minutes long including discussion. The area is popular with tourists, so accommodation should be booked early.

Please contact the organiser, Sylvain Charbonnier (e-mail <**scharbonnier@mnhn.fr**>) for the First Circular, which includes more details about the venue and Symposium. Registration deadline: 1st September 2015.

Palaeo Down Under 2 (PDU2)
Adelaide, Australia *11 – 15 July 2016*

Australasian Palaeontologists cordially invites all palaeontologists from Australia, New Zealand and around the world to participate in PDU2 in Adelaide, South Australia, in the first half of July 2016. A full conference programme is proposed, covering all aspects of palaeontology and associated disciplines. Dedicated symposia on the Ediacaran and Cambrian systems will be a highlight of the programme, under the auspices of the respective International Subcommissions on Stratigraphy, focusing on recent rapid advances in our understanding in these areas. The Conference will include guest keynote lectures, general and thematic sessions, symposia and posters.

The Conference will be preceded by a field excursion to Ediacaran and Cambrian fossil localities in the renowned Flinders Ranges to the north of Adelaide, and will also feature the Emu Bay Shale Konservat-Lagerstätte on Kangaroo Island, south of Adelaide. A half-day mid-conference

field excursion will be arranged to a location of international geological interest in the vicinity of Adelaide. A post-conference camping-style excursion to Mesozoic and/or Cenozoic fossil localities in the arid Lake Eyre Basin is under consideration, pending number of interested participants.

For further information, please see the conference website: <**http://aap.gsa.org.au/PDU2.html**>.

9th International Meeting of the Society of Avian Paleontology and Evolution
Diamante, Argentina *1 – 5 August 2016*

The meeting will be hosted by and held at the Centro de Investigaciones Científicas y Transferencia de Tecnología a la Producción de Diamante (CICYTTP-CONICET).

The First Circular and the Registration Form will be available in the near future at: <**www.cicyttp.org.ar/sape2016.html**>.

14th International Palynological Congress and the 10th International Organization of Palaeobotanists Congress (IPC XIV/ IOPC X 2016)
Salvador, Brazil *late September – early October 2016*

Local organizers are planning the Congress to occur after the Olympics in Brazil. Further details to come.

DINO11
EPOC Laboratory, Bordeaux University, Bordeaux, France *2017*

Further details to come.

Please help us to help you! Send announcements of forthcoming meetings to <**newsletter@palass.org**>.

Meeting REPORTS

Progressive Palaeontology
University of Bristol, UK *9 – 11 April 2015*

Progressive Palaeontology is an annual PalAss-supported conference, organised by students to help young palaeontologists meet and hone their presenting skills. The University of Bristol's large and highly successful Palaeobiology group recently moved into the University's brand new Life Sciences building, and this was shown off to full-effect on the evening of the 9th with an icebreaker reception held in the rooftop tea-room, the dramatically-named Sky Lounge. The open-air terrace's view across Bristol provided a striking backdrop to eating, imbibing, and mingling. Proceedings eventually moved to the pub, and then home, ready for Friday's full day of talks and posters.

The Conference was introduced by **Mike Benton** with a brief talk taking us through the history of palaeobiology research at Bristol. This was followed by the first session, on Diversity and Ecology. These talks covered a range of macroevolutionary topics, mainly mammalian, but with some crocodyliforms, Triassic tetrapods and marine invertebrates thrown in for good measure. Second came the Early Vertebrate Evolution session, which whizzed us through the history of the vertebrate clade. A strikingly wide range of techniques was employed to uncover this history, from oxygen isotope analyses to computed tomography.

After lunch the third session brought us the lightning talks, a format introduced at last year's conference, which limit each talk slot to an all-too-brief five minutes. Despite this challenge, an impressively large amount of information was crammed into each slot. Posters followed, accompanied by coffee, and they covered a wide range of topics. The final session of the day was Taphonomy, Taxonomy, and Evolution, encompassing everything from the description of Transarctic lophotrochozoans to the cranial biomechanics of ornithischian-like crocodylomorphs. All talks can be watched on the Palaeocast website, at <**http://www.palaeocast.com/progpal15/**>.

Assembled delegates at the end of Friday's talks. Photo courtesy of Dave Marshall.

Once the day of talks had ended, we decamped to a nearby restaurant for the conference dinner. During dinner, prizes were presented for the winning talks and posters. The prize for the best full talk went to **Caitlin Colleary**, who used state-of-the-art mass spectrometry to characterise the taphonomy of melanin in the fossil record. The prize for the best lightning talk went to **Virginia Harvey**, who is using sub-fossils in pristine cave systems on Cayman Brac to reconstruct the faunal impact of humans on the Cayman Islands. **Fiann Smithwick**, who sought to understand the transition of the Actinopterygii over the Triassic–Jurassic boundary using morphometric techniques, received the best-poster prize.

Following the prize-giving came the first ever Progressive Palaeontology auction, which aimed to raise money for a travel fund to help delegates to attend next year's conference. The inimitable **David Button** hosted the auction, clad (slightly confusingly) in a judge's wig, and wielding a gavel with wild abandon. Lots included various signed books, some beautiful palaeoart prints, a range of hand-painted palaeontological mugs, and an enigmatic mystery box. Perhaps the highlight was the improbably intense bidding war over a larvikite slab, which was eventually sold for a princely sum. All in all the auction was a great success, and raised £708 for next year's travel fund!

Bright and early the next morning we embarked on the field-trip, featuring an impressively varied range of localities near Bristol. We started off below the cliffs at Aust, on the shores of the Severn Estuary, which is known for its Rhaetian (Late Triassic) fish remains. Many fish scales were found, as well as a possible crocodile tooth and an indeterminate reptile bone. We then crossed the Severn and headed north for the second site, the Silurian Usk inlier in south-eastern Wales, featuring typical Silurian shelly fauna. In addition to brachiopods aplenty, fragmentary trilobites (including some pygidia) and corals were also found.

Delegates looking for Silurian shelly fauna at the second field site, the Usk inlier. Photo courtesy of Joe Keating.

By this point lunch was overdue, and we stopped in to a nearby pub for some excellent pies and beer before progressing on to the final site, Craswall, in the Brecon Beacons. Craswall is an Early Devonian locality comprising material from a disused quarry, and features disarticulated vertebrate remains as well as arthropods and vascular plants. Some jawless "ostracoderm" vertebrates were found, in the form of a number of disarticulated heterostracan headshields. However, invertebrates stole the show with the discovery of a large pterygotid eurypterid coxa by **Dave Marshall**.

Exploring the Lower Devonian at Craswall, the third field site, with pterygotid eurypterid coxa part and counterpart on right. Photos courtesy of J.J. Hill and Dave Marshall.

This brought an end to the field-trip: it was a very enjoyable day out with remarkably clement weather. Many thanks to the organising committee for doing such a good job arranging the Conference, and I look forward to next year!

Richard Dearden
Imperial College London

Lyell Meeting 2015: Mud, glorious mud, and why it is important for the fossil record
Burlington House, London, UK *11 March 2015*

Preservation! Preservation! Preservation! Palaeontologists, whether amateur enthusiast or professional scientist, are looking for the best specimens possible. In the case of the researcher this is to provide the clearest, most unaltered view of the evolution and the impact of life on Earth's history. The common experience of all fossil hunters is that the best preservation most often occurs in clay facies, or 'mud'. This year's Lyell Meeting considered this association across the broad spectrum of disciplines and interests that are encompassed, or informed, by palaeontology (Figure 1). Presentations considered the full gamut of possible organisms from vertebrates to nannofossils, whether mineralised or not. They took in the full time scale from the Neo-Proterozoic to the Quaternary. All this provided the platform to discuss the evolution of life, palaeobiology, palaeoecology, palaeoclimatology, extinction events, climate change, and taxonomy, utilising evidence that is best derived from 'muds'.

Figure 1. a) Delegates view the posters in Burlington House. Photo courtesy of William Gosling. b) Bositra radiata*, an opportunistic bivalve that survived the environmental change associated with the onset of the Toarcian Oceanic Anoxic Event, now interred in mud. Photo courtesy of Angela Coe.*

Of course, evidence of the fossil record is observed in other facies, but only clays, or mud, provide a level of preservation that allows the palaeontologist to properly study and discuss ancient life on Earth with a minimum of assumptions and provisos. The Konservat-Lagerstätten and their associated exceptional preservation were widely referenced from the classic Cambrian Burgess Shale (**Derek Briggs**, Yale University) to the Eocene Messel oil shale (**Derek Briggs** and **Volker Wilde**, Naturmuseum Senckenberg). However, others considered a wide range of different clay sequences that provided invaluable fossil preservation for giving views into ancient worlds. They suggested that maybe, if investigations were focused on the right deposits, the preservation was not so much 'exceptional', but 'exquisite' (as suggested by **Samantha Gibbs**, University of Southampton).

So what constitutes 'exquisite' preservation, and how is it invaluable to palaeontologists? The preservation of soft parts is the most obvious case, and provides insights into palaeobiology that would otherwise have to be surmised, such as fossil colours (**Derek Briggs**) and musculature (**David Martill**, University of Portsmouth). 'Exquisite' preservation can also refer to the organic remnants of organisms without mineralised components that would otherwise not be expected to be observed in the fossil record, and this provides a greater insight into ancient environments, communities, and evolution (**Ross Anderson**, Yale University and **John Marshall**, University of Southampton). However, although these unexpected preservational events are most commonly referred to as exceptional preservation, there are also other forms of preservation that are invaluable to palaeontologists from mineralised fossils.

Mineralised fossils are the most commonly found fossils, but invariably they are flattened, crushed and mineralogically altered. 'Exquisite' preservation therefore also encompasses 3D preservation, as observed in trilobites from Scandinavia (**Euan Clarkson**, University of Edinburgh; Figure 2a) and Jurassic vertebrates from the Kimmeridge Clay (**David Martill**). Mineral preservation, especially aragonite, is important as it indicates that most of the biomineralised palaeofauna is preserved and that the whole of the skeleton/shell is preserved, especially in bimineralic organisms (**Paul Taylor**, Natural History Museum, London; Figure 2b). This has important implications

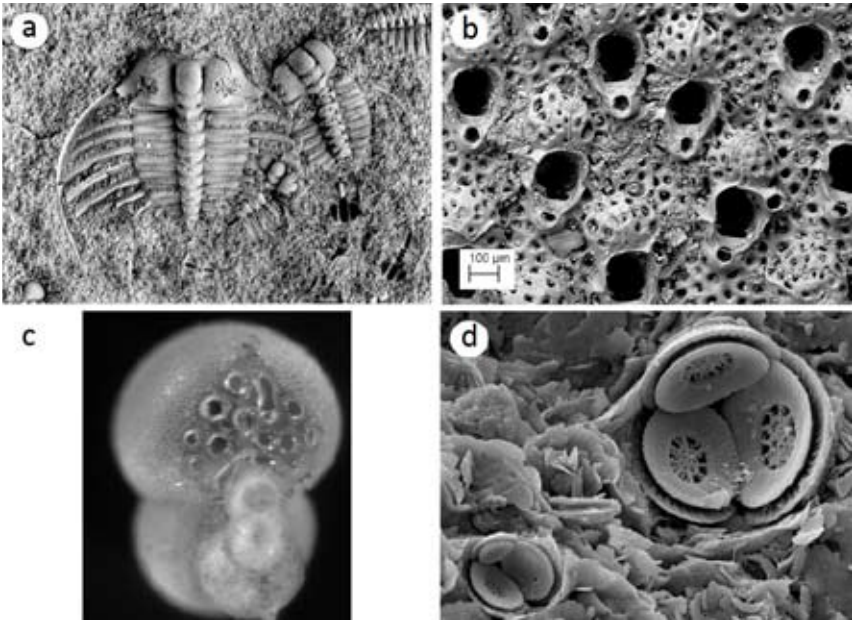


Figure 2. a) spiny Ctenopyge rushtoni*, preserved in 3D, Upper Cambrian (Furongian) Alum Shales, Sweden (image courtesy of Euan Clarkson); x6. b) fossil bryozoa* Hippodiplosia strangulata *Canu and Bassler, Oligocene, Bucatunna Fmn, Sylvarena, Mississippi (image courtesy of Paul Taylor); scale bar is 100µm. c) fossil foraminifera* Cribrohantkenina inflata*, Early Eocene, Tanzania (image courtesy of Paul Pearson); x24. d) coccolithosphere from the PETM, Bass River, New Jersey (image courtesy of Paul Bown and Samantha Gibbs); x3000.*

with regards to palaeobiology (for example trilobite ontogeny (**Euan Clarkson**; Figures 3a-b)) and palaeoenvironments. 'Exquisite' preservation is also very important for geochemical analyses, as any form of alteration can lead to environmental proxies within the mineralised shells and test being overwritten by diagenetic signals (**Paul Pearson**, Cardiff University; Figure 2c).

This retention of environmental proxies in the shell is of particular importance in micro- and nannofossils, which are becoming increasingly important as palaeoceanographic and palaeoclimate indicators. This is not just important for such things as foraminifera (**Alice Kennedy**, The Open University and **Paul Pearson**) and coccolithophores (**Samantha Gibbs**; Figure 2d), but also for spores (**William Gosling**, University of Amsterdam and **Luke Mander**, University of Exeter) and organic carbon components (**Crispin Little**, University of Leeds, **Jan Hennisen**, BGS and **John Marshall**). The better preserved the specimens or organic component of the sediment within a stratigraphically well-constrained sequence, the more can be garnered from the data derived.

All of these forms of 'exquisite' preservation are predominantly interred in clays and muds. Why is this? 3D preservation is most likely in less compacted sediments, which is not necessarily clast size-dependent. Dissolution is less likely due to point contacts (**Paul Taylor**), plus early diagentic mineralisation, such as phosphatisation and pyritisation, of the fossil appears more likely in clays under certain conditions. This may be linked to impermeability of the sediment and low oxygen

levels (with associated lack of bioturbation) that can also lead to soft part and organic matter preservation. Conversely, the impermeability can also lead to the preservation of pristine shell mineralogy with no later mineralisation (**Paul Taylor** and **Paul Pearson**; Figures 3c-f), with the shell material being isolated from diagenetic pore waters. The reasons why clays preserve the fossils so well would therefore seem to be complex, and dependent on factors that vary slightly between different 'exquisite' preservational deposits. However, what we can say for certain is that they are all associated with muds, which are organic matter traps and faunal magnets (**Nick McCave**, University of Cambridge) and, as such, it is within these fine-grained deposits that we should continue to search for our clues to ancient life and environments.

Robin Knight
Chatham, Kent

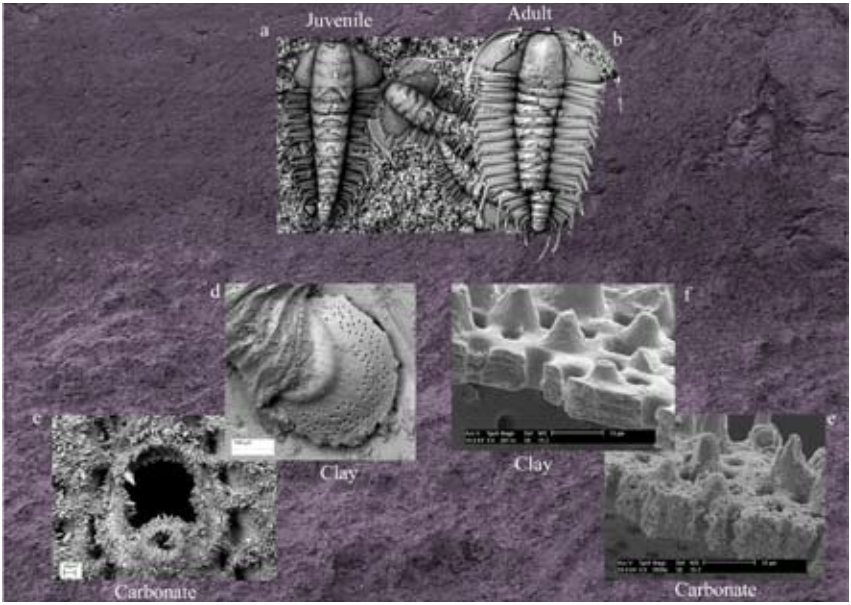


Figure 3. Background: Albian, Gault Clay Formation, Folkestone. a–b, preserved ontogeny of Parabolina*, Upper Cambrian (Furongian) Alum Shales, Scania, Sweden, images courtesy of Euan Clarkson; a) juvenile, magnification x4.5; b) adult, x1.2. c–f show excellent preservation in clay compared to carbonate. c) Calcite cement obscures the outline of the primary orifice and suboral avicularium in a fossil bryozoan; scale bar is 20µm. d) Preservation of pseudopores in the fossil bryozoan* Diaperoecia purpurascens*; scale bar is 100µm (images c–d courtesy of Paul Taylor). e) Poorly preserved Early Eocene foraminifera* Morozovella *from ODP site 865; scale bar is 10µm. f) Well-preserved Early Eocene foraminifera* Morozovella *from Tanzania; scale bar is 10µm (images e–f courtesy of Paul Pearson).*

Moray Geology: Past, Present, Future at Elgin Museum
Moray College, University of the Highlands and Islands, and Elgin Museum, UK
21 – 22 March 2015

In March the Elgin Museum hosted a celebration of its Scottish Government Recognised Collection of Devonian fish, Permian and Triassic reptiles and Permian trackway fossils, all collected locally from quarry, river and coastal sites in the early to mid-nineteenth century. The event, marking the completion of a year-long project to inventory and organise the Collection, was held at the Alexander Graham Bell Centre lecture facilities of Moray College and at the Elgin Museum. Financial support, gratefully received from the Palaeontological Association (meeting support), Geologists Association (Curry Fund) and Museums Galleries Scotland (Recognition Fund), was crucial for the success of the event.

The plenary session, attended by over 80 delegates, began with an overview of the Museum, the fossils it houses, and associated local and international figures, from Prof. **Nigel Trewin** (University of Aberdeen). **Bob Davidson** (University of Aberdeen) described the various types of Devonian fish from the Moray Firth area, notably those from Tynet Burn, and the predominance of preservation in carbonate nodules. **Nick Fraser** (National Museum of Scotland) moved the topic on a few hundred million years with a talk on the types of reptiles present in the Triassic, specifically the 'Elgin reptiles' and their significance in the transition from a mixture of bizarre earlier reptile forms to those more recognisable today. Prof. **Mike Benton** (University of Bristol) concluded the morning session with a review of our current understanding of the origin of dinosaurs, focusing on *Saltopus*, a Triassic reptile from Lossiemouth on the Moray Coast, now considered a dinosauriform rather than a dinosaur in the strictest sense.

The afternoon session began with **Sue Beardmore** (Elgin Museum) describing the process of re-organising the Scottish Government Recognised Collection at Elgin Museum, including

Delegates at the Alexander Graham Bell Centre, Moray College, University of the Highlands and Islands. Photo by James Welsh.

improvements regarding access, specimen location and storage. **Alison Wright** (Highland Geology Society) then highlighted the problem of sandstone degradation in variable weather conditions and as a result of lichen and algae growth, with a focus on a sandstone from Clashach Quarry noted for its greater weather resistance compared to other sandstones from Scotland. After the coffee break, **Laura Säilä** (University of Helsinki) described the casting of *Leptopleuron* reptile fossils from the Triassic rocks at Lossiemouth, and how these were used as part of her PhD project to reconstruct the skeleton and ecology of the taxon. The final talk, by **Neil Clark** (University of Glasgow), showed the various techniques used to visualise and reconstruct fossils, and how these have developed in recent years.

Discussion sessions covered diverse topics from the place of local museums in education, a crucial consideration for the future of Elgin Museum, and techniques for recording and conserving fossil trackways, specifically at Clashach Quarry on the Moray Coast, before they degrade to an unrecoverable state.

The session was followed by a welcome reception at Elgin Museum among the permanent geology and palaeontology displays. A special temporary exhibit showing a sketch by Lady Eliza Gordon-Cumming of Altyre of the fish *Cheirolepis* alongside examples of specimens she may have drawn from, illustrated letters from Hugh Miller, research posters on sandstone weathering and dicynodont phylogeny were also on display. These were alongside models by Stephen Caine and Paul de Buisonje, kindly provided by Bob Davidson, of various fish (*Mesacanthus*, *Coccosteus*, *Osteolepis, Dipterus, Diplacanthus*), the early tetrapod *Elginerpeton* and the dinosauriform *Saltopus*, all of which inhabited Moray millions of years ago. The *Saltopus* received particular attention as it had been produced with a coating of fur; this is now on loan to the Museum for display.

The meeting concluded with a field-trip to local sites where fossils have been found in the past. The morning was spent at Cuttie's Hillock Quarry, west of Elgin, known for rare reptile trackways and body fossils, notably of the pareiasaur *Elginia mirabilis* and dicynodonts *Geikia* and *Gordonia*.

Permian sandstone in Cuttie's Hillock Quarry. Photo by Sue Beardmore.

The group also took in views across the Laich, an extensive area drained for farmland over the past several hundred years, before moving on to Lossiemouth where the fossil reptiles *Stagonolepis*, *Brachyrhinodon*, *Leptopleuron* and *Saltopus,* among others, had been excavated. The afternoon was spent on the Moray Coast, beginning at the footprint 'amphitheatre', a collection of Permian Hopeman Sandstone slabs with various trackways recovered from the adjacent privately owned Clashach Quarry. Over 300 trackways have been recorded to date, with the range of sizes and types recorded being greater than for any other similarly aged rock, including the Cocconino Sandstone in America and localities in Germany. Preservation varies from prints with clear toe and claw impressions to characteristic pits and mounds or amorphous undertracks, a relatively high number of which show 'tail drags'. At beach level, examples of cross-bedding, ripples and soft sedimentary structures in rocks of the same age were shown as evidence for the Moray area being a hot, arid, desert covered with sand dunes, occasionally subjected to flash flooding. The trackways were left behind by reptiles of various sizes as they climbed up the dune slopes during migration or in the search for food and water. Despite the slightly damp conditions on the day the group remained enthusiastic throughout, making it an enjoyable excursion all round and a memorable end to an informative weekend of events.

Sue Beardmore
Elgin Museum

13th Meeting of Early-Stage Researchers in Paleontology - XIII Encuentro en Jóvenes Investigadores en Paleontología (XIII EJIP)
Cercedilla, Spain *15 – 18 April 2015*

The 13th EJIP meeting was held in the small mountain town of Cercedilla (north of Madrid) and was a great success, with a total of 130 attendees. The scientific level of the communications and posters was very high and it was the ideal venue to get to know what young people in palaeontology are currently working on.

This edition was organised by young researchers from the School of Geological Sciences at Universidad Complutense de Madrid (UCM, Spain); the National Museum of Natural Sciences-CSIC (Spain); the Geosciences Institute (IGEO-CSIC-UCM, Spain); the Naturhistorisches Museum Wien (Austria); the Museum für Naturkunde (Berlin, Germany); and the Institut de Génomique Fonctionnelle de Lyon (France). EJIP is open to early-stage researchers of all nationalities, although currently the majority of participants come from Spain and Portugal. At this meeting we also had studies presented by researchers from Chile, Peru, Colombia, Austria, Germany and France.

Attendees at the EJIP meeting included undergraduate and graduate students as well as postdoctoral researchers, with ages mainly ranging from 20 to 35 years old. This meeting therefore constitutes a great (and sometimes, first) opportunity for undergraduate and graduate students to present their studies and to attend talks of slightly more advanced young researchers at the postdoctoral stage. It also favours networking and discussions in a friendly, inclusive environment.

Studies from all of the disciplines in palaeontology were welcome and we were able to put together an attractive programme with varied sessions that included: vertebrate palaeontology,

Attendees at the 13th Meeting of Early-Stage Researchers in Paleontology (XIII EJIP), Cercedilla.

invertebrate palaeontology, palaeobotany, palaeontological heritage, and education and outreach in palaeontology. The studies were presented as oral communications and posters throughout the 16th and 17th of April. All of the works presented at the XIII EJIP have been compiled in a proceedings volume that is now available at our webpage: <**http://ejip2015.blogspot.com.es/**>. The works were subjected to a peer-review process in order to guarantee the highest standards of quality for this publication.

We had four keynote speakers. **Cayetana Martínez-Maza** (National Museum of Natural Sciences-CSIC) gave a talk called 'Fossils under the microscope: histological data for the reconstruction of development and behaviour in the evolution of vertebrates'. **Enrique Peñalver**, researcher at the Geological and Mining Institute of Spain, talked about 'The marvellous island: palaeoecology of forested ecosystems and amber in the Cretaceous'. The organising committee is dedicated to the dissemination of scientific results in an easy and straightforward language so that the lay audience, regardless of their circumstances or level of education, can understand the scope of the works presented. With this in mind we also invited **Alejandra García-Frank** (UCM) and **Miguel Gómez-Heras** (IGEO-CSIC-UCM and Ciencia sin Barreras (Science without Barriers)) to give a joint communication about their experience of the organisation 'Science without Barriers' entitled 'Bringing science to people with disabilities'.

The Organising Committee is aware of the current difficulties faced by students of palaeontology, and geosciences in general, when it comes to finding jobs. As such, we devoted part of the Friday evening session to a round-table discussion about professional prospects (other than academia) for students of palaeontology. We included professionals from the oil industry, experts in monitoring palaeontological heritage in the public sector, and entrepreneurs. The round-table was an open space for unregulated discussion, in which attendees and invited speakers all actively participated.

On Saturday 18th April, the XIII EJIP concluded with a field-trip to the nearby Sierra de Guadarrama National Park. We had a really pleasant day learning about the palaeontology, geology, ecology and history of this area that was declared a National Park only two years ago, and it was an excellent opportunity to recognise the value of the natural and historical heritage of this area.

From the beginning of the event, the Committee was aware of gender issues. In order to avoid discrimination and to foster values of equality, we generated and published statistics on attendance by gender (available on our webpage). We are very satisfied that the XIII EJIP reached approximate parity with total percentages of attendance of 47% women and 53% men.

Most of the activities offered at the XIII EJIP (opening session, icebreaker party, coffee breaks, lunches, closing party and field-trip), as well as lodging for three nights, were included in the €50 registration fee. Because the participants at this meeting were mainly students and young researchers with low incomes, we made every effort to keep the registration fee as low as possible. The financial contributions of our sponsors were entirely devoted to this purpose and, among all of our sponsors, the Palaeontological Association stood out for providing the most generous contribution. A big thank you to the Palaeontological Association for making the XIII EJIP possible!

XIII EJIP Organising Committee
<http://ejip2015.blogspot.com/>

Lyme Regis Fossil Festival
Dorset, UK 1 – 3 May 2015

Step into the PalAss time machine, a one way ticket to fun, facts, and learning!

In May this year, the Palaeontological Association ran an outreach stall at the 10th annual Lyme Regis Fossil Festival. This wasn't the first time that PalAss had attended the event, but it was my first time as a PalAss outreach volunteer at the Festival, and what a wonderful celebration of fossils and palaeontology it is! The Lyme Regis Fossil Festival operates as a completely free, and open-to-all, outreach festival. Numerous Earth and life science departments from universities across the UK, as well as natural history museums and scientific associations, had representatives ready to engage with the public about palaeontology. The Natural History Museum, London, had the largest presence at the Festival, with an impressive number of stalls showcasing everything from a huge *Baryonyx* skull, to sifting sand for tiny shark teeth. Plymouth University were getting kids to 'walk like a dinosaur' with paint covered dino-wellies, the University of Southampton were offering a 'dig for fossils' activity, and Oxford University Museum of Natural History were showcasing local Lyme Regis fossils from their collections. Along the back of the marquee situated on the Lyme Regis beach, local collectors were displaying and selling their impressive fossil finds, just as Mary Anning once did along that very beach more than 150 years before them. It is a festival of passion, discovery and intrigue for everyone involved; volunteer and visitor alike.

The PalAss outreach activity was designed as a voyage back in time. Four time periods were chosen to represent different environments and ecosystems through time; the Silurian, the Carboniferous, the Jurassic, and the Pleistocene. Each of these time periods had an associated reconstruction,

painted by the talented palaeoartist **James McKay**. Also displayed were a selection of each period's most iconic and abundant fossil fauna and flora. The oldest time period represented was the Silurian and the diorama depicted a warm, shallow sea, with reef-building corals, trilobites, eurypterids, orthoceras, and crinoids, all of which were present as fossil specimens. The Carboniferous focused on the plant life that dominated during this time period, as well as the large insects and creepy crawlies; Carboniferous fern fossils were also displayed. The Jurassic section dove into a 150 million year old marine setting, when ichthyosaurs and plesiosaurs ruled the oceans, and ammonites were abundant. Many of the ichthyosaur, fish, and ammonite fossils on display for the Jurassic were found in local Lower Lias rocks. The final and youngest time period represented on the PalAss stall was the Last Glacial Maximum, or 'Ice Age'. This diorama showed classic Ice Age animals such as mammoths and cave lions against a snowy backdrop. A fossil mammoth tooth and an ox skull were among the fossils displayed.

Edine Pape speaking to school children about palaeontology and fossils.

The Festival kicked off for PalAss with **Caroline Butler** and **Lucy McCobb** from Amgueddfa Cymru – National Museum Wales visiting Thomas Hardye School in Dorchester. Although the activities took place in this school, groups of pupils from other schools in the area also attended, meaning their activities reached a large number of students in one day. The second day was similar to the first in that our outreach was aimed at school groups, but by now the whole team had arrived in Lyme Regis, and we had set up in the festival marquee. We ran the activity several times for different schools, starting with a discussion about what a fossil is and what a palaeontologist does. We then told them that we were going to take them in a time machine, back to four different periods in Earth's history. We took them around the different sections of the stall, and described what Earth may have been like during each different time period. We asked them if they could identify any of the fossils displayed, and encouraged them to handle and explore them, before explaining what they were. Finally, we rounded off the activity by asking the students which time period they would most like to visit; the Ice Age was the clear winner!


James McKay painting mythical beasts for children at the Festival.

Over the weekend, the Festival opened to members of the public, and the PalAss team was joined by James McKay. James spent his time at the Festival painting 'mix and match' prehistoric beasts for children, and giving these creatures scientific names. These paintings drew a lot of attention, and while the children waited for them, we were able to engage with them about palaeontology and real extinct animals, as well as showing them round our stall. On the Sunday, **James Witts** was interviewed by a local radio station, Abbey 104, for their 'Local World' programme. He spoke about the activities that we were doing at the Festival, and the importance of fossils when trying to understand Earth history.

Outreach is a crucial part of science. As an academic community, we owe it to the public, as well as to future generations of scientists, to communicate our ongoing research clearly and effectively. Fiona Gill, the PalAss outreach officer, Caroline Butler, the education officer, and Liam Herringshaw, the publicity officer, do an excellent and extremely important job in organising outreach activities such as this at various festivals and events across the country on behalf of PalAss. I hope that events such as the Lyme Regis Fossil Festival can go some way toward encouraging the next generation of palaeontologists and spreading enthusiasm for natural sciences in general. So whether you are in a position to volunteer, or you are passionate about palaeontology and want to find out more, get yourselves down to future Lyme Regis Fossil Festivals; I can guarantee a fantastic, fun-filled and highly educational weekend.

Gemma Benevento
University of Oxford

The PalAss Lyme Regis 2015 outreach team (from left to right): James McKay, Gemma Benevento, Tim Palmer, Lucy McCobb, Edine Pape, Fiona Gill, James Witts, Caroline Buttler and Jo Hall.

——OBITUARY——

Percy Milton Butler 1912 – 2015

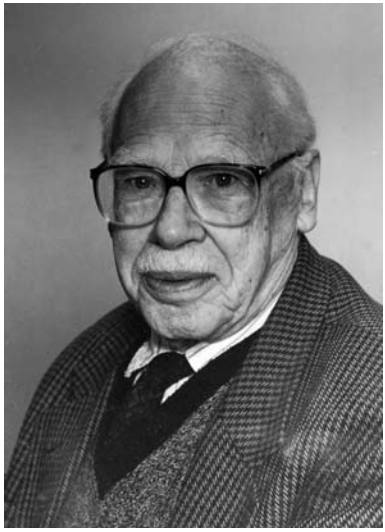


Photo courtesy of Royal Holloway, University of London

Percy Butler died on 7th February 2015 at the remarkable age of 102. He was Emeritus Professor in the Department of Biology at Royal Holloway University of London in Egham and internationally renowned for his work on mammal teeth. He gained a BA degree at Pembroke College, Cambridge and a BSc in Zoology at London University (external), both in 1933. He gained his PhD in 1939 at the University of Cambridge under the supervision of Clive Forster Cooper. He had a long association with the Natural History Museum (formerly British Museum (Natural History)), which he first visited in 1933. In 1936, he visited the USA, having received a Commonwealth Fund Fellowship at Columbia University, to study fossil mammal teeth in various museums. While in the country, he collected some fossil mammals, including a molar of the large Late Eocene brontothere *Megacerops*. During World War II, he applied his knowledge of insects in the Infestation Division of the Ministry of food, where the work involved entomological inspection of ships and examinations of a wide variety of food storage and manufacturing premises in Northern Ireland. An account was published jointly with A.F. O'Farrell in 1948. He lectured at Exeter and Manchester Universities before joining Royal Holloway in 1956 as Reader and Head of the Department of Zoology.

In the 1930s, Percy was at the forefront of research into understanding how mammalian teeth evolved, in particular their character development, cusp homology and dietary function. For 21st century palaeomammalogists, it is hard to appreciate that the developmental relationships between milk teeth, premolars and molars, primary cusp identification and knowledge of the process of mastication through observation of wear facets had not at that time been firmly established. These are all phenomena that we accept today and rely upon to build more elaborate hypotheses and apply to phylogeny and ancient dietary reconstruction. A series of observationally meticulous and clearly argued papers in the late 1930s to early 1950s pioneered these studies. They show how cusps can be correctly homologized through the study of comparative anatomy, ontogenetic development and individual variation. He is particularly well known for his field theory of 1937 (elaborated in 1939). This shows how dental characters should not be regarded as evolving separately on individual teeth but as morphogenetic fields with their expression occurring in varying gradients and extents along the tooth row. Thus a dentition is to be viewed as a metamerically arranged organ. In 2001, he had lived long enough to publish a review of the theories that had been proposed subsequently, through embryological and genetic research, on the causes of differentiation of the dentition as described by his field theory.

Percy's mammal tooth work began with insectivorans (*i.e.* members of the order Insectivora, rather than just mammals that eat insects and other invertebrates), as their molars appeared the least modified and therefore suitable for studying dental evolution. In 1948 he published

a comprehensive paper on the teeth and skulls of modern and fossil hedgehogs. It is a sound, important work still regularly cited today. As time went on it became clear to him that insectivorans were not just primitive and that they included quite differently specialized types. They were a 'wastebasket' group that today we categorize as paraphyletic and polyphyletic. He played an important role in splitting them up into their component natural monophyletic groupings. Thus, we now recognize, amongst others, elephant-shrews (order Macroscelidea, which he named in 1956) and tree-shrews (Scandentia, to which he gave ordinal status in 1972). These groups are no longer considered close relatives of hedgehogs, moles and shrews (core insectivorans in the order Lipotyphla), and are as phylogenetically remote from one another as monkeys and elephants. He also took on the task of describing mainly the smaller mammals (insectivorans and bats) that were being collected from Neogene rocks in East Africa by Louis Leakey in the 1950s and 1960s, at times co-authoring with Marjorie Greenwood and Arthur Tindell Hopwood.

His meticulous examination of teeth led him to realize that they did not function as pestles and mortars as many of his early contemporaries thought, but, especially in the case of premolars and molars, had complex patterns of mastication. He documented, homologized and numbered wear facets, which are the flat worn areas on teeth where upper and lower teeth effectively meet as they shear or grind food. This work began with fossil members of the order Perissodactyla (horses, rhinos and tapirs) and he subsequently applied it to many different groups, including rodents, primates and extinct Mesozoic orders.

Insectivorans led Percy on to studying the earliest mammals of the Mesozoic Era, which lived alongside dinosaurs, in a quest to understand the first stages of mammalian evolution. His earliest studies of modern insectivorans were of the tenrecs of Madagascar, which have a particularly simple molar structure known as zalambdodont. He noted that zalambdodonty and many other types of molar structure had evolved independently multiple times. He was particularly impressed by the amount of evolutionary convergence of form that existed in nature, especially as demonstrated by the fossil record. He continued to pursue his Mesozoic studies, including co-authoring with his late colleague Zofia Kielan-Jaworowska. Early in his career, Mesozoic mammals were exceptionally poorly known, the best being jaws and teeth from the UK middle Jurassic and early Cretaceous, the North American late Cretaceous and some cranial material from the late Cretaceous of Mongolia. Since those early years, the rate of new finds of Mesozoic mammals and their quality rose exponentially from all parts of the world and he kept abreast of such developments, modifying his ideas accordingly.

Percy speaking at his 100th birthday party at Royal Holloway on 19th July 2012. Photo courtesy of Christopher Dean.

Some predictions made by Percy have been shown subsequently to be correct. In 1973, jointly with Zofia, he suggested that a Cretaceous supposed placental insectivoran from Mongolia, called *Deltatheridium*, based on rather poorly preserved material, might instead be

a marsupial. A quarter of a century later, much more complete and better-preserved specimens showed that this animal was indeed a stem marsupial. In 1978, he concluded that another Cretaceous supposed placental from Texas, called *Pappotherium*, and known from little more than a few isolated teeth, was a marsupial. This has also been corroborated by more recent work. A group of very early mammals, mainly from the late Triassic and early Jurassic, called haramiyids, had been enigmatic since their discovery in the early 19th century, as they consisted only of isolated teeth that were unlike those of any modern mammal. Thus, it was unclear which were upper and which lower teeth, and also which was front versus back and left versus right sides. In a joint paper with Giles MacIntyre in 1994, Percy worked out how the teeth chewed by looking at the wear facets and thereby reconstructed the dentition. Three years later, haramiyid jaws with teeth were discovered in Greenland by Farish Jenkins, which showed Percy's reconstruction to be fully accurate.

Percy received numerous awards in the course of his long career. They are: Membership of the Society of Sigma Xi, devoted to the Promotion of Research in Science (1937); Certificate of Appreciation from the Zoller Memorial Dental Clinic, University of Chicago (1966); Membre d'Honneur (certificate and medal) of the Groupement International pour la Recherche Scientifique en Stomatologie (1971); La Médaille de la Ville de Paris (1986); Honorary Membership (1994) and the prestigious lifetime achievement award, the Romer-Simpson Medal (1996), of the Society of Vertebrate Paleontology.

Percy's research career involved not only fossil and modern mammals, but also modern insects and ecology, for which he is less well known. He published more than 100 papers and book chapters, and edited one book jointly with Ken Joysey in 1978. His first paper was in 1935, co-authoring on the ecology of Bardsey Island in Wales. His publications currently span a remarkable 78 years. However, there are still two co-authored manuscripts, one with him as lead, which are currently in different stages of completion. The impact of his work on the way we study teeth today has been immense. He was an unassuming person, friendly and ready to share his ideas and listen to the ideas of others. He will be greatly missed by all his friends and colleagues across the world.

Jerry Hooker
Natural History Museum, London

Acknowledgements. I thank Graham Twigg, Christopher Dean and David Polly for providing important information and photos included in this obituary.

Percy playing snooker after dinner at a Dental Morphology conference in 1998 in Oulu, Finland. Photo courtesy of Christopher Dean.

——OBITUARY——

Lennart Jeppsson 1940 – 2015

Photo: Mikael Calner.

Professor Lennart Jeppsson, one of the leaders in research on Silurian geology, passed away on 22nd April 2015 after a long illness. He was considered a world authority on conodonts and conodont biostratigraphy, but also made many other contributions of lasting value.

Lennart was born in Scania, the southernmost province in Sweden, and after attending local schools, he continued his education at Lund University where his academic studies included botany, zoology, chemistry, genetics and geology. He received his Fil. Mag. (approximately M.Sc.) degree in 1967 and his Fil. Lic. degree (the degree below Ph.D.) in 1971. From his high school years he had a deep interest and expertise in the local flora, and during a floristic inventory of his home region he even discovered a plant new to Sweden, a most unusual achievement for a young student. He maintained strong interests in plants to near the end of his life and published several botanical articles. He introduced hundreds of species into his garden that became a well-known showpiece in the city of Lund. However, during an elementary course in geology given by Stig M. Bergström (SMB), he changed his scientific focus from botany to geology and became particularly fascinated by conodonts and conodont biostratigraphy, which became his thesis topic under the general guidance of SMB. Lennart was associated with the Geology Department at Lund University through his entire career, where he held several positions and became Professor in 2000.

His studies initially focused on the Silurian successions in Scania and on the Island of Gotland, whose diverse conodont faunas had remained essentially unknown prior to his work. Over the years he also worked on collections from many other parts of the world, such as Australia, the UK, Bohemia and North America. He was a visiting Professor in Waterloo, Canada in 1970–1971, visited North America again in 1975, made two long research trips to Australia in 1996 and 2000, studied Silurian geology in the UK on several occasions starting in the 1960s, and participated in geological congresses in quite a few countries. He was co-organiser (with A. Löfgren) of the 3rd European Conodont Symposium in Lund in 1982.

As early as his first conodont paper (1969), he pioneered the use of multielement taxonomy for Silurian conodonts, a practice that did not fit well with some established but more conservative conodont workers of the time, some of whom continued using the old form taxonomy into the latter half of the 1970s. Because conodonts are generally not abundantly represented in the Gotland Silurian succession, Lennart carried out an enormous collecting programme in order to obtain collections of adequate size. This programme included annual collecting trips to numerous localities, the collection of tons of limestone, and the use of individual sample sizes of up to 70 kg. One can safely say that it is highly unlikely that this programme will be matched in the future. This huge collecting effort resulted in, among other achievements, the discovery of many very rare species which are unlikely to have been found using more conventional collecting work. The data

from his work on Gotland were published in a series of papers, some of monographic size, such as 'Silurian conodont apparatuses and conodont dimorphism' (*Geologica et Palaeontologica* 1972), 'Aspects of Late Silurian conodonts' (*Fossils and Strata* 1974), and 'Silurian conodont faunas from Gotland' (*Fossils and Strata* 1983). These detailed reports have become international standard references and are of lasting scientific value.

Lennart also possessed a technical talent and keen interest in improving conodont extraction methods. He designed a conodont preparation laboratory in Lund that is probably still the most advanced in the world with, for instance, computer-monitored and push-button changes of acid in huge sample processing baths. In cooperation with a couple of chemistry colleagues, he developed new extraction methods using buffered acids for breaking down especially clay-rich limestones that greatly increased conodont retrieval while simultaneously reducing the risk of losing, and etching, specimens due to acid effects. These methods are now used routinely worldwide. His views on microfossil extraction were summarized in a paper entitled 'Biases in the recovery and interpretation of microfossil data' (*Palaeontology* 2005).

His work on Gotland resulted not only in the establishment of a greatly refined Silurian conodont biostratigraphy of worldwide application but also in the discovery of ten conodont extinction events that subsequently have been shown to coincide with positive $\delta^{13}C$ excursions and be distributed globally. These extinction events are not restricted to conodonts but can also be recognised in the ranges of species of other fossil groups, and at least to some extent, they are also identifiable lithologically. Lennart proposed a relatively complex but logical oceanographic model to account for these events that involved changes from icehouse to greenhouse cycles combined with changes in the carbon cycle and even Milankovitch effects. In several papers, partly in cooperation with local workers, Lennart extended the application of his oceanographic model to Silurian successions in North America, Greenland, the UK, eastern Baltoscandia and Australia. Perhaps the best description of these events is his 1998 summary paper in the *New York State Museum Bulletin* 491 that also illustrates his incomparable knowledge of global Silurian conodont biostratigraphy. These events have figured prominently in the international literature but their cause is still a matter of discussion.

Lennart sustained a remarkable publication activity during the last decade of his life, as evidenced by the fact that 23 of his approximately 130 authored or co-authored papers were published in 2004–2014. Most of these deal with biostratigraphy, chemostratigraphy and extinction events but there are also studies on bentonites, depositional environments, vertebrates, graptolites, scolecodonts, hyoliths and problematic fossils.

Lennart suffered from a variety of health problems, particularly during the last quarter of his life, such as fibromyalgia. During his last few years he experienced progressive frontal lobe dementia and also developed skeletal cancer. The cause of his death was stated as pneumonia. He is survived by his wife, Ann-Sofi, who provided much support to him in many ways throughout his entire career, and his two children Anna-Lena and Anders.

Lennart had an unusual personality – very bright, independent in thought, and he was full of ideas and enthusiasm. He had firm opinions about some matters that occasionally caused practical problems. Lennart loved science in a broad way, read voraciously, and could discuss matters at a high level in subjects far from his beloved geology and palaeontology. He also had a wonderful sense of humour of the dry, witty, academic kind. In many respects, his research opened up new

and fertile ground. His friendliness, helpfulness and expertise were much appreciated by his students, some of whom (such as Mikael Calner and Mats Eriksson) have become internationally known. Many international conodont workers came to Lund to visit him, and throughout the years he maintained extensive contacts with specialists from many parts of the world. His leading position globally in Silurian conodont research is shown by his receipt of the Pander Society Gold Medal in 2006, which is the highest international award in conodont research.

It is sad to note that in the last few years, Silurian geology and especially Silurian conodont research, has lost several of its internationally best-known workers, such as Otto Walliser, Richard Aldridge, and now Lennart Jeppsson. The enormous body of expertise lost with the passing of these eminent workers is not replaceable, and the fact that several other Silurian specialists are now retired suggests that the end of the 'golden age' of Silurian conodont research during the last 50+ years may not be very far off.

Stig M. Bergström
Ohio State University

Per Ahlberg
Lund University

Mikael Calner
Lund University

Mats E. Erikssson
Lund University

Birger Schmitz
Lund University

Fredrik Terfelt
Lund University

Lennart Jeppsson at Ireviken, Gotland, Sweden, August 2005.
Photo by Mikael Calner.

Research Grant REPORTS

Comparative Experimental Taphonomy of Marine Crustaceans: Clues to their Fossil Record

Adiël A. Klompmaker
Florida Museum of Natural History, University of Florida

Introduction

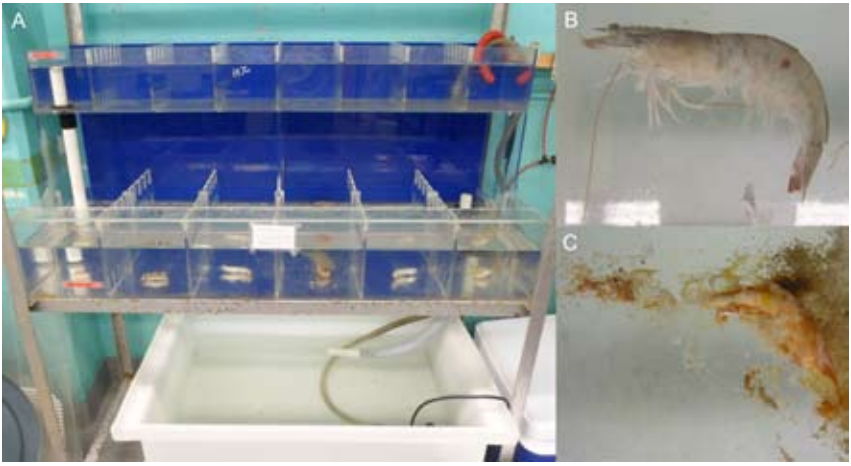
Marine crustaceans are abundant members of modern marine ecosystems and are also well known from the fossil record. However, not much is known about their relative preservation potential due to the lack of comparative taphonomical experiments among crustacean clades. Previous work has focused typically on one crustacean species per study, which makes comparing among clades problematic due to different experimental conditions (*e.g.*, Plotnick (1986) and Butler *et al*. (2015) for a species of shrimp; Hof and Briggs (1997) for a species of stomatopod; Babcock *et al*. (2000) for a species of horseshoe crab; and Stempien (2005), Mutel *et al*. (2008), and Krause *et al*. (2011) for a species of crab). Shrimps were qualitatively suggested to have a lower preservation potential compared to other crustaceans such as crabs (*e.g.*, Förster 1985), and Klompmaker *et al*. (2013) showed that exquisite preservation of decapod crustaceans in Late Jurassic Lagerstätten may affect Mesozoic diversity patterns to a certain extent. The lack of comparative research severely hampers our understanding of the differential preservational biases across crustacean clades and, as a result, their true biodiversity through time.

The aim of this research is to address this lack of knowledge by carrying out comprehensive comparative taphonomical experiments (see Brett and Baird 1986; Briggs 1995) based on modern representatives of major marine macrocrustacean clades. The study should help to answer questions such as: What is the rate of decay of a shrimp relative to a crab? Which skeletal parts have the highest likelihood to preserve for each clade? What do the results mean for Cenozoic and Mesozoic biodiversity patterns of crustaceans? Which crustacean clades are unlikely to preserve?

Methods

The first part of this research is a trial run to explore how much time the decay process takes for specimens to be largely disintegrated based on similar-sized specimens (~2–3 cm carapace length) and to figure out the best experimental setup. The species used thus far comprised specimens of a calico crab (*Hepatus epheliticus*), a swimming crab (*Portunus gibbesii*), a pink shrimp (*Penaeus duorarum*), a striped hermit crab (*Clibanarius vittatus*) as well as non-decapod crustaceans with a known fossil record such as a mantis shrimp (*Squilla empusa*) and a horseshoe crab (*Limulus polyphemus*). All specimens were readily available in the panhandle area of the Gulf of Mexico in Florida, whereas lobsters were virtually absent from this region and isopods were too small to make meaningful comparisons. Freshly killed crustacean specimens (one of each species) were

put into saltwater aquarium compartments. This aquarium experiment lacked scavengers and natural perturbations such as storms so that the decay process should be dominated by bacteria and other microorganisms. Experimental conditions were as follows: ~50‰ salt concentration; pH 8.1; temperature 20°C; light conditions: 12 hours dark – 12 hours light in lab per day; ammonia (NH_3/NH_4^+): 0 ppm; nitrite (NO_2^-): ~5 ppm; nitrate (NO_3^-): ~10 ppm. Specimens were not touched during the experiment. All experiments were carried out in accordance with local ethical guidelines.



Crustacean taphonomical experiments. A) Experimental setup of the aquarium compartments for the trial run. A pump in the white basin ensures constant water flow through the compartments. B) The pink shrimp just after it was put into the aquarium and C) after seven weeks of decay, showing that the carapace and the associated soft tissue have largely disappeared. Length of carapace without rostrum is 30 mm.

Preliminary results

Unlike the hypothesis that complete decay should proceed quickly (weeks), decay appears to be relatively slow under these experimental conditions. The specimens were all more or less intact after the first few weeks of decay. Some notable changes became apparent: 1) all specimens developed a white coating on some or many parts within a matter of days, except for the horseshoe crab (~2 weeks); 2) most specimens became swollen within a matter of days, possibly due to the white coating that developed; 3) some odour was noticeable within a few days; 4) colour differences were apparent: the red spots on the calico crab faded in some weeks, whereas the colour of others became more prominent or darker (pink shrimp, horseshoe crab) initially. The white coating was most prominent around areas with a lot of soft tissue; some pink coating developed after about two weeks. The disappearance of the white and pink coating in the next weeks on nearly every specimen was an indication that much of the soft tissue was consumed by that point.

After four weeks, the stomatopod suddenly collapsed after all soft tissue was consumed. After another two weeks the only notable fragments left were thin layers of the uropods and antennal scales and the most heavily calcified parts of the specimen, the raptorial claws. The next specimen that showed signs of collapse was the hermit crab: after one month the posterior carapace started to fragment. In the weeks thereafter, the appendages including the chelipeds disarticulated. The

abdomen, consisting of soft tissue, had decayed entirely after ~1.5 months. The carapace of the shrimp started to disintegrate after slightly over one month and had collapsed completely after ~1.5 months, whereas the abdomen remained largely intact for many more weeks. The appendages had disintegrated after ~1.5 months. The horseshoe crab and the two crabs showed the slowest rate of decay within seven weeks, although some appendages of the latter two had disarticulated and the shell of the horseshoe crab became translucent. The expectation is that most will be left from the crab *Hepatus* in the coming months.

Subsequent research

When the trial run is completed, lab experiments will be expanded to include specimens of different sizes for each species as available. As lab experiments do not fully mimic natural conditions, for example lacking wave activity, macroscavengers and encrusters, the experiments are planned to be carried out in a coastal setting as well. Once complete, the results will be used to compare to Cenozoic fossil crustacean assemblages.

Acknowledgements

Roger Portell, Michael Frick, Stephan Barron and Sean Roberts are thanked for help with this research thus far.

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Undergraduate Bursary REPORTS

X-Ray Approaches to the Identification of Tropical Plant Fossils

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Introduction

Techniques in X-ray microscopy, micro-computed tomography (CT) and synchrotron radiation X-ray tomographic microscopy (SRXTM) were used to analyse fossil floras from two interesting intervals in the Cenozoic: the Eocene and Miocene. The Early Eocene Climatic Optimum (EECO), 52–49 Ma, was the warmest time in the Cenozoic, when tropical vegetational belts spread across much of the Northern Hemisphere (Wolfe 1985). The flora of the London Clay Formation, likened to modern paratropical rainforests, is very diverse and a global benchmark for EECO vegetation (Collinson 1983).

The Miocene, 25 Myr later, was a critical time in the evolution of our own lineage: apes arose and underwent diversification during this epoch (Stewart and Disotell 1998). Hominoids, including *Proconsul*, are known from the early Miocene of Africa, for instance, from the deposits on Rusinga Island, Lake Victoria, Kenya (Walker *et al*. 1993). The Rusinga Island deposits have also proven to be rich in floral remains (Collinson *et al*. 2009). Palaeobotanical studies of this early Miocene flora are important, because they help improve the understanding of the environment and vegetation in which hominoids evolved.

Kenyan Miocene Fossil Seeds – in collaboration with Marion K. Bamford (Witwatersrand, South Africa), Selena Y. Smith (Michigan, USA) and Federica Marone (Swiss Light Source (SLS), Switzerland).

The early Miocene (~18Ma) flora of the Hiwegi Formation on Rusinga Island, Kenya has yielded an unexpectedly diverse flora, featuring at least 21 families (Collinson *et al*. 2009). Many fossilized seeds have been recovered from the site, including seeds now thought to belong to the genus *Cissus* (in the family Vitaceae). If this taxonomic revision is confirmed, these seeds would represent the first occurrence of Vitaceae in the African fossil record.

These *Cissus*-like seeds were previously placed in a different family, the Menispermaceae, by Chesters (1957). However, the fossils show outer ornamentation strikingly similar to modern *Cissus* seeds (Figure 1a-d). Five of the *Cissus*-like fossils were scanned using CT at the Natural History Museum, London (NHM), and 37 modern *Cissus* species were scanned using SRXTM at the TOMCAT beamline of the SLS. SRXTM was used to generate high-resolution images with cellular detail. By scanning modern *Cissus* species it was hoped that 'virtual taphonomy' – the digital removal or infill of structures to mimic fossilization processes (see Smith *et al*. 2009) – could be used to understand which botanical layers were preserved in the fossils.

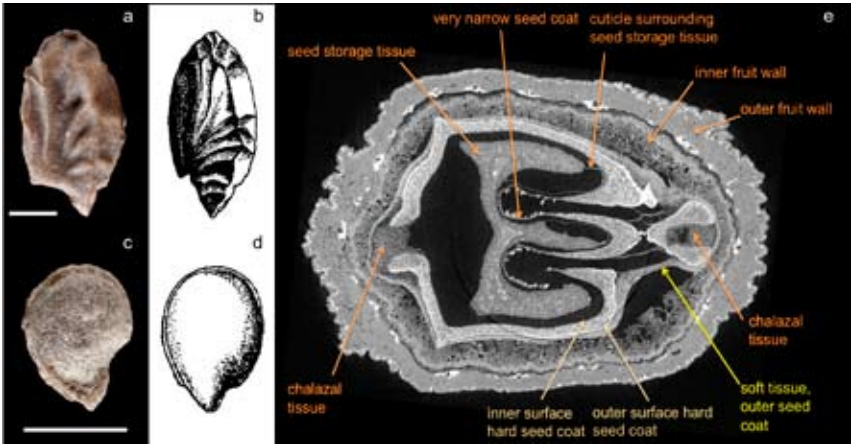

Figure 1. (a)–(d) Ornament similarities between fossils and modern Cissus seeds: (a) V33753 (holotype of Menispermicarpum crenulatum *Chesters) showing very similar ornament to (b)* Cissus integrifolia *(Baker) Planch., (c) V68506 (*Menispermicarpum *sp.) with similar ornament to (d)* Cissus petiolata *Hook.f.; (e) the complex layers observed in a high-resolution SRXTM image of a modern fruit of* Cissus populnea *Guill. and Perr., cellular detail and tissue organisation is clear, with layers of varying resistance evident from the variable tissue density and scattered mineral phases (white patches in X-ray image). Modern* Cissus *images, (b) and (d), from Dewit and Willems (1960). Scale bars in (a) and (c) are 1cm.*

CT imaging of the fossils has revealed internal organisation characteristic of *Cissus*, and SRXTM images of modern specimens have shown an unexpected internal complexity (Figure 1e). There are soft, organic layers and hard, partly mineralized layers, which would each have a different likelihood of preservation in the fossil record. Initial virtual taphonomy results suggest that the deep ventral infolds, which characterize *Cissus* seeds, were likely infilled during fossilization. This could explain the initial incorrect taxonomic assignment.

Fossil Fruits from the London Clay Formation – in collaboration with Steven R. Manchester & Gregory W. Stull (FMNH, USA), Paul Kenrick & Dan Sykes (NHM, UK).

The flora of the London Clay Formation is one of the most diverse Early Eocene floras globally, with over 300 species (Collinson 1983). The family Icacinaceae (mainly lianas) is well represented by 24 species in 7 genera. New data on internal morphology of 22 London Clay Icacinaceae fruits were collected to help resolve their position in the angiosperm phylogeny (Stevens 2012).

Pyritized fossil fruits, including unique holotypes and figured specimens, were CT scanned at the NHM. Some of these historic specimens were collected nearly 200 years ago and are stored in silicone oil to prevent pyrite decay. Traditional destructive sectioning is inappropriate to study the internal anatomy of these important specimens. X-ray imaging was therefore ideal for obtaining high-resolution internal images without damaging specimens or removing them from the silicone oil.

Taxonomically useful information was obtained for the majority of specimens, even those badly damaged or encrusted. 3D visualizations, as well as transverse (TS) and longitudinal sections (LS), were imaged for each specimen. For example, Figure 2a-c shows a 3D rendering of the locule cast, along with a TS and LS, of *Iodes corniculata* Reid and Chandler. The position of the funicle (the stalk

carrying conducting tissues) and the texture and shape of surface depressions and ridges can be easily visualized, and confirm its affinity to modern *Iodes*. Despite heavy encrustation (Figure 2d), it was also possible to image the locule cast of the *Iodes multireticulata* Reid and Chandler holotype (Figure 2f). This cast shows features indicative of Icacinaceae (bisymmetry and a ridge extending in the plane of symmetry (Figure 2e), but the absence of a funicle suggests that this specimen may not belong in *Iodes*. Despite the few cases like this, where taxonomic revision may be needed, internal features of Icacinaceae holotypes, never before imaged, have confirmed (a) affinities with modern tropical taxa, and (b) the diversity of Icacinaceae species in the London Clay Formation.

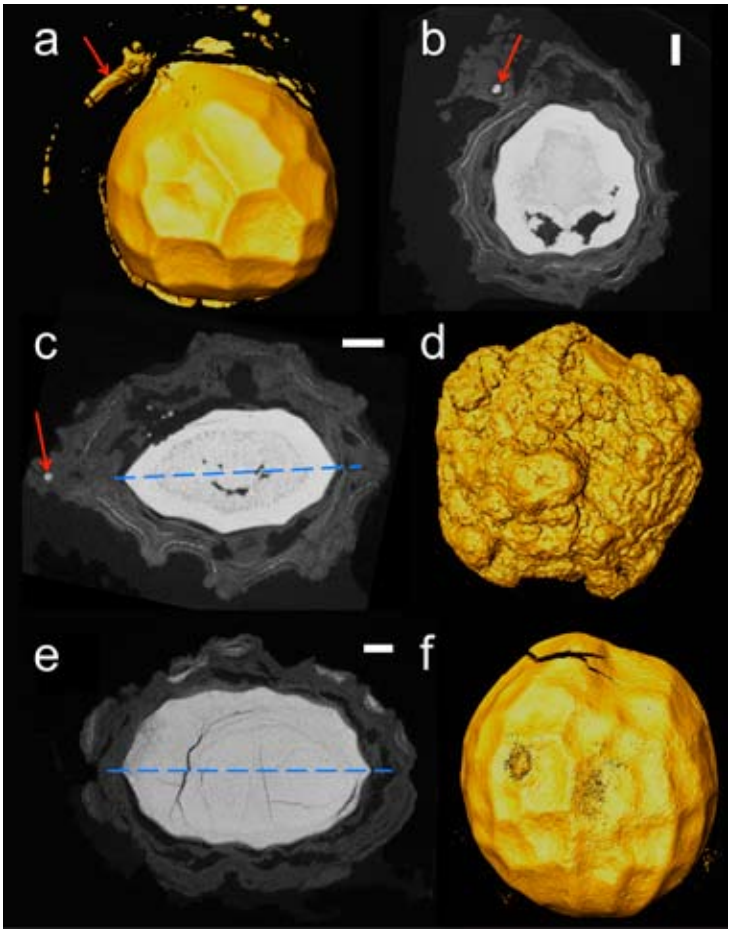

Figure 2. (a)–(c) Iodes corniculata *(V22579, holotype): (a) 3D rendering of the locule cast, showing reticulately ridged surface with few, large depressions, (b) longitudinal section and (c) transverse section, showing the central pyrite locule cast and outer dominantly organic layers of the endocarp; (d)–(f)* Iodes multireticulata *(V22589, holotype): (d) 3D rendering of outer endocarp surface, showing total pyrite encrustation, (e) transverse section, and (f) 3D rendering of the locule cast, with no funicle visible. Red arrows show the position of the funicle in* I. corniculata. *Blue dashed line shows bisymmetry indicative of Icacinaceae. Scale bars in (b), (c) and (e) are 1mm.*

Conclusions

This project has provided new, high-resolution images of the internal anatomy of fruits and seeds from two famous Cenozoic floras. CT images of historic holotypes from the London Clay, never before internally imaged, have confirmed affinities with modern tropical relatives and highlighted the diversity of Icacinaceae in the flora. This research has shown that taxonomically useful images can be generated via the CT scanning of pyritized fossils. Future work should expand on the permanent datasets now obtained for the Icacinaceae, by scanning vulnerable holotypes of other taxa from the London Clay, and from sites of similar preservation, to ensure that they are not lost to science due to pyrite decay.

The use of CT in the study of Miocene seeds, originally placed in the Menispermaceae, has confirmed their affinity with *Cissus* based on hidden, internal features. This now represents the first appearance of the Vitaceae family in the African fossil record. Initial results from virtual taphonomy, using SRXTM images of modern species, suggest mineral infilling obscured the ventral grooves characteristic of *Cissus*, which led to the original incorrect taxonomic assignment. Therefore the use of CT/SRXTM on specimens that cannot be taxonomically placed using their external morphology, or are suspected of being misplaced, may reveal internal features useful for their correct identification.

Acknowledgements

I am most grateful to the Palaeontological Association for funding this research. The SRXTM was performed on the TOMCAT beamline at the SLS, Switzerland. I thank the SLS for granting beamtime for Proposal 20140402, and the NHM, London for permission to study specimens in their collections and for granting CT time to scan the Icacinaceae fruits. I am also indebted to my supervisor, Margaret Collinson, for her commitment, enthusiasm and considerable time spent on this project. I also thank our collaborators for fruitful discussion and support throughout this project.

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Palaeogene and Neogene hydrocarbon seep molluscs from the Caribbean region

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General Background

Hydrocarbon seeps are discrete sites along deep continental margins where hydrocarbon-rich fluids flow onto the seafloor. Seeps are dominated by animals hosting chemoautotrophic bacteria in their gills and other tissues. These bacteria oxidise methane and sulphides to produce energy, which is used to fix inorganic carbon for their hosts (Sibuet and Olu 1998). Such animals include bivalves (*e.g.* vesicomyid, lucinid and bathymodiolin clams), and vestimentiferan tubeworms, many of which are obligate to seeps (Gill *et al.,* 2005). Seeps also contain non-symbiont-housing gastropods, which are primarily grazers or detritivores (e.g. provannids and trochids), and are also endemic to these deep-sea habitats (Sibuet and Olu, 1998; Amano and Little 2014).

Since the discovery of modern seeps in the mid-1980s the recorded number of modern and ancient seeps has increased almost exponentially (Amano and Kiel 2010). Ancient seeps date back to the Silurian and there have been substantial changes in seep fossil assemblages from the Palaeozoic to the early Cenozoic (Amano and Kiel 2010). The Caribbean region has many ancient seeps that are Eocene–Miocene in age. These contain fauna found at modern seeps, such as bathymodiolin mussels, and a number of now extinct taxa including the vesicomyid *Pleurophopsis* (Figure 1A) and hokkaidoconchid gastropods (Figures 2A and B) (Gill *et al.* 2005). Fossil seep faunas from Barbados and Trinidad were described in a preliminary paper by Gill *et al.* (2005), but since then additional specimens have been located, and knowledge of Mesozoic and early Cenozoic seep faunas has increased substantially (Kiel *et al.* 2010).

Such advances in our understanding include the increasing number of recorded bivalve and gastropod species from recently discovered modern seeps, such as offshore Colombia (Gracia *et al.* 2012) and offshore West Africa (Warén and Bouchet 2009). These modern seeps also contain taxa with fossil relatives, such as provannid gastropods with species found from the Late Cretaceous (Warén and Bouchet 2009; Amano and Little 2014). In addition, hokkaidoconchid gastropods, originally discovered from Mesozoic Japanese seeps, have since been found at Mesozoic seeps in France (Kiel *et al*. 2010) and even Antarctica (Kaim and Kelly 2009). Lastly, phylogenetic analyses of modern vesicomyid bivalves have helped resolve the evolutionary relationships of modern species and some of their fossil relatives (Krylova and Sahling 2010). Such discoveries have enabled us to undertake a thorough reinvestigation of Caribbean region seep fossils, offering new insights into the evolutionary history of these enigmatic faunas.

Project aims, preliminary results and future work

The project aims were to provide detailed taxonomic descriptions of the bivalves and gastropods from Palaeogene and Neogene seeps from Barbados and Trinidad, as well as site-by-site species richness counts. Over 250 bivalve and 200 gastropod specimens were described from collections housed at the University of Leeds, comprising at least 15 and 18 species respectively. These include five new species of bivalves and eleven new species of gastropods. Of particular interest in the fauna are abundant tall spired gastropods, previously referred to as 'zygopleurids' but now reassigned to the genera *Hokkaidoconcha* (Figure 2A) and *Ascheria* (Figure 2B), both within the family Hokkaidoconchidae. Until now the hokkaidoconchids have only been recorded in Mesozoic

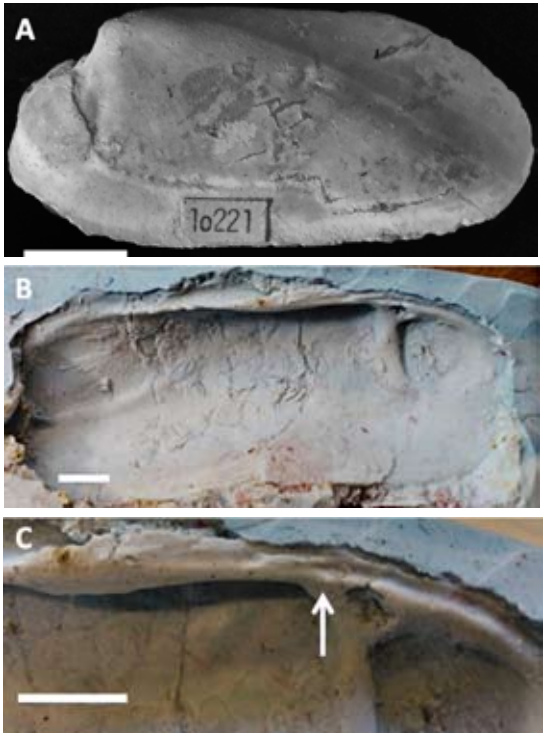

Figure 1. Elongate vesicomyids from Caribbean seeps. A) Pleurophopsis unioides*, internal mould of left valve, LUSEE 185a. Image adapted from Gill* et al. *(2005). B) Elongated edentulous vesicomyid silicon rubber cast of internal left valve mould, LUSEE 221. C) Detail of B with arrow pointing towards the lack of dentition. Scale bars are 1cm.*

seeps (Kaim and Kelly 2009; Kiel *et al.* 2010), so their occurrence in Caribbean seeps as young as Miocene was quite a surprise.

Bivalve specimens common in the Barbados and Trinidad seep fauna belong to several species within the family Vesicomyidae. Some have been previously described in the genus *Pleurophopsis,* but lack the characteristic dentition of that genus (Figures 1B and C) and thus require a new generic determination, work on which is on-going. This new genus also occurs in Cenozoic seep sites in Ecuador and Peru. Another common vesicomyid in the Barbadian and Trinidadian seep fauna is a new species of *Pliocardia* (Figures 3A and B), with notably thinner dentition compared to other species of the genus (*e.g.* Martin and Goffredi 2012).

One of the Barbadian seep sites (Windy Hill) has a number of bivalve and gastropod taxa not found in the other Barbados sites; further research is planned to establish if this is because this site is a different age from the others, or if it originated in a different water depth. I presented my work as a poster at the 2014 Palaeontological Association Annual Meeting in Leeds and at the 2015 British Conference of Undergraduate Research in Winchester. I also presented my work as a lightning talk at Progressive Palaeontology 2015 in Bristol, and I plan to submit my work for publication this summer.

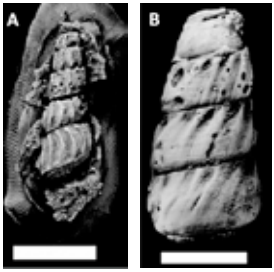

Figure 2. Caribbean seep gastropods previously described as 'zygopleurids,' now reassigned to the Hokkaidoconchidae. A) Hokkaidoconcha chmieli *silicon rubber cast of external mould, LUSEE 320. B)* Ascheria *sp., NMB H17143. Both images adapted from Gill* et al. *(2005). Scale bars are 1cm.*

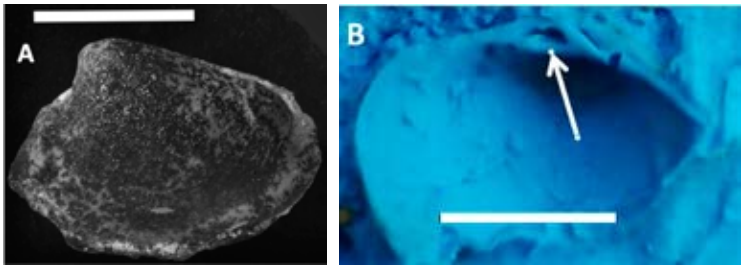

Figure 3. Pliocardia *sp. from Caribbean seeps. A) Internal mould of articulated specimen, LUSEE 277. Image adapted from Gill* et al. *(2005). B) Silicon rubber cast of right valve internal mould with arrow pointing to cardinal dentition, LUSEE 278. Scale bars are 0.5cm.*

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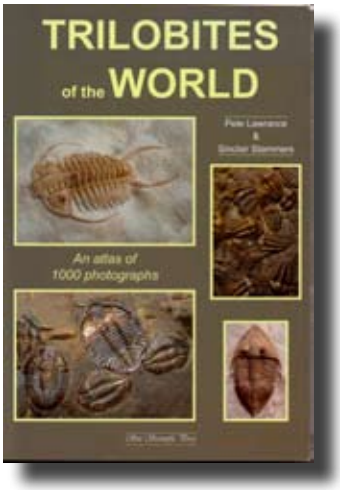
Book Reviews

Trilobites of the World: An atlas of 1000 photographs

Pete Lawrance and Sinclair Stammers. 2014. Siri Scientific Press, Rochdale. 416pp. £45.00 (softback). ISBN: 978-0-9574530-3-6. Available direct from the publisher at <**http://www.siriscientificpress.co.uk**>.



Trilobites are some of the most iconic and popular invertebrate fossils, and have attracted generations of professional and amateur palaeontologists alike over the years. Besides a host of academic papers, there is a number of books published on the subject to appeal to non-specialist audiences, for example Richard Fortey's acclaimed *Trilobite! Eyewitness to Evolution*. The present volume is an atlas of photographs based primarily on what must be one of the largest, if not the largest, private collection of trilobites in the UK, accumulated over a period of nearly 50 years by Pete Lawrance through personal field work, exchange and purchase. He has now brought this collection into the public domain through this atlas, with images by scientific photographer Sinclair Stammers. The book is dedicated to all trilobite enthusiasts. The bulk comprises 352 pages of colour photographs. These are preceded by a short introduction to trilobites, which includes their ordinal classification according to Adrain (2011), followed by a list of countries from which those illustrated originate. At the end is a list of references, and a taxonomic list of species illustrated, arranged by order and family.

The majority of the photographs are of specimens in Lawrance's collection, augmented by a number from that of Bob Kennedy. The standard of the photographs is almost without exception excellent, and they include trilobites from Europe, Asia, Africa, Australia and the Americas. Some 50% are from the UK and Morocco. My only real quibble with the photographs concerns those of some enrolled specimens (*e.g. Acaste downingiae*; *Wenndorfia* sp.), where, frustratingly, only lateral and anterior, but no dorsal views of the cephalon and pygidium are provided. The trilobites illustrated inevitably include many well-known taxa, but the strength of the atlas lies in the inclusion of a significant number of lesser known species among which are, to my knowledge, the first illustrations of articulated specimens of genera such as *Cyphaspides*, *Koneprusites* and *Boedaspis*. Taken as a whole, it is good to have under one set of covers high-quality illustrations demonstrating the enormous diversity of morphology exhibited by the Trilobita.

Most of the identifications appear to be correct, although some updating is needed here and there; however, *Placoparina sedgwickii* is wrongly attributed to *Placoparia*, and *Warburgella* (*Owensella*) *ludlowensis* is a *Proetus obconicus*. Each photograph has a brief caption providing geological and locality details, plus comments on aspects of the morphology and in some cases

speculation on palaeobiology. Where there are several photographs of the same specimen/species, similar information is unnecessarily repeated – a cross-reference would have sufficed. The stratigraphical terminology employs largely regional names, some of which have been superseded by internationally agreed nomenclature, and it is a pity that the latter was not used.

Unfortunately, the text and figure captions are plagued by a host of minor errors, and this really lets this book down. I will not begin to attempt to list them all here, but here are some examples: the geographical information is commonly incorrect – Bundenbach is in the Hunsrück, not in the Eifel, and nor is Aprath, which is to the east of the Rhine; Dyfed was not formerly Radnorshire – the latter is in Powys; Siberia was not 'formerly part of Russia', but is an intergral part of the Russian Federation; Podolia is not in Siberia, it is in Ukraine, and 'Onjectr' River is presumably Dniestr River. There are incorrect spellings of taxonomic names such as *Cremastoglottos*; *Cornovica*; *musheni*; *sedgwickii*; *ramsayi*; *Zeliszkella*, *Redlichia*, among others. A number of author names are misspelt, including Robison, Linnarsson and Shumard, and diacritical marks are frequently omitted. Mistakes occur in stratigraphical names, *e.g.* Haragan. The morphological terms librigena, pl. librigenae and fixigena, pl. fixigenae are consistently incorrectly referred to as 'librigene', 'librigenes', 'fixigene', 'fixigenes'. The chapter on 'Major trilobite deposits worldwide' provides cross-reference to relevant references. In several cases these are incorrect, for example under Australia, reference 45 relates to Belgium; under Belgium, 118 is to Spitsbergen; Poland, 133 is to Norway; Portugal, 78 is to Australia; Russia, 158 and 184 both to North America. A notice to potential authors by the publishers at the beginning of the book states that 'we specialize in high quality, rapid production'. It seems here that too much emphasis was placed on the latter, sacrificing accuracy of the text, which would have benefited by having been reviewed in advance of publication. This would have improved the book immeasurably. Let's hope that any future editions will be free of the errors in this one.

In spite of inadequacies with the text, the photographs and range of trilobite taxa illustrated in this volume should hold strong appeal to trilobite enthusiasts, amateur and professional. The cover price probably will not!

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Amgueddfa Cymru – National Museum of Wales

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Fossil Insects: An introduction to palaeoentomology

D. Penney and J. E. Jepson. 2014. Siri Scientific Press, Rochdale. 222 pp. £24.99 (paperback). ISBN: 978-0-9574530-6-7. Available direct from the publisher at <**http://www.siriscientificpress.co.uk**>.

This is a very nice general and accessible book that fills a gap in the market. It is produced on good quality paper and has high-quality colour images (240 figures, mostly photographs), many of which have not appeared in print before. The study of such a diverse group, over 400 million years of its history, from around the world, is a huge topic to cover in a general book and the authors have

done an excellent job of covering so many aspects as well as being up to date. However, inevitably there are a few niggling errors or extra facts that would be worth including, which hopefully can be incorporated in the event of a 2nd Edition.

After a short Introduction which includes information on insects in general, the first chapter has the long title 'A note on the geological timescale and the dating of insect fossils'. This includes palaeogeographic maps of each period commencing with the Devonian, however, unfortunately they are not annotated with the names of the land masses that are mentioned in the text. Each period is accompanied by a very nice reconstruction by Richard Bizley, though most of the insects depicted are rare and unusual taxa rather than more common typical components of the fauna.

The third chapter is self-explanatory, 'Insects and their fossilization', discussing their preservation in rock and their exceptional preservation in amber. It is mentioned that silverfish (Zygentoma) are 'reasonably common' in amber but they are actually extremely rare. Perhaps the authors meant springtails (Collembola) instead. Another minor factual error is that the Rhynie Chert, the source of the oldest fossil hexapods in the world, referred to as about 400 million years old, was recently dated as 411.5 million years old (Parry *et al.* 2011). The sub-title in this chapter 'Why study fossil insects?' would have been better as a short chapter in its own right.

This is followed by 'How to study fossil insects' which provides an overview of the simple and sophisticated methods of studying them, such as micro CT-scanning. CT reconstructions of the strange nymph *Anebos phrixos* are provided; however, it is referred to as 'aquatic', whereas the authors who named it concluded it was terrestrial.

The fifth chapter, one of the largest, is a list of 'Significant fossil insect localities'. Brief descriptions are provided for 68 localities, both rock and amber, from around the world, accompanied by photos of some of the more stunning specimens from them. Stage data is provided for most of the localities, though is missing for Solnhofen (Tithonian).

'Diversity of fossil insects' is the longest chapter, which is not surprising. This consists of a list of 48 orders (16 of which are extinct), each with a brief description of the general morphology, the number of described living species, and comments on its fossil record. Again this chapter is accompanied by stunning photographs. Of these, Figure 136 is actually an aquatic bug (Heteroptera), rather than a diving beetle. Nematoceran flies are described in this chapter as having feathery antennae, whereas it is actually only male midges that have feathery antennae.

The seventh chapter 'Insect behaviour and ecology in the fossil record' looks at death assemblages, and insect behaviours. Many of the behaviours, such as parasitism, are known from the exceptional preservation of specimens trapped in amber. Another identification I am uncertain of is Figure 217 which is referred to as a Trichoptera (caddisfly) larva in its case. However, the antennae in this specimen are not typical and the arthropod fragments adhered to the case indicate that it is much more likely to be a predatory larva, such as that of a lacewing (Neuroptera).

Then follow several short chapters on 'Sub-fossil insects', 'Insect trace fossils' and 'How long does an insect species exist?'. The authors list 17 extant species that have been recorded from the fossil record; however, two of them, *Mymaromma anomala* and *Palaeomymar duisburgi*, long referred to as occurring in Baltic amber, are no longer considered to have a fossil record (Gibson *et al*. 2007).

The last short chapter – 'How to become a palaeoentomologist' – although aiming to 'encourage future palaeoentomologists' unfortunately is negative and is likely to put people off from going down this path. I agree that being a generalist in this subject as a paid professional is extremely rare in this country (UK). However there are more opportunities abroad, and given the high diversity and many undescribed species languishing in museum collections, it is possible to become an expert on one particular taxon, and the further back in time you go the less knowledge of recent fauna is required. The index at the end only refers to genera; however, lists of figures by taxonomic order and by deposit are provided at the beginning of the book.

This book appears to be aimed at a general audience, although it does contain some long words for which a definition is not provided, and unfortunately there is no Glossary. This book will be of use to anyone interested in fossil insects, and will be equally useful to the palaeontology lecturer or amateur fossil collector, as well as entomologists. It is reasonably priced for the level of content.

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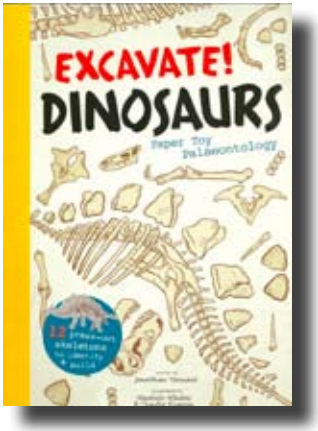
PARRY, S. F., NOBLE, S. R., CROWLEY, Q. C. and WELLMAN, C. H. 2011. A high-precision U-Pb age constraint on the Rhynie Chert Konservat-Lagerstätte: time scale and other implications. *Journal of the Geological Society* **168**, 863–872.

Excavate! Dinosaurs Paper Toy Palaeontology

Jonathan Tennant with illustrations by Vladimir Nikolov and Charlie Simpson. 2014. Ivy Press, Lewes. 80 pp. £12.99 (paperback). ISBN: 9781782401445.



Amidst the plethora of dinosaur books aimed at children of all ages (I am now 42) this is a quite innovative package. The book contains 12 3D models of various dinosaurs, but goes beyond being either another descriptive book about dinosaurs or a craft activity that just happens to be based on dinosaurs.

The first 20 pages deal with a range of topics in two-page spreads, ranging from 'What Were Dinosaurs?' to 'Rebuilding Skeletons' and then a discussion of the Triassic, Jurassic and Cretaceous Periods. The next section is a 'Field Guide' to the dinosaurs, which is a commendable introduction to comparative anatomy, as each description tends to list features under the same headings, where feasible, while highlighting defining

features. The life reconstructions and short paragraphs of text are a good balance between facts and pictures to allow children to tell stories or ask questions about the images, which enhance the educational and re-use value of the book.

Twelve 'Dinosaur Digs' take up the rest of the book. At first glance, these stir memories of the rather dubious science fair staple activity of the sandpit excavation of a cast dinosaur skeleton. I've never excavated a Mesozoic vertebrate by brushing sand off it! However, the idea is that the reader tries to work out which of the dinosaurs they are excavating, based on clues and reference back to the Field Guide pages, helped by the fact that the dig sites indicate which period the dinosaur remains are from. Different dinosaurs are mixed up within each site, so the activities are fairly involved, making them good child-with-adult team affairs.

The text is generally informative, although there are occasional lapses where the text skips a little bit of detail. For instance, the paragraph about *Giraffatitan brancai* that discusses the problem with the notion it was mainly amphibious does not explain that the water pressure would have "crushed" the lungs, not the whole body. The selection of a lively font that is not Comic Sans MS is a blessed relief, as is the standard use of metres and centimetres. Convert the youngsters to metric units early!

The book offers an awful lot of play value that justifies the price tag. You would expect to pay 50p to £1 for a cheap plastic dinosaur (or other tetrapods mislabelled as dinosaurs) so this is a dozen dinos-worth and you get to build them yourself. As a child grows, I think it is possible they will revisit the book, and those who want to take aspects of the science discussed in the book further will be able to do so independently.

Al McGowan
Hills of Hame/BioGeoD, Edinburgh

Books available to review

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

- *Great Transformations in Vertebrate evolution*, by K. P. Dial, N. Shubin and E. L. Brainerd (eds).
- *Techniques for Virtual Palaeontology*, by M. Sutton, I. Rahman and R. Garwood.

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Careering off course!

Inspirational palaeontologists

Jenny McElwain is a palaeobotanist at University College Dublin (UCD) in Ireland. She is an Associate Professor of UCD's School of Biology and Environmental Science, member of UCD's Earth Institute, and Director of the Programme for Experimental Atmospheres and Climate (PEAC) facility. Over the past 20 years her research and teaching have focused on the development and use of palaeobiological proxies to understand the evolution of Earth's atmosphere and climate on multimillion year timescales, and how fluctuations in both have influenced large scale patterns in plant evolution. She has published over 75 papers including research articles, book chapters and two editions of an undergraduate textbook '*The Evolution of Plants*'. Before joining UCD in 2006 she was an associate curator of fossil plants at the Field Museum of Natural History in Chicago, USA (2000–2006) and a post-doctoral researcher at the University of Sheffield, UK (2003–2006). She graduated from Trinity College Dublin (TCD), Ireland, with a BA in Botany in 1993 and from Royal Holloway, University of London, UK, with a PhD in 1997.

When did you first get interested in palaeontology?
In the first year in my undergraduate degree at TCD following a course in quaternary palynology and geomorphology of the Irish landscape. I was also very much influenced by my first exposure to fossil plants in a lab by Geoff Clayton at Trinity.

When did you decide to follow the career path you are on now?
During my undergraduate dissertation project which was on stomatal density changes throughout Holocene sediments in the West of Ireland. I started the project as a 'stomatal density proxy sceptic' and was surprised to find myself a convert to stomata and research in general by the end of it.

What are you most proud of in your career to date?
That I have survived despite many ups and downs. I am also immensely proud of all my former students and post-docs who have gone on to achieve independent research careers all over the world.

What is your favourite fossil and why?
That is very difficult. I think it has to be *Ginkgo minuta* from the late Triassic of Greenland. Why was it so small?!

In an average week, how many hours do you work?
I try to have a good work-family/life balance so I usually work 45 to 50 hours a week and never at weekends unless I have a big deadline.

How many people do you work with on a daily basis?
There are currently about 12 people in my lab and we are grouped together in connected office and lab space so I interact with at least five or six people every day for research and usually many more. When I am teaching I could be interacting with a class of 350 or 25. When I'm writing I try to avoid everyone and hide at home to concentrate.

What gives you the most satisfaction in your job?
Science, continuous discovery, new ideas, exposure to different minds and ideas, teaching. I love my job, basically, and the only thing I'm not particularly keen on is the admin.

What are the worst things about your job?
Rejection of research grants, tough peer reviews, rejection of new ideas expressed in manuscripts. As an academic we are constantly under peer review no matter what stage of career we're at. It does not get any easier but you do learn not to take it so personally.

Do you get to do much overseas travel for work and do you do much fieldwork?
I have had great opportunities in my career to travel for fieldwork and work purposes. I have travelled to almost every continent to collect modern or fossil plants or to speak at conferences or departmental seminar series. My lab are currently in Fiji collecting tropical plants for a big modern trait-based study to help interpret fossil plant physiology and function. Follow the blog of the field work at <**http://www.ucd.ie/plantpalaeo/**>.

Has there been a paper or book that has influenced your career?
The Shell Guide to Reading the Irish Landscape by Frank Mitchell had a huge influence on me as an undergraduate student. I had no idea that vegetation could be tracked in the past or reconstructed using the pollen and spore record until I read this book. I started to look at the whole landscape differently once I realised the processes that had shaped different features. I think this is where I got the bug for palaeo.

Who have been the most important mentors in your career so far?
My undergraduate supervisors Fraser Mitchell (not related to Frank Mitchell!) and Mike Jones, and my PhD supervisor Bill Chaloner. Bill was particularly wonderful because he was so generous with his time and patience. His door was always open and he kept up a subtle but encouraging pressure throughout my PhD which kept me on track and prevented me from going off on tangents. Ian Woodward at Sheffield was also a wonderful post-doc mentor – he was always full of humour and incredibly enthusiastic about science and discovery.

What has been the best career advice you have received?
The best career advice I have ever been given was by Ian Woodward who said that you need staying power to succeed in academia. In other words you need to be able to accept or deal with the set-backs and try again. Mostly this means re-submitting a paper or grant if they get rejected.

Are there any major obstacles to being successful in a career like yours?
The biggest issue is that there are far more brilliant and capable people than there are jobs available. The competition to get a permanent job is therefore getting harder and harder. My advice is to start early to think about developing a research programme. Think about the key question that will drive your work over a 5 and 10 year period and focus all your efforts towards that goal. A set of quality publications that are coherent in terms of an overarching question or theme are more important than many publications touching on a lot of different subjects.

If you could have dinner with a famous palaeontologist (living or dead), who would you choose?
I would love to go for dinner with Tom Harris and learn about his exploits in East Greenland in the 1920s. I would also like to have dinner with Marie Stopes. She seems to have been a formidable woman and palaeobotanist who was an innovator of women's rights.

For jobs in academia the following websites may be useful, as well as individual university's websites:

<**http://www.jobs.ac.uk/**>
<**http://www.earthworks-jobs.com/**>

Palaeontology

VOLUME 58 • PART 3

CONTENTS

Palaeontology

VOLUME 58 • PART 4

CONTENTS

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