# The Palaeontology Newsletter

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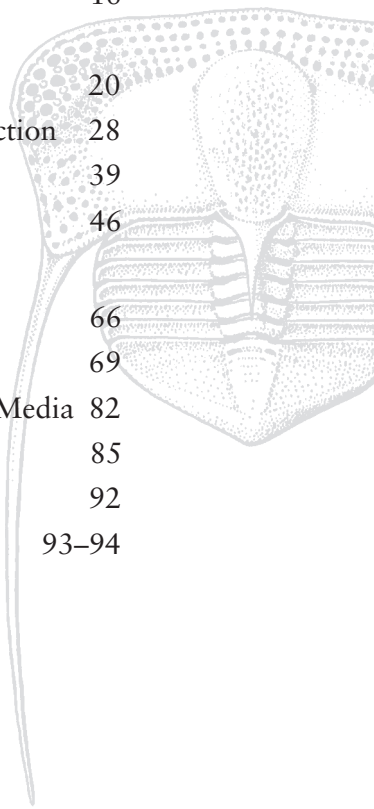

Reminder: The deadline for copy for Issue no 86 is 9th June 2014.

On the Web: <**http://www.palass.org** />

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# Editorial

The role of Newsletter Reporter is becoming part of the portfolio of responsibilities of the PalAss Publicity Officer, which is Liam Herringshaw's new post on Council. This reflects a broader re-organization of posts on Council that are aimed at enhancing the efforts of the Association. Council now includes the posts of Education Officer and Outreach Officer, who will, along with the Publicity Officer, develop strategies to engage with different target audiences. The Association has done what it can to stay abreast of developments in social media, through the establishment of the Palass Twitter Feed (@ThePalAss), the development of Palaeontology [online] and the work of Palaeocast, which is a project that has received support from the Association. Progressive Palaeontology has more or less migrated to Facebook. Such methods of delivery have overtaken the Newsletter, the News side-boxes on the Pal Ass website and …

However, our real asset in the publicity sphere is you, the members. As palaeontologists, we hold the subject-specific knowledge and the links among the different spheres of knowledge in the other sciences that contribute to our understanding of the history of life. To those outside of our workplaces, we're people that you don't meet every day, and I would be surprised if you have not found people of all ages bursting with questions or asking you about a fossil they have found when they find out you're a palaeontologist. Such moments act as chances for personal contact that cost nothing except a few minutes of your time. Even better, get into the habit of carrying a few objects around with you, whether it is fossils, an SEM image or a microfossil card, that people can handle, along with a cheap hand lens.

The best places to get a lot of experience in face-to-face engagement is at big events, whether science festivals or the more focused fossil festivals. This year the Association is involved in two: the Lyme Regis Fossil Festival and a new one on the Yorkshire Coast. However, it will really help our new troika of officers if they hear about what you've been doing and what has worked well in different settings. We're also happy to take reports of outreach activity in the *Newsletter*. We can't offer the instant fame of trending on Twitter but we can offer a permanent record, freely available in the PDF version on the web, that is accessible and more than 140 characters long.

**Al McGowan**
*University of Glasgow*
*Newsletter Editor*
**<newsletter@palass.or g>**

# Association Business

## Annual Meeting 2014

**Notification of the 2014 Annual Meeting, AGM and Annual Address**

The 2014 Annual Meeting of the Palaeontological Association will be held at Leeds University, UK, on 16–19 December, organised by Dr Crispin Little and colleagues in the School of Earth and Environment.

## Nominations for Council

At the AGM in December 2014, the following vacancies will occur on Council:

- Vice President
- Newsletter Editor
- Book Review Editor
- Meetings Coordinator
- Ordinary Members (max. 2)

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. Nomination must be accompanied by the candidate's written agreement to stand for election and a single sentence describing his or her 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'. Further information on the responsibilities of Trustees can be obtained from <**secretary@palass.or g**>.

The closing date for nominations is 8th October 2014. They should be sent to the Secretary: Prof. Richard J. Twitchett, School of Geography, Earth and Environmental Sciences, Plymouth University, Plymouth, PL4 8AA, UK; email<**secretary@palass.or g**>.

The following nominations have already been received:

> Meetings Coordinator: Dr T. Vandenbroucke (2nd term)

# Grants-in-Aid

## Grants-in-Aid: Meetings

The Palaeontological Association is happy to receive applications for loans or grants from the organizers of scientific meetings that lie conformably with its charitable purpose, which is to promote research in palaeontology and its allied sciences. Application should be made in good time by the scientific organizer(s) of the meeting using the online application form (see 'Awards and Grants' > 'Grant-in-aid schemes' at <**www.palass.org**>). Such requests will be considered by Council at the March and the October Council Meetings each year. Inquiries may be made to <**secretary@palass.org**>, and requests should be sent by **1st March** or **25th September** 2014.

## Grants-in-Aid: workshops and short courses

The Palaeontological Association is happy to receive applications for loans or grants from the organizers of scientific workshops or short courses that lie conformably with its charitable purpose, which is to promote research in palaeontology and its allied sciences. Application should be made in good time by the scientific organizer(s) of the meeting using the online application form (see 'Awards and Grants' > 'Grant-in-aid schemes' at <**www.palass.org**>). Such requests will be considered by Council at its March and October Meetings each year. Inquiries may be made to <**secretary@palass.org**>, and requests should be sent by **1st March** or **25th September** 2014.

# Postgraduate Travel Fund and EGU 2014

We would like to remind the members of the Association that we provide funding to help postgraduate students with travel expenses for attending international conferences of their choice. Postgraduate students who are members of the Association can claim up to £200. Awardees are expected to give a presentation that falls within the scope of the Association's charitable aims.

Applications can be made very easily online via the website, up to two months before the meeting. You only need to send us a copy of the message that your talk/poster has been accepted, along with some other details. Everything is explained on the web page. We encourage all our postgraduate student members to take advantage of this opportunity!

An additional number of these 'postgrad travel grants' are made available specifically for the EGU 2014 meeting (27 April – 2 May) in Vienna, to support student members presenting in EGU sessions with a palaeontological topic. The list of sessions can be found on the postgrad-travel webpage, or directly on the EGU 2014 website. You can apply for these EGU-travel grants up to one week before the meeting (deadline 20th April).

**Thijs Vandenbroucke**
*Meetings coordinator*

# Awards and Prizes: AGM 2013

## *Lapworth Medal: Prof. Dianne Edwards, CBE, FLSW, FSB, FRSE, FRS*

*Charlie Wellman writes*: Dianne was trained as a botanist at Cambridge and has spent all of her subsequent academic life in Cardiff, where she has studied fossils of the earliest land plants and lectured in all aspects of elementary botany, plant diversity and palaeobotany. Dianne began as a postdoctoral Fellow of the University of Wales and ended up as Head of the School of Earth and Ocean Sciences and Distinguished Research Professor, a position she still holds with additional responsibilities for innovation and engagement.

Dianne's pioneering research involves discoveries and descriptions of *c*. 400 million year old plant fossils – plants that transformed terrestrial surfaces, creating soil and habitats for animals while modifying the atmosphere by increasing rock weathering and draw-down of carbon dioxide. Throughout her career Dianne has collaborated with geologists, chemists and, most particularly, neobotanists as she attempts to reconstruct the fossils as living plants. Dianne has also helped facilitate palaeobotanical researches in China and South America where she has travelled extensively.

Dianne admits to having enjoyed the enormous privilege of undertaking fundamental, pure research while developing Earth Sciences in Cardiff as a world centre for integrated studies on early land plants. She was also involved in bringing geomicrobiological research to the School, with the appointment of the international leader in this area, Professor John Parkes FRS, in 2003, thus creating a unique combination of world-leading research.

Latterly Dianne has become increasingly involved in university administration and wider service in the community. She was a founder trustee of the National Botanic Garden of Wales and directly involved in its development, having been greatly inspired by membership of the boards of the Royal Botanic Garden Edinburgh and the Countryside Council of Wales. Her interests in museums and their taxonomic activities have been progressed by a long association with the National Museum of Wales and as a trustee of the Natural History Museum. Dianne sits on a number of senior Royal Society committees and is a member of the Leverhulme Trust Advisory Panel. A founder fellow of the Learned Society of Wales, Dianne is now the vice-president in charge of STEM subjects. She is a past president of the Palaeontological Association and currently President of the Linnean Society of London.

**Dianne Edwards' Awards**

| | | |
|---|---|---|
| 1988– | National Museum of Wales | Honorary Research Fellow |
| 1989 | Geological Soc, London | Lyell Fund |
| 1993 | Geol Soc, Glasgow | T N George Medal |
| 1994 | Botanical Soc of America | Corresponding member |
| 1994–1995 | Leverhulme Trust | Senior Research Fellow |
| 1996– | Fellow of the Royal Society | |
| 1997– | University of Wales, Swansea | Honorary Fellow |
| 1999 | CBE (Queen's Birthday List) | |
| 2001– | Fellow of the Royal Society (Edinburgh) | |
| 2004 | Geological Society, London | Lyell Medal |
| 2005 | University of Dublin | Honorary Sc. D. |
| 2010 | Linnean Society | Botany Medal |
| 2010 | Palaeontological Association | Life membership |
| 2010 | Institute of Biology | Fellow |
| 2010 | Learned Society of Wales | Founder Fellow, Vice President |
| 2014 | University of Uppsala | Honorary Sc. D. |

# *President's Prize: Prof. Charles Wellman*

*Thomas Servais writes:* I am pleased to propose the nomination of Prof. Charles H. Wellman for the award of the President's Medal in 2013. Being of the same generation, I have known Charles almost from the beginning of his career, as we met regularly at international conferences (and for several years in the PalAss Council), and I have always been impressed by his scientific excellence and personal modesty. After a B.Sc. (1987) at the University of Southampton, Charles completed his Ph.D. (1991) at Cardiff University, followed by a first PDRA at The Natural History Museum, London (1991–1992) and a second PDRA at Cardiff University (1994–1997). He was appointed Lecturer, Senior Lecturer and Reader at the University of Sheffield (1997–present).

Charles Wellman is very well respected within the palaeobotanical community in the UK and overseas. He is today clearly recognized as the leading expert of the origin of plants. His international recognition is evidenced by frequent invitations to speak at international meetings, his involvement in collaborative research in different parts of the world (China, Oman, Saudi Arabia, Spitsbergen, *etc.*), his participation in review processes and editorial boards, and his publication record in high-quality peer-reviewed journals.

Charlie's research addresses the highly topical and controversial problem of the origin and early evolution of land plants. Fossil evidence is in the form of early land plant megafossils and dispersed microfossils – spores and fragments. Some of the major discoveries include the oldest fragments of land plants from Oman (*Nature* 2003), the oldest land-plant-derived miospores from Saudi Arabia (*Science* 2009), and the earliest non-marine eukaryotes (*Nature* 2011). Charlie also investigates living plants in order to interpret the earliest land plant fossils by integrating cladistic analyses of evolutionary relationships, molecular clock analyses of evolutionary divergence times, and analysis of physiological adaptations required for plants to invade the land (particularly Evo-Devo studies on the molecular genetics of spore/pollen wall development). In addition, Charlie explores the

impact of the invasion of the land by plants on global change, for example the long-term changes in ultraviolet-B radiation (*Nature Geoscience* 2008).

Charlie was and is very active in the national and international network of scientists. After being Secretary/Treasurer of the Commission Internationale de Microflore du Paléozoïque (the largest association of Palaeozoic palynologists), he was first Councillor (2000–2004), then Committee Member and Newsletter Editor (2004–2008) and Committee Member and Secretary Treasurer (2008–2012) of the International Federation of Palynological Sciences (the 'palynological equivalent' of the IPA – International Paleontological Association), before being elected to be its President (2012–2016). Charlie was also a Council Member 2000–2008 and a Vice President (2007–2008) of the Palaeontological Association.

In sum, these achievements make Charles Wellman a worthy candidate for the President's Medal.

# *Hodson Award: Dr Matthew Friedman*

*Zerina Johanson writes*: Matt completed his B.Sc. at the University of Rochester, New York, before undertaking an M.Sc. at Cambridge and a Ph.D. at the University of Chicago. One measure of his achievements, even at this early point in his career, is that he immediately took up a position at Oxford University after his Ph.D. (having also been awarded a Newton Fellowship at the Natural History Museum, which, unfortunately for us, he turned down). I've known Matt since 2007, and I am amazed at how much he has accomplished in such a short period of time. He has literally revolutionized the study of teleost evolution, bringing new perspectives that address broader questions of diversity and disparity, and rates of evolution through the fossil record. This work, with titles such as 'Resolution of ray-finned fish phylogeny and timing of diversification', is being published in major journals such as *Nature*, *Science*, *PNAS* and *Proceedings B*.

I am currently involved in two major research grants with Matt: one addressing the evolution of the major teleost group Acanthomorpha (NERC), and a second that proposes to bridge the research gap

between ichthyologists and palaeoichthyologists through morphometric study of 3D fish skulls from the British Chalk and London Clay (Leverhulme). And, he is currently holding a second NERC research award as well. This is almost unprecedented for someone who has only held a position for three years.

*Matt Friedman "amongst his subjects". (Photo: Zerina Johanson)*

Matt hasn't restricted himself to the teleosts, having also published several papers on sarcopterygian relationships, including one that established a framework for resolving various poorly known or misinterpreted fossil taxa as stem- or crown-group sarcopterygians and actinopterygians. This paper was awarded the Taylor and Francis Best Student Paper in the *Journal of Vertebrate Paleontology* (2010). I'm the Chair of this prize committee, and all committee members praised Matt's paper highly. Matt has fully taken on the teaching and administrative responsibilities of an Oxford lecturer and has impressive capabilities as a supervisor. He also teaches at Cambridge (as part of Jenny Clack's 'Topics in Vertebrate Evolution' module), and presents interesting, engaging talks at several conferences per year.

# *Mary Anning Award: Dr Hans Hess*

*PalAss President Mike Benton presents Dr Hess with his Award. (Photo: Andy Gale)*

*George Sevastopulo, Bill Ausich, Andy Gale, Mike Simms and Andrew Smith write:*Hans Hess is an outstanding amateur Swiss palaeontologist, who has made extensive collections of Jurassic fossils from Switzerland and elsewhere, now in Basel Natural History Museum, and has published more than 80 papers and books dealing with fossil echinoderms.

Fossil crinoids have always been the main focus of Hans' work. His first paper in 1951 described a new crinoid, *Paracomatula helvetica*, that remains a key taxon in our understanding of the early evolution of comatulid crinoids, and since then he has remained at the forefront of Mesozoic crinoid research. His papers have addressed various aspects of systematics and taxonomy, together with palaeobiology, taphonomy and even biochemistry. Publications have ranged from short papers to monographic works describing many new genera and species. Through his meticulous attention to detail and thorough descriptions he has increased significantly our awareness of the taxonomic and morphological diversity of Jurassic crinoids. Other echinoderm groups have not been neglected, with significant publications on asteroids, echinoids and ophiuroids. In particular he was the first to undertake a systematic analysis of disarticulated ophiuroid ossicles back in the 1960s, an avenue of research that only now is being revisited.

Several substantial works have been aimed at a broader palaeontological audience, among them an overview of fossil echinoderms of the Swiss Jurassic published in 1975, and the highly successful *Fossil Crinoids* book, for which Hans was the instigator and driving force. More than a decade later this latter work remains as much the standard text for this group as ever. Among his more recent works was a complete rewrite of the articulate crinoid volume of the *Treatise on Invertebrate Palaeontology*, a truly formidable undertaking but one which he carried out with his customary efficiency, attention to detail and, for a *Treatise* volume, remarkable speed. Today Hans, at 83, remains as productive as ever, with several manuscripts submitted each year and various collaborative projects under way.

# Small Grant Awards AGM 2013

The small grants awarded for 2014 by the Association include the Sylvester-Bradley, Callomon and Whittington awards. Council agreed that the following applicants should receive Sylvester-Bradley awards: Dr Milo Barham (£1,500), Nathan Barling (£1,395.50), Luke Hauser (£520), Laura McLennan (£1,500), and Michael O'Sullivan (£1,468). The Callomon Award was awarded to Edine Pape (£1,300), and the Whittington Award to Dr Cecilia Apaldetti (£1,500).

## *Evolutionary patterns of Early Sauropodomorpha*

**Cecilia Apaldetti**
*Museo Paleontológico Egidio Feruglio, Argentina*

Basal sauropodomorphs, known as 'prosauropods', represent the first large radiation of herbivorous dinosaurs that dominated Pangaea for approximately 40 Ma (Late Triassic – Early Jurassic). They are well known around the world although many aspects of their history – especially their phylogenetic and biogeographic relationships – remain uncertain. Recent studies show biogeographic patterns among basal sauropodomorphs, evidenced by the close relationships of several taxa from Southern Pangaea. The endemic distribution of some clades in Southern Pangaea is supported by the close affinities of the Late Triassic and Early Jurassic taxa from South America, South Africa and Antarctica. In a phylogenetic context, these taxa represent key points on the evolution of basal sauropodomorphs towards sauropods, as some of them are successive outgroups to the transitional forms leading towards Sauropoda. This project focuses on the anatomical study of non-sauropod sauropodomorphs recorded in the Triassic and Jurassic of the southern hemisphere, with the aim of incorporating new information into a biogeographic analysis utilizing evolutionary relationships of sauropodomorphs. The main objective is to increase knowledge about the evolutionary history of basal sauropodomorphs, exploring anatomical, phylogenetic and biogeographic aspects to reach a comprehensive understanding of their distribution and evolution during the Late Triassic – Early Jurassic of Pangaea.

## *Exploring controls of $\delta^{18}O$ in micro-mammal teeth*

**Milo Barham**
*Curtin University of Technology*

Since the discovery (several decades ago) that the different isotopes of oxygen fractionate into mineralised tissues of creatures under constrainable conditions, the search has been on for high-fidelity oxygen-bearing biological media to reconstruct aridity, temperature and salinity of Earth's ancient environments. Recently, due to advances in analytical techniques and understanding of micro-mammal metabolism, the dense, robust enamel of micro-mammal teeth has been proposed as an important and under-exploited high-resolution archive of palaeoenvironmental data for the Cenozoic. However, a significant, and as yet unexplored, potential problem with the

use of micro-mammal remains is the fact that their abundance in sediments at archaeological and geological sites is a result of predation, ingestion and eventual excretion/regurgitation. This project will test the effect of ingestion on micro-mammal teeth fed to zoo and sanctuary-based predators (varying taxa, health and sex). The preservation of material will be assessed using microscopy and geochemistry. The oxygen isotope composition of the teeth from scats/pellets and non-ingested controls will then be analysed (using in-situ ion-probe and isotope ratio mass spectrometry) to test the application of this biogenic apatite media in palaeoenvironmental reconstructions. This project will represent a key proof-of-concept study that may influence whether micro-mammal teeth succeed in becoming established as common O-isotope media.

## *Taphonomy of Cretaceous Odonata from the Crato Formation*

**Nathan Barling**
*University of Portsmouth*

The Early Cretaceous Crato Formation of Brazil yields an abundant and highly diverse assemblage of some of the most exceptionally preserved non-amber fossil insects known. Both internal and external structures can be preserved, sometimes with nanometre scale resolution, including organs that usually decay within hours after death. Despite this astonishing preservation, the majority of work on Crato insects to date has focused on their systematics. The extent and processes of preservation have only been examined briefly, and this project aims to investigate the fidelity and mode of insect preservation in more detail.

The largest collections in Europe are held in museums in Stuttgart and Karlsruhe, with smaller collections in Berlin and Frankfurt. In particular, the Crato Odonata have been well collected and a large number of specimens are held in Stuttgart. This group provides an excellent opportunity to perform a statistically sound taphonomic analysis due to the high abundance of specimens, the morphological similarity within the group, and their chronostatic ecology.

With the aid of the Small Grants scheme I will be able to study these collections in detail and obtain donated specimens for more thorough SEM analysis, linked to an overall self-funded Ph.D. project elucidating the fidelity of preservation of the Crato Formation insects.

## *The palaeontology and sedimentology of the Downton Bone Bed*

**Luke Hauser**
*University of Portsmouth*

Research is being undertaken on the documentation of the Downton Bone Bed, from a section in the Upper Silurian (Ludlow Series) of Shropshire, UK. Despite there being over two centuries of investigation in the area, this bone bed remains very poorly documented. This section is of significance, as it represents an important time in the history of life, the colonization of land.

Previous studies of the Ludlow Bone Bed have yielded fossil remains of jawless fish, early jawed vertebrates in addition to early plants, and some of the first land animals (Arthropoda). It is thought that the Downton Bone Bed will contain a similar fauna and flora due to its stratigraphic position less than 2 m above the Ludlow Bone Bed.

The aims of this project are to document and describe all of the macro- and micro-fauna and flora found in the section, and to analyse sedimentologically the bone bed to enable an interpretation of the palaeoenvironment and palaeoecology. The main objective for fieldwork in 2014 is to collect more lithological samples for the extraction of microfossils from the host rock. Additional samples will also be required to complete the sedimentological analysis of the bone bed. The other aim is to determine the lateral extent of the bone bed. The expected outcome of this fieldwork is the completion of the PhD thesis, which will lead to a number of papers on the palaeoecology, sedimentology and different taxa described from the Downton Bone Bed.

# *Did the Great White shark cause Megalodon's extinction?*

**Laura McLennan**
*University of Leicester*

The Great White Shark (*Carcharodon carcharias*) and Megalodon (*Carcharocles megalodon*) have iconic status as apex predators. Understanding the evolution and ecological interactions between them is thus a research topic of appeal and interest. Recent research has suggested that *C. megalodon* was driven to extinction through competition for food with *C. carcharias*. This hypothesis is controversial, not least because evidence of competitive replacement in the fossil record is rare.

For competition to occur between *C. carcharias* and *C. megalodon* for food, they must have had the same diet when they coexisted in the Pliocene. Modern adult *C. carcharias* consume fish, sharks and marine mammals. It is believed that *C. megalodon* had a very similar diet. These hypotheses of past diets are consistent with the theory of competitive replacement, but the evidence for diet in fossil representatives of these species is weak.

This project will use a new approach to establish whether the diets of these two species were the same. Quantitative microtextural analysis of tooth surface wear has been shown to be a successful dietary discriminator in other animal groups. Casts of teeth of both species, from the Florida Museum of Natural History, will be analysed using an Alicona infinite focus microscope to answer the question, "does the texture of tooth microwear differ between *C. carcharias* and *C. megalodon*?" This will provide an independent test for the hypothesis of competitive replacement.

# The Taxonomy of British Jurassic Pterosaurs

**Michael O'Sullivan**
*University of Portsmouth*

The UK is one of only two European countries with deposits that have produced a large number of pterosaur remains. While the majority of pterosaurs are of poor quality, over 400 fossils have been recovered. One of the most significant of these formations is the Bathonian Taynton Limestone Formation, more commonly known as the Stonesfield Slate. 90–95% of these fossils are appendicular elements. The rest are isolated jaws and three cranial specimens. Bar one or two exceptions, none of this material has been discussed or described. Preliminary examination of *Parapsicephalus* (GSM 3166) results support the maintaining of it as a unique genus, and the specimen was recently CT scanned at the Natural History Museum. The nature of *Rhamphocephalus prestwichi* (OUM J28266, Bathonian, Stonesfield) has been questioned in the past, therefore the holotype is being re-described. All other known specimens of UK Jurassic pterosaurs have been databased and catalogued and are currently undergoing examination in the hopes of finding valuable taxonomic signatures. Four manuscripts are currently being developed including the first record of a family previously unrecorded in Britain.

# Chemosymbiosis in methane seep fossils from Japan

**Edine Pape**
*University of Leeds*

Chemosymbiosis is an unusual nutritional strategy that makes it possible for marine invertebrates to live in the inhospitable conditions of the deep sea. The animals harbour bacteria in their gills that provide nutrition, by using gases coming from the seafloor as an energy source to fix carbon. But despite the ecological importance of this symbiosis, its evolutionary history is poorly understood, as it has not been possible to definitively prove the presence of chemosymbiosis in the fossil record. By investigating organic matter present in the shells of bivalves and brachiopods, we aim to trace chemosymbiosis through geological time. The carbon, sulphur and nitrogen stable isotope values of shell-bound organic matter reflect the nutritional strategy of the animal, independent of geological indicators. If preserved in fossils, this will allow us to investigate the evolutionary relationship between chemosymbiosis and Phanerozoic seep and vent fauna. In addition, the occurrence of chemosymbiosis can be related to environmental factors, such as seawater chemistry changes. To enhance the existing suite of fossil material available for this research, funding is sought to allow sampling of two fossil seep localities in Japan: the Miocene Izuro seep and the Pleistocene Kakinokidai seep. Their recent geological age and excellent preservation will be invaluable for assessing the occurrence of chemosymbiosis in this time period, as well as interpreting results of more ancient localities.

# Advance notice about subscription changes in 2015

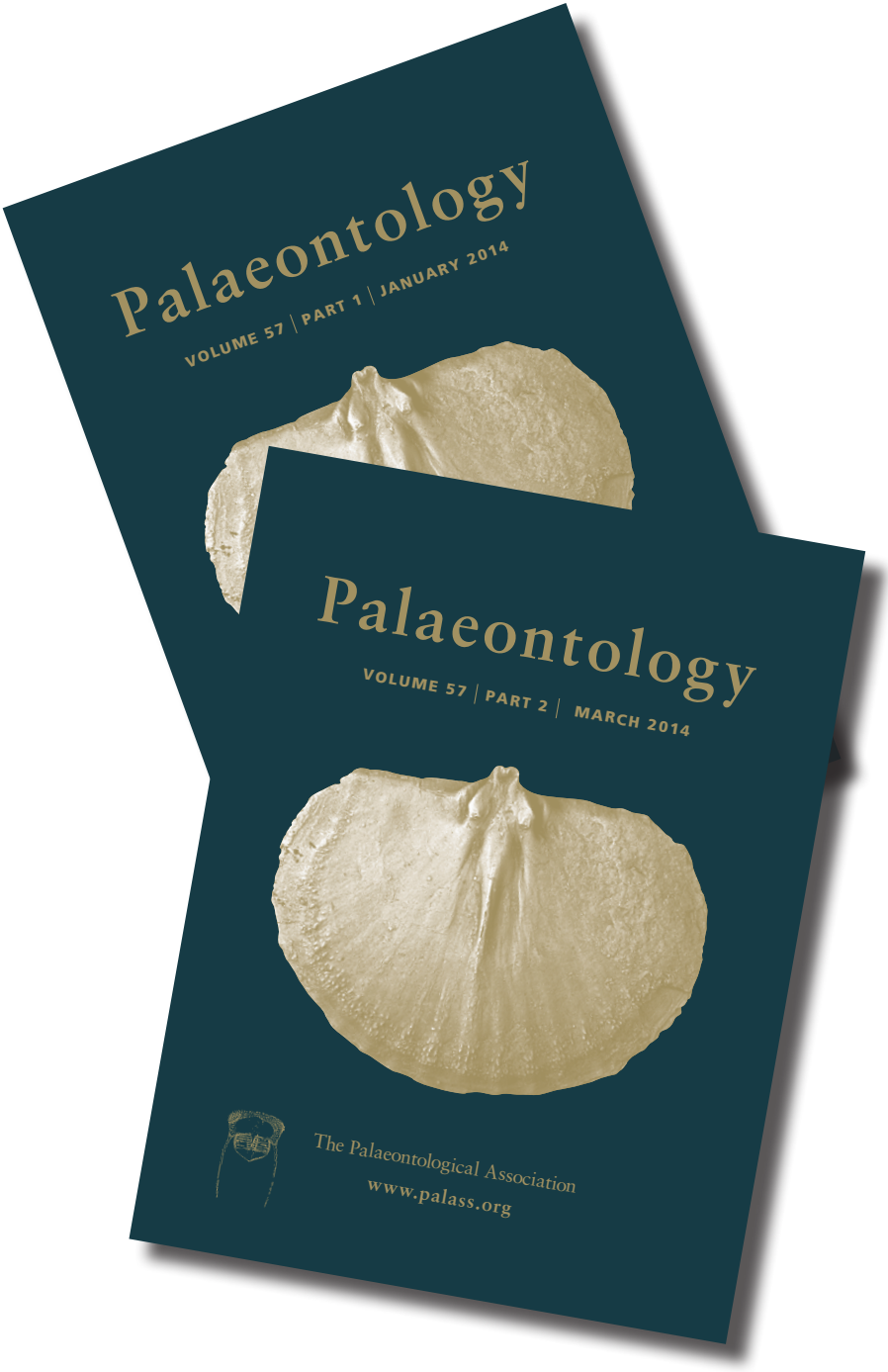
Many of you will know that some changes to the costs of membership were agreed at the AGM held in Zurich on Saturday 14th December 2013. These will begin in 2015 with *Palaeontology* volume **58**. The main reason behind these decisions was to reduce the membership subscription for those who elect to receive *Palaeontology* in the electronic version only (currently there is no subscription reduction for the 200 or so members who do this), and to increase the subscription to members who want both electronic and paper copies to better reflect the additional costs of printing and (particularly) mailing. The new prices will be as follows:

| | |
|---|---|
| Ordinary Member online only | 30.00 GBP |
| Ordinary Member online + print | 45.00 GBP |
| Retired Member online only | 15.00 GBP |
| Retired Member online + print | 36.00 GBP |
| Student Member online only | 15.00 GBP |
| Student Member online + print | 36.00 GBP |
| *Special Papers* supplement | 30.00 GBP |

Final arrangements are still being discussed, and more details will be given in the next Newsletter. The subscription forms that we use will obviously reflect the changed rates. However, if you are an Ordinary or a Retired member (not a Student member) who currently pays your subscription by Standing Order with your UK bank, then you will need to change the details of this arrangement with them (we cannot do this for a Standing Order). Please contact your bank to make the changes; subscriptions are due on 1st January of the year in question. You may even prefer to cancel your Standing Order and renew online through the renewals pages at <**www.palass.org**>, using your username and password to pay through Worldpay. This is the easiest method for us, and will bring about your access to the online *Palaeontology* automatically, without your needing to contact us.

History shows that getting the last 10% of the membership to update their Standing Order details every time we make a subscription change is a thankless task, and that there is a rump of recalcitrant members who never get round to doing this, even having received many reminders and much pleading. You may be one of them. We eventually stop providing their (your?) full requirements, so if you do not want to be treated in this cavalier manner, please update now. It will be clear from our bank statements and records what you have done, so you don't need to tell us as well.

**Tim Palmer**
*Executive Officer*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# ASSOCIATION MEETINGS

**58th Annual Meeting of the Palaeontological Association**
University of Leeds, UK *16 – 19 December 2014*

The 58th Annual Meeting of the Palaeontological Association will be held at the University of Leeds, UK, organized by Crispin Little, Fiona Gill, and colleagues from the School of Earth and Environment.

**Symposium and Annual Address**
The meeting will begin with a symposium on Tuesday 16th December, followed by the Annual Address and an evening reception in the Parkinson Building of the University.

The topic for the Annual Symposium this year is 'The photosynthesis revolution: how plants and photosynthetic micro-organisms have bioengineered the planet'.

Confirmed speakers are Professor Simon Poulton (University of Leeds), Dr Bettina Schirrmeister (University of Bristol), Professor Charles Wellman (University of Sheffield), Dr Nick Butterfield (University of Cambridge), Professor Dianne Edwards (Cardiff University), Professor David Beerling (University of Sheffield), Professor Else Marie Friis (Swedish Museum of Natural History) and Dr James Riding (British Geological Survey).

The Annual Address will be given by Professor Alan Haywood (School of Earth and Environment, University of Leeds).

**Conference**
The conference will commence on Wednesday 17th December with a full day of talks and posters. In the evening there will be the Annual Dinner at the Leeds City Museum.

Thursday 18th December will be a full day of posters and talks in parallel sessions (depending on demand). The Association AGM will take place after lunch. Talks for both days will be allocated 15 minutes including questions. Posters will be displayed throughout the meeting in the same venue as the refreshments, buffet lunch and advertisers' stands.

A field-trip to explore some local Yorkshire geology and collect fossils is planned for Friday 19th December. The location is still being planned; details will be available later, in the next *Newsletter* and on the website.

**Venue and travel**
The conference will take place in the campus of the University of Leeds, which is located close to Leeds city centre, about 15 minutes walk from Leeds train station, or a very short taxi ride. Talks will take place in the Conference Auditorium on Tuesday and Wednesday, and the Roger Stevens Building on Thursday. Posters and refreshments will be in one of the Sports Halls in the Edge. Campus maps are available at <**www.leeds.ac.uk/info/20014/about/157/how_to_find_u s**>; hard copies will be provided at registration, which will take place in the Conference Auditorium atrium during the meeting.

Accommodation is available within walking distance of the University and the city centre. The Annual Dinner venue is in the city, also within easy walking distance.

**Getting to Leeds**

*By Train*

Leeds is on the main inter-city train network, so is easily accessible from anywhere in the UK, and this is probably the best travel option. Booking early will get the best ticket prices, particularly if travelling from London on East Coast Trains (<**www.eastcoast.co.u k**>). From Leeds train station the University is a 20 minute walk uphill to the North (see link above). For local transport links see <**www.wymetro.co m**>.

*By Bus*

Intercity buses arrive in the south side of Leeds city centre, about 30 minutes walk from the University. Buses are usually cheaper than trains. For information see National Express Coaches (<**www.nationalexpress.co m**>) and Megabus (<**www.uk.megabus.co m**>).

*By Car*

There is limited parking around the University, and almost none on campus, so driving is not the best option. The closest major car park (which is expensive) is Woodhouse Lane Car Park (LS2 3AX).

*By Plane*

Leeds is served by Leeds-Bradford Airport (LBA), which has connections to many other European cities (see <**www.leedsbradfordairport.co.u k**>). The airport is about 30 minutes drive to the North of the city, depending on traffic. There are buses into Leeds bus station, or a taxi booking service. Alternatively, the much bigger Manchester Airport (MAN, see <**www.manchesterairport.co.u k**>) is 1.5 hours away by train (<**www.tpexpress.co.u k**>) from Leeds. Another option is to fly into London airports and get an intercity train to Leeds from London Kings Cross station (<**www.eastcoast.co.u k**>). These run every 30 minutes or so, and the journey takes about 2.5 hours.

*Taxis*

Leeds city taxis are black and white, and there a good number of designated stops around the city, including outside train stations and the Parkinson Building of the University. There are also lots of local-hire taxis that have to be booked. One is Amber Cars (0113 231 1366).

**Registration and booking**

Registration, booking and abstract submission will commence in June 2014. Abstract submission will close in September (exact date to be confirmed) and abstracts submitted after this date will not be considered. Registration after this date will incur an additional administration charge of approximately £30, with the final deadline in November 2014. 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 available online via the Palaeontological Association website (<**palass.org**>) from June 2014.

**Accommodation**

This needs to be booked separately.

Leeds has a wide variety of hotels, hostels and guest-houses at a range of prices that can be booked through the usual on-line resources. We will be attempting to block-book some hotels nearby the University at reduced rates. More information about these and other accommodation will be available in the next *Newsletter* and on the meeting website in due course.

**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 poster. For the Leeds 2014 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 (e-mail <**palass@palass.org**>) once the organisers have confirmed that their presentation is accepted, and before **1st December 2014** . Entitle the e-mail "Travel Grant Request". No awards can be made to those who have not followed this procedure.

**Leeds and Yorkshire**

Leeds and the famous Yorkshire Dales to the North will feature internationally in July 2014 when the Tour de France starts off in the city (<**letour.yorkshire.com**>). Why not visit some of the areas the tour will visit? The Dales in particular are fantastic for walking, and have many picturesque towns and villages, many of which are accessible from Leeds by train and bus (see <**www.yorkshire.com**>). Alternatively, spend time exploring the Victorian industrial heritage of Leeds (see <**www.leeds.gov.uk/museumsandgalleries/Pages/Visit.aspx**>), or go by train to nearby York, to see its medieval architecture (<**www.visityork.org**>).

We look forward to seeing you in Leeds in December.

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*Organizers: Jessica Lawrence, Jon Lakin, Dave Carpenter, Liz Martin, James Hansford and Aubrey Roberts*

## From our Correspondents

# Twenty-eight thousand leagues across the sea

It was just one of many mysteries on this voyage – though one suspects that it affected the seafarers more acutely, more *viscerally*, than most of the others. It was Christmas Day of 1872. The roast turkey, left in the galley to cool before the feast, just … disappeared. Without, indeed, a trace. The next day, Boxing Day, the roast goose went also. This time, a few remnants were later found high in the rigging. It wasn't the end. The officers' meat supply, later put for security into a locked and guarded room, vanished also. There was a thief onboard, of rare talent, and the who and the how of it seems never to have been solved[1]. A trifling matter? When life is hard, then it is the small, much-anticipated pleasures that keep people going. One suspects that, even when set among the real tragedies that took place on this voyage, these minor hurts left their mark.

All in all, it was a hard voyage: four years aboard something that was about as far from being a luxury cruise liner as it is possible to imagine. The *HMS Challenger* might have attained giant-like status as the ship that, essentially, founded marine geology, but it was *small*. Not much more than 60 metres long and 12 metres across, it had – or at least it started out with – 269 men, as it set off for a journey of some one hundred thousand kilometres through polar seas (the Great Ice Barrier of Antarctica), tropical seas (the Caribbean), exotic seas (around Hawaii), downright frightening seas (around Tierra del Fuego) – and more. These impressively varied seascapes were slight recompense for the cramped conditions, brutally hard and monotonous work and danger[2] – not to mention the unevenly-shared meat supply. Disheartened, a quarter of the crew deserted along the way. But then, pioneering is rarely easy, by definition. History tells us that the prize was worth the pain, though that might have been scant comfort to those who *made* the history. For this was the first long, hard look at marine strata in the making. Marine strata are, of course, standard geology.

Standard geology, now… For some decades, Charles Lyell's commonsensical approach to working out the history of the Earth had held sway. Look at present processes, he said, translate them through the almost unimaginably wide (if, still, poorly defined) reach of geological time, and that will explain what we see in the present, and what we see in the strata. That's all very well, but most rock strata reflect what goes on under the sea, and not on land, and what we see around us is a wide and emphatically subaerial landscape. There is a disconnect here, which roughly lies at the level of the sea's surface – or, more precisely (if one wants to be pernickety) somewhere between the reach of a pearl diver and of one of the fishing nets of the day.

[1] The ship's cat seems not to have been interrogated.

[2] Death was never far away, from the poor sailor drowned before he even reached the ship – he slipped off the wet gangplank – to the youngest of the 'Scientifics', Rudolf von Willemoes Suhm, who succumbed to illness late in the voyage.

That left enough imaginary space to seriously wonder whether the depths of the ocean might be lifeless – as Edward Forbes had posited, for what seemed to be the best of empirical reasons[3]. Or whether the oceans might be truly ancient features, hiding all manner of primitive animals that otherwise only appear as fossilized impressions within strata. If they did – then a prehistoric world existed down there, in the depths. If they did not, then that meant that the prehistoric world was truly a lost world, a *permanently* lost world, that spoke of a one-way biological history, that includes taxonomic loss as well as a (dimly conceived, then) taxonomic gain.

I sometimes wonder about the inspired deduction of Buffon[4], who proposed, a generation before Cuvier, that because rocks around his country estate teemed with ammonites and belemnites, and these creatures were no longer to be found in the seas – then they must have died out, some time in the distant past. Such a deduction of biological extinction depends, of course, on having a good enough idea of what lives in today's oceans. Was there enough knowledge, then, to render Buffon's proposition reasonable – or was it just a lucky hit?

Living ammonites[5], then as now, had not been pulled out of the sea. But ammonites live, die and are buried in marine waters, and so that might not be unexpected. So, what happens to a dead ammonite? Here, the most sensible model beast seems to be its more primitive relative the *Nautilus*, with its coiled shell and octopusish innards. We now know it as a true living fossil: writ large[6], this kind of animal has a fossil record of around 400 million years – though curiously, it is vanishingly rare in the more recent record, *i.e.* in Plio-Pleistocene strata. Today, we know it as a rare-ish deep tropical beast of the Pacific, much sought after for its pearly shell, to be bought in the posher kind of department store and, depressingly, on e-Bay. So when did our proto-ammonite hove into human view as a zoological phenomenon and – more to the point – did this recognition happen early enough to have a bearing on Buffon's suggestion that true ammonites were no longer to be found in the seas?

Richard Davis's marvellous summary of the early history of *Nautilus* research suggests a resounding yes. Extraordinarily, the first recognition of this creature may have been by no less a figure than Aristotle, in a passing, ambiguous comment in his *Historia Animalium*, written in the third century BC. He describes a relative among the cephalopods, that he calls a nautilus, and which is the 'paper Nautilus' *Argonauta*: it's not a *Nautilus* as we now understand it but is rather a widely distributed pelagic octopus often surrounded by a paper-thin egg-case[7]. It does occur as a dwarf form in the Mediterranean, so it is no surprise that Aristotle – and Pliny the Elder too – was aware of it. His description of it is unambiguous – but then he goes on to say that there is another form that lives in a shell 'like a snail' and that can put out tentacles.

Was it a true *Nautilus*? Richard Owen (who later came in on the story) thought so. What else could it have been, he asked? – adding that Aristotle was too good a naturalist to mistake another kind of animal for a cephalopod. Where could he have got it from? Plunder from the wide-reaching armies of his one-time pupil, Alexander the Great, just perhaps. Not everyone has been convinced, though, and there have been suggestions that, for instance, Aristotle was describing

[3] See *Newsletter* **81**.

[4] See *Newsletter* **79**.

[5] Ammonoids, one should say. But then, sometimes the pull of the vernacular is too strong.

[6] Writ particular, *Nautilus* is Cenozoic. There's the likes of *Boionautilus*, though, in the Silurian (Turek 2008), which to my eye (a poor guide, but to Joachim Barrande's, too) is of the same ilk.

[7] The Chinese name for it, charmingly, is 'white sea-horse's nest'.

*Oocythoë*, an enterprising species of octopus that lives in a discarded salp-case. Well, perhaps – though one might at this point reiterate Owen's stance on Aristotle as a natural historian competent enough to know a coiled shell when he saw one. But on the other hand the mention of tentacles is mysterious: an ancient Greek souvenir somehow obtained from the Pacific might retain its shell, but preserving the soft parts too would be decidedly unusual.

The Dark Ages came and went without mention of the *Nautilus*: nothing, it seems, by the Venerable Bede or his many confrères. Then, it turns up in the mid-16th century, unambiguously, but continuing the nomenclatural confusion that started with Aristotle. The French physician and natural historian Pierre Belon described and illustrated some 'nautilus' (that were *Argonauta*), and then went on to say that there was also a different form, a 'Nautilus' that had a 'great shell of mother of pearl'. Round about the same time, that proto-palaeontologist Konrad Gesner got in on the act, and figured a 'nautilus' with tentacles. Richard Owen was sniffy about this one – doubtful, he said – and it seems to have been an *Argonauta* again.

Then, a clear sighting – and clear illustration, too. Georg Everard Rumpf, late 17th century citizen of Frankfurt, had, frankly, a hell of a life. A career as would-be mercenary halted before it started by capture and long imprisonment, then exile to Batavia (Djakarta) to work for the East India Company, blindness, the loss of his wife in an earthquake, the loss of manuscripts and plates in fire and shipwreck. However, what he called his 'lucubrations' kept him going – his night-time studies of the region's botany, something for which the East India Company, remarkably, (and despite a reputation for hard-nosed focus on commerce and profit alone) supported him in even after he went blind. Among the Batavian plants, he studied and figured – unmistakably – the *Nautilus* (from the seas of the Moluccan islands, he said), in the forbiddingly-titled *D'Amboinsche Rareitkamer*, published in 1705.

Rumpf's work had a mixed reception. The Academia Naturae Curiosum in Vienna called him 'The Pliny of India' for his work in general, though Baron Cuvier later was disparaging about the *Nautilus* illustration: 'undecipherable', he said. That was unkind – it is clear enough as a *Nautilus sensu stricto*. Importantly, Linnaeus cited Rumpf's work as he first formally set up the system of, well, formally setting up a formal taxonomic system – and formally describing the genus *Nautilus* in 1758. Linnaeus gave *Nautilus* a generous expanse – no less than 14 species, with the kind of hit-and-miss classification of the day. One species is still recognized – *N. pompilius*, the common-ish one. Others are 'undetermined', while a couple are foraminifera (you see what I mean about taxonomic generosity) and one is a snail.

Even before Linnaeus, someone else had got into the act. This was the polymath Robert Hooke – 'England's Leonardo', certainly one of the most remarkable scientists to have lived, even though cantankerous, envious, touchy, irascible, suspicious or simply – as his more charitable biographers put it – 'difficult'. Almost inevitably, he also got on the wrong side of another irascible, touchy – and so on, and so on – brilliant scientist of his day, which did him no good at all. Isaac Newton[8] did his best to cover Hooke's light with as many bushels as he could lay his hands on, including destroying (it has been said) the only portrait made of him.

[8] Newton, as president of the Royal Society, was more powerful. Hooke was only curator of experiments there. Politics, always politics.

Nevertheless, in between redesigning London after the Great Fire of 1666, building telescopes and microscopes, working out that light was composed of waves, getting close to the inverse square law of gravity, working out what air was made of – and so on, and so on – Hooke looked at fossils. In particular, he looked at ammonites – and also, specifically, at the *Nautilus* shell. They were basically the same, he said, and would have controlled their buoyancy by producing 'artificial air' to fill the chambers. Could it be, he said – anticipating both Buffon and Cuvier – that ammonites were extinct – or still waiting to be found in the waters of some distant ocean?

Thus, by the time Buffon was writing *Les Époques de la Nature*, the world's first stratigraphy textbook, there was a body of knowledge on relatively obscure forms of modern life from far corners of the Earth, with which to begin to compare the strangely shaped petrifactions that were being excavated from strata. Buffon would have known a lot of this. He was a formidably hard worker and avid reader and correspondent: enough, at least, to quarrel with Linnaeus's implausibly over-rigid (to him) classification of living organisms. His inference that the petrifactions represented animals that were no longer alive seems, on closer examination, to have been less a shot in the dark than a reasonably founded inference. If the distant *Nautilus* could have centuries – perhaps millennia – of study, then the ammonites – far more numerous as fossils – should have turned up somewhere as gleaming, freshly-picked shells in a seafarer's kitbag, or as tribute to some minor potentate, or within the curiosity cabinet of a harassed administrator of the growing global empires. That they didn't, suggests that they were indeed … dead.

Between Buffon and the *Challenger*, knowledge of the *Nautilus* in western science deepened. On 24th August, 1829, a ship lay at anchor off Erromanga, one of the New Hebrides islands, and something like a small tortoiseshell cat was seen floating in the water. Now a tortoiseshell cat really had no business in those parts, not even in such a paradise of cross-planetary species invasions as humans have managed to produce. A boat was sent to see what it was. It was a dead *Nautilus*, complete with the body inside the shell. There was a physician on board the ship, and he had the foresight to put the corpse into a spirit-filled jar, to preserve it during the long voyage back. Two years later, the specimen, now at the Royal College of Surgeons in London, caused something of a sensation – almost as if it was the first discovery of this living fossil.

The specimen was given to that upcoming young anatomist, Richard Owen, to dissect. Owen – mindful of his position in the scientific pecking order, travelled with it to Paris, to the old, famous Baron Cuvier. Alas, the great man was too old if not (to him, at least) too famous. As Owen was travelling, the Frenchman lay on his deathbed, and died without seeing the specimen. The young Owen, having inherited the mantle of the world's foremost anatomist, had to work on the specimen alone. The monograph he wrote on it became his first substantial publication. At Yale University, there is a fine portrait of a fresh-faced Owen as young scientific lion, clad in robes against a dark skyline. In his left hand he holds the *Nautilus* shell that helped propel his meteoric career.

The *Challenger*, during all of its long voyage and intense sampling programme, picked up just one *Nautilus*. It turned up in a dredge net from over half a kilometre's water depth off the Fijiian islands. A lucky find, perhaps – but nevertheless an example of one of the things that the expedition was looking for: a trace of a lost zoological world in the deep ocean, and so evidence

that might help determine whether Darwin's theory of descent with modification was true or not. They had already made other findings of this ilk, notably a crinoid dredged up from a mile-deep sea floor off Lisbon, which supported the idea – as Darwin had suggested – that the deep sea floor could still be a haven for forms of life otherwise only known as fossils.

If this was the case, then Forbes's idea of a lifeless 'azoic' deep sea floor could not be true – something else that the expedition was ostensibly testing. In truth, by 1874, that idea had pretty well been exploded. Charles Wyville Thomson, the expedition leader and Forbes's successor as professor of natural history at Edinburgh, had long been suspicious of the idea, noting earlier records of animals dredged or pulled up from deep water. He had, too, organized an earlier, smaller-scale expedition, of the HMS *Lightning* in 1868, that had retrieved marine animals from sea floors more than twice as deep as Forbes's limit of 300 fathoms (about half a kilometre).

With that effectively out of the way, and the aim of testing Darwin's theory as some sort of misty distant goal, the expedition could become a survey in the *widest* sense: of the nature of the water in the oceans, from bottom to top; of the sediments in the deep ocean – and where they might have come from; and of the life in the ocean, particularly now in its (clearly habitable) depths.

It is this systematic survey that provided the crown jewels (still brightly gleaming) of this expedition – and began to make clear what the hidden part of the world really was made of. Systematic survey, though, of such territory sorely tested the strength and patience of the crew. Wearisome sampling was certainly the order of the day, in particular the seemingly endless dredging in very deep water. Reeling out a few kilometres of rope and piano wire only to pull it in again, day in, day out, just for a bucketful of mud, left something to be desired as an occupation of variety and fascination. Small wonder that there was such attrition of the crew by desertion. Even the ship's terrestrial naturalist, Henry Moseley, was clearly unimpressed, particularly as 'the same tedious animals kept appearing from the depths in all parts of the world'.

Chief among the culprits here was the foraminifer *Globigerina*, which made up most of the white ooze that filled up the endless dredge buckets. One of the officers, an aristocrat, Lord George Thompson, was even less impressed than Mosely. "The mud!", he wrote in his memoirs, "Ye Gods! Imagine a cart full of whitish mud, poured all wet and sticky and slimy onto some clean planks and you may have some faint idea of what globigerina mud is like!"

Wearisome, certainly – but this creature, the *Globigerina*, represented a first order scientific question. Did it live on the sea floor? That was the general notion then, and Wyville Thomson certainly thought so. To him it was yet one more example of the abundant life of the now definitively non-azoic sea floor. But one of the expedition's junior scientists, John Murray, had his doubts. The Challenger's surface sampling was picking up this foraminifer at or near the sea's surface. Could it be the *Globigerina* lived high in the surface waters, and then, after death, its tiny calcareous skeletons sank down to the sea floor in their billions, to pile up as the endless carpets of white ooze?

By mid-way through the expedition, it was clear that Murray was right and Wyville Thomson was wrong. The older man took it on the chin, and generously too. Still on board ship, he wrote a

paper for the Royal Society to say that the 'very strong opinion' that he used to hold on this was in error, and giving the credit to the 'mass of evidence' accumulated by Murray.

It warms the heart, this sort of thing, not just for Wyville Thomson's dignified acceptance of scientific defeat, but because Murray in his youth had been one of those students who would just not have survived the modern university system, not even for a term. At Edinburgh, he generally skipped lectures and – just imagine it today! – *never* attended examinations, but just threw himself into the study of whatever happened to take his fancy. The university authorities, instead of sending him successions of increasingly sternly-worded letters and then throwing him out on his ear, just let him get on with it.

The gamble paid off – and how. The charismatic and ebullient Murray[9] was to go on to prove his worth in all kinds of ways. Not least, because of the stamina that went with the mercurial spirit: at the end of the expedition, the staggering amount of data needed to be systematized, ordered and published. Wyville Thomson by then was exhausted – almost literally a broken man. After the first couple of volumes he could go on no longer, and died soon afterwards. It was Murray who took on the tasks of compiling and editing the 50 volumes that became the legacy, in exhaustive (and beautiful, in the illustrations) detail of the expedition. It set the style for the documentation of the sea's strata, as anyone who has ever walked into a room lined with the oh-so-solid volumes of the Deep Sea Drilling Project (and its successors) can testify. Murray had energy and imagination to burn, and was a practical man too: on the *Challenger* expedition, he observed the guano deposits of Christmas Island and later set up a successful company to exploit them to support Europe's burgeoning agriculture.

The expedition changed the shape, the bestiary, the very *texture* of the sea floor in human minds. Some of the more quirky changes are – as ever – the most memorable. Take *Bathybius huxleyii*, for instance. This was a concept perhaps even eerier than Forbes's azoic desert: a primordial slime that Ernst Haeckel, in the kind of fine grand idea that came so naturally to him, suggested covered the entire deep sea floor, as a kind of globe-encircling superorganism that Thomas Huxley himself – perhaps not unnaturally – enthusiastically promoted. The ship's chemist, John Young Buchanan, though, showed that this monstrous proto-protozoan was simply a chemical precipitate of the most anthropogenic kind: calcium sulphate, formed as a reaction between the preserving fluid and seawater. Huxley took the news in his stride. '*Bathybius*', he observed, 'has not fulfilled the promise of its youth'.

And there was much, much more: the discovery of the pteropod oozes on sea floors shallower than those on *Globigerina* piled up, the red clays at yet deeper levels, the fields of manganese nodules, the discovery of what is now called the Challenger Deep, the finding of some 4,000 new biological species. It gave, literally, a new vision of the ocean depths.

Another persuasive vision of the ocean was already in place, mind, from the pen of Jules Verne. Egged on by George Sand, the prolific and extravagantly imaginative French novelist had just produced his own vision of the oceans, *Twenty Thousand Leagues Under the Sea*. There are some uncanny parallels between the two epics. For a start, the *Challenger* and Captain Nemo's marvellous undersea device, named – but what else? – the *Nautilus*, travelled very similar

[9] This is how Richard Corfield describes him in his fine account of the *Challenger* expedition, from which part of this essay is culled.

distances. The non-fictional oceanographical ship ran the extra mile, with its 111,000 kilometres (68,900 miles, as imperially measured) representing just a touch under 28,000 leagues[10]. The imagined epic was near-synchronous with the physically endured one, being published in 1870, just two years before the *Challenger* set out – and so is one of the last popular classic descriptions of the oceans before some serious scientific constraints were placed upon this realm.

For all that, it is quite an impressive forerunner. Verne was quite aware of the scientific understanding of the oceans in that pre-*Challenger* mid-nineteenth century. He quoted, repeatedly, the authorities of the day, starting with Cuvier, and going on to Humboldt, Agassiz, Buffon, Milne-Edwards, Orbigny, Maury. The latter is cited in the novel, quite rightly, as authority for the description of ocean currents and of what we now know as the slow-moving gyres that they surround, while Darwin is brought in as the man who divined how coral atolls formed. Verne's first-person protagonist, Professor Aronnax, is clearly placed within this scientific elite, while his faithful and imperturbable manservant, Conseil, is given an obsession with zoological classification. This is not only a literary excuse to run through extended lists of species of fish, corals, jellyfish, crustaceans, pteropods and other molluscs (and of crinoids too) – but also to establish their key taxonomic factors and relationships. That's quite something in a popular adventure story, and I can't think that a publisher would dare let an author pull off this trick today. The science – far less far-fetched than that in *Journey to the Centre of the Earth* and *Journey to the Moon*, is smuggled in to the plot with skill and, indeed, panache. No wonder this book was one of the main inspirations for Jacques Cousteau.

More: in the character of the third of the reluctant adventurers, the implacable whaler Ned Land, a man with a great reverence for his stomach and a single-minded determination towards filling it, Verne has the means to repeatedly describe the impending biological impoverishment of the oceans, with whales, dugongs, sea otters – and, with uncanny foresight, the cod of the Grand Banks of Newfoundland – posited as the victims of human rapacity. To complete the picture, there is Captain Nemo himself, not just outlaw and merciless avenger of his murdered family and ravaged country – but also engineer and scientist measuring the very things that the Challenger was to record – water temperature, density, salinity, biological content, at different levels in the sea. Nemo, too, chides Ned Land for his urge to kill anything alive in the ocean for sport, as well as for necessity.

Yes, Verne's oceans were dramatized – but by and large not outrageously so. Atlantis makes an appearance – but in the relatively reasonable incarnation of a sunken volcanic island. The South Pole is reached by the submarine – although this contemporary impossibility probably represents how difficult it was to establish the geography of Antarctica in those days. The icy terrain, mind, is described gloriously – and is preceded by a long list of the true-life explorers who managed to successively penetrate ever farther south. When the *Nautilus* is attacked by giant squid, these are only magnified in size by about a half (though they are portrayed as ferocious killers that hunt in packs, rather than the solitary creature that they actually are[11]). The Maelstrom, off Norway, too

[10] Using the version of leagues – they were a very movable feast, as regards length-scale – that Verne had in mind, at four to the kilometre. Mind, one of the several alternative titles of the original draft was *Twenty-five Thousand Leagues Under The Sea*, which would have made the distance travelled near-identical.

[11] The poor sperm whale is also slandered as vicious killer of other whales – and indeed a pack of them are laid low by the *Nautilus* in what is perilously close to an unprovoked attack.

– that eventually put paid (it seems) to the *Nautilus* – is shown as the demonic phenomenon of Edgar Allen Poe, rather than the only moderately energetic tidal vortex that it actually is.

For perfect, delicious symmetry, Captain Nemo's *Nautilus* runs across a school of nautilus, in the Indian Ocean. These are, though, as is expressly stated, the nautilus of Aristotle and of Pliny the Elder – and hence they are *Argonauta*, not *Nautilus*. Just to make the point absolutely clear, Conseil is called upon to explain that the argonaut is a member of the Dibranchiata and is acetabuliferous (*i.e.* a bearer of suction tubes), while the genus (and not the submarine) *Nautilus* is in the family Tetrabranchiata and is a bearer of tentacles – so any confusion of the two should be simply unforgiveable. Bravo, M. Verne! There's been homework done here, and no mistake.

Of course, as time has gone on, there has been progress in the description of the ocean realm for popular consumption. I think back to my youth and that immortal TV series *Voyage to the Bottom of the Sea*. Here, the heroes had to do battle with mummies, werewolves[12], abominable leprechauns, dinosaurs, flame men, frost men and aliens. Guaranteed, it was, to stop any promising oceanographic career in its tracks in under a minute's viewing time.

Ah well. At least it showed that there was mystery left in the sea. And as regards great unsolved sea mysteries, there is still the identity of HMS *Challenger*'s ingenious turkey-snaffler to be unveiled. Well, if Wyville-Thomson and Murray had read Verne before they sailed, and tried to imbibe the spirit of Aronnax (and of the better side of the Janus-faced Nemo), maybe one of the crew had read the new best-seller, too, and thought that Ned Land would be the better role model. That, for sure, would have brought in a thoroughly modern spirit of enterprise to the pursuit of ocean science.

**Jan Zalasiewicz**

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[12] Mer-wolves?

# R for palaeontologists

# 1. Introduction, the R language and plotting data

**Introduction**

During a recent conversation with the *Newsletter* editor, Al McGowan, about the possibility of writing a column on programming with **R** I was reminded about a question I was once asked during a job interview. When asked what, if anything, I would have done differently during my PhD I replied that I would have learned how to code in R from the outset. This skill has had a huge effect on my research, allowing me to perform a much wider range of analyses as well as allowing me to develop methods that suit my exact needs. Also, having all the code I need for data processing, analysis and outputting of figures in a single package saves the need for moving data between multiple platforms that may require the data to be in different formats.

There has been a growing movement in recent years to widen opportunities to learn the basics of computer programming, with websites such as <**www.code.org**> and <**www.codeacademy.com**> devoted to just that. I appreciate that to the novice the art of programming in any language may appear daunting. However for those currently reading this and thinking 'but I can't code', trust me with a little bit of work you most certainly can.

My aim with these articles is not to provide a compendium of all the functions and capabilities of R, but to introduce the basics of programming and statistical analyses, and to introduce some of the most commonly used packages within R. Throughout these articles I have provided a number of examples that can be run directly in R, all of which are highlighted in **bold**. Finally, all the code and data files required to reproduce graphs/analyses will be placed on the Palaeontological Association website in due course.

**Why use R?**

Since its release in the mid-1990s R has become one of the most commonly used statistical environments. Within the field of palaeontology, R has become a common tool for a wide range of analyses including: trait evolution (Hunt, 2007; Sookias *et al.*, 2012; Young *et al.*, 2011); rates of morphological evolution (Lloyd *et al.*, 2012); the quality of the rock record (Benson and Mannion, 2012) and geometric morphometrics (Arbour and Brown, 2014). It has several advantages that make it a valuable statistical package for academics at least. Firstly and importantly it is open source, freely available and supported on UNIX, Mac and Windows operating systems. Secondly, the graphics package within R allows for the creation of publication-quality vector figures that can be quickly and easily changed without the need for fiddling around with other graphics software (*e.g.* Illustrator). Finally, one of the most useful features of R is the package system, allowing users to create libraries of functions for specific purposes ranging from plotting functions to more complex analytical toolkits (currently there are over 5,000 registered packages). Several packages are available that are of particular use to palaeontologists, and I will focus on these in greater detail in later articles. One extremely useful package is APE (Analysis of Phylogenetic Evolution)

(Paradis *et al.*, 2006), which is designed for the manipulation and analysis of phylogenetic data (both morphological and molecular).

**Installation and the R console**

R can be easily downloaded from the CRAN website (Comprehensive R Archive Network), at <**www.r-project.or g**>. From here you will need to follow the 'download R' link and choose a mirror site (*e.g.* <**www.stats.bris.ac.uk/ R**>), then you can choose the appropriate version for your operating system. The current version is R v.3.0.2 although, unless otherwise stated, the code I provide here will work just as well on previous versions.

You won't need to install any packages to get started; R already comes with a wide range of functions related to arithmetic calculations, statistical tests and graphics. When you first open it you will be met with the R console (Figure 1). You'll see the command prompt (>); this is where you will enter your instructions to R. For example if you type **2+3** after the prompt then press [Enter], R recognizes this as a mathematical equation and will return the number 5 on the next line (Figure 1).

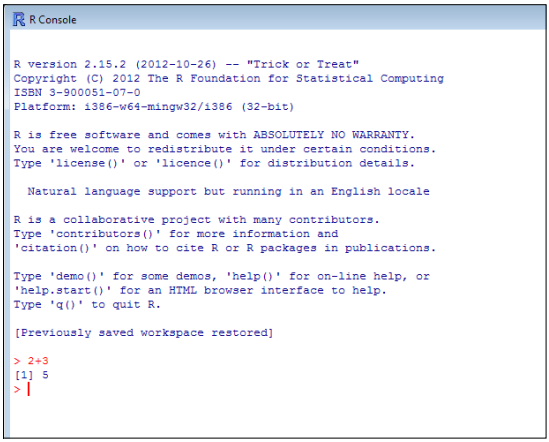


*Figure 1. The standard R interface.*

When working in R it is good practice not to write all your code directly into the R console but to use a text editor such as the one provided in R (File>New script). This has several advantages, not least in backing up your work just in case your computer were to crash. Also it allows you to run your entire program at once, which is especially useful with large analyses. Another piece of good coding advice is to make use of the hash-tag (#); this tells R to ignore anything placed after it. It is wise to use the hash-tag to comment your code explaining what the purpose of that line is. This helps when coming back to a project after a long period of time or to help another user understand what you were doing.

Before we begin with the basics of programming, syntax and plotting there is one other important feature of R I want to introduce, and that is the help system. Every R package and function has an associated help page that provides a description, list of all the options, and example code. If you want to see the help page for the function **plot** type either **help(plot)** or **?plot**. Should you want a more general search for all plotting functions, type **??plot**. If you want you can run just the example code provided; try typing in **example(plot)** or **example(log)**.

**Syntax and data types**

Now is the best time to introduce the terminology associated with different types of data and data manipulation that I will be using throughout this series. Simply speaking, any data that you will use in your analyses must be given a name; this is called a variable. There are several different modes of data that can be stored as variables including numeric (*e.g.* 1, 10), character (*e.g.* "a", "hello") or logical (*e.g.* TRUE or FALSE). Assigning information as a variable is commonly done using the <- symbol. The simplest form of data is known as a scalar, that contains only one value; for example if you wish to create the variable *x* that contains the number 4 you would type:

```
x <- 4
```

If you then type **x** R will return the number 4. It is important to note that R variables are case sensitive, so **x** is different from **X**. The second data type is known as a vector, which is a variable that contains more than one scalar of the same mode (*e.g.* all numerical, or all characters). You can create these in multiple ways such as simply concatenating the values using the concatenate function **c**:

```
y <- c(11,12,13,14,15,16,17,18,19,20)
```

Or you can use a series function to create a sequence of numbers, such as separating the extremes of the range you want by a colon (:):

```
y <- 11:20
```

Or through using the function **seq** that creates a sequence of numbers that increase at a rate specified by the user through the argument by:

```
y <- seq(from=11,to=20,by=1)
```

Finally, a *matrix* is a multidimensional variable made up of both rows and columns, so you can think of a *vector* as a one-dimensional matrix with just one row. In order to create an empty matrix you use the function **matrix**, and to fill it you use the argument **data**:

```
z <-  matrix(ncol=2,nrow=2,data=c(1:4))
```

If you now call **z** you will get the following:

| | [,1] | [,2] |
|---|---|---|
| [1,] | 1 | 3 |
| [2,] | 2 | 4 |

You will have noticed that there are two different kinds of brackets used by R; square [ ] and rounded ( ). These have distinct uses: the rounded ones are used in functions while the square brackets are used to define the location of different elements within vectors, matrices *etc.* Because scalars and vectors have only one dimension, only one number is required between the brackets to locate a particular value(s). Returning to vector *y* that we created earlier, to return just the second element you would type:

**y[2]**

[1] 12

If you wanted multiple elements such as the 1st and 5th you can use the concatenate (**c**) function from before and type:

**y[c(1,5)]**

[1] 11 15

You can also put logical commands between the square brackets if you wanted to return only values that matched a particular condition, such as those that were greater than 15:

**y[y>15]**

[1] 16 17 18 19 20

Or to be more specific:

**y[y > 15 & y<18]**

[1] 16 17

Because matrices have two dimensions (containing both rows and columns), a comma is used to differentiate between the value for rows and columns respectively. You can think of these numbers as map grid coordinates with the rows as the northings and columns as eastings. If you call **z** then you can see that the values for the rows come first (*e.g.* [1,] and [2,]) and the columns come second (*e.g.* [,1] and [,2]). Using one number for either the row or the column will return all values for that row; for example **z[1,]** will return the numbers 1 and 3 whereas if you specify both the row and column R will return only the value of one cell, so in our example **z[1,2]** will return the number 3.

**Introduction to functions**

Most of the work in R is done with functions. These are pieces of independent code that take in one or more data files either to transform (*e.g.* calculate the mean) or to be used in an analysis (*e.g.* Principal Components Analysis, PCA), the results of which are returned to the user. Within functions are a series of options or arguments that are used for specific purposes related to that function. The help files for every function will tell you what the default settings are for the arguments (under 'Usage') as well as providing an explanation of the options allowed in each case. For example in the function **sort** the argument *decreasing* can be set to either TRUE or FALSE, with FALSE being the default.

**v <- c(10,1,15,3,20,9,12)**

**sort(v)**

[1] 1 3 9 10 12 15 20

**sort(v,decreasing=TRUE)**

[1] 20 15 12 10 9 3 1

**Vector calculations**

Now that you've created a number of small datasets you can start to perform some basic calculations. Taking the vector *v* as an example, any calculation you want to perform (*e.g.* multiplication, *; division, /; addition, +; or subtraction, -) will be performed on each element individually. For example:

**v*2**

[1] 20 2 30 6 40 18 24

**v/2**

[1] 5.0 0.5 7.5 1.5 10 4.5 6.0

There are a great many functions that apply to the entire vector, providing descriptive statistical values on that dataset. Some examples of these are shown in Table 1.

**Table 1. Examples of calculations that can be performed on vectors of numerical data.**

| Function | Description |
|---|---|
| min(y) | The smallest value in *y* |
| max(y) | The largest value in *y* |
| sum(y) | The sum of all values in *y* |
| sort(y) | Sorting values of *y*, use option descending=TRUE to reverse the order |
| range(y) | Returns the largest and smallest values of *y* |
| mean(y) | The average of all values in *y* |
| median(y) | The median value of vector *y* |
| quantile(y) | Returns the quartile values for vector *y* |
| cumsum(y) | Returns the cumulative sum of all values in the vector |
| sd(y) | The standard deviation of vector *y* |

**sum(v)**

[1] 70

**range(v)**

[1] 1 20

**mean(v)**

[1] 10

**Example datasets**

On the Palaeontological Association website (<**www.palass.org**>) you will find all the datasets and code required to reproduce the figures presented here. For this article the data file *extrinsic.txt* is taken from the supplementary information of Mayhew *et al*. (2012) and contains measures of diversity, temperature and rock area measurements for the Palaeozoic. The second example dataset, named *asaphidae.txt*, contains a series of measurements taken from twenty-one trilobite genera of the Family Asaphidae (Bell and Braddy, 2012). In addition to these the file *Number 1 – Introduction.R* contains the relevant code for Figures 2-3.

**Basics of plotting**

The function **plot** is one of the most useful in the R repertoire, although there are many other plotting functions, many of which are for specific analyses/data types (*e.g.* **plot.phylo**). This function also provides an excellent way-in for new users to understand how functions work and the effect of the many arguments such as those built into **plot**.

Before you can plot or analyse your data they must be loaded into the R environment. A useful first step is to change the working directory to the folder where your data files are located. This means that files can be quickly loaded without the need to type out the entire location. Also this is the location where R will save any data or figures you have created, keeping everything in the same place. The working directory is set using the function **setwd** as below, and you can find out where it is currently set to by typing **getwd()**. The result will look something like the examples below on my computers, but will reflect your own computer's file directory.

```
setwd("/Users/markbell/Newsletter")  # For Mac users

setwd("C:/Users/markbell/Newsletter")  # For PC users
```

Next you can load in the file *extrinsic.txt* using the function **read.table**; the argument *header* if set to TRUE tells R that the first row of data should be considered as the column names.

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

Now that the data have been read into R you can start to explore and plot them. Try calling the first column using **extrinsic[,1]** or the first row using **extrinsic[1,]**. The file *extrinsic* has column names that you can see if you type in **names(extrinsic)**, and you can use the column names instead of the row/column numbers. So to get the first column you can also use **extrinsic[,"Age"]**.

The function **plot** only requires a vector of information, a list of values, to create a plot. Figure 2a represents a basic plot using **plot(extrinsic[, "Rock.area_europe "])**, plotting the values of the column 'Rock.area_europe' against the index, or the position of each value in the vector; simply put, it plots the values in order. Plotting two variables requires both an explanatory variable (x-axis) and a response variable (y-axis); Figure 2b, shows the same data plotted against the column "Age" – the geological age in millions of years.

```
plot(extrinsic[,"Age"],extrinsic[,"Rock.area_europe"])
```

There are a large number of arguments available to plot that can be used to control the size, shape, colour of everything from the individual points to the tick marks on the axes (Figure 2c,d). Table 2 provides a list of useful arguments and examples of how to apply them (see the 'Graphical Parameters' section of **help(par)** for a more comprehensive list). You can add another dataset on top of the first using points or lines (Figure 2d).

```
plot(extrinsic[,"Age"],extrinsic[,"Rock.area_europe"],type="l")

points(extrinsic[,"Age"],extrinsic[,"Rock.area_australia"],type-"l",col="red")
```

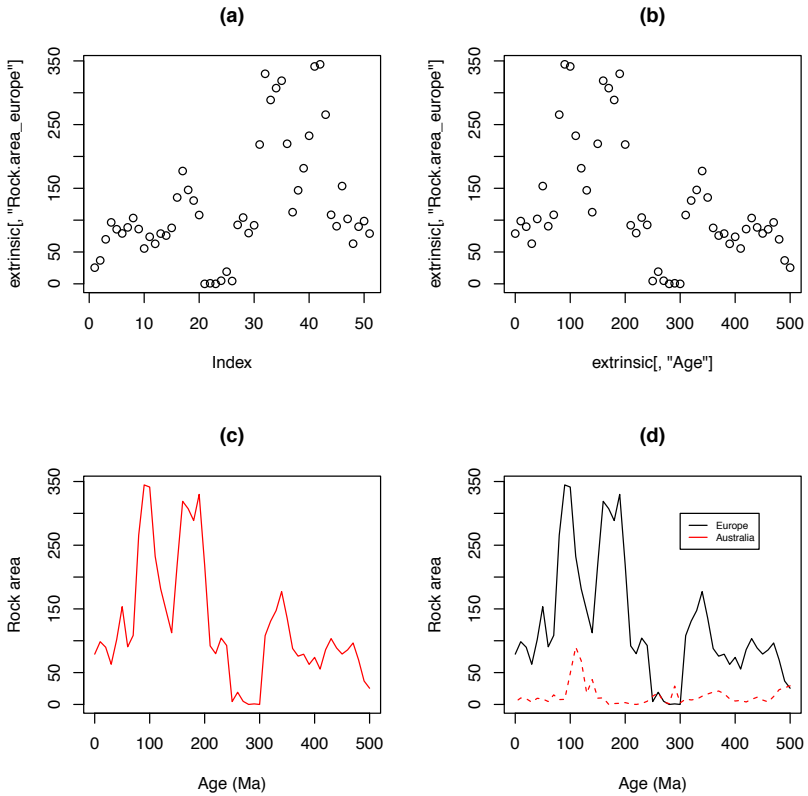


*Figure 2. A series of plots that use the Rock.area_europe data from the file* extrinsic.txt, *to demonstrate the variety of options available for the* **plot** *function, some of which are highlighted in Table 2.*

**Table 2. A table of graphical options that can be used with the** plot **function, their resulting effect and an example.**

| Argument | Result | Example of usage |
|---|---|---|
| pch | The type of the plotted points | plot(extrinsic[,1],extrinsic[,2],pch=19) |
| cex | The size of the individual points | plot(extrinsic[,1],extrinsic[,2],cex=2) |
| type | The kind of plot: "l" – lines, "p" – points, "b" – both | plot(extrinsic[,1],extrinsic[,2],type="l") |
| lwd | The width of any plotted lines | plot(extrinsic[,1],extrinsic[,2],type="l",lwd=2) |
| lty | The type of line: 1 – solid, 2 – dashed, 3 – dotted | plot(extrinsic[,1],extrinsic[,2],type="l",lty=3) |
| xlab, ylab | The label of the x, y axes | plot(extrinsic[,1],extrinsic[,2],xlab="Age(Ma)") |
| xlim, ylim | The range of the x, y axes | plot(extrinsic[,1],extrinsic[,2],xlim=c(100,200)) |
| col | The colour of the points of lines | plot(extrinsic[,1],extrinsic[,2],col="red") |
| log | Changes the axes to a log scale | plot(extrinsic[,1],extrinsic[,2],log="y") |
| main | Text to use as a header for the plot | plot(extrinsic[,1],extrinsic[,2],main= "Hello world") |

In addition to bivariant plots you may wish to compare the distribution of two or more samples of your data; this can be done either statistically or visually. For now I will focus on the two visual methods of examining the distribution of your data: histograms and box plots. Histograms display the distribution of a sample of the number of counts (frequency) of the sample between discrete intervals. Box plots (or box and whisker plots) show the same distribution using a box that represents the first and third quartiles or the 25th and 75th percentiles of the data with a horizontal line representing the median or the 50th percentile. The whiskers refer to the vertical line joining the upper and lower limits of the distribution.

Using the dataset *asaphidae.txt* the distribution of the body-size of one of more genera can be shown using both a histogram (Figure 3a) and box plots (Figure 3b).

```
asaphidae<-read.table("asaphidae.txt",header=T)

hist(asaphidae[,"Isotelus"],xlab="isotelus")  # for histograms

boxplot(asaphidae[,"Isotelus"],asaphidae[,"Asaphus"],names=c("Isotelus","Asaphus"),
xlab="Genus",log="y")  # for boxplots
```

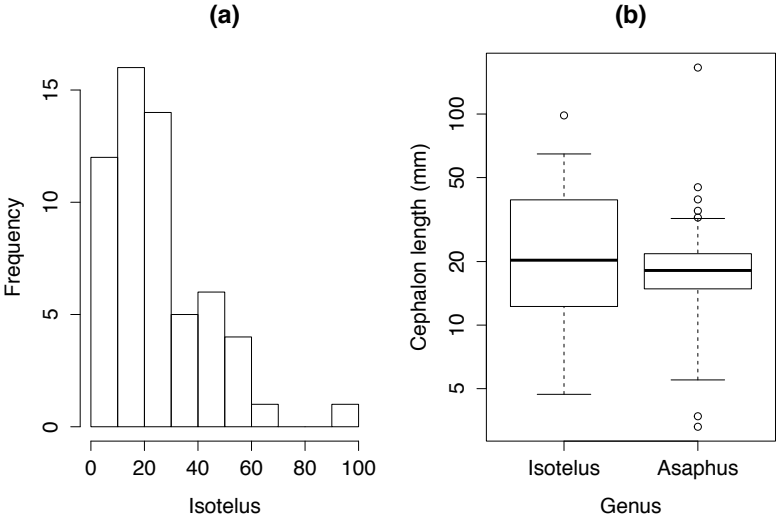


*Figure 3. Plotting the body-size distribution of trilobite genera using (a) histograms and (b) boxplots.*

**A quick note on your own data**

Sometimes, for the first time user, one of most annoying issues can be getting R to read in your data without returning an error. These errors can range from not finding the file of that name (in that case check the working directory is correct) to the data containing either blank cells or not having as many values in a row as there are headers. Here are a few tips to help you read in your data successfully.

If you have a table of observations you want to analyse in R the best way is to save the table as a tab-delimited file (.txt) as R can't read in an excel file directly for example. However, it should be noted that R does not like blank cells either. One way around this is to enter **NA** (short for not available) into any blank cells – which will be read as empty by R. Another way to deal with the problem of gaps in your data is to save the file as a comma-separated file (.csv) and load it in using the function **read.csv**.

In addition you will see that in the file *extrinsic.txt* no column headers contain any spaces, but – for example – "Sepkoski_p" instead of "Sepkoski p". In the second example R would read "Sepkoski" and "p" as two different column names and return an error asking why there are not enough values to fill all the columns it thinks your data has.

**Saving your work**

Finally, at the end of a productive day of coding you will want to save your code, results, figures or the entire workspace. While you can save the workspace or the contents of the plotting window from the menu system (File > Save workspace) I personally find it more useful to save figures from the command line, outputting files as the code is running.

Using **write.table** will save a data file as a .txt file to your working directory. If you want you can save only the columns you have been working with. The argument **sep** determines how the values are separated in the file; *e.g.* "\t" specifies tab-spaced.

```
extrinsic_new <- extrinsic[,c("Age","IQS")]

write.table(extrinsic_new,file="new data.txt",sep="  \t")
```

For figures, the function **pdf** will save all figures you create between **pdf()** and **dev.off()** into the one file.

```
pdf(file="plot.pdf")

plot(extrinsic[,"Age"],extrinsic[,"IQS"],type="o",col="red")

plot(extrinsic[,"Age"],extrinsic[,"SQS"],type="o",col="blue")

dev.off()
```

Finally, saving your entire workspace, using the function **save.image**, will allow you to continue exactly where you left off with all your data files, variables and functions already loaded into the R environment.

```
save.image("workspace.RData ")
```

**Summary**

By the end of this article I hope that you will be able to load and plot your data in R as well as run some of the most basic of statistical functions. Next time I plan to go over the basics of writing your own functions as well as an introduction to some of the statistical tests available in R.

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**<mark.bell521@gmail.co m>**

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YOUNG, M. T., BELL, M. A. and BRUSATTE, S. L., 2011. Craniofacial form and function in Metriorhynchidae (Crocodylomorpha: Thalattosuchia): modelling phenotypic evolution with maximum-likelihood methods. *Biology Letters*, **7**, no.6, 913–916.

**FURTHER READING**

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FIELD, A., MILES, J. and FIELD, Z., 2012. *Discovering statistics using R*. SAGE publications Ltd. 992pp.

You can find the support material for this column, such as the data files *extrinsic.txt* and *asaphidae.txt*, in the Newsletter section of the PalAss website, at <**www.palass.org**>.

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

**Challenges in Macroecology: Scaling the Time Barrier**
Natural History Museum, London *1 April 2014*

We are delighted to announce a one-day meeting exploring the links between palaeontology and macroecology. With an emphasis on discussion and networking opportunities, we aim to facilitate new collaborations between palaeo- and neontological macroecologists, and to determine the strengths and limitations of integrating concepts, questions and data across timescales. There will be three keynote speakers (David Jablonski, Kathy Willis and Lee Hsiang Liow) through the day, as well as a mixture of lightning talks (five minutes) and discussion sessions.

Registration is now open at <**www.eventbrite.co.u k**>. If you are interested in giving an enlightening talk, please enter the title as part of the registration process.

The meeting organisers are Isabel Fenton (e-mail <**isabel.fenton@nhm.ac.u k**>), Victoria Herridge (<**victoriaherridge@mac.co m**>), Phil Jardine (<**phillip.jardine@open.ac.u k**>), and Adriana De Palma (<**adriana.de-palma10@imperial.ac.u k**>).

**European Geosciences Union General Assembly 2014**
Vienna, Austria *27 April – 2 May 2014*

The 2014 EGU meeting will have a strong palaeontology section. There are sessions (titles simplified here) on the terrestrial biota and past environments (SSP4.1), early human expansion (SSP4.2), ocean acidification (SSP4.3), Mesozoic and Cenozoic foraminifera (SSSP4.4), Cenozoic biodiversity (SSP4.5), palaeobiology (SSP4.6), mass extinctions in deep time (SSP4.8, co-organised) and an open session on geosciences (SSS4.12, co-organised).

For example, the "Terrestrial biota and environments in deep time" session is dedicated to the study of terrestrial organisms and their ecology through the ages. Proxy data based on these archives document environmental and climate change on land and may help to understand today's and future system earth.

To register and for further information please check the EGU website at <**http://www.egu.eu /**>.

**Mid-Mesozoic: The Age of Dinosaurs in transition**
Fruita, Colorado & Green River, Utah *, USA 30 April – 5 May 2014*

The Morrison Formation is world famous for its Upper Jurassic dinosaur fossils and is one of the most extensively studied dinosaur-bearing units in the world. It is exceptionally well-exposed across the Colorado Plateau and preserves at least two dinosaur faunas. In contrast the overlying Lower Cretaceous Cedar Mountain Formation spans roughly 35 million years, in comparison to

the Morrison Formation's seven million years. The Cedar Mountain is approximately half the stratigraphic thickness, but represents about five times as much in geologic time, in comparison to the two closely related faunas in the Morrison; the Cedar Mountain preserves at least six different distinct faunas.

Colorado Plateau's Morrison–Cedar Mountain Formations are contributing critical information about an important period of time in the history of terrestrial life in the Northern Hemisphere. The density of biostratigraphic, chronostratigraphic and palaeoclimatic data make the Colorado Plateau a standard on which to resolve the geological and palaeobiological history of the mid-Mesozoic in the northern hemisphere.

This field conference has been structured to minimize the participant's cost ($230.00 US). It consists of four day-long field trips to visit pivotal sections and localities, with an optional pre-meeting trip to Dinosaur National Monument ($50.00 US). Additionally, there are two days for conference talks and posters of international scope.

Check the conference website at <**http://www.utahpaleo.org/mid-mesozoic-conference.htm l**>.

**Fossil Fishes and Fakes:**
**The Sir Arthur Smith Woodward 150th Anniversary Symposium**
Natural History Museum, London *21 May 2014*

Smith Woodward built his scientific reputation on detailed and meticulous studies of fossil fish, many of which helped to form the foundations of current research on numerous fish groups. However, he also contributed to our knowledge of other extinct animals and regional geology, and he endured some notoriety for his involvement in the Piltdown Man hoax. Almost no attempt has been made to assess Smith Woodward's wider impact on palaeontology. This one-day symposium aims to rectify this omission, with invited speakers who will present papers on Smith Woodward's life and career, his varied scientific outputs, and his involvement in Piltdown.

To pre-register and receive further information please email the Meeting Coordinator (e-mail <**ASW150@nhm.ac.u k**>).

**150th Anniversary of *Homo neanderthalensis* King 1864**
National University of Ireland, Galway *23 – 25 May 2014*

The study of human evolution began in earnest when William King (1809–1886), Professor of Geology at Queens College Galway, as NUI Galway was then known, proposed the name *Homo neanderthalensis*, at the 1863 meeting of the British Association for the Advancement of Science, for fossil human remains discovered in a cave in the Neander Valley of Germany seven years previously.

We hope this meeting will be a celebration of Neanderthal research in general and also a fitting tribute to a geoscientist who made an important contribution to palaeoanthropology, at a time

when it was still very much in its infancy. William King's great grand-daughter will be attending, and is looking forward to meeting the scientists currently investigating and researching Neanderthal people – work which her great grandfather immersed himself in a century and a half ago.

To register and submit abstracts please e-mail <**neanderthal150@nuigalway.ie**>. For further information please see the meeting website at <**http://www.neanderthal150.org/**>.

**The Micropalaeontological Society Palynology Group Meeting 2014: Palynology in the Modelling World**
Geography Earth & Env. Sciences, University of Birmingham, UK *4 June 2014*

This year's meeting will include the 1st annual von Post Lecture, which will be delivered by Prof. Alan Haywood (University of Leeds).

Further details, including schedule and travel information, will be announced soon. Please check the TMS palynology group website (<**http://tmsoc.org/paly.htm**>) or contact Fabienne Marret-Davies (TMS Group Chair, e-mail <**F.Marret@Liverpool.ac.uk**>).

**The Micropalaeontological Society Foram – Nanofossil Spring Meeting**
Texel, The Netherlands *22 – 25 June 2014*

The venue will be on the island of Texel, at the Royal Netherlands Institute for Sea Research (NIOZ). The meeting has been rescheduled for 22–25 June (previously, 25–28 June). This is due to accommodation issues caused by the annual regatta on the 28th. The actual symposium will be on 23rd and 24th June. The field-trip will be on Wednesday 25th June.

The theme will be "Foraminifera and nannofossils through time; qualification and quantification". There will also be a satellite morphometrics Workshop on 22nd June 2014.

Please check The Micropalaeontological Society website at <**http://www.tmsoc.org/nanno.htm**> or contact Els Ufkes (e-mail <**e.ufkes@vu.nl**>) for further information.

**Commission Internationale de la Microflore du Paléozoïque International (CIMP) General Meeting 2014: What's trending in palynology?**
Ghent-Liège, Belgium *5 – 11 July 2014*

This meeting will consist of three parts: chitinozian workshop on 5–10 July (University of Liège), CIMP meeting on 7–10 July (University of Gent), and a one-day field trip on 11th July.

For more information check the CIMP website at <**http://cimp.weebly.com/index.html**> or e-mail <**p.steemans@ulg.ac.be**>. *Registration and abstract deadline 31st March 2014.*

**9th European Palaeobotany-Palynology Conference**
Padua, Italy *26 – 31 August 2014*

The Italian group of palaeobotanists and palynologists is very glad to be able to invite all of you to Padova in 2014 for the next EPPC.

Padua (Padova in Italian) is a picturesque, historic city in Northern Italy (about 40 km west of Venice), with a dense network of arcaded streets, large communal "piazza" (squares) and many bridges crossing the various branches of the Bacchiglione.

All scientific sessions will be held at the new Department of Geoscience, and the famous Botanical Garden and Museum of Geology and Palaeontology will be involved in this conference. Field-trips are planned in the fascinating landscapes of the Dolomites, Sardinia, Emilia-Romagna, Latium and Tuscany.

For further information contact the conference secretary (e-mail <**Evelyn.Kustatscher@naturmuseum.it**> or look for updates on the conference website at <**http://www.geoscienze.unipd.it/9th-european-palaeobotany-palynology-conference/**>.

**9th International Congress "Cephalopods – Present and Past" (ISCPP 9) and the 5th International Coleoid Symposium**
University of Zurich, Switzerland *4 – 14 September 2014*

This series of cephalopod meetings was launched in the seventies in York. Thereafter, they were held every three or four years in various cities including Tübingen, Granada, Vienna, Fayetteville, Sapporo and Dijon. It is the only occasion in which cephalopod workers meet from around the world. There are normally three to four days of scientific presentations. The interesting and important aspect of this meeting is that both biologists and palaeontologists meet, although there traditionally have been slightly more palaeontologists. This might change at the 2014 meeting, however, since it will host the International Coleoid Symposium for the first time.

Traditionally, two field-trips are associated with the meeting. For this meeting, trips are planned to the Fossillagerstätten of southern Germany and fossil localities yielding cephalopod fossils in Switzerland, each of which will last a couple of days. Details of these field-trips will be announced in due course.

For further information visit the conference website at <**http://www.pim.uzh.ch/symposia/ISCPP9/index.php**>.

**6th International Symposium on Lithographic Limestone and Plattenkalk**
Museo del Desierto, Saltillo, Mexico *15 – 19 September 2014*

The Museo del Desierto invites you to the 6th International Symposium on Lithographic Limestones and Plattenkalk. This multidisciplinary meeting is planned to address aspects of the study of lithographic limestones and plattenkalk deposits across all disciplines, from palaeontology (taxonomy, palaeoecology, taphonomy), to geology (stratigraphy, sedimentology, palaeoenvironments), and also mineralogy and petrology of Plattenkalk deposits and related Fossil-Lagerstätten. The meeting is organized in collaboration with the Institute of Earth Sciences of the University of Heidelberg, Germany. We plan field-trips to the famous plattenkalk deposits of Vallecillo, Cuatro Cienegas and possibly Muzquiz.

Please visit the conference website at <**http://isllpsaltillo.uni-hd.de/**> for updates.

**Are there limits to evolution?**
St. John's College, Cambridge *25 – 26 September 2014*

What will evolutionary biology look like in 50 years? More of the same or will there be new paradigms, new syntheses? What lies on the horizon?

The impact of evolution is undeniable, but it can be viewed through different lenses. For the scientist it is the investigative discipline, mapping out the history of life, uncovering its intricacies and revealing its mechanisms. For others it might be the grand narrative, and across society it brings different meanings – sometimes to the point of polarization.

This conference is an opportunity to focus on the important research objectives, discuss the best ways to achieve them, and use these to set a considered agenda for the continued study of evolution. This event is part of a larger programme on evolution funded by the Templeton World Charity Foundation. Keynote speakers include Margaret McFall-Ngai (University of Wisconsin), Eors Szathmary (The Parmenides Foundation, Munich), Geerat J. Vermeij (University of California at Davis) and Gunter Wagner (Yale University).

Accommodation will be available in College, and the Conference package will include all meals, a wine reception, and a Conference Dinner in John's medieval Dining Hall. Further information is available by contacting Dr Victoria Ling (e-mail <**vl237@cam.ac.uk**>). *Registration is now open, please visit the Department of Earth Sciences website.*

**4th International Palaeontological Congress (IPC 2014) to include the 47th AASP-TPS (AASP – The Palynological Society) Annual Meeting**
Científico Tecnológico, Mendoza, Argentina *28 September – 3 October 2014*

Local organizers are planning a comprehensive congress with an intellectually motivating scientific programme. The congress will create opportunities for participants to present and share experiences, explore new directions, and debate topics among specialists from across the globe. The meeting will include the 47th AASP-TPS Annual Meeting.

A varied array of meeting styles with a combination of keynote lectures, special symposia on leading issues, interactive workshops, technical sessions, and short courses promises to hold sessions of interest to all palaeontologists.

Delegates will have the opportunity to enjoy a wide range of conference excursions to rich and well-known Argentinean palaeontological sites involving a combination of scientific and touristic attractions. The schedule of field-trips covers superbly exposed sedimentary successions, representing a great diversity of marine and continental palaeoenvironments, and encompasses nearly the whole stratigraphic record.

Organisers for the 47th AASP-TPS Annual Meeting are now calling for Symposium topics. If you have any great ideas for palynology-related symposia, please feel free to contact Thomas Demchuk (e-mail <**tdemchuk@swbell.net**>.

Please see the conference website (<**http://www.ipc4mendoza2014.org.ar/**>) for further conference details. *Abstract deadline March 2014.*

**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. Sessions will include: Systematics & Ecology, Systematics & Evolution, Systematics & Taxonomy and Systematics & Fossils.

Please check the Systematics Association website at <**www.systass.org**> for updates.

**Flugsaurier 2015, The International Meeting of Pterosaurology**
University of Portsmouth, UK *either late August or early September 2015*

In 2015, Flugsaurier, the International Meeting of Pterosaurology, will be held in the United Kingdom for the very first time. Flugsaurier 2015 will be held at the University of Portsmouth with the dates coordinated to fit in with the Symposium of Vertebrate Palaeontology and Comparative Anatomy.

Anyone who would like to be included on the mailing list so that they receive the first circular should contact Dr Dave Martill (e-mail <**david.martill@port.ac.uk**>).

**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.

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

# *Meeting* REPORTS

**PalAss goes Swiss and gets high: "Mammuts" in the snow**
University of Zurich, Switzerland *13 – 16 December 2013*

The 2013 Annual Meeting was hosted by the Palaeontological Institute and Museum of the University of Zürich in Switzerland from 13th to 16th December. The meeting welcomed participants from more than 20 countries, who were not all used to the temperatures slightly below freezing point (down to -3°C) in this part of Europe. With this weather in mind a mammoth was the ideal logo for the meeting, although it was probably chosen to highlight the exceptional mammoth finds made close to Zürich in Niederweningen.

The meeting kicked off strongly with a thematic symposium on "Fossilised ontogenies and evolution", an important research topic at the Palaeontological Institute, which is also one of the main focuses of its director Hugo Bucher, the lab of Marcello Sanchez-Villagra and the working group of Christian Klug, the chief organiser of the meeting.

The symposium included up-to-date presentations by well-known experts on the development of many important fossil groups, from plants (**Hans Kerp** on development and reproduction in the Rhynie chert flora), to invertebrates (**Alex Nuetzel** on larval ecology in fossil gastropods; **Nigel Hughes** on trilobite 'evo-devo') and vertebrates (**Zerina Johanson** on the embryonic development of Gogo placoderms; **Rainer Schoch** on life histories of early tetrapods; **Jukka Jernvall** on developing teeth). Some of my personal highlights were pictures of *c.* 400-million-year-old nematode eggs in the talk by Hans Kerp, Jukka Jernval's demonstration of how his students can grow teeth on Petri dishes, and Rainer Schoch's Napoleon-hat-shaped early tetrapods.

**Michael Coates** closed the talks on the first day with the annual address on "Sharks and the deep origin of modern jawed vertebrates", which reviewed the somewhat shifting views on using the morphology of chondrichthyans as basal for the jawed vertebrates as a whole. Of particular interest was his demonstration that critical anatomical information could still be extracted from a specimen of *Gladbachus* flattened like a "poppadom", with the aid of computed tomography (CT).

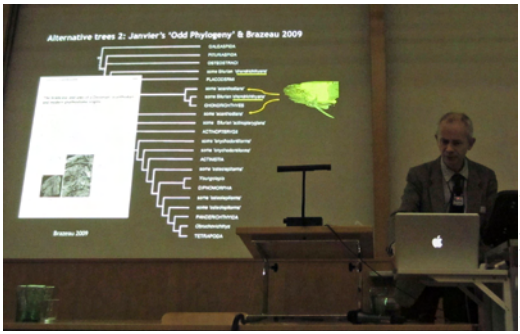


*Photo: Christian Klug*

*Michael Coates in the middle of his annual address.*

The increasing importance of CT-imaging was also evident in several talks and posters on this topic throughout the meeting. One of these posters – by David Button on "Biomechanical insights into sauropodomorph craniodental evolution" – deservedly won the Council's Poster Prize. The ice-breaker reception was held at the Zoological Museum of the University of Zürich. There could have

been no more suitable setting for such a gathering than the Museum, where we were rather fittingly surrounded by displays of fossil and biological specimens. "Maggie", a life-size reconstruction of *Megatherium*, received a particularly large amount of attention, but it is unclear if this was more closely related to its general cuteness, or the amount of free alcohol being served.

*Photo: Christian Klug*

*Ice-breaker reception at the Zoological Museum of Zürich.*

The next day, things began nice and early at 8.45 with an introduction by the dean of the faculty, Prof. Dr **Michael Hengartner.** Subsequently, the sessions were organized more stratigraphically than systematically. This broke the typical pattern of separate sessions for fossil plants, invertebrates and vertebrates, and made for an interesting and eclectic selection of talks in each session. The first two sessions covered the Proterozoic and the Cambrian and included excellent talks on 3-D reconstruction of Precambrian cyanobacteria (**Bettina Schirrmeister**), the fossil record of euglenoids (**Charles Wellman**), both Doushantuo early animals (**John Cunningham**) and acritarchs (**Peter Adamson**) from the Ediacaran. There were also several talks on the usual suspects of the Ediacaran biota (**Jennifer Cuthill**, **Charlotte Kenchington**, **Jack Matthews**), as well as novel investigations of the emergence of the phoronid–brachiopod total group (**Lea Devaere**) and chemical variability of Cambrian lingulate shells (**Liisa Lang**). The main organizer, **Christian Klug**, also managed to sneak in a slightly off-topic talk on Palaeozoic invertebrate gigantism, because one of the original speakers unfortunately had to cancel. During the lunch break, we received tasty sandwiches, an apple and drinks.

In the afternoon, the meeting proceeded in the main lecture hall with a session on Palaeozoic arthropods. This featured a number of great talks on various arthropod lineages, including the functional morphology of megacheiran appendages (**Joachim Haug**), exceptionally preserved neural characters of 'great appendage' arthropods (**Xioaya Ma**), fuxianhuiid arthropods (**Javier Ortega-Hernández**) and the use of ontogenetic data in phylogenetic analyses of trilobites (**James Lamsdell**). Due to changes in the schedule, **I** replaced one of the speakers with my own talk on the link between pearls and parasitic flatworms, and **Duncan Murdock** gave an interesting talk on decay studies in non-arthropod onychophorans. During his talk, **Joachim Haug** demonstrated that despite the possibilities of advanced 3-D models, simple cardboard models can be equally as good or even better for illustrating the underestimated agility of leanchoiliid appendages.

I had the honour of chairing the next session in the main lecture hall on the Devonian and Carboniferous, which featured talks on Middle Devonian trees (**Jennifer Morris**), fossil horseshoe crabs (**Carolin Haug**), the impact of fossil data on arthropod phylogeny (**David Legg**) and the quantification of volumetric growth and buoyancy of Paleozoic ammonoids (**Christian Klug** – who continued with his hidden agenda of sneaking in talks that day because the original presenter, Carole Naglik, was absent for unforeseen personal reasons). There were also talks on Carboniferous ammonoids from the Shannon Basin (**Anthea Lacchia**), finite-element occlusal and microstructural analyses of conodonts (**Carlos Martínez-Pérez**), cranial endocasts of ancient ray-finned fishes (**Sam Giles**), palaeoneurology of a Devonian lungfish (**Tom Challands**) and, last but not least, a talk on the immature stages of acanthodiform acanthodians (**Marion Chevrinais**).

As I was presenting or chairing sessions in the main lecture hall, I sadly missed interesting parallel sessions on evolution and the Palaeozoic in the smaller lecture hall. The evolution session contained a mix of talks on various topics and groups, ranging from more methodological talks (on phenotype space by **Sylvain Gerber** and the discordance between evolutionary rates and disparity by **Anjali Goswami**), to talks on morphological evolution (tooth development in the earliest jawed vertebrates by **Martin Rücklin** and in batoids by **Charlie Underwood**; body shape evolution of ray-finned fishes by **Erin Maxwell**) and phylogeny (of coleoids by **Dirk Fuchs**, living "fossil" fishes by **Lionel Cavin** and the dinosaur–bird transition by **Stephen Brusatte**). As a fan of the Palaeozoic, I was particularly sad to miss the parallel session on the Palaeozoic, which featured talks on Palaeozoic plants (**Oive Tinn**) and plankton (**Taniel Danelian**), spectacular suspension feeding (**Jakob Vinther**) and double-flapped anomalocaridids (**Peter Van Roy**). There were also presentations on the origin of nacre (**Michael Vendrasco**), enigmatic Ordovician–Silurian brachiopods (**Lars Holmer**), synchrotron tomography of Cambrian echinoderms (**Sebastian Clausen**) and possible soft-part preservation in a solute echinoderm from the Fezouata Biota (Bertrand Lefebvre). The scientific sessions concluded with the Annual General Meeting hosted by **Michael Benton** (President of PalAss) and **Richard Twitchett** (Secretary of PalAss).

The annual dinner was held at Uto Kulm at the top of the Uetliberg (873 metres above sea level). We got a special ticket for the train to reach the summit of the Uetliberg, where we started with drinks in the snow, outside near small fires, and enjoyed the amazing view of the city of Zürich

Photo: Daniel Marty

*The setting for the annual conference dinner.*

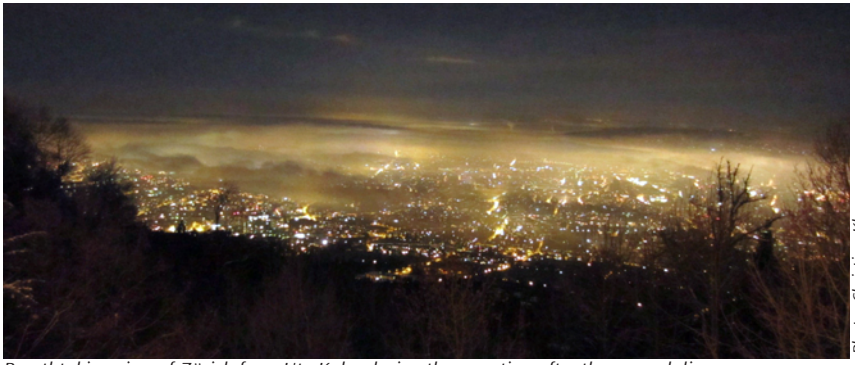

Photo: Christian Klug

*Breathtaking view of Zürich from Uto Kulm during the reception after the annual dinner.*

in the background. Then came the main event, with the dinner featuring a small appetizer followed by rich Swiss cheese fondue and drinks "a discretion" (as much as you can eat or drink). As the tradition dictates, this year's medallists (portrayed more extensively elsewhere in this newsletter) were announced during the dinner. The Lapworth medal went to the palaeobotanist **Diane Edwards**, famous for her work on early land plants from the Rhynie chert, who was visibly honoured. Her impact on the palaeontological community became immediately clear as one of her former students, **Charles Wellman** (University of Sheffield), won the President´s Medal for his own contributions to the field of (early) plant evolution. **Matt Friedman** (University of Oxford) won the Hodson Award for his innovative and diverse contributions to gnathostome evolution. The Mary Anning Award went to **Hans Hess**, a Swiss palaeontologist who specializes in fossil echinoderms. He gladly accepted this honour, and while doing so questioned a quote by Mary Anning on the lesser importance of the echinoderm remains that she found. After our bellies were adequately filled with cheese, bread and drinks, we caught the last train back to town. I ended up together with many other palaeontologists at the Safari Bar for some more drinks, where the owners seemed a bit surprised by the liveliness of palaeontologists.

Sunday began with a dedicated poster session between 8.45 and 10.00. The posters encompassed a broad spectrum ranging from the Cambrian to the Cenozoic, from unicellular fossil organisms, over multiple arthropod groups to dinosaurs. Apart from the award-winning poster from **David Button**, my personal favourites included the posters on the myth of exploding carcasses (**Achim Reisdorf**), the evolution of brood care in dictyopteran insects (**Marie Hoernig**), giant rodent diversity in the Neotropics (**Juan Carillo**) and identifying chemosymbiosis through geological time (**Edine Pape**). The high quality of all the posters was particularly striking this year, and the previous selection reflects my personal

Photo: Christian Klug

*Michael Benton with Hans Hess who has just received the Mary Anning Award.*

taste in peculiar, unusual or 'underdog' topics. I was also a bit distracted by the fact that the first masters student I co-supervised was presenting his poster on taphonomic biases of coleoid cephalopod tissues, and humbled by the gesture that on one of the other posters, a crinoid and an orthoconic nautiloid species were named after my wife and me (as a kind of belated wedding gift).

The oral presentations started again with a specialized session on the Triassic and Jurassic in the main lecture hall. It featured talks on Triassic ammonoids (**David Ware**) and conodonts (**Morgane Brosse**, **Nicolas Goudemand**), an intra-early Triassic crisis of benthic ecosystems (**Richard Hofmann**), the palaeoecology of placodonts (**James Neenan**), the developmental basis of Jurassic mammal teeth, and the taphonomy of ichthyosaurs (**Silvia Danise**, **Susan Beardmore**).

After a sandwich lunch, the meeting proceeded with parallel sessions on the Jurassic to Cenozoic in the main lecture hall (Session 7A) and the Silurian to Triassic (Session 7B) in the smaller lecture hall. I went to Session 7A, which started with talks on Miocene rhodoliths (**Cristina Rebelo**), polychelidan lobster diversity in La Voulte (**Denis Audo**) and the latest Cretaceous Antarctic cephalopods (**James Witts**). The session went on with several vertebrate talks including presentations on teleost evolution (**John Clarke**), Micro-CT reconstructions of hedgehog inner ears (**Olivier Maridet**), the aquatic sloth *Thalassocnus*, Early Miocene dolphins from New Zealand (**Gabriel Aguirre-Fernandez**) and the evolution of seabirds in the Humboldt Current (**Martin Chavez Hoffmeister**). I missed out on an equally interesting session on the Silurian to Triassic. It included talks on the colonization of the water column by Silurian ostracods (**Vincent Perrier**), Devonian lycopod forest (**Christopher Berry**) and Devonian tabulate coral–crinoid biocenosis (**Mikolaj Zapalski**), and the diversity of Tournaisian tetrapods (**Jennifer Clack**). Particularly interesting sounded the latter part of the session including presentations on Romer´s Gap (**Timothy Smithson**), the Lilliput effect in latest Permian ammonoids (**Dieter Korn**), extinction and recovery of Permo-Triassic fishes (**Carlo Romano**), as well as the diversification and diversity partitioning of Early Triassic benthic ecosystems (**Michael Hautmann**). **John Clarke** (University of Oxford) deservedly won the President's Prize for his excellent talk on "150 Million years of morphological evolution in half of all vertebrates", where he convinced even the most sceptical among us that "there´s something special about teleosts" by integrating molecular methods and fossil morphological and diversity data.

After the coffee break, we were treated to parallel sessions on methods and varia which didn't fit into any of the previous sessions. The 'methods' session included talks on experimental decay of phyllocarids (**Oliver Knevitt**), taphonomy of tooth wear (**Laura McLennan**), trace elemental imaging of fossils (**Pierre Gueriau**), a new R Package for quantifying the effects of phylogeny on measures of disparity (**Graham Lloyd**), visual systems of pterygotid eurypterids (**Ross Anderson**) and morphological and functional diversity of therizinosaur claws (**Stephan Lautenschlager**). The 'varia' sessions comprised talks about acritarchs (**Thomas Servais**), terrestrial vertebrates in the Jura Mountains (**Daniel Marty**), extreme warming during the Paleocene–Eocene thermal maximum (**Tracy Aze**), bryozoans from a Miocene volcanic island (**Björn Berning**), Fe-mummification of bryozoans (**Consuelo Sendino**), catshark egg capsules from methane seeps (**Crispin Little**) and fungal symbionts in the fossil deep biosphere (**Stefan Bengtson**).

The winners of the President's Prize for the best talk (John Clarke) and Prize for the best poster (David Button) were announced at the end of the final session.

On Sunday afternoon, I travelled back home like many of my colleagues, while others prepared to join one of the field-trips or go to the Swiss Light Source, about 40km away from Zürich. I seemingly missed out on an important and jolly night of karaoke as many palaeontologists landed at the Wolfs Bierhalle for some drinking and singing (as became obvious from pictures and videos posted on social network sites). I have been told the excursions were also a great success. One field-trip went to Ticino under the guidance of Dr **Heinz Furrer** (curator of the Palaeontological Museum of the University of Zurich) to visit the world-famous Fossillägerstatte Monte San Giorgio (listed as a UNESCO world heritage site) and the new Museum Meride, which exhibits fossils from the Triassic of Monte San Giorgio as well as spectacular models of the animals of Monte San Giorgio made by Beat Scheffold (collection assistant of the Museum of the University of Zurich). Another excursion went to the world-renowned Dinosaur Museum in Aathal, where they were welcomed by its director and founder Dr H.C. Hans-Jakob Siber and the vice-director and curator Dr Thomas Bolliger.

Photo: Jack Matthews

*John Clarke, a PhD student at the University of Oxford, whose talk won the President´s Prize for the best presentation.*

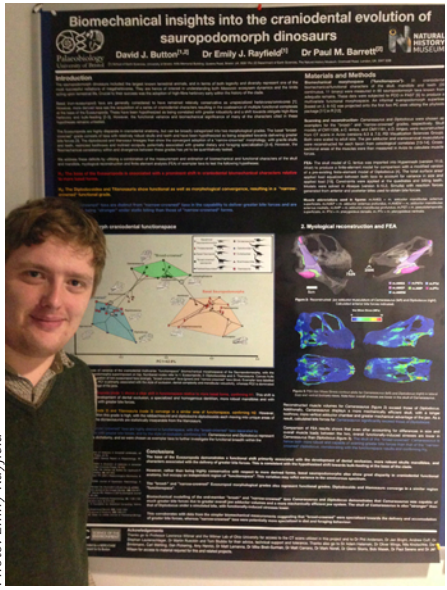


Photo: Emily Rayfield

*David Button, a PhD student at the University of Bristol, with his award-winning poster.)*

All people involved with the organization of the meeting did an amazing job. Particular compliments to Christian Klug, who organized this meeting in his own style and even managed to get the brand "Mammut" to make special custom-made backpacks (instead of the traditional conference bags which often end up in the bin afterwards). We can deem ourselves lucky that this meeting happened before the Swiss introduced a quota on the number of palaeontologists allowed in their country. Even people who weren't able to attend didn't miss the meeting: for the first time ever, the Annual Meeting was streamed live through the Palaeocast website. Currently, most of the talks are also being released as lunchtime talks through the Palaeocast podcast website (courtesy of Dave Marshall and his fellow Palaeocasters).

Photo: Christian Klug

*Excursion to Monte San Giorgio; Heinz Furrer showing the entry to one of the ancient mines at Monte San Giorgio.*

Photo: Christian Klug

*A glimpse of the new Meride Museum.*

**Kenneth De Baets**
*GeoZentrum Nordbayern,*
*Fachgruppe PaläoUmwelt,*
*Friedrich-Alexander-Universität Erlangen-Nürnberg*

**72nd Annual Meeting of the Society of Vertebrate Paleontology**
Raleigh, North Carolina, USA *17 – 20 October 2012*

The Society of Vertebrate Paleontology (SVP) serves to advance the science of vertebrate palaeontology and to this end it has held an annual meeting every year since its founding in 1940. Although the meetings have usually taken place in the United States, the ~2,300 professionals, students, artists, preparators, and avocationalists that make up the SVP membership include a significant international contingent <**http://vertpaleo.org/**>.

Consistent with recent meetings, the conference took place over four days bracketed by pre- and post conference field-trips to local sites. Oral presentations were 15 minutes long and organised in three parallel sessions. Dedicated poster sessions were held in the afternoons, with most posters displayed for a single day. Exceptions included posters related to education and outreach, and for the first time the Colbert Student Poster Prize; these posters were displayed for the duration of the meeting.

The 72nd meeting of SVP was held at the Raleigh Convention Centre in Raleigh, North Carolina. On arriving in the sedate and relatively leafy city centre it was immediately obvious that Raleigh (named after Sir Walter) was going to provide a somewhat different atmosphere to that of the previous year's meeting held in Las Vegas (Figure 1).

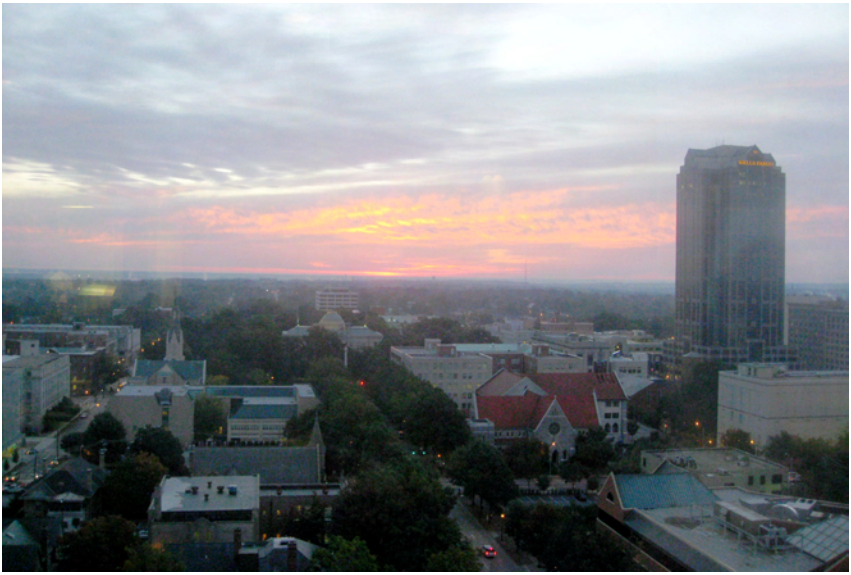

*Figure 1. Raleigh at dawn's early light.*

The pre-meeting field-trip 'Experiencing Newark Supergroup Basins' was led by **Andy Heckert** (Appalachian State University) and **Vince Schneider** (North Carolina Museum of Natural Sciences). Paul Olsen was scheduled to help out, but family matters prevented his attendance, so **Nick Fraser** (National Museums, Scotland) ably stepped in. Twenty-two participants representing the USA,

England, Scotland, Germany, Switzerland and Argentina (via South Africa) attended. On the first day the participants visited sites in the Durham and Sanford sub-basins near Raleigh, with highlights including the site of the Cumnock coal mine (source of the AMNH phytosaur mount) and a chance to find fossils in boulders moved as part of a road-widening project (Figure 2).

*Figure 2. Participants on the Experiencing Newark Supergroup Basins Field-Trip look for vertebrate fossils exposed in the "US 221 road cut" of the Upper Triassic Cow Branch Formation, Dan River/ Danville basin.*

**Russ Patterson** (Patterson Exploration Services) served as local guide to the geology of the Sanford sub-basin. The second day started in the Boren Clay pits with a search for vertebrate food (plant fossils in the Pekin Formation) of the Sanford sub-basin, and ended at the Virginia Museum of Natural History, where **Alton ('Butch') Dooley** and crew hosted a banquet as well as exhibits and collections tours. The third day was dedicated to the Virginia Solite quarry, a world-class Lagerstätte in the Cow Branch Formation of the Dan River/Danville basin (Figure 3). There participants strove to discover new specimens of the archosauromorph *Tanytrachelos* from the beautifully cyclic layers before returning to Raleigh. The weather was sunny and mild for all three days, allowing the combination of field and museum experiences to proceed seamlessly. Logistical support by the host institutions and permission to access sites, particularly from the quarry owners and operators, were essential, and are gratefully acknowledged.

The day before the conference proper included two workshops (Archival Materials and Phylogenetic Comparative Methods) and an evening lecture by **Larry Witmer**. In this well-attended public event hosted by the North Carolina Museum of Natural History, Larry showed how advances in Computed Tomography (CT) and computer processing have provided new insights into the complex anatomy and palaeobiology of dinosaurs. The talk featured numerous three-dimensional computer models created in the Witmer Lab to test hypotheses about soft tissue anatomy <**http://www.oucom.ohiou.edu/dbms-witmer/lab.htm**>.

The conference centre was spacious but functional, with all three sessions just a few strides from one another. However, one had to be careful when sitting down mid-talk due to the tendency

*Figure 3. Nick Fraser (National Museums Scotland, Virginia Museum of Natural History) explains the stratigraphy, depositional environments, and palaeontology of the Virginia Solite Quarry Lagerstatte on the Experiencing Newark Supergroup Basins Field-Trip.*

of the chairs to make a comical high-pitched noise. Registration, posters and merchandise were downstairs but together in one large, well laid out, and appropriately lit room (Figures 4 and 5).

Wednesday morning began with a plenary talk by **Megan Lowman** about using research discoveries to inspire science literacy and recruit the next generation of scientists. This presentation was followed by a symposium on the palaeobiology of the Neotropics, and concurrent sessions on theropod dinosaurs and 'fish' plus early tetrapods.

The symposium on the Neotropics highlighted the growing importance of this region's fossil record, particularly for understanding the relationships between climate and diversity. **Paul Barrett** opened proceedings with a description of material from the subtropical bone bed at La Grita, Venezuela, which likely represents the first known Triassic ornithischian dinosaur. **Hans Larsson** suggested that diversity hotspots could be identified in the fossil record, pointing to a Cretaceous fauna from Colombia that shows endemism, an abundance of 'oldest' taxa, and diversity of phenotypes. **Edwin Cadena** helped fill the gap in the turtle neotropical fossil record with a description of four new taxa (one with a shell length approaching two metres!) from the Palaeocene Cerrejon Formation. **John Bloch** questioned how the Paleocene–Eocene Thermal Maximum (PETM) would have affected Eocene tropical mammals that, in theory, would have had difficulty dissipating heat. He asserted that the diversity of the Etayoa site (at least 20 mammal species) and significant plant diversity indicate a lower temperature estimate than previously predicted. **Jason Head** returned us to the Cerrejon, and inferred a maximum temperature of 35°C based on faunal comparisons. **Ross MacPhee** assessed the virtues of different models of dispersal in the Quaternary in the Caribbean archipelago, suggesting that short-term magmatic rises may have had a role in dispersals from the

*Figure 4. The Raleigh Convention Center exhibit hall made an excellent venue for posters and exhibitors.*

Philippines to the Greater Antilles. **Jorge Velez-Juerbe** rounded off the session before the lack-of-coffee break by looking at the largely South American influences on the palaeobiology of Jamaica. Post-break talks included **Torsten Scheyer** discussing a highly diverse assemblage of crocodylians from the Miocene of Venezuela.

*Figure 5. The conference organisers had heard the hype about "squabbling palaeontologists" and feared the worst.*

The theropod dinosaur session began with **Lindsay Zanno** describing a new theropod from the Cretaceous Cedar Mountain Formation. **Eric Snively** presented an impressive multibody dynamics analysis of feeding in *Allosaurus* and **Yoshi Kobayashi** described a therizinosaur with unusual teeth. **Stephan Lautenschlager** stayed with therizinosaurs and discussed the biomechanics of the skull. **Anjali Goswami** extolled the virtues of teeth from the Late Cretaceous Kallemedu Formation of India that perhaps includes the first Gondwanan troodontid. **William Parsons** compared the shoulder region of *Deinonychus* to those of *Velociraptor* and birds, showing a gradual transition.

The session on 'fish' plus early tetrapods included talks by **Zhikun Gai** on the origin of the vertebrate jaw, **Katherine Criswell** on CT scans of holocephalan fish crania, **Sam Giles** on the endoskeletal

anatomy of the earliest definitive ray-finned fish *Cheirolepis*, **Kathryn Mickle** on homology of the snout bone in actinopterygians, **John Long** on a tetrapodomorphan fish from Australia, and **Christine Janis** on the function of early dermal bone. The second half featured presentations by **Jason Pardo** on tooth implantation of early tetrapods, **Jeff Liston** on growth in *Leedsichthys*, the largest known fish, **Matt Friedman** on the historical biogeography of cichlid fishes, and **Judd Case** on Antarctic faunal turnover during Eocene climate change.

Raleigh's quiet streets included a surprising number of lunch options such as Beasley's Chicken and Honey, the Busy Bee, and the world-famous Clyde Cooper's barbecue. Raleigh's quiet streets also featured a number of life-sized colourful model bovines from North Carolina's Cow Parade <**cowparadenc.com**>.

Technical sessions after lunch focused on archosaurs, terrestrial mammals, and aquatic mammals. The terrestrial mammal session began with **Jessica Theodor** discussing whether *Caenotherium* was a good representative of Caenotheriidae, followed by **Jordan Noret**, who used $\delta^{18}O$ values to look at the Palaeogene–Neogene transition in Ethiopia. **Jelle Zijlstra** presented the first tarsier from southern Pakistan, which suggests the South East Asian rainforest extended further westwards than previously thought. The highlight of this section, however, was the back-to-back talks given by **Michael Granatosky** (for the second standing-in for **Charlotte Miller**): he showed that primates, sugar gliders, sloth lemurs, sloths, and bats all show different solutions in the phalanges and vertebral column to the biomechanical problem of suspension and the associated trade-off between mobility and stability. This talk was followed by three papers using Geometric Morpometric Methods (GMM): **Andy Grass** on sloth scapulae and locomotion; **Aaron Wood** on equine ankle bones and environment type; and **Joshua Samuels**, who used skull morphology to predict ecology with 87% success in rodents and 94% in Carnivora, based on size and the position of major sense organs. The aquatic mammal session featured talks by **Alec Boyd**, **Eric Ekdale** and **Nick Pyenson** on vertebral morphology, cetacean ears, and cetacean mass death assemblages respectively. The session on archosaurs included talks by **Casey Holliday** on how the lower jaws of archosaurs connect with one another, and **David Button** on continuous characters and pterosaur phylogeny.

The poster session included a diverse array of posters which included one advertising a website for sharing GMM data <**morphometry.org**> (**William Gelnaw**), and two reporting new UK marine reptiles, by **Adam Smith** and **Dean Lomax**. Wednesday evening involved a welcome reception and buffet at the North Carolina Museum of Natural History. Later in the evening several delegates wishing to continue their 'networking' were left confused by the widespread 'meet under the whale' plan as there were two different whale mounts in separate buildings at opposite ends of the museum.

Thursday morning featured the Romer Prize session (student talk prize), a symposium on Late Cretaceous faunas of Appalachia (dedicated to the memory of Donald Baird), and the preparators' session. The Romer Prize was well attended and produced many high-quality talks. **Emily Bamforth** examined the driving factors of Cretaceous diversity for better understanding of the K/Pg extinction event, and **Christine Böhmer** presented on the relationship between Hox domains and vertebrae across amniotes. **Nicolas Campione** strove to find some consistent scalar for body size in mammals and diapsids. **Alex Dececchi** used patristic methods to identify 'hotspots' of evolutionary speed in the evolution of flight in avian dinosaurs, concluding that the idea that birds lengthen their forelimbs is false, and that the rate of evolution is fastest prior to when Aves arise,

when the hindlimbs are instead being reduced. **Francois Gould** presented a method for comparing surfaces using surface laser scans and an algorithm for automatically assigning landmarks. He illustrated this with an example of knee articulation in ungulates. **Ashley Hammond** asked whether we were missing signals of locomotor mode in groups with no extant analogue, such as the suspensory apes of the Miocene, and **Alexander Hastings** presented evidence for paedomorphosis in dyrosaurid crocodiles which may have helped survive the K/Pg extinction event. One of the most entertaining talks was by **Ashley Heers**, who used juvenile birds as models for non-avian theropod dinosaurs, and showed convincingly that even without full flight, proto-wings can generate significant lift, especially with 'flap-running' up steep slopes. **Tyler Lyson** investigated the origin of the turtle shell, suggesting an origin for turtles outside diapsids, and with notosaurs, followed by **Julia McHugh**'s analysis of the effect of the P-T extinction on temnospondyls. By far the most entertaining and informative talk, however, was given by the eventual winner **Zhijie Tseng**. He traced the sequence in which traits arise in two mammalian clades that converge on a bone-cracking habit. Trends in skull morphology, the structure of Hunter-Schreger bands and diet (inferred from microwear) were shown and supplemented by a memorable video of a hyena eating a pig neck. Following this talk, **Kevin Uno** reconstructed the seasonal diet variation in a Rancho La Brea mammoth, using the weekly records laid down in tooth enamel, and **Eric Wilberg** rounded off the candidates with a phylogenetic analysis of crocodylians to resolve the positions of the three major longirostrine groups.

The Appalachia symposium included talks on fish (*e.g.* **Charles Ciampaglio**), crocodiles (**Chris Brochu**), hadrosaurs (**David Weishampel**), and theropods (*e.g.* **Steve Brusatte**), and palaeobiogeography of eastern North America (*e.g.* **Cynthia Crane**). The preparators' session included a talk by **Mathew Colbert** demonstrating the potential of data from CT to guide the preparation of fossils encased in variable matrix.

The afternoon session on Thursday included further talks on dinosaurs and mammals. One session began with a plea from **Nizar Ibrahim**, standing in for Paul Sereno, to make use of Phenoscape <**http://phenoscape.github.io/**>, to bring together vastly different types of data, to identify candidate genetic correlates of particular phenotypes. The struggle to have a single, simple measure for diversity led **Elizabeth Ferrer** to propose using phylogenetic branch distance (total length spanned by a tree including all species in a community), and then proposed treating time periods as communities, and hence finding out the effect of extinctions on communities, with species richness and phylogenetic richness following very different curves. **John Alroy** tested the efficacy of various measurements of bone parameters as a predictor of body mass, suggesting that a combination of skull length and scapula length (with humerus and radius if need be) was the best. **Sarah Werning** identified lines of arrested growth in mammals, contrary to expectations, and suggested that marsupials, in fact, never stop growing, as their epiphyses are unfused at the time of death. **Thomas Halliday** presented evidence that a hypothesised mechanism of lower molar development involving an inhibitory cascade is plesiomorphic to Mammalia. **Robert Asher** argued persuasively that Atlantogenatan mammals have a differing rate of development, with very slow dental eruption, axial variability, and demonstrated this with new data from xenarthrans, though admitting that disentangling the difference between sexual dimorphism and juvenile-like tooth eruption in adults is difficult. Finally, **Marcelo Sanchez-Villagra** suggested that marsupials had not been out-competed by placentals, but were less disparate and diverse due to age of the clades, differential survival at the K/Pg extinction, restriction in space, and a lack of opportunity, rather

than a developmental constraint. The two concurrent sessions also included several interesting talks. **Jason Bourke** used fluid dynamics to test different hypotheses of nostril position in sauropod dinosaurs. **Matthew Bonnan** suggested that differences in the appendicular joint anatomy of mammals and saurischian dinosaurs (*e.g.* cartilage contribution, subarticular surface complexity) reflect different strategies for terrestrial locomotion which have implications for scaling and the evolution of greater body size. **Paul Upchurch** and **Philip Mannion** presented complementary talks on aspects of titanisauriform sauropods. **Danielle Fraser** used mammal data from the Miocene to illustrate how warmer climates weaken latitudinal gradients.

Judging for the Colbert Student Poster Prize took place on Thursday. Stand-out posters included those by **Neil Brocklehurst** on diversity in lepidosaur skull shape, **Jessica Miller-Camp** on the problems of testing sexual dimorphism, and the winner, **Stephanie Crofts**, on the mechanics and trade-offs of crushing teeth. Posters outside the Colbert included those on turtles (*e.g.* **Sandra Chapman**), birds (*e.g.* **Estelle Bourdon**), and intraspecific variation (*e.g.* **Chloe Marquart**). On Thursday evening the student roundtable forum and reprint exchange (organised by Eugenia Gold and Rissa Westerfield) gave students a chance to converse with more experienced members of SVP in an informal fashion about a wide range of topics such as fieldwork opportunities and advice on publishing research (Figure 6).

*Figure 6. The well-attended student roundtable event.*

Friday morning saw sessions on sauropsids, synapsids, and the symposium titled 'New Quantitative Approaches to the Study of Vertebrate Evolution'. During the latter, **Julia Brown** advocated the use of likelihood models in phylogenies due to their strengths in rate-based branches. **Ross Mounce** investigated character compatibility between taxa, before **David Bapst** suggested using random extensions to fossil ranges to come up with a true uncertainty of branch lengths, which has benefits when analysing rates of trait evolution. **Graeme Lloyd** continued this theme by

explaining how a probability distribution could help close the difference between molecular and morphological date estimates, before **Graham Slater** told us what we already knew – that fossils are extremely valuable to phylogenies – but showed statistically that even a small percentage of total taxa being fossils makes a large difference, giving encouragement to analyses of taxa with sparse records. **Peter Wainwright** discussed the relationship between coral reefs and fish diversity. The first part of the synapsid session included talks by **Keith Angielezyk**, **Richard Blob**, and **Christian Kammerer**. The second began with **Rachel O'Meara**, who identified determinate growth in *Morganucodon*. **Julia Schultz** then used synchrotron analysis of the direction of tooth microwear to infer mammalian jaw movement during mastication. The highlight of this session (and perhaps the whole conference) was the presentation by **David Krause** on the first skull of a gondwanathere – images of the specimen from Madagascar elicited loud gasps from the audience. **David Grossnickle** demonstrated an increase in mammalian diversity throughout the Cretaceous, correlated with that of angiosperms, and **Gregory Wilson** rounded things off with an introduction to some metatherian cranial material from the Mesozoic. The sauropsid session began with **Gabe Bever** discussing temporal ligaments and cranial fenestration. **Paul Gignac** described method refinements for staining soft tissue in CT. **Richard Butler** provided a revision of two phytosaur skulls from the Late Triassic of Europe and their palaeobiogeographic context.

The second half began with a talk by **Julia Molnar** on crocodilomorph axial mechanics, and **Aki Watanabe** presented an impressive GMM analysis of crocodilian skull shape. **John Hutchinson** discussed the complexities of locomotor evolution in Crocodylomorpha using a diverse pool of data that included detailed observations of living animals; galloping croc videos abounded.

In the afternoon, there were more talks on dinosaurs, mammals, and a session on lepidosaurs. The mammal talks relocated into a small room with many technical difficulties, but there were talks from **Eric De Bast**, who discussed the mammalian fauna of a Palaeocene site in Belgium, and **William Clemens** discussing the stratigraphy of the Hell Creek Formation. The lepidosaur session began with several talks on mosasaurs. Next **Jacque Gauthier** provided an overview of squamate morphological characters using CT data from the Tree of Life project. **David Demar** described a nearly complete fossil skeleton from the Late Cretaceous of USA, which promises to greatly clarify our understanding of iguanian relationships and diversification. **David Larson** gave a great talk on quantified tooth variation in monitor lizards (*Varanus*) and its implications for understanding the diversity of theropod dinosaurs. Posters included that of **Alison Bormet** on ecomorphology of the distal phalanx in deer. On Friday night the 30th annual SVP auction, hosted by a superhero-clad assembly, raised $21,000 for SVP with the usual scramble for reprints, books, curios, and casts.

Saturday morning included another session on dinosaurs, (yet more) mammals, and a phylogenetic pick-and-mix. The dinosaur session featured **Jordan Mallon** using a variety of biomechanical proxies to identify ornithischian diet, whereas **Gregory Erickson** established the presence of cementum and dentine in the teeth of hadrosaurs. In the mammal session **Steve Wroe** used computer modelling to examine the biomechanics of sabre tooth skulls. **Anthony Friscia** used a phylogenetic Principal Component Analysis to characterise tooth morphospace in Carnivora, which suggested a rapid expansion of morphospace followed by local specialisation. **Lars Werdelin**, using similar methods, identified a faunal turnover and elimination of large omnivorous carnivorans in the East Africa region. **Andrew Hill** inferred the social structure of extinct elephants from trackways, before **Michael Cherney** used the differing levels of oxygen and nitrogen isotopes in

snowmelt and rainwater to determine the season in which a Colorado mastodon died. **Luke Wicks** looked at differing methods that mammals use for dealing with $C_3$ and $C_4$ plants, and **Yuri Kimura** found that small mammals lag behind larger ones in isotopic analysis, and that murines are better than perissodactyls for reconstructing local soil chemistry. The phylogenetic pick-and-mix session included talks by **Nicholas Fraser** on a new long-snouted protorosaurian from the Middle Triassic of China and **Roland Sookias** on body size evolution in therapsids and archosauromorphs.

The final afternoon included presentations on various aspects of Palaeogene mammal biology, beginning with **Ross Secord**, who identified differing $\delta^{13}C$ values in Palaeocene mammal assemblages, indicating niche partitioning between several "condylarth" genera. **Gabriel Yapuncich** dealt with the functional morphology of multituberculate ankles using micro-CT techniques, concluding that they were probably terrestrial. **Jorg Habersetzer** reconstructed the inner ear of an Eocene bat from Africa, and used physical measurements of the inner ear region to predict diet. **Irina Ruf** used the inner ear of *Leptictis* and *Leptictidium* to resolve locomotory capacity, finding results which contradicted previous estimations of speed in these taxa. Convergence on mechanisms of fossoriality was discussed by **Heather Ahrens**, who demonstrated that different styles of digging can result in disparate biomechanical requirements, and tested them in a variety of fossils. **Jerry Hooker** described some new pseudorhynchocyonid finds, and put forward the idea that leptictids might be close to Pholidota. Trends in brain evolution of early Carnivora were identified by **Michelle Spaulding**, who showed an increase in cerebral size over the cerebellum. **Richard Stucky** then closed the conference with his review of the stratigraphy of the Wind River Formation.

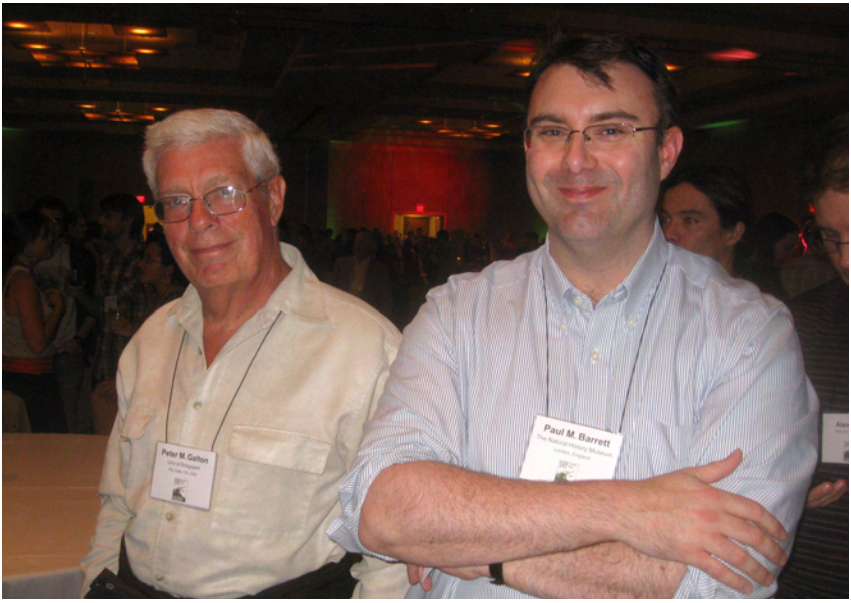


*Figure 7. Peter Galton and Paul Barrett at the conference after-party.*

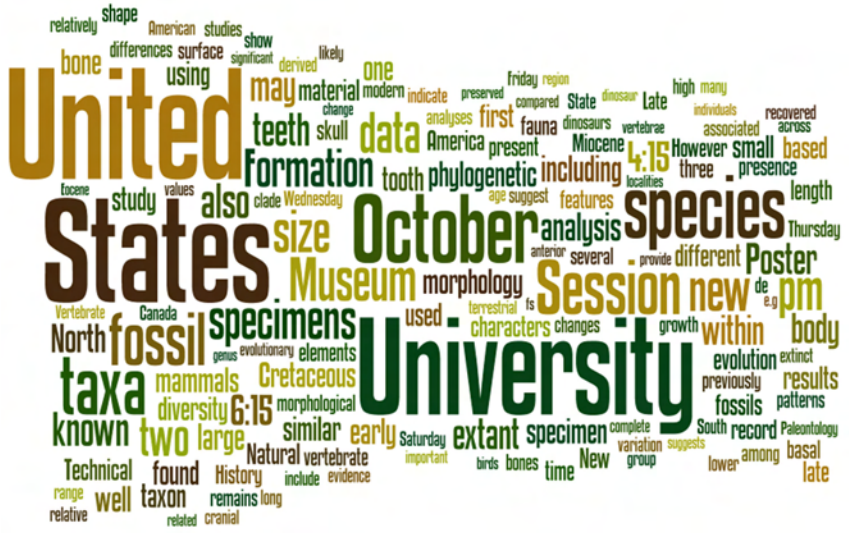


*Figure 8. A word frequency analysis of the 2013 SVP Abstract book.*

Posters included several on biomechanics, such as the differences between the skull mechanics of ornithomimids and other theropods (**Andrew Cuff**), the kinematics of footprint makers in semi-fluid substrate (**Peter Falkingham**), and squamate reptiles from the Upper Cretaceous of Texas, USA (**Randy Nydam**).

The awards banquet took place in the ballroom and was very well attended. During the repeated standing ovations the audience became increasingly amused by the obscene whines made by the chorus of 1,000 chair cushions. Nevertheless, **Catherine Forster**, the incoming president of SVP, did an outstanding job in keeping proceedings rolling along at a sincere and healthy pace. Seemingly immune to the distraction, she showed who the most important chair in the room was. The after-party continued into the early hours and as is customary many delegates swapped name badges (Figure 7).

For those of hardy constitution, and perhaps not so sore of head, the Sunday included opportunities to visit the Duke Lemur centre or Cenozoic deposits at Carmel Church Quarry.

Overall this was an enjoyable and productive conference held in a winsome venue that facilitated networking and socialising between sessions. It involved 1,145 delegates, from 27 different countries, and a variety of topics and taxa (Figure 8). There were many great talks and posters that we did not have space to mention above. Comparative analysis, quantitative data, GMM, and phylogenetic correction featured repeatedly during the meeting. The growing importance of CT for morphological studies was also evident; 13% of the posters included some form of image generated using CT (Table 1). This meeting will not simply be remembered for the rude noises made by the chairs during the conference dinner. Abstracts are published in the Journal of Vertebrate Paleontology, SVP Program and Abstracts Book 2012.

| Table 1. Survey of poster imaging | | |
|---|---|---|
| Number of posters sampled: Wed, Thu, & Fri but not Sat | 233 | 100.0% |
| Poster features at least one image of a specimen | 210 | 90.1% |
| Poster features at least one image of a specimen not based on CT data | 200 | 85.8% |
| Poster features at least one image of a specimen based on CT data | 30 | 12.9% |
| Poster features images of specimens based on both CT and non-CT data | 20 | 8.6% |
| Poster does not feature a specimen | 23 | 9.9% |

The 74th meeting of SVP is due to take place on 5–8 November 2014 in Berlin, Germany: only the second time the annual meeting will be held outside North America. For further details please contact Johannes Müller <**Johannes.Mueller@mfn-berlin.de**>.

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## Jurassic Palaeoenvironments & Life: British Council 'Researcher Links' workshop

Marrakech, Morocco *28 – 31 January 2014*

Thanks to funding from the British Council 'Researcher Links' programme, late January saw Morocco host a Jurassic workshop for early career researchers, organized by Dr Paul Taylor of the Natural History Museum, London, and Dr Abdellah Ait Addi of Université Cadi Ayyad, Marrakech.

The workshop brought together around 30 postgraduates, postdocs and new lecturers, half from the UK and half from North Africa, with the aim of stimulating new research collaborations. A small group of established academics from both regions, including professors Steve Hesselbo and John Cope, acted as mentors.

There were many good reasons for taking part, but the allure of escaping a wet British winter was particularly attractive. In the end, though, the Moroccan weather wasn't much drier or warmer! Held in a hotel in the outskirts of Marrakech, the workshop began with a late afternoon arrival, dinner, and an evening ice-breaker with a few posters by the pool (table).

Next morning, Dr Martin Rose of the British Council Morocco helped open the meeting, noting that the initial seating preferences made it look like a wedding, with two separate groups on either side of the room. He hoped the workshop would achieve its aim and break up the geographic separation.

Over the next two days, participants gave a series of short talks explaining their research interests in Jurassic palaeoenvironments and life. The mentors also gave presentations on key topics.

In starting the workshop by reviewing Jurassic palaeontology, **Paul Taylor** explained that the first fossils he ever found were from the period. They didn't come from anywhere as exotic as Morocco, hailing instead from South Cave station quarry near Hull. To be fair, if you come from North Africa, the East Riding of Yorkshire is probably pretty exotic.


*Welcome to Marrakech!*

**John Cope** followed this with a talk on Jurassic stratigraphy and its key protagonists, introducing the audience to the subtleties and challenges of chopping up time. We then had presentations on subjects as diverse as volcanism of the Central Atlantic Magmatic Province and its impact on life; micropalaeontology and isotope analysis of the early Jurassic; and the difficulty of defining the Jurassic–Cretaceous boundary.

After a fine luncheon, a mostly North African session focused on the Jurassic of Morocco, in particular the Early Jurassic carbonates of the Atlas Mountains. As the workshop field-trip was to head there, this served to whet the appetite, although I have to confess I didn't fully follow the content when one speaker decided to give his talk in French.

Next, a quick coffee break, before John Cope returned to the stage to discuss the palaeobiology of Jurassic ammonites, looking in particular at sexual dimorphism within the group. **Steve Hesselbo** examined the palaeoenvironmental changes of the Early Jurassic, particularly the Toarcian Oceanic Anoxic Event, and then **Ibtissame Berrado** of the British Council brought the day to an end with an investigation of the funding sources available to researchers.

On the second day, **Haddou Jabour** of the National Office of Hydrocarbons & Mines, Rabat, presented an overview of Moroccan petroleum geology, highlighting the importance of the Jurassic to the country's offshore exploration interests. It was then time to investigate the Toarcian OAE in more detail, moving from a bioturbated shale succession in Japan to the bivalve-dominated ecosystems seen in the UK, with some rhenium isotopes and foraminiferans thrown in for good measure. There was also a chance to pop over to Argentina and glimpse the Toarcian of the Neuquen Basin.

The morning coffee break saw plenty of discussion around the posters, and a bit of filming, as one of the delegates began compiling a workshop movie. Then we returned to the meeting room to hear about marine Jurassic fossils, their identification, and their importance to palaeoenvironmental analysis. The content was similar after lunch, with bryozoans, dinoflagellates and ostracods all getting a look-in. Paul Taylor brought the talks sessions to an end, and the hot-off-the-press workshop video was shown, before the group then made the short walk round to the university geology department to inspect the museum collections.

Plenty of discussions were now forthcoming, the wedding-like segregation clearly breaking down, and the interaction was further enhanced when we all jumped on to the packed No. 1 bus into town. The medina of Marrakech is a UNESCO World Heritage site, and the central square of

Djemaa el Fna always worth a visit, whether you wish to haggle for gifts in the souks, or simply enjoy the hubbub and the liveliness. Even a bit of rain couldn't dampen the enthusiasm.

Next morning, after a slightly delayed start, we jumped on another bus and headed east out of Marrakech for a couple of days in the Atlas. We were graced with a day of beautifully volatile weather, and the drive up into the mountains was spectacular. There were plenty of interesting rocks and fossils too, traversing the various carbonate facies of the western Tethyan Gulf.

Overnight, we stayed in a lakeside hotel at Lac Bin El Ouidane, a huge reservoir that supplies both hydroelectric power and water for irrigating the plains north of the Atlas. Thanks to engineering work, the water levels were deliberately low, enabling us to wander the shore the next morning, admiring sedimentary structures, body fossils and traces in the Early Jurassic successions. A little further round the corner, the rocks became terrestrial, and two dipping bedding planes offered up some impressive dinosaur trackways. Sadly, it was raining too much to admire them properly.

The last stop was definitely not the least, at the Cascades d'Ouzoud. These dramatic waterfalls also cut through the Jurassic rocks, and are home to some very cheeky monkeys. There can be few more amusing ways to end a workshop than by getting your colleagues to have a Barbary macaque perch on their heads, and I heartily recommend it.

Perhaps inevitably, as we headed back to town, the clouds began to lift, and by the time we flew home the next morning, Marrakech was bathed in sunshine. L ondon Gatwick certainly wasn't, but if the workshop achieves its aims, there will be plenty of future opportunity to enjoy more of Morocco. Many thanks to Paul, Abdel, and the British Council for making it happen.

**Liam Herringshaw**
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*A lunch stop*

## ——OBITUARY——

# Richard J. Aldridge
# 1945 – 2014

Few reading this will need any introduction to Richard J. Aldridge, known to all in academic circles as Dick. His recent death – far too early – has deprived palaeontology of one of its leading lights. Dick was raised in south London, where he acquired an early and broad interest in natural history that endured as a love of ornithology as well as geology. He went on to obtain a first class degree in geology at the University of Southampton before completing a Ph.D. at the same institution, supervised by Ronald Austin. After a couple of short-term positions Dick was appointed to a lectureship and then as a Reader at the University of Nottingham. In 1989 he moved to Leicester, where he was promoted to professor, later holding the position of F. W. Bennett Professor of Geology until his retirement.

The initial topic of Dick's Ph.D. thesis was Carboniferous conodont stratigraphy, and he published a paper in *Nature* – based on his first period of study – before switching his thesis topic to the conodont stratigraphy of the British Silurian which at the time was an entirely unknown quantity. Dick's thesis, published as a *Bulletin of the British Museum (Natural History)*

in 1972, remains a landmark publication in Silurian conodont taxonomy and stratigraphy, and it defined his research programme for the first phase of his career, extending his research from the British Silurian to Europe, the Arctic, the Arabian Peninsula, and South East Asia. Dick exploited the conodont fossil record in many other and innovative ways. He was an early adopter of the Conodont Alteration Index, which he applied to understanding the Caledonides. He also wrote seminal papers exploring the application of numerical taxonomy to conodont systematics, the concept of homology in conodonts and application of a biologically meaningful anatomical terminology, as well as the first papers applying numerical cladistics to understanding the evolutionary relationships of conodonts and the internal phylogeny of the clade.

Dick's taxonomic and stratigraphic work contributed to establishing the Silurian stratotypes which, of course, provided the model on which other stratigraphic systems were subsequently defined. With David Siveter, he led a research programme exploring the micropalaeontology of Silurian stratotypes, including ostracod, foraminiferal, acritarch, chitinozoan and spore biostratigraphy. This work led to a revised understanding of Silurian stratigraphy, but also revealed faunal and floral evolutionary dynamics in response to environmental change. This work culminated in the development of the P and S Cycle theory of climate and oceanographic change in the Early Palaeozoic that he developed with Lennart Jeppsson. This theory is both controversial and provocative and, as such, it has served as a vehicle for debate over climate change in truly Deep Time.

The second phase of Dick's career focused on conodont palaeobiology and the nature of the conodont organism. As late as 1981 the celebrated palaeozoologist and conodontologist Klaus Müller identified the affinity of conodonts as 'one of the most fundamental unanswered questions in systematic palaeontology'. In that same year, in collaboration with Derek Briggs and Euan Clarkson, Dick Aldridge identified the first soft tissue remains of the conodont organism (published

in 1983) and in the ensuing years the debate was constrained to chordates and then to vertebrates – no mean feat since conodonts had previously been attributed to almost every major animal phylum, as well as to plants and to fungi. Dick then led an international renaissance of conodont palaeobiology that revolutionised understanding of every aspect of the biology and evolution of these organisms, and brought the significance of these advances to global prominence in the debate over the origin of vertebrates, demanding the attention of molecular and developmental biologists, comparative morphologists and phylogeneticists alike. In so doing, he built a dynamic research team that survived several academic generations, the legacy of which is a series of distinct research teams in United Kingdom universities led by former Ph.D. students and postdocs.

*Dick Aldridge performing a card trick to provide amusement on a rainy day during field-work in China.*

Dick had some thirty Ph. D. students in all and his approach to supervision was characteristic and generous. He was firmly of the view that doctoral students should not be taken on unless the supervisor was prepared to give away part of their own research, providing intellectual space for the student to flourish. Through this approach, a keen interest in the philosophy and methodology of science, and by the love and care he has always directed to the personal and intellectual development of his research students and postdocs he fostered many of his charges to prominent positions.

Soft tissue remains of conodonts were encountered in Scotland, and in the USA, but it was the discoveries of giant conodonts in South Africa that broadened Dick's interests in soft tissue preservation, and this can be recognised as the third phase of his career. Dick devoted much of the last two decades to elucidating the composition, preservation and evolutionary significance of the Late Ordovician Soom Shale Lagerstätte, stimulating a comparative analysis of soft tissue preservation through low-temperature geochemistry. In turn, this led him to China and the Early Cambrian Chengjiang Lagerstätte, resulting in a catalogue of papers in the world's leading journals and an encyclopaedic volume detailing its fauna.

Dick Aldridge succeeded scientifically at the highest level, but his career contributions are much more than the sum of the papers. He served two terms as Head of Department at the University of Leicester, a demanding and at times thankless duty. Dick did it with aplomb: calm, efficient, honest, always with an open door and willingness to listen and help. He respected his staff and in turn was respected for his loyalty and integrity. He also served as Sub-Dean of Graduate Studies, Senator, on the University Research Committee (including Chair of Physical Sciences), as External Examiner for undergraduate degrees at a number of UK Universities, and in innumerable

research degree examinations worldwide. Dick also served on the Review Panel of the Natural Environment Research Council, as a Specialist Advisor for RAE2001 and RAE2008, on Royal Society research grant committees, co-chaired the Third International Palaeontological Congress (London, 2010), and co-wrote the bid to make the Chengjiang Largerstätte a UNESCO World Heritage Site. Early in his career Dick's professional duties included Chair of the Conodont Group of the British Micropalaeontological Society (as was), President of the Geology Section of the British Association, on the Councils of the Geological Society and the Palaeontographical Society, and for the Palaeontological Association he served as Marketing Manager. Dick eventually served as the chairman/president of most of the major professional societies in palaeontological science, including the British Micropalaeontological Society (1995–1998), the Pander Society (1998–2004), the International Palaeontological Association (2002–2006), and of course the Palaeontological Association (2008–2010). Characteristically, he did not accept any of these as honorific roles and worked tirelessly to lobby for individuals and institutions under threat or seeking new opportunities.

Dick Aldridge's achievements and contributions to our science were recognised by the award of the Pander Medal (the highest award of the international society of conodontologists), the Brady Medal of The Micropalaeontological Society, the Coke Medal of the Geological Society of London, the Lapworth Medal of the Palaeontological Association, and Honorary Visiting Professor positions in the China University of Geosciences (Wuhan) and Yunnan.

Dick was also great fun to spend time with. Whether in the field or lab, wherever it was in the world – in South Africa or in Wales with friends from the Ludlow Research Group – banter with Dick was always an amusing and eclectic mix of science, sport, jokes and music. Anyone who spent time with him, during long journeys on field excursions for example, will know this and will recall with a smile some of those irritating riddles, anecdotes and word games that helped to while away the hours. And those of us lucky enough to have been there for the occasion will never forget his 50th birthday celebrations at the Annual Meeting in Galway.

A measure of Dick's impact and academic legacy, and the esteem in which he was held, comes from his nomination for the Lapworth Medal of the Palaeontological Association – a joint nomination from twenty-two of his former students, with supporting letters from 21 leading scientists from 11 countries, including all inhabited continents.

**Howard Armstrong**
*(University of Durham)*

**Phil Donoghue**
*(University of Bristol)*

**Sarah Gabbott**
*(University of Leicester)*

**Mark Purnell**
*(University of Leicester)*

**David Siveter**
*(University of Leicester)*

**Paul Smith**
*(Oxford University Museum of Natural History)*

# *Sylvester-Bradley* REPORTS

## *Abbey Wood Excavation*

**Jerry Hooker**
*Natural History Museum, London*

### Historical background

Although the site of Abbey Wood, London Borough of Bexley, has been known for its Early Eocene fossils ever since Whitaker (1872) first found shark teeth in the sand excavated by rabbits from their burrows, the majority of the mammals, for which the site is famous, have been found in the last few decades. The main stratum cropping out in the wood, formerly known as the Blackheath Beds and now formalised as the Blackheath Formation because of its distinctive lithology and contacts with adjacent strata (Hooker 2010), is the source of a well-preserved, although relatively restricted shelly fauna, indicating nearshore marine to brackish conditions. Large numbers of shark teeth and other fishy debris accompany the molluscs, along with scattered turtle and crocodilian remains, but what make the site so important are the rare land mammals and even rarer birds that occur.

The Blackheath Formation is about 30 m thick at the site. It owes its local substantial thickness to its infilling of an incised valley, which cuts out an estimated 27 m of earlier Eocene and late Paleocene sediments, all of which exist only about 2 km away in Woolwich. The source of the fossils is the lower part of the formation, where the Lessness Shell Bed interfingers with sands below the main mass of pebbly strata that comprise the majority of the formation at the site. At the time of formation of the Lessness Shell Bed, land was likely to have existed nearby, perhaps in Woolwich and elsewhere, where the land-based vertebrates potentially lived and died, accounting for their diversity in a marine deposit.

The first mammals to be found owe their discovery to the excavations made by Epps and Marriott in the 1920s (Marriott 1925; Epps & Priest 1933). They were mainly collected by sieving, but as most of the specimens that were found then are larger than 4 or 5 mm, it is clear that smaller specimens (*e.g.* isolated teeth of mouse- or shrew-sized mammals) were being missed. Sieving to 0.5 mm mesh size, together with accurate stratigraphic and geographic recording, was introduced by members of the Tertiary Research Group (TRG), which began operations in 1969 (Rundle 1971). Thus, early collections were dominated by isolated teeth and jaw fragments of a dawn horse (then identified as *Hyracotherium*, now referred to Owen's resurrected genus *Pliolophus*) and the cow-sized extinct pantodont *Coryphodon* (Cooper 1932a,b), and it was soon realised that there were great similarities at genus level with Early Eocene faunas of the western USA. The realisation that a primate, originally named *Protoadapis eppsi* by Cooper (1932a), belonged to a new genus *Cantius* Simons, 1962 (named after the county of Kent) led to its recognition in the USA, where it had previously been wrongly called *Pelycodus* (Gingerich 1981).

**The TRG era**

Post-1968 sieving soon resulted in the finding of *Hyopsodus* (Hooker 1979), a genus of small burrowing condylarthran mammal that is one of the most abundant in penecontemporaneous strata in the Bighorn Basin of Wyoming (Rose 1981). The Abbey Wood mammal fauna steadily grew from eight species in 1969 (Cooper 1932a; Kühne 1969) to 46 species in 2008 (Hooker 2010), when it seemed timely to monograph the fauna, even though some species were still poorly represented. In the intervening interval, some adequately represented taxa were described (Hooker 1996, 2007) and some implications for intercontinental dispersal were discussed (Hooker & Dashzeveg 2003). Since 2008, a 47th species has been found (Hooker 2013) and also a 48th, which is as yet too incomplete to name. In 2010, of the 46 species-rank taxa described, there were still 13 identifiable only to genus, three to family and two to order, plus several species with cf. qualification. One of these has subsequently been named (Hooker 2013), but the rest await better, more complete specimens to allow either identification or naming as new. In a European Early Eocene context, the fauna is rich and fills a gap in this record at around 55.5 Ma. Analysis of its ecological diversity indicates a tropical aspect evergreen forest habitat existing shortly after the Paleocene–Eocene Thermal Maximum (Hooker 2010).

Most of the post-World War II excavations have been made in an area enclosed by Bexley Council with a wooden fence. This approximates the area originally dug by Epps and his associates, but was unlikely to reflect the entire extent of the Lessness Shell Bed outcrop. It was nevertheless with some dismay in 2012 that I discovered that the Shell Bed was essentially exhausted within the enclosure and that it would be necessary to search for its continuation immediately to the west, where its level is buried by an increasing thickness of overlying unfossiliferous pebble beds. The need to carry out an extensive prospecting dig as well as the annual one for collecting in 2013 was therefore vital. My funding by the Palaeontological Association covered the hire of the mechanical excavator and driver on these two digs plus the site hire on the second.

**Results**

In September last, Bexley Council and Natural England (the site is an SSSI) permitted the excavation of three trenches at intervals west of the enclosure. The northernmost and the southernmost trenches were found to lack Lessness Shell Bed, which was disappointing. Moreover, curiously, the base of the overlying pebble beds in the northernmost trench was at a significantly lower level than elsewhere at the site. Happily, the central trench showed shell bed continuing into the hillside for at least 7m. This was excellent news, although my excitement was somewhat dampened by the next event, which was the disintegration of one of the tracks on the mechanical excavator, which rendered it helpless. With only my colleague David Ward to help, it was left to the two of us to refill all three large trenches manually, to make them safe. The work continued all afternoon until dark and resumed the following morning with the additional help of Alison Ward.

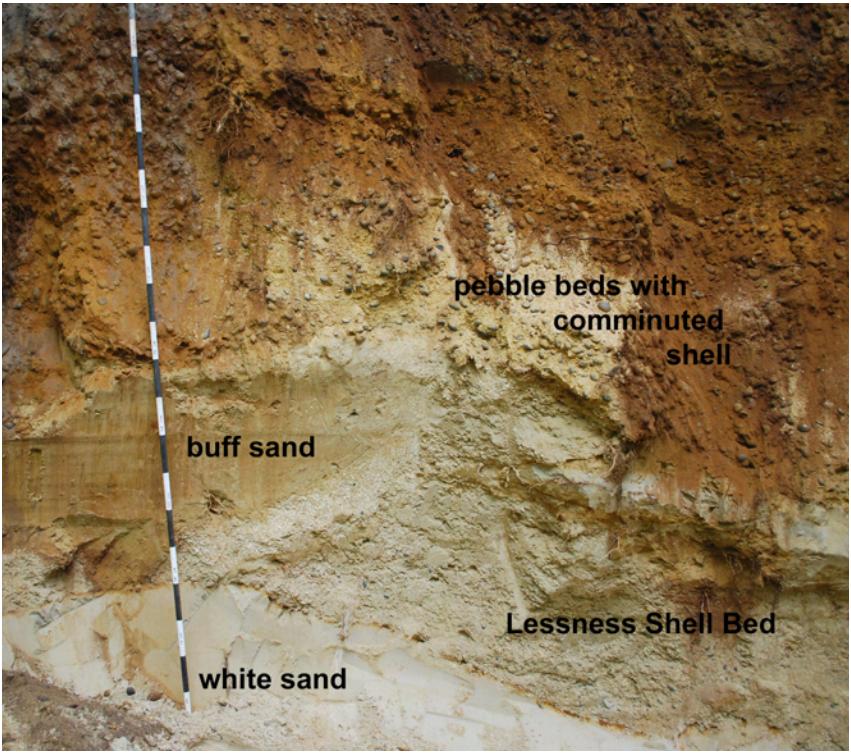
The following month, the main excavation (run by the TRG) was made in the vicinity of the central trench, in the knowledge that shell bed would be available for collection. It was already known that the Lessness Shell Bed could vary in thickness from 2m to nothing in only a few metres distance, owing to the nature of such high-energy deposits. Such thinning out had been seen to manifest itself in two ways: by complex interdigitation with a contemporaneous sand unit, and by wedging out against swells in the surface of the underlying sand unit (Hooker 2010). The new central trench

excavation displayed aspects of both of these phenomena, plus a third. At the extreme western end of the trench, the base of the overlying pebble beds began to dip NNW, progressively cutting out shell bed and associated sand. This channelling thus now explained the low level of the pebble beds earlier noted in the northernmost trench. An additional new feature of the pebble beds in the central trench was the abundant presence of comminuted shell. Apart from the occasional small lens, this had never been seen before, the pebble beds thought otherwise to be unfossiliferous. Well-preserved shark teeth were observed and samples taken, so it will be interesting to see whether they contain any mammals. In light of this local channelling nature of the pebble beds, it is possible that the comminuted shells have been reworked from the underlying Lessness Shell Bed.

Since the 1990s, Bexley Council have provided water pumped from a bowser to the enclosure site, allowing TRG members to wet sieve the Lessness Shell Bed to facilitate recovery of its fossils. With respect to mammals and birds, relatively little recovery is achieved on site, unless the remains are particularly large and thus visible to the naked eye, which is a welcome but unpredictable occurrence. The time-consuming task of subsequent residue picking may take several years. The October 2013 dig went according to plan and a large bird phalanx was recovered on site by Keith Smallwood. The hope is that in due course remains of small mammals will be recovered, belonging to new species and/or to existing undetermined ones, allowing them to be named and applied to further understanding of the climate and environment in which they lived. So far, one specimen has been picked from residues sieved on the 2013 dig by Brian Gasson and is tantalising in the extreme. It is part of a very worn molariform tooth with one complete root and edges of the bases of two others. It is truncated by a sharp, fresh break suggesting (hopefully) that the other half may be found in someone else's residue. Such heavy wear, removing all crown features, is typical of aged individuals of carnivorous taxa. When complete, however, it must have been larger than the largest carnivorous mammal known by teeth from Abbey Wood, the puma-sized creodont *Palaeonictis gigantea*. The only larger carnivorous mammal from the site is a scavenging mesonychid condylarth identified as *Pachyaena* cf. *ossifraga*. Remarkably, this species is represented by an uncrushed cranium (most Abbey Wood mammal specimens are teeth or jaws and mesonychids are globally rare), but which frustratingly lacks jaws and teeth. The possibility exists that this new tooth fragment belongs to this taxon, although it will probably never be certain. Finding the rest of the tooth might help. This demonstrates the serendipitous nature of the mammal occurrences, whose remains appear to have been both size- and shape-sorted on the highly current-active floor of this shallow Eocene sea.

**Acknowledgements**

I am most grateful to the Palaeontological Association for funding this project, to Bexley Council and Natural England for their co-operation and permission to excavate, and to the many members of the TRG for their painstaking work over the years in sorting residues and making great finds.




*Section of Blackheath Formation excavated at Abbey Wood, October 2013. Lessness Shell Bed rests with basal iron pan layer on an irregular surface of white sand and interfingers with buff sand. The pebble beds have a horizontal base in the left half and then dip to the right, truncating Lessness Shell Bed and buff sand. The scale has 10cm divisions.*

*Phalanx of bird recovered on the October 2013 dig. Scale bar = 5mm.*

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# *Priapulid Diversity Beyond the Burgess Shale*

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Today a minor phylum, priapulids and their kin were a major constituent of Cambrian communities; indeed the trace fossils that mark the base of the Cambrian were probably produced by a priapulid-like organism. Nevertheless, their lack of mineralized components restricts their body-fossil record to Burgess Shale-type localities, curtailing efforts to understand their diversity, ecology, and distribution in time and space.

In contrast, the ubiquitous Small Carbonaceous Fossils (SCFs) sample a broad suite of locations and palaeoenvironments, giving them potential to provide a fuller picture of priapulids' disparity, range and scope. Putative priapulid teeth have been reported from Early–Middle Cambrian deposits across the globe (Butterfield and Harvey 2012), but on their own, these isolated elements cannot be reliably connected to complete organisms.

A Sylvester-Bradley award allowed me to undertake an extensive survey of Burgess Shale priapulid worm sclerites using electron microscopy. This documentation of diversity within and between species allows a more thorough interpretation of isolated SCFs – establishing not just that they truly represent priapulid sclerites, but that they belonged to an *Ottoia*-like organism.

## Burgess Shale material

The first component of the project involved examining almost a hundred separate priapulids from the Burgess Shale under environmental pressure scanning electron microscopy. This technique has proven potential to recover fine microstructure and anatomical detail, connecting Burgess Shale material to Small Carbonaceous Fossils (Caron *et al.* 2013; Smith 2014). Owing to its superior preservation and an abundance of specimens, *Ottoia* (Figure 1) formed a focus of this study, although images of *Selkirkia*, *Fieldia* and *Ancalagon* allow a comparison between different priapulid taxa.

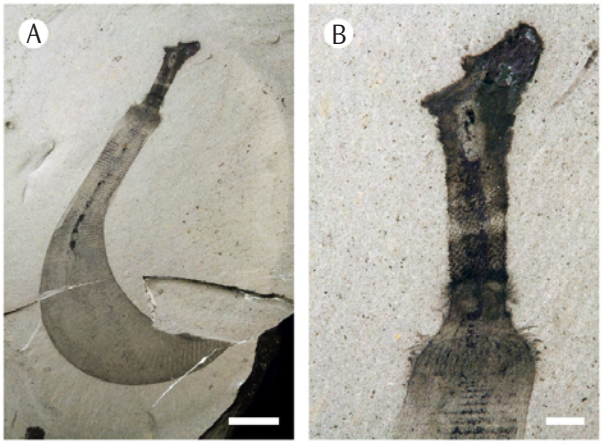


*Figure 1.* Ottoia *from the Burgess Shale, showing A, complete specimen; B, enlargement of proboscis. Scale bars: A = 10 mm; B = 2 mm.*

A small proportion of specimens preserved the original carbonaceous component of their most robust sclerites, allowing clear imaging of their morphology through backscatter electron detection. The majority of sclerites, however, were less robustly preserved; these could be detected only under secondary electron imaging (Kearns and Orr 2009), with beam parameters requiring fine-tuning for each separate specimen. With perseverance, it was possible to obtain sub-micron detail from each of *Ottoia*'s six types of sclerites.

SEM imaging upheld Conway Morris's (1977) reconstruction of four distinct tooth zones plus proboscis-borne hooks, while adding new detail to the limited resolution obtainable by light microscopy – identifying, for example, intergrading morphologies between distinct tooth zones (Figure 2). Zone A sclerites are narrow, spire-shaped sclerites, perhaps with marginal denticles. Zone B sclerites have a labile base with a polygonal patterning, and a crown of multiple robust spines; these spines are hollow, with a central cavity extending to their base. Zone C sclerites have an elongated shaft with a pectinate margin, and intergrade gradually from Zone B sclerites below them to the Zone D sclerites above. Zone D sclerites have a broad base with a finely pectinate distal margin. Proboscis hooks have a gentle curvature with large conical teeth protruding, slightly offset, from their concave margin.

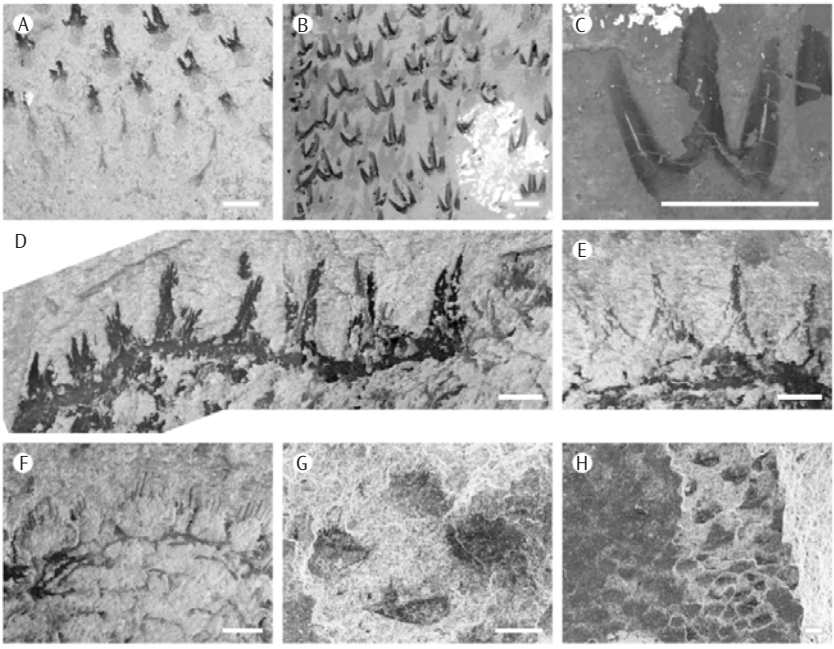


*Figure 2.* Ottoia *spinules. A, type A spinules at base of armoured proboscis zone, type B sclerites with rounded base above; B, type B sclerites showing three prongs; C, hollow sclerite prongs containing pyrite crystals; D, sclerites gradational from zone B (left of image) to zone C/D (extreme right of image); E, sclerites transitional from zone C to D. F–H, type D sclerites. A–C, backscatter; D–H: variable pressure secondary electron. Scale bars = 200 µm.*

Zone B sclerites in the Smithsonian material have five to nine spines in their crown; in the Royal Ontario Museum collections, only three spines are present. This seemingly corresponds with the

different stratigraphic horizons represented in the two institutions' collections; Walcott's material, at the Smithsonian, samples the Great Marrella Layer; the ROM specimens are from around a metre below. These two sclerite morphologies are consistently distinct, and seem to represent grounds to recognize separate species. A fuller stratigraphic sampling scheduled for later this year will determine whether the two species co-existed or whether one replaced the other.

**Small Carbonaceous Fossils**

In light of this new morphological detail, it is now possible to evaluate the diversity present in the small carbonaceous fossil record. Working with Nicholas Butterfield (Cambridge) and Thomas Harvey (Leicester), it was possible to identify exact morphological analogues of each *Ottoia* sclerite morph in the middle Cambrian Pika and Deadwood formations of central Canada, with single samples containing all morphs. This confirms the ubiquity of priapulid worms in the Cambrian period, and suggests that the *Ottoia* body-plan (or at least proboscis-plan) was not just dominant in the Burgess Shale, but was the most abundant form in a range of ecological and environmental settings. Despite the disparity in the Burgess Shale, it seems that there was a single dominant group across the Canadian Shield. Future SCF sampling will readily establish the possible temporal and global range of ottoiids, which are strikingly under-represented in the Chinese Cambrian lagerstätten – despite the abundance of priapulids *per se* (Dornbos and Chen 2008; Zhao *et al.* 2014).

**Conclusions**

This study has revealed unanticipated diversity in Burgess Shale specimens of *Ottoia*, which – with further sampling – will cast light on the evolutionary dynamics *within* the Burgess Shale itself. It brings isolated Small Carbonaceous Fossils well into the priapulid fold, allowing their identification as part of an *Ottoia*-like proboscis, and establishing the dominance of *Ottoia*-like scalids in well-sampled microfossil communities. This paves the way for a broader scale understanding of priapulid diversity and evolution throughout the Cambrian, and provides a tool to understand the relationships between the markedly distinct priapulid communities in Chinese and Canadian lagerstätten.

**Acknowledgements**

I thank the Palaeontological Association for the opportunity to travel to Washington and Toronto to examine these specimens. I am also grateful to Nicholas Butterfield, Thomas Harvey, Jean-Bernard Caron, Doug Erwin, Kathy Hollis, and Peter Fenton for access to material, and to Scott Whittaker (NMNH) and Siobhan Braybrook (Sainsbury Laboratory, University of Cambridge) for assistance with electron microscopy. Parks Canada provided research and collection permits to ROM teams led by Desmond Collins.

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# *Extinction, invasion and body size in Mediterranean bivalves*

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A number of mechanisms has been proposed to explain spatial variation in body size distribution observed among modern biotas, but the role of Neogene extinctions or biotic invasions in shaping those patterns remains poorly understood (but see *e.g.* Morales-Castilla *et al.* 2012). The Mediterranean Basin, with its complex history of climate-driven Pliocene–Pleistocene extinctions (Monegatti and Raffi 2001; Vermeij 2012) and massive immigration of exotic taxa currently taking place (Zenetos *et al.* 2010), can serve as an excellent system for evaluating the importance of historical and biogeographic events. The opening of the Suez Canal in 1869 re-established the link between the Mediterranean and Indo-Pacific realms that last existed during the Middle Miocene, allowing the spread of hundreds of Red Sea species into the Mediterranean Sea, with molluscs being among the most prolific invaders. With the ongoing influx of the tropical immigrants and increasing sea surface temperatures, Mediterranean ecosystems are currently gaining a more tropical character, interpreted by some authors as a restoration of the situation from the Pliocene Climatic Optimum (Por 2010), in spite of different source pool of the newcomers (Vermeij 2012). As the Mediterranean biota is increasingly becoming a mixture of faunal stocks with different evolutionary histories, large-scale patterns in body size may reflect not only energetic or ecological constrains, but also historical contingencies.

The aim of this project was to document distribution of body size in the Pliocene (Zanclean–Piacenzian) marine bivalves in order to provide a broader context for the present-day macroecological patterns in this region. In particular, I wanted to test the hypotheses: 1) that a selective nature of the Plio-Pleistocene extinctions in the Mediterranean basin affects the shape of the present-day size-frequency distribution (SFD) in this region, and 2) that the ongoing invasion of tropical Red Sea species is restoring the pre-extinction body-size patterns in accordance with the "return of the Tethys" hypothesis of Por (2010).

The Sylvester-Bradley Award provided me with an opportunity to study rich Pliocene and Pleistocene collections at the Museum of Natural History in Turin and the Museum of Natural

History in Florence, Italy. Together with a literature survey this allowed me to compile data on the temporal distribution and body sizes of Mediterranean Pliocene bivalves. A previous compilation of stratigraphic ranges of shallow-water taxa by Monegatti and Raffi (2001) was updated in terms of taxonomy and supplemented with records of deep circalittoral and recently described species. Galeommatoidean and teredinid bivalves, imposing taxonomic and sampling problems in both fossil and modern faunas, as well as bathyal taxa, were excluded from the analyses. Shell size data were obtained for over 1,900 fossil specimens representing 307 species, and can be compared with SFDs of modern Mediterranean and Red Sea bivalves (Fig. 1; Nawrot *et al*., in prep.). Following previous studies (*e.g.* Roy *et al*. 2000), the geometric mean of the shell length and height of the largest specimen was used as a proxy for species' body size.

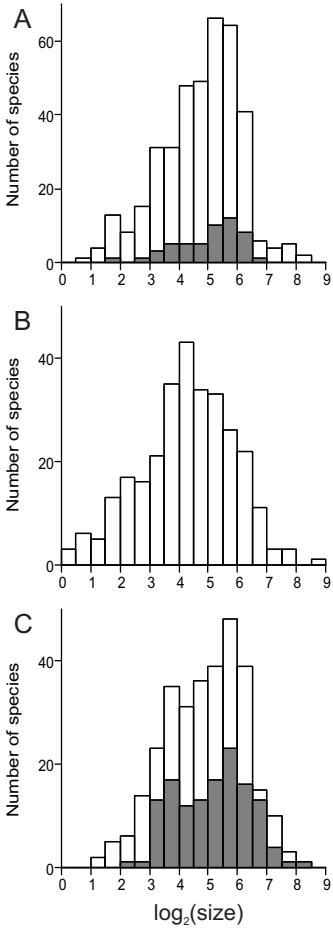


*Fig. 1. Size–frequency distributions of marine bivalve species in (A) the Recent Red Sea fauna (n = 388), (B) the Recent Mediterranean fauna (n = 294), and (C) the Pliocene Mediterranean fauna (n = 307). Shaded bars denote Red Sea species which entered the Eastern Mediterranean through the Suez Canal (A) and Pliocene species which went extinct in the Mediterranean region (C).*

Initial analyses suggest that out of 320 Pliocene bivalves species only 182 (57%) are still represented in the Recent Mediterranean fauna. Median size of these survivors (29.2 cm) is significantly smaller than regionally extinct species (41.0 cm; Mann-Whitney U-test, p=0.007). Similar size-biased extinction pattern can be observed when comparing Pliocene species that survived until the Galesian (Early Pleistocene) with the victims of the late Piacenzian phases of the extinction (27% of the species). Taphonomic overprints require that special caution is required in comparisons of SFDs of fossil and modern faunas. Nevertheless, the characteristic left-skewed shape, median size and modal class of the Pliocene SFD make it very similar to the distributions documented in the Recent Red Sea (Fig.1) and along the Eastern Pacific costs of North America (Roy *et al.* 2000). In contrast, the present-day Mediterranean bivalve fauna is characterized by a distinct, more log-normal SFD, which is significantly different in both shape and median size from its fossil counterpart (Kolmogorov-Smirnov test and Mann-Whitney U-test, both $p < 0.001$).

The causes of the discrepancy in the SFDs between the present-day Red Sea and the Mediterranean are not clear, since the predominantly oligotrophic conditions in both regions argue against direct environmental control. Size-selective nature of late Neogene extinctions in the Mediterranean basin may thus serve as a potential explanation. Late Piacenzian extinction pulses, which were related to the onset of the Northern Hemisphere glaciations and strongly affected warm-water taxa, were not followed by re-immigration episodes owing to the isolation from the tropical Atlantic biota by the cold upwelling along the NW coasts of Africa (Monegatti and Raffi 2001; Vermeij 2012). The distinct shape of the present-day Mediterranean SFD may, therefore, reflect depauperate species pool in this region, under-saturated in (sub)tropical taxa.

The Red Sea bivalves which managed to cross the Suez Canal and colonize the Mediterranean Sea are significantly larger than native species, reflecting gross differences in the regional SFDs in the two areas. With continuing inflow of tropical invaders, the Mediterranean SFD will be progressively shifted towards values typical for the Indo-Pacific realm, restoring in this way Pliocene body-size patterns. In this context it may be interesting to note that out of 16 Red Sea genera recently established in the Mediterranean Sea and not represented among native species, five genera (31%) are present in the Pliocene–Pleistocene Mediterranean fossil record.

This ongoing study illustrates that the fossil record may hold a key to understanding the origins of present-day macroecological patterns and provide a broader perspective on regional-scale effects of human activities.

**Acknowledgements**

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# *Geochemistry and palynology: a proof of concept study*

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If we really want to understand the controls on the distribution of biodiversity through time and space, we need data for both the biota and the physical environment, preferably from the same samples/deposits. And to convince funding bodies that this sort of thing is worth putting money into, one needs to be able to demonstrate that both types of data will be obtainable. This was the basic remit for my Sylvester-Bradley award from the Palaeontological Association – a 'proof of concept' study, to generate enough pilot data to justify a larger grant or fellowship application (or not, as the case may have been).

I'm a palynologist with an interest in the greenhouse world of the Palaeogene, and my targets for this project were the US Gulf and Atlantic Coastal Plains. These regions have extensive Palaeogene successions and a long history of palynological research, so I could already demonstrate that terrestrial (pollen and spores, the main focus of my research) and marine (dinoflagellates) palynomorphs are present in these sediments, although new quantitative pilot data targeting specific cores and formations was desirable. The larger unknown was the climatic proxy that I was interested in using – a novel biomarker-based method for estimating temperature, that uses branched glycerol dialkyl glycerol tetraethers (GDGTs) from the membrane lipids of soil bacteria (known as the MBT/CBT proxy). Using this approach means that the same sediment sample can be split for palynological and organic geochemical analyses, maintaining stratigraphic resolution and consistency for time series analysis and modelling. This would offer a large improvement

over relying on broad correlations with the global oxygen isotope curve, or indirectly using climate estimates from stratigraphically patchy leaf macrofossil deposits.

I went out to the US for sampling in May 2013. The USGS National Center in Reston, Virginia stores many cores from both the Atlantic and Gulf Coastal Plains, and I spent three days collecting samples in the company of Dr Lucy Edwards, who has spent many years working on the dinoflagellates from these sections. I collected 75 samples from across four sediment cores: the South Dover Bridge and Solomon's Island cores from Maryland, the Haynesville core from Virginia, and the Lauren's #1 core from Georgia. Most of the sampling was focused on the Eocene and early Oligocene, to cover the temperature changes that this interval includes. I also opportunistically collected some Cretaceous and Miocene samples, to assess palynomorph and GDGT recovery in these older and younger sediments. Each sample was split into two during collection, with one part destined for palynological analysis, and the other for geochemistry.

Palynological analysis has confirmed a well-preserved and abundant palynomorph record. The Gulf Coastal Plain (represented by the Lauren's #1 core) contains countable quantities of pollen and spores through time interval. The Atlantic Coastal Plain samples have less of a terrestrial signal in the earlier part of the Eocene, being dominated by dinoflagellates until the upper Eocene formations when pollen and spores become more common. The Miocene samples all contain pollen, spores and dinoflagellates. For geochemical analysis sixty of the samples went off to the University of Bristol Organic Geochemistry Unit, headed by Professor Rich Pancost. Gordon Inglis, one of Rich's PhD students who is studying Eocene climates, has been carrying out this work which is still ongoing, but happily there are a mix of relevant biomarkers, and the sediments aren't too thermally mature for GDGTs to be present.

I've now embarked on a three-year post-doc at the Open University, so a fellowship application won't be going in for another year or two. However, publications will be on the way from these datasets, and the results will certainly be used to pave the way for further research into long-term climatic and vegetation change during the Palaeogene. Thanks to Lucy Edwards for helping with putting the application together and for logistic support while I was at Reston, and to Gordon Inglis and Rich Pancost for their interest in the geochemical aspects of this project. Thanks also to the Palaeontological Association for providing funding for this work, which naturally wouldn't have got off the ground without it.

# Old fossils, new media

A minor restructuring of the Association Council was approved at the annual meeting in Zurich. Two new positions were created – Education officer and Outreach officer – whilst the job of Newsletter Reporter has been subsumed into the Publicity officer role. I've moved to this new position, Dr Fiona Gill was appointed Outreach officer, and Dr Caroline Buttler was made Education officer.

Over the next newsletter or two, we intend to explain a bit more about what the Association is hoping to achieve in these areas. One of the key objectives is to try and help PalAss members bring fossils to new audiences and promote palaeontology as widely as possible. To this end, an outreach and education fund has been approved, and will soon be open to applications. There's no point me jumping that gun, but if you have fossil-based educational activities or outreach projects you're looking to get funded, keep an eye out for the announcement.

Also, to give members an idea of whether a job might suit them when positions on Council become available, we will be asking Council members to reveal just what it is they do in their role. So, even though I've only just started, here's a flavour of what palaeontological publicity activities are currently occupying my time. Whether they bear much resemblance to what previous publicity officers did, and whether they tempt you to volunteer for the position in due course, only time will tell.

To start with the Association's key output, its peer-reviewed papers: publicizing these is always fun, but increasingly dynamic. Now that articles in *Palaeontology* are available to view online early, often many months in advance of print publication, news coverage of the peer-reviewed research we produce can spring up at almost any time. The first 2014 issue of the journal may have come out in January, but one of the papers was receiving publicity in late October. The study by Tony Martin and colleagues, describing the oldest avian footprints from Australia, caught the attention of the press right across the world.

I had little direct role to play – the Wiley-Blackwell press office combined with that of Tony Martin's university in the US to do most of the publicizing – but it was interesting to take part. When you've seen the original press release, watching how it gets filtered by the media is instructive. In the hands of some, the oldest fossil bird trackways in Australia become transmogrified into "the oldest bird fossils in the world," but most articles were pretty good at capturing the gist of the research. Tony's enthusiasm for speaking to the press also helped to get the message across more accurately.

Mostly, my role saw me publicizing the publicity. I monitored how the story developed, and used the various online channels open to the Association to alert people to the highest-profile and best bits of coverage.

The Web is an interesting machine. I've never been very fast to sign up to new technology; my phone is not smart, my laptop is old. I was also rather sceptical of the value of social media, especially to an academic organization such as ours. However, the last few months have led me to change my opinions. If you are in any way social, and are happy to use different media to promote your research, devices like Twitter and Facebook can be very useful.

The Association has been on Facebook for a while, but only recently have we tried to develop our presence. The Facebook group now has more than 350 members, and a fair percentage of these use the page to promote upcoming events and new papers, show off specimens they've found, and ask questions. However, the group activity still feels a bit half-hearted, as if no-one's quite sure whether PalAss belongs there, and items that get posted rarely lead to much discussion.

In terms of international presence, and our stated aim of promoting the study of palaeontology, I think it does belong there. We just need to be a bit more engaged. Of the other Facebook groups I follow, we could learn a lot from the Ichnology cohort, which is successfully facilitating open scientific discussions across the globe. To give one recent example, a professor in Alabama posted on the group page, asking if anyone had a photograph of an unusual example of the trace fossil *Arenicolites*. Within an hour, academic colleagues from Georgia, Morocco, Canada and the UK had offered specimens, images, and locality information on the type material. "This is amazing," beamed the original poster. "Some people think that Facebook is a waste of time!"

I can see no reason why we can't facilitate similar speedy exchanges on the PalAss Facebook page, and enable palaeontologists across the globe to help each other out. If you're a member of the group (or if you've not yet signed up), please don't be shy. Get involved. I'd be delighted to see more posts and more discussions.

Plenty of people think that Twitter is a waste of time too, but the Association has an account, and – hey presto! – I am mainly responsible for its content. Under the username @ThePalAss – the last three letters of which have raised a confused eyebrow or two among US-based non-palaeontological tweeters – we try to promote Association activities as succinctly as possible. For someone as verbose as me, this is tricky.

Condensing a message into a tweet is a great test, though, and I encourage people to try it. We might bemoan the world's shortening attention span, but if you can't summarize your research into a pithy sentence, you're clearly not interested in communicating to a wider audience. Forget about 200 word abstracts, make sure your next submission to the Annual Meeting or to *Palaeontology* is also available as a 140-character tweet, and send it my way.

If you don't think Twitter is for you, fair enough, but the rise of Fossil Friday puts paid to the notion that it isn't bringing palaeontology to a new or wider audience. Hashtags – the act of sticking a # sign in front of a pithy phrase, such as #WorldCup2014 or #MikeBentonLovesOneDirection – allow Twitter users to quickly find all messages covering a particular theme.

Like so many modern media, #FossilFriday began in North America. Reliable sources tell me that the Royal Ontario Museum sent out the first tweet with that alliterative hashtag. However, it's only in the last year or so – thanks to a cluster of dedicated palaeo-tweeters in the Natural History Museum – that the term has spread more widely.

As a consequence, at the end of every week, #FossilFriday now acts as a palaeontological magnet. Across the world, fossil-lovers are using the term to promote their work and introduce people to their interests, be they professionals with new papers, or amateurs posting photos and asking if anyone can help identify their find. On the website Pinterest, the NHM has created a dynamic

gallery of all the images – at <**http://www.pinterest.com/nhmlondon/fossil-friday/**> – and there are more than 700 fossil pictures included.

Just a few weeks ago, the term was even used to promote big news. On Friday 7th February, the British Museum and Natural History Museum used #FossilFriday to tease and then reveal the discovery of the oldest human footprints outside Africa. The flurry of activity was startling, but perhaps not as startling as the news that dinosaur-loving members of boy bands have also gotten in on the act to tweet about coprolites. No, really: <**https://twitter.com/dougiemcfly/status/426773284517339136**>.

On a more serious note, Twitter can be a good way of finding out what's happening at conferences. I'm not completely convinced by the idea of live-tweeting every talk at a meeting, especially those presentations that are based on unpublished data, but if you're a member of the Association and can't attend the AGM, it's certainly within you're rights to hear what's going on. For December's meeting in Leeds, just follow #PalAss14. Based on Dublin and Zurich, there will be plenty of activity.

Talking of publicizing meetings, I should mention the Lyme Regis Fossil Festival, which runs from 2nd to 4th May. This will be the third year that the Association has taken part, and the 2014 Festival has the theme of 'Citizen Science'. The organizers are always looking for volunteers, and with thousands of visitors, particularly children, it's a great opportunity to promote palaeontology.

So successful has Lyme Regis been, that in September it will have a sister event, the Yorkshire Fossil Festival, based in and around William Smith's fabulous Rotunda Museum in Scarborough. The content is still being finalized, but I've decided – for Twitter purposes, of course – that the festival's nocturnal event will be called #AmmoNight, whilst the #trilobike will promote the festival during the Yorkshire legs of the Tour de France. If you can come up with some actual content to go with these pithy phrases, do drop me a line.

Do drop me a line also if you have any meetings, events or activities you want PalAss to promote, especially if you're not that keen to venture into Facebookland or the Twittersphere. If you can think up a short, catchy hashtag that the outside world could latch onto, even better. #PleaseMakeLiamStop is probably a reasonable start.

Next time, we'll delve a little further into the roles of the new education and outreach officers, including a very exciting new online project we're developing with the Earth Science Teachers' Association. And if you're free in early September, we also plan to be promoting virtual palaeontology at the British Science Festival in Birmingham.

Until then, keep tweeting...

**Liam Herringshaw**
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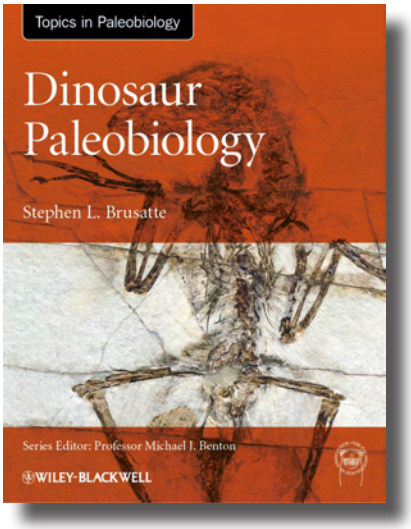
**<reporter@palass.org>**

# Book Reviews

## Dinosaur Paleobiology

Stephen L. Brusatte. 2012. Wiley-Blackwell. 322 pp. £34.95 (paperback).
ISBN: 978-0-470-65658-7.




*Dinosaur Paleobiology* is an excellent, very well illustrated, introductory book to the study of dinosaurs. It is written by one of the most productive young palaeontologists of our times, Stephen Brusatte, and summarizes the most up-to-date research concerning the biology of dinosaurs in a concise and easily understandable way.

The book starts with a short introduction to what dinosaurs are, both by definition, as well as from a more evolutionary point of view, highlighting the morphological features that characterize the group. The order of the subsequent chapters follows the process of palaeontological research, starting with a detailed discussion of hard tissues and their anatomy, given that most dinosaur specimens preserve just bones or teeth. Soft tissues follow, then phylogeny, before we get to the more "life-related" topics like form, locomotion and posture, feeding and diet, reproduction, growth and physiology, and finally arrive at wider topics such as palaeoecology and dwelling, and macroevolution and extinction. Thanks to this structure, the reader can closely follow the process of palaeontological studies, starting with what is actually fossilized and found, and subsequently including more and more evidence and analytical tools to understand dinosaur biology. This is facilitated by the avoidance of technical terms where possible, and their careful introduction where necessary.

Every chapter is introduced by a short abstract, stating the most important issues and questions asked in the section. The main part of each chapter then reviews a vast number of recent scientific papers on the topic under discussion (more than 40 pages of references are listed). The chapters finish with a conclusion, which points to the most active and exciting research in the respective field, and open questions that still need to be solved.

Throughout the book, Brusatte provides easily understandable examples of important research concepts and methods, which can be difficult to comprehend by only reading the technical literature. Comprehensibility is further enhanced by 175 figures and 16 colour plates, which are all freely available on an accompanying website as Powerpoint slide shows for teaching or personal use. The only criticism here is that the figures are black and white, both in the book and online. Whereas this is understandable for the book (it keeps at least the paperback at a reasonable price), the online figures could have been provided in colour. Be that as it may, the fact that the material

is freely available online definitely renders this book the perfect candidate as an introduction to dinosaur palaeobiology for undergraduate studies. Not only that, this book provides the most up-to-date and comprehensive list of research on the various dinosaur subgroups. Consequently, it could also help more experienced palaeontologists who might be starting research with subgroups they are not familiar with.

Unfortunately, some errors were not detected before printing, the most important of these probably being in the captions of Figures 1.16 and 2.20, which mention a small theropod called *Miragaia*. *Miragaia*, however, is an aberrant, long-necked stegosaur from Portugal (Mateus *et al.* 2009), as correctly explained on page 185, in the section about ornithischian feeding. The bones in the two figures are indeed from a small theropod, called *Mirischia* (S. Brusatte, pers. comm., 2014). Very few typos are present and do not affect the readability of the book.

In sum, I highly recommend this book both to undergraduate students interested in the latest research on dinosaurs, and also to more experienced scientists specialized in one group, who want to update their knowledge of current research in other dinosaurian subclades. Moreover, together with the slide shows available online, it provides a valuable source for teaching dinosaur palaeobiology at secondary school and university level.

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**REFERENCE**

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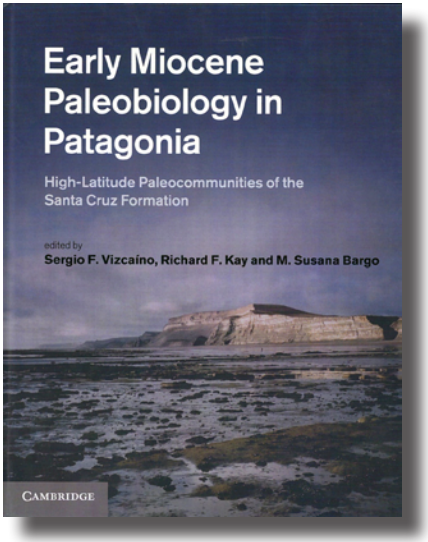
## Early Miocene Paleobiology in Patagonia: High Latitude Paleocommunities of the Santa Cruz Formation

Sergio F. Vizcaíno, Richard, F. Kay and M. Susana Bargo (Eds.) 2012. Cambridge University Press. £105 (hardback). ISBN: 978-0-521-19461-7.

This is the second excellent volume on the palaeontology and palaeobiology of the non-marine mid-Cenozoic of Patagonia in recent years, being preceded by Madden *et al*. (2010). Both volumes are the work of a large number of contributors, many from the University of La Plata (UNLP), Department of Vertebrate Palaeontology, and other institutions in Argentina. Taken together, these publications demonstrate the tremendous human resource within Argentina devoted to the study of Vertebrate Palaeontology, and also their high level of expertise. By good fortune I spent three years (1970–1973) at UNLP as Visiting Professor in Micropalaeontology. My *boliche* being near Vertebrate Palaeontology, I made friends there, especially with the Professor, the late Rosendo Pasqual who – with many of his staff and students, especially the late Dr Oscar Odreman-Rivas – inspired my enthusiasm and interest in fossil mammals and the great significance of the South American fauna. Reading this book has rekindled that interest and renewed my pride at having worked at the Museo de La Plata.




**Chapter One.** This introductory background by the editors is a model for such a chapter, in that it brings the reader up to date with all that has gone before and, thereby, allows them to judge the contribution of the volume in terms of the advances it makes in the various fields. It provides an excellent synopsis and well-referenced history of the study of fossil terrestrial mammals in South America in general, and Patagonia in particular. It introduces readers to South American Land Mammal Ages (SALMA) and relates them to the International standard for the Cenozoic. There are valuable sections on the present-day environment, collecting methodology, the fossiliferous localities, and an interesting discussion on future research directions. Two important maps, of the entire Province of Santa Cruz, and of the collecting localities in the coastal region of the southeastern part of the Province, are also provided.

**Chapter 2** is a highly technical and very competent account of the tephrochronology of the Santa Cruz Formation (SCF) and the largely coeval Pinturas Formation to the northwest. Lab and field methods (sample collecting and section measuring) are described in detail, and localities are located on a useful map. All this is accompanied by a tephra correlation diagram that enables correlation among 26 localities. Extensive data sheets of electron probe analyses of glass shards from selected tephra are evidence of the extent of the investigation, which is of great significance in providing absolute dates of evolutionary events among the rich mammalian faunas of this formation.

**Chapter 3** outlines the often contentious development of a biostratigraphy for the two formations, from the time of Commander Sulivan RN whose collection of specimens Darwin passed to Richard Owen, who described them in 1846. More recently, a series of fundamental studies using K-Ar, based on data from four important fossil localities, shows that the SCF ranges from "about 17.6 Ma to perhaps 16.0 Ma … and the SALMA from about 18.0 Ma to about 15 Ma" (Marshall 1986). Recent data also show that absolute radiometric ages and the Global Magnetic Polarity Timescale at the critical sections at Cerro Observatorio and Monte León correlate with Chron 5.

**Chapter 4**, concerning sedimentology and sedimentary environments in the SCF, shows that the lower Estancia La Costa Formation is mainly fine tuffs, while the overlying Estancia La Angelina Formation is coarser and silicoclastic. The lower member yields rich mammalian faunas and represented a lower energy regime with palaeosols in a warm fluviatile system on an extended floodplain. The upper member had a cooler, drier, higher energy regime and a sparser mammalian fauna.

**Chapter 5** shows that a shell bed at the base of the SCF was, with the exception of a single species of *Crassostrea,* reworked. The *in situ* species represents a marginal marine environment indicating a marine/brackish influence at the base of the SCF.

**Chapter 6**, on ichnology, uses trace fossils to demonstrate that the SCF was a warm moist floodplain in its lower part that became drier and cooler upwards.

**Chapter 7** provides an analysis of the plant remains from the lower member of the SCF. The chapter is well illustrated with macro and micro plant structures, and a useful taxonomic presentation of the flora. The vegetation was a mixture of open temperate semi-arid forests and humid warm temperate forests, suggesting that seasonal low precipitation was a limiting factor to plant growth.

**Chapter 8** shows that the herpetological fauna was much less diverse than the mammalian. Frogs, iguanid lizards and 'colubrid' snakes were representative of warmer, wetter conditions than those obtaining at the present day. Sadly there is no mention of the agile terrestrial crocodiles and gigantic snakes, which are referred to in a later chapter.

**Chapter 9** concerns the diversity and palaeobiology of the SCF avifauna. Although the fauna contains no passerines, due no doubt to taphonomy, 18 species of bird, in 15 genera and nine families, are recorded. Some of these taxa are clearly analogous with living species of "rheas", tinamous and falcons, including one very similar to the extant 'Laughing Falcon', a specialist predator of snakes. In addition, the pelecaniformid *Liptornis* is very similar to the modern *Anghina*, fish eating on most freshwaters, while the cicconiformid *Protibis* is considered to be a relative of the spoonbills. There are also some very large birds represented in the SCF fauna, such as the anseriformid, *Brontornis*, an enormous bulky bird more than 2m in height with a huge beak, and the similarly sized so called "terror birds" of the Order Cariamiformes.

**Chapter 10** is a palaeoecological analysis of non-carnivorous marsupials of the Pauciterburculata and Microbiotheria, with different ecological niches being inferred from estimates of body mass, diet and locomotory behaviour, and analogues with living marsupials. The authors deduce that both groups occupied several niches: small-medium sized insectivores, small-medium insectivores-frugifores and medium-large frugifores. The one extant microbiothere, *Dromiciops gliroides*, confined to South American bamboo forests and southern Andean *Nothofagus* temperate forests, is the only South American marsupial to hibernate. All the extant Paucituberculata are "shrew opossums" with a disjunct Andean distribution from Venezuela to southern Chile and Argentina. The authors conclude that SCF representatives were diverse, and lived in warm forested environments with seasonal rain, with evidence from vascular plants and other mammals that the overall environment was in balance between closed and open habitats of park savannah type.

**Chapter 11** concerns the palaeoecology of marsupial carnivores. One consequence of Cenozoic long-term isolation was that the carnivore guild in South America was made up of marsupial sparassodont carnivores, along with the "terror birds", large agile terrestrial crocodiles and gigantic snakes, rather than the placental mammalian Criodonta and Carnivora found elsewhere. The best-known carnivorous marsupial is the sabre-toothed sparassodont *Thylacosmilus*, that so closely, but superficially, resembles the placental sabre-toothed felids. Sparassodonts ranged from the Palaeocene (64–62 Ma) to the Middle Pliocene (3.3 Ma), with their acme in the SCF, after which they were gradually replaced by placental immigrants from the North. The authors review the taxonomy of the group and show that the 11 SCF species range in size from 1 kg American opossum-like species, to large forms of some 100 kg with diverse locomotor habits. The chapter includes good plates of crania and mandibles and post-cranial material of new specimens from the SCF, a good taxonomic and phylogenetic section, and a useful analysis of technical data. The reconstructions

of six of the 11 SCF species are very good, although the fact that the fauna belongs to ten different genera is a little disturbing.

**Chapter 12** concerns the palaeobiology of cingulates, a group which originated in South America, and which are characterized by scaly armour and sheathed tails. Living cingulates are represented only by armadillos, but fossil cingulates had much greater diversity and are common in the SCF, with several genera and considerable species richness of both armadillos (with flexible armour) and glyptodonts (with more rigid armour). Armadillos are diggers, as attested to by their strong claws, but while extant taxa are animaliferous or omnivorous, Vizcaino in this chapter and earlier papers shows that a rather wide variety of dietary habits have been inferred, including herbivory. Considering the taxonomic richness of Santacruzian armadillos compared with the distribution of living species and the ecomorphological diversity of glyptodonts, the authors consider that they indicate a mixture of open and relatively closed to very closed vegetation in dryish conditions, such as bushlands or dry forests, essentially similar to the modern Chaqueña biogeographical province.

**Chapter 13** concerns the Pilosa, which includes the Vermilinguae (anteaters) and Folivora (ground and tree sloths). Living vermilinguans, as their name indicates, have long, worm-like tongues and no dentition in a skull with an elongated rostrum and a hard palate – adaptations related to their diet of social insects, mainly ants and termites. Only one genus is known in the SCF, *Protomandua rothi*, a small semi-arboreal digger. Conversely, there are a great variety of sloths, with nine genera of megatherioids and two genera of mylodontids represented. These were moderately large but with locomotor habits different from living species and more like those of living anteaters and pangolins. While capable diggers, they probably exhibited both terrestrial and scansolial activities. Megacytherioids were most likely folivorous while mylodontids probably fed on fruit and tubers. Overall the locomotory and feeding habits of both groups indicate forests in warm tropical and warm temperate environments, while the feeding habits of the mylodontids means that open environments cannot be ruled out.

**Chapter 14** is a complex but interesting chapter dealing with the palaeobiology of SCF native ungulates. There are five groups of endemic extinct ungulates: astrapotheres, pyrotheres, notoungulates, litopterns and zenungulates, all traditionally considered herbivores. Their phylogenetic relationships are unclear and they were once united in a single taxon, Meridiungulata, on the premise that all South American endemic ungulates were monophyletic. The authors outline the history of phylogenetic thinking on the group and admit that a comprehensive systematic review is still pending; they are clear that using the term "ungulate" does not imply any recent common ancestry with modern extra-South American ungulates. Croft (1999) provides an excellent summary of South America ungulates. Many of the South American ungulates possess morphologies that are similar, through convergent evolution, to "ungulates" from elsewhere. Despite their great diversity, the South American endemic ungulates point to an SCF environment of open grasslands with adjacent forested areas.

**Chapter 15** details a morphofunctional approach to the palaeobiology of SCF caviomorph rodents, a monophyletic group that underwent the earliest rodent radiation in South America. Modern caviomorphs exhibit a wide diversity of locomotory and feeding behaviours, occupy a wide range of environments and consume a wide variety of foods. This has allowed the authors to undertake a morphofunctional analysis of SCF caviomorphs in the context of a comparison with their extant

descendents. The authors conclude that the environment in which the SCF was deposited would have been a mosaic rather similar to the modern Brazilian Cerrado.

**Chapter 16** is devoted to the Santacrucian primates. Anyone familiar with the extra-Andean environments of modern Argentinian Patagonia – arid to semi-arid, stony, windswept, usually treeless, plains – would be astonished to see a wild monkey there. The primate in the SCF is *Homunculus patagonicus,* a small (1.5–2.5 kg) stem platyrrhine. Today the most southerly occurrence of such primates is at a latitude of 29°S, while the SCF localities studied are around 51°S. However, during the early Miocene, a time often known as the Mid-Miocene Climatic Optimum, medium-sized monkeys lived much further south in Patagonia. Dental analysis indicates a diet of leaves and fruit, but the nature of the mandibles and the massive zygomal arches plus heavy tooth wear suggests that physically resistant foods were an important element of diet. Other skeletal characters point to an above branch arboreal habit with leaping ability. This is another very absorbing, well-executed chapter.

**Chapter 17**, written by the three editors, synthesises the diverse, complex and exhaustive data of the preceding chapters. It uses the combined data to confirm the climatic history of SCF times and the nature of the various palaeoenvironments. Table 17-1 details the entire fauna of fossil levels 1-7 for the SCF, while other tables present extant communities and climatic data. Fig. 17.6 is a composite diorama reconstructing the fauna and environments obtaining at fossil levels 1-7. This single figure conveys very well what the book has set out to demonstrate from so many different specializations, but also reveals that the real purpose of the book is to advance our knowledge of the fossil Mammalia.

The book is eminently readable and extremely well-edited; almost without flaw. The English is clear and grammatical and not too obstructed by jargon. The science is always clearly presented and authors are very open in mentioning, and often detailing, alternative viewpoints, particularly with respect to phylogeny and palaeoecology. In cases where taxonomy is still under review, rival schemes are described and readers, to a degree, are allowed to judge for themselves.

In all sections of the book the most modern and sophisticated methodologies are used to accumulate data and equally modern computational methods are used in its analysis. In most cases the raw data are available to the reader. Each chapter has relevant and comprehensive references; indeed the volume as a whole contains a vast resource of references to literature, old and new, mostly concerning Patagonia but also worldwide and multidisciplinary in scope.

I may be biased, but £105, while a lot of money, is not overly expensive for this volume because it is an investment in such a good read and such a repository of knowledge. The book seems to be aimed at a variety of classes of readers:

i) All postgraduates, postdocs and established academics in the field of fossil mammals should find the book fascinating and a valuable addition to their libraries, while for those working on South American fossil mammals it is a *sine qua non*.

ii) Undergraduates taking degree courses with a significant component of vertebrate palaeontology, and perhaps also the evolution in isolation of South American Tertiary mammals as an elective special topic,

iii) This splendid and most interesting volume will appeal to many established academics in the Earth and Life sciences, since it is such a good read.

iv) For amateur palaeontologists with a sense of adventure, and who may already have read Simpson, 1934 and 1980, and other works in the appended reference list, (and if not should determine to do so), their perspectives will be entirely changed. One might even opine that the volume should carry a health warning, as it could so easily lead to an obsession.

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# Books available to review

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

- *Anatomy, Phylogeny and Palaeobiology of Early Archosaurs and their Kin* , edited by S.J. Nesbitt, J.B. Desojo and R.B. Irmis.
- *Bone Histology of Fossil Tetrapods: Advancing Methods, Analysis and Interpretation* , by K. Padian and E-T. Lamm.
- *Rough and Tumble: Aggression, Hunting and Human Evolution* , by T.R. Pickering.
- *At the Top of the Grand Staircase: the Late Cretaceous of Southern Utah* , edited by A.L. Titus and M.A. Loewen.
- *Mammoths and the Environment* , by V.V. Ukraintseva.
- *Foraminifera and their Applications* , by R. Wynn Jones.
- *Fossil Seahorses and other Biota from the Tunjice Konservat-Lagerstatte, Slovenia* , by J. Zalohar and T. Hitij.

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