The Palaeontology Newsletter

67

Contents

Reminder: The deadline for copy for Issue no 68 is 16th June 2008.

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

ISSN: 0954-9900

Foreword

It is of no little surprise to me that we are already well into 2008 and the 52nd year of The Association. Our immediately past Annual Meeting, in Uppsala in December, was a great success with over 250 delegates present. Graham Budd and his team of helpers deserve all our thanks for their efficient organisation and kind hospitality. The pre-meeting Symposium on the Sunday was a stimulating event, followed by two crowded days of talks and posters at the high standards we have come to expect. At the Annual Dinner, it was a great pleasure for me to present the Lapworth Medal to Professor Tony Hallam in recognition of his many significant contributions to our subject. And in all this, the snow stayed away!

Now our planning already looks forward to Glasgow and the 52nd Annual Meeting, where Maggie Cusack and her colleagues will certainly give us a true Scottish welcome. First details are included in this Newsletter, and we look forward to seeing you all there.

The past year has been a busy one for the Council. We are especially pleased to have concentrated on extending our support for research and excellence in palaeontology via the instigation of a new Research Grant initiative, and of a new President's Medal to recognise outstanding 'mid-career' contributions. Together with all previous award schemes, details of the criteria and closing dates for submission are included in this Newsletter.

Our publications continue to be heavily subscribed, attesting to the recognition of their high quality and contents. One immediate problem faces us as I write, because our Editor in Chief, Professor David Batten, has decided to stand down as from April. The search is already on for his successor – but he will be a hard act to follow. During his tenure, David has overseen the transformation of our editorial systems into the electronic age, coupled with the change to an A4 format for both *Palaeontology* and *Special Papers*. We owe him a great deal of gratitude for all that he has done in managing our publication programmes to their present standard.

At the AGM in Uppsala I was able to thank Council and all retiring members for their continuing work on behalf of The Association. Equally, I look forward to working with new Council members, who are giving their time and skills towards running our day-to-day management and our varied, wide-ranging initiatives across all aspects of palaeontology. The support and involvement of the whole Association membership is equally appreciated, and I extend very best wishes to everyone for 2008.

Michael Bassett
President
National Museum of Wales

Association Business

Vacancy for Editor-in-Chief (0.7 fte)

Consequent on the imminent retirement of Prof. D. J. Batten a vacancy has arisen for the position of Editor-in-Chief.

Prospective candidates should have editorial experience (both scientific and technical) that includes systematic palaeontology and taxonomy, and online manuscript handling systems (the Association currently uses Manuscript Central). The Editor-in-Chief has responsibility for the management of the Association's publication portfolio and the handling editors, and reports in the first instance to the Chair of the Publications Board.

The position is 0.7 fte and the Association offers an attractive salary with a non-contributory pension.

Interested applicants are invited to send, preferably electronically, copies of their curriculum vitae, a covering letter to include a statement of editorial experience and the names of two referees to Prof. D. A. T. Harper (Chair of the Publications Board: <**DHarper@snm.ku.dk**>).

Awards

Lapworth Medal awarded to Prof. A. Hallam

Tony Hallam has been one of the giants of British palaeontology in the second half of the twentieth century. He began writing papers as a schoolboy and over 50 years later he is still going. Tony has always been a pioneer in his numerous research areas and typically has recognised key research questions years and sometimes decades before the main research community. Indeed by the time a subject has reached bandwagon status Tony has often moved on to more virgin topics. Thus, his PhD work on the Lower Jurassic Blue Lias Formation was the first to recognise and undertake trace fossils analysis in the UK (Hallam 1960, *Palaeontology*; 1960, *Proc. Geol. Ass.*), following initial pioneering work by German palaeontologists. His investigations of the origins of small-scale cyclicity in the 1960s included the highlighting of the importance of diagenetic overprint (rhythmic unmixing as it is called nowadays) and presaged an intense debate in the 1980s that Tony was at the heart of. Tony is also renowned as a key player in sea-level analysis and once again the numerous key contributions he made, particularly to our understanding of Jurassic eustasy (*e.g.* Hallam 1978, *Palaeo 3*; 1981, "*Vicariance Biogeography: a critique*." Columbia University Press), predates the giant sequence stratigraphic bandwagon that began rolling in the late 1980s.

photo: Paul Wignall

The list of pioneering and innovative work goes on. In the early 1980s, when the rest of the geological community was waking up to the possibility of a bolide impact at the K/T boundary, Tony investigated the end-Triassic mass extinction instead (Hallam 1981, *Palaeo 3*; Hallam & El Shaarawy 1982, *Lethaia*). He also discovered the early Jurassic (Toarcian) mass extinction event around the same time (Hallam 1986, *Nature*). For two decades this research area essentially "belonged" to Tony, but since 2000 it has witnessed an exponential increase in research activity and research papers. Tony remains the world expert on these events (he has had a 20-year head start after all), and continues to actively research them (Hallam 2002, *Lethaia*; Wignall, Hallam *et al.* 2006, *Geobiology*).

As well as pioneering numerous research fields, Tony has always been directly involved at the centre of many other key debates within geology and palaeontology. Thus, one of his contributions to the continental drift/plate tectonics revolution, "The fit of the southern continents" published in *Nature* with A. G. Smith, is his most cited work, with nearly 400 citations. Tony's contribution to evolutionary studies has also been immense and includes his early work on the evolution of *Gryphaea* (Hallam 1960, 1962; both in *Geol. Mag.*) that debunked the established orthodoxy of increasingly coiled oysters. This raised the ire of several senior establishment figures at the time, but he survived their wrath because he was right. His subsequent collaborations with Stephen Jay Gould (Hallam & Gould 1975, *Proc. Roy. Soc. London*) were a key part of the exciting punctuated equilibria debates of the 1970s. Tony would not list the end-Cretaceous mass extinction as one of his key research areas but nonetheless his contributions in this field are also extremely well cited (*e.g.* Officer, Hallam *et al.* 1987, *Nature*). The list could go on and include mention of Tony's contributions to numerous other palaeo-related areas such as Mesozoic palaeoclimates, source rocks, palaeobiogeography and to the history of geological studies.

In addition to this, Tony has inspired and collated a number of high profile edited volumes, often cross-cutting traditionally delimited subject matters, for instance, publications with Chaloner uniting marine and terrestrial ecosystems at critical points in the evolution of the biosphere, as well as Hallam (1973) *Atlas of Palaeobiogeography*. This major tome includes many highly cited papers that mark the onset of active research fields.

Despite retiring several years ago, Tony remains active at the present day and is still undertaking research on extinction events as well as spending much of his time editing journal contributions. He is currently serving on the Editorial Boards of *Palaeogeography, Palaeoecology, Palaeoclimatology*, *Earth-Science Reviews*, *Journal of Biogeography*, as well as more honorary roles including various European and Chinese regional journals.

Tony's broader contributions to the community have also been substantial. He served on the Pal Ass council in the 1960s and was the President from 1982 to 1984. He has written seven books: some are research texts and some are aimed at undergraduates or the public. Many have become

best sellers and been translated into numerous languages. He is fond of recounting that his *Facies Interpretation* is one of the few (maybe the only) geological book to be translated into Basque.

There have been dozens of Hallam-supervised research students and, during his time at Birmingham, where he was the Lapworth chair in Geology, he supervised on average one research student per year. The research papers produced by these students have been a major contribution to palaeontology for the past 40 years. He could easily have inflated his publication record (although he doesn't need to) by tagging his name on these papers but it is a measure of Tony's fairness that he only put himself on his students' papers if he wrote a substantial part. Indeed, the great majority of Tony's vast output is as single author, not because he doesn't collaborate with others, but because he's happy to help colleagues and students without demanding the credit.

Prof. P. Wignall
University of Leeds

Hodson Fund award to Dr Shanan Peters

Shanan Peters is a young palaeontologist who works at the interface of palaeobiology, stratigraphy and global geology, and who has opened up new and important directions of research. Although analysis of the stratigraphical distribution of fossils has fuelled analytical palaeobiology in its search for large-scale patterns of evolution, understanding what controls the stratigraphic distribution of fossils has often been neglected. Stratigraphy, like taxonomy, became something that was acknowledged to be essential for underpinning the science of palaeontology but which was largely glossed over in the rush to discover how life had evolved through taxon counting.

What Peters has done, in a series of brilliant papers, is to show that macrostratigraphy, the architecture of sedimentary deposits on a continental scale, and fossil diversity through time are at least in part linked by a common cause. Of course many before, starting with Shloss in the 1970s, had used regional sedimentary architecture as the foundation for sequence stratigraphy, while others had pointed out the biases that sequence architecture introduces to the fossil record at a basinal or regional scale. Peters' insight in the early 2000s was to demonstrate that large-scale macrostratigraphical patterns and large-scale palaeontological patterns are intimately related. He has achieved this through a mixture of rigorous analysis of large data sets and empirical testing of specific model systems. His work extends from small-scale studies on the implications of macroarchitecture on crinoid diversity across the Ordovician–Silurian boundary and detailed field studies of specific formations, to the establishment of macrostratigraphic architecture for North America and the demonstration of how this relates to Phanerozoic diversity and extinction patterns. His analyses are always carried out with the highest levels of rigour and he has developed new ways of quantifying the temporal and spatial nature of the rock record. Peters' innovative and perceptive studies have helped to underpin the idea that diversity patterns and macroarchitecture of sedimentary sequences are both controlled by the same global processes. Yet at heart Peters remains a field palaeontologist interested in palaeontological questions. He is very deserving of the Palaeontological Association's Hodson Fund.

Prof. Andrew Smith
Natural History Museum

Mary Anning awarded to Mr John "Jompa" Ahlgren, Mariestad, Sweden

Jompa is an avid fossil collector with an outstanding knowledge of life and environments in the Palaeozoic. Born in 1934 and raised in Gothenburg, Jompa has spent most of his adult life in Västergötland, south-central Sweden, a province famous for its table mountains with flat-lying and undisturbed Cambrian–Silurian successions. During the past two decades, he has extensively studied Cambrian and Ordovician successions in Västergötland, and has become a specialist of the fossil fauna in the province. He has paid special attention to trilobites from the middle Cambrian–Lower Ordovician Alum Shale Formation and his collected material has been essential for numerous palaeontological studies over the last 15 years. Before he moved to Mariestad in 2005, his home on Mount Kinnekulle became a Mecca to palaeontologists and other fossil-enthusiasts who visited the area.

Jompa is by natural disposition positive and generous, and foremost highly knowledgeable in the field of Baltoscandian invertebrate palaeontology. He actively participates in the promotion of collaboration between private collectors and professionals, and has contributed extensively to scientific discussions on, for instance, Paleonet. Jompa frequently participates in palaeontological conferences in Sweden. In 1997 he was co-organiser of the *Second Friends of the Alum Shale Meeting*. His enthusiasm and affection for palaeontology have brought him to several Palaeozoic outcrops outside of Västergötland, and he has collected Cambrian fossils from various areas in Scandinavia, ranging from Torneträsk in northernmost Sweden to the Danish island of Bornholm. He is well known for his studies and publications on the morphology and ontogeny of Cambrian olenid trilobites, and he has also co-authored papers on Cambrian agnostids and exotic trilobites in the upper Cambrian Alum Shales.

Jompa is a professional artist. His talent is expressed through artworks of paintings, etchings and drawings, and his work has been displayed in several public collections, including art exhibitions, books, and on national TV. He is also a gifted jazz musician and a skilled ornithologist. Jompa has been of prime importance for our knowledge of Palaeozoic faunas in Scandinavia in general, and in Västergötland in particular.

Dr Jan Ove R. Ebbestad
University of Uppsala

Prof. Per Ahlberg
Lund University

Nominations for grants, awards, Council

Palaeontological Association Research grants

Council has agreed that Association funds should be made available to support primary palaeontological research. Awards will be made to assist palaeontological research up to a maximum value of £15,000. Typically grants could support single research projects or 'proof of concept proposals' with an aim of supporting future applications to national research funding bodies. Online guidelines and application form are available for the deadline of **1st May 2008**.

Lapworth Medal 2008

The Lapworth Medal is awarded by Council to a palaeontologist who has made a significant contribution to the science by means of a substantial body of research; it is not normally awarded on the basis of a few good papers. Council will look for some breadth as well as depth in the contributions in choosing suitable candidates. The medal is normally awarded biennially. Nominations will be invited by **1st March** each year, supported by a resume (single sheet of details) of the candidate's career, and further supported by a brief statement from two nominees. A list of ten principal publications should accompany the nomination. Council will reserve the right not to make an award in any one year. Details and nomination forms are available on the Association Website and in The Newsletter. The Medal is presented at the Annual Meeting.

Note: For this year only (2008), because of the short notice of this announcement, the closing date for nominations will be 1st May. For all future years the closing date will be strictly 1st March.

President's Medal

Council is instigating a mid-career award for a palaeontologist in recognition of outstanding contributions in his/her earlier career, coupled with an expectation that they will contribute significantly to the subject in their further work. Nominations are invited by **1st March** each year, supported by a single sheet of details on the candidate's career, and further supported by a brief statement from a seconder. A list of ten principal publications should accompany the nomination. Council will reserve the right not to make an award in any one year. Details and nomination forms are available on the Association Website and in The Newsletter. The Medal will be presented at the Annual Meeting.

Note: For this year only (2008), because of the short notice of this announcement, the closing date for nominations will be 1st May. For all future years the closing date will be strictly 1st March.

Grants in Aid

Grants-in-Aid: Meeting Support

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 <**http://www.palass.org/modules.php?name=palaeo&sec=awards&page=128**>). Such requests will be considered by Council at the March and the October Council Meetings each year. Enquiries may be made to the <**secretary@palass.org**>, and requests should be sent by **1st March** or **1st September** each year.

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. Such requests will be considered by Council at the March and the October Council Meetings each year. Enquiries may be made to the <**secretary@palass.org**>, and requests should be sent by **1st March** or **1st September** each year.

Nominations For Council

At the AGM in December 2008, the following vacancies will occur on Council:

- Vice-President
- Newsletter Editor
- four Ordinary members

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 their interests.

All potential Council Members are asked to consider that:

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

The closing date for nominations is **1st October 2008**. They should be sent to the Secretary: Dr Howard A. Armstrong, Department of Earth Sciences, University of Durham, Durham DH1 3LE; email <**h.a.armstrong@durham.ac.uk**>or via <**secretary@palass.org**>.

The following nominations have already been received:

> Vice President: Dr T. Servais (nominated by Council)
>
> Newsletter Editor: Dr Richard Twitchett (nominated by Council)

The University of Manchester
The Manchester Museum

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2008

29th - 31st May

The organisers of Prog Pal and the Manchester Museum...

Invite participation in "**Meet the Fossil Detectives**," an open day at The Manchester Museum where palaeontologists will have the opportuity to discuss their work with the public in a workshop format. The open day will take place on the 29th May 2008, prior to the pre-conference reception.

The open day will begin with a public lecture from Prof. Mike Benton on "The Greatest Mass Extinction of all Time," after which visitors to the museum will be guided through the discovery center where participating palaeontologists will be on hand to discuss their work, and where possible present specimens, in a fun and informal atmosphere.

Prog Pal attendees who participate will be eligible for subsidies towards travel expenses.

Contact: manchester2008@palass.org

ASSOCIATION MEETINGS

52nd Annual Meeting of the Palaeontological Association
Glasgow, Scotland *18 – 21 December 2008*

The 52nd Annual Meeting of the Palaeontological Association will be held at the University of Glasgow, organized by members of the Department of Geographical & Earth Sciences and the Hunterian Museum.

The meeting will commence with a field excursion on Thursday 18th December to explore some of the fossiliferous Carboniferous rocks of the Midland Valley of Scotland. This will be followed by a half-day symposium on the afternoon of Friday 19th December entitled "Biominerals – the hard part of palaeontology," and that evening there will be a drinks reception hosted by Glasgow City Council in the City Chambers. The conference proper will commence on Saturday 20th December with a day of talks and posters, the AGM of the Association and the Association's Annual Address. In the evening there will be a drinks reception in the Hunterian Museum hosted by the Museum and the Geological Society of Glasgow followed by the Annual Dinner in the Bute Hall, the main ceremonial hall of the University. Sunday 21st December will be a full day of talks and a dedicated poster session.

The time allocated to each talk will be 15 minutes including questions; there will be no parallel sessions.

Venue and travel

The conference will take place at Glasgow University (<**http://www.gla.ac.uk/**>) in the west end of this vibrant and friendly city (<**http://www.glasgowguide.co.uk/**>). The area around the University includes a great variety of places to eat and drink, the botanic gardens and the City Museum & Art Gallery, and is a short journey on the Underground from the city centre with its many cultural and gastronomic delights. The city has excellent rail and motorway links to the rest of the UK. The nearby international airports are served by a wide range of carriers, including budget airlines. Glasgow Airport is 7 miles (11 km) from the University and there is an airport bus to the city centre. Prestwick Airport is 22 miles (35 km) away and has a rail connection to the city centre (see <**http://www.gla.ac.uk/about/locationmapsandtravel/mapsandtravel/**>).

Accommodation

Rooms in a variety of hotels at a range of prices and within easy reach of the University have been reserved up to 17th October (details will be placed on the PalAss website <**http://www.palass.org/**>). After this date, accommodation in these establishments cannot be guaranteed. Information on cheaper, hostel-style accommodation will also be provided.

Registration and booking

Registration and booking (including abstract submission) will commence on Monday 28th April 2008. Abstract submission will close on Friday 5th September and abstracts submitted after this

date will not be considered. Registration and booking after 5th September will incur an additional administration cost of approximately £15, with the final deadline of Friday 21st November. The conference lecture theatre has a capacity of 300 and the number of registrants will be capped at this figure, even within the registration deadlines if necessary. 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 from online forms available on the Palaeontological Association website <**http://www.palass.org/**> from Monday 28th April. Accommodation must be booked separately and details will be placed on the website.

Programme

Thursday 18th December	• Field excursion to fossiliferous Carboniferous rocks in the Midland Valley
Friday 19th December	• Half-day symposium "Biominerals – the hard part of palaeontology" • Evening Civic Reception – Glasgow City Chambers
Saturday 20th December	• Scientific sessions (talks and posters) • AGM and Annual Address • Reception in the Hunterian Museum • Annual Dinner
Sunday 21st December	• Scientific sessions • Presentation of awards

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 Glasgow meeting, grants of **up to £100** (or the Euro equivalent) will be available to student presenters who are travelling from outside the UK. The amount payable is dependent on the number of applicants and the distance travelled. Payment of these awards is given as a disbursement at the meeting, not as an advance payment. Students interested in applying for a PalAss travel grant should contact the Executive Officer, Dr Tim Palmer (<**palass@palass.org**>) once the organisers have confirmed that their presentation is accepted, and before **8th December 2008**. Entitle the E-mail 'Travel Grant Request'. No awards will be made to those who have not followed this procedure.

SYNTHESYS

SYNTHESYS Project funding is available to provide scientists based in European Member and Associated States to undertake short visits to utilize the infrastructure at one of the 20 partner institutions for the purposes of their research. The 20 partner institutions are organised into 11 national Taxonomic Facilities (TAFs).

The 11 TAF institutions represent an unparalleled resource for taxonomic research, offering:

- Collections amounting to over 337 million natural history specimens, including 3.3 million type specimens.
- Internationally renowned taxonomic and systematic skill base.
- Chemical analysis.
- Molecular and imaging facilities.

SYNTHESYS is able to meet the users' costs for research costs, international travel, local accommodation, and a *per diem* to contribute towards living costs.

The eighth and final deadline is: 28th March 2008

For more information visit <**http://www.synthesys.info/**> or contact <**synthesys@nhm.ac.uk**>.

news

The Wren's Nest, Dudley: problems ahead?

Many geology graduates from British universities will have visited the Wren's Nest in Dudley as part of their field teaching. It is a classic exposure of the Silurian Much Wenlock Limestone Formation which has so far yielded 600–700 fossil species. 65% of the fossils defining this part of the Silurian come from Dudley and 186 species were first described there. 63 of these species are unique to Dudley. In 1956 Wren's Nest was made the first urban National Nature Reserve (Figure 1, overleaf), following concerns about its deterioration since the limestone workings were abandoned in 1924. The geological community was particularly worried, and this was eloquently expressed by Professor Shotton of Birmingham University in 1953:

> *"Sections at Castle Hill and the Wren's Nest are World famous and now that Castle Hill is inaccessible through its conversion to a Zoo, it is more important that the Wren's Nest should be preserved. It has yielded fossils unrivalled for their variety and preservation so that geologists throughout the World know the name of Dudley… … Sections are regularly visited by students and geological experts, and always will be."*

A combination of time, natural erosion, collapse and safety regulations has once again brought the accessibility of the Wren's Nest into question. Mining first went underground here in 1750, and in 1800 a canal tunnel was built from the main canal network into the East mine. This was extended into the West mine some 13–15 years later. The Wren's Nest is a N–S striking faulted pericline (Figure 2). As can be seen from the cross section, the eastern limb dips at angles up to $80^0 - 85^0$, while on the western limb the dip is a more moderate $50^0 - 60^0$. The Much Wenlock Limestone Formation has two 'Quarried Limestone' beds: the Upper (UQLst), which is 8–10m thick, and the Lower (LQLst), at 12–16m. The Nodular Member between them is 30+m thick.

In the West Mine the miners chased the LQLst down the dip to the canal using a pillar and stall method. The seven pillars at the surface became known as the 'Seven Sisters', familiar to most visitors. There are no longer seven pillars, because there is a prominent bentonite layer along which sliding – and so collapse – is common, and in 2004 this cavern was infilled with a temporary fill to stop any more rock falls and satisfy public safety concerns.

The East mines pose a different problem. The miners excavated vast galleries at right angles to the canal in the Quarried Limestone members. As in the West mine it is fair to say that close to the canal the rock is 'riddled' with workings, many of them below canal level. The canal from the East mine which runs eastwards to join the main system has partially collapsed, but could be cleared and made safe. The only way of getting into the mine is by the Step Pit (Figure 2). This entrance is where miners would get to the mine workings, but today engineers can use this with the aid of a large 'bucket' holding three people attached to a winch.

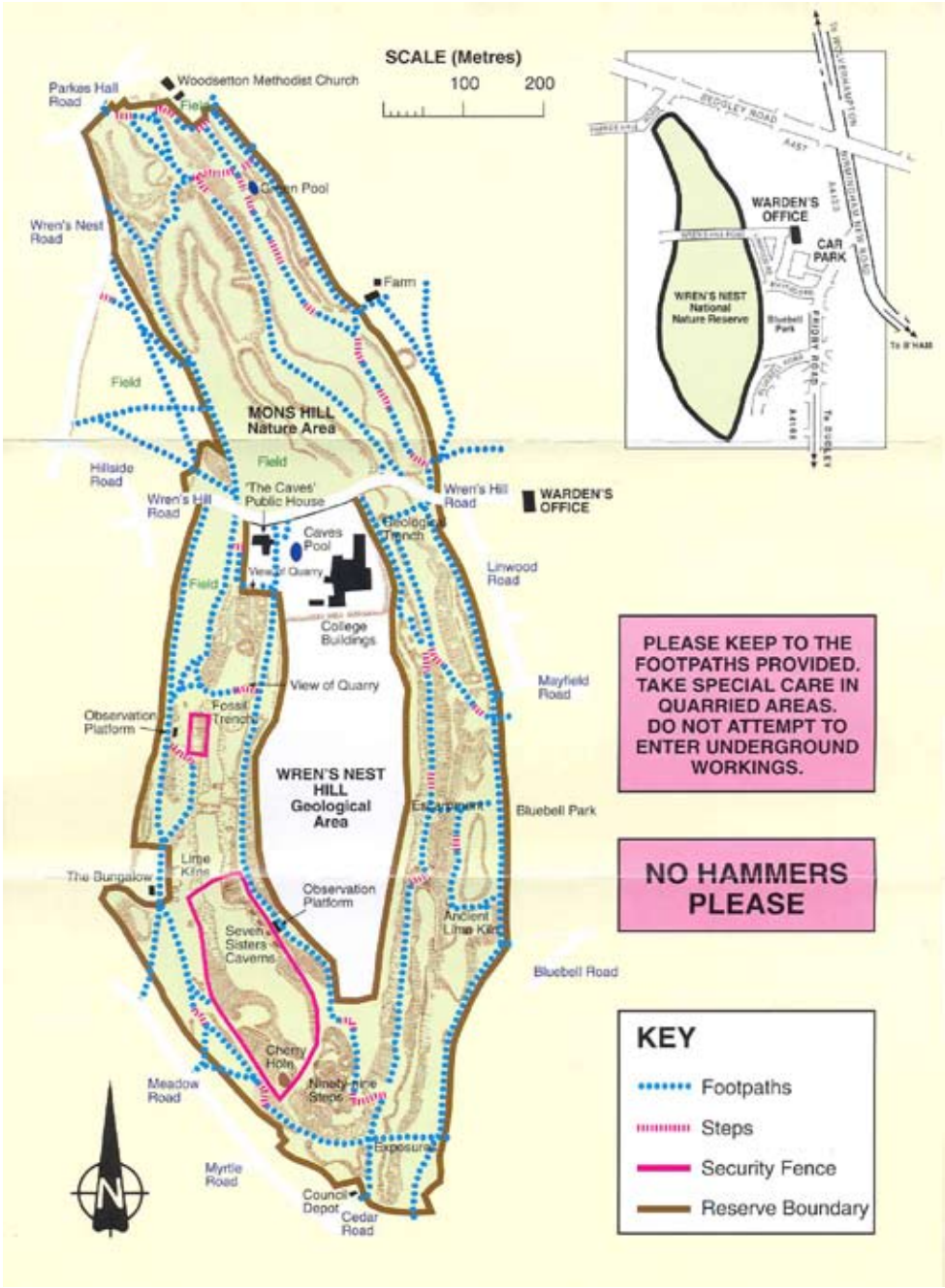
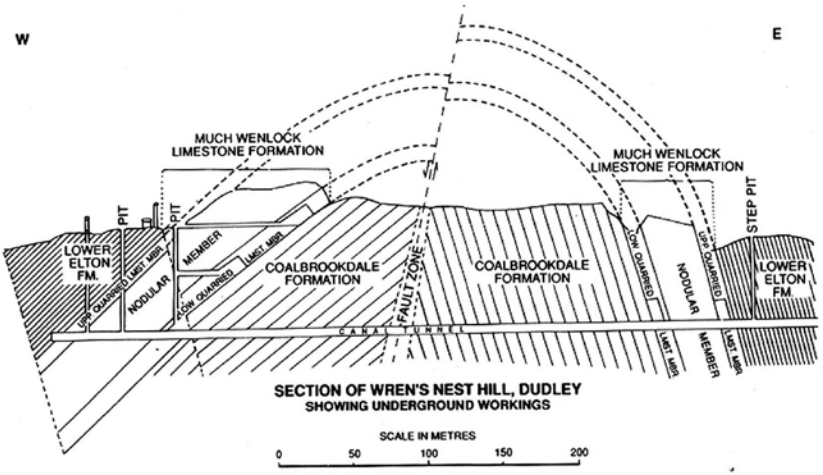


Figure 1. the Wren's Nest National Nature Reserve.



Cross-section through Wren's Nest Hill showing the anticlinal structure broken along its axis by a fault zone. The old limestone workings and canal tunnel through which the stone was carried away are clearly shown. The line of the section runs east-west approximately 400 m south of the college buildings.

Figure 2: cross section of the Wren's Nest.

The geologists involved, led by Graham Worton, the Keeper of Geology for Dudley Museum and Art Gallery, are trying to preserve as much of the underground workings as practical. One gallery in particular is the focus of attention; called the Cathedral Gallery, it is in the UQLst and runs to the south of the canal. It is 35m long, 15m wide and 20m high (Figure 3). One wall has a superb exposure of ripples. It could collapse at any time; some engineers give it a life expectancy of just one year. Other features include the biggest underground canal basin in the world, 70m by 10m, and an excellent section through the whole Much Wenlock Limestone Formation.

The STRATA project sets out to stabilise this area and open it to the geological community and the general public as part of a wider tourist attraction. The hope was that £50m could be obtained from a recent National Lottery competition, which for a variety of reasons failed. The Cathedral Gallery would eventually be rock bolted, a huge and expensive task. However, the urgent need now is to prevent collapse, by filling it with 42,000 tonnes of 40mm gravel. But with such difficult access this is likely to cost in excess of £1m. Hopefully a way forward can be found. From the view of palaeontology, when the underground area is cleared, a vast volume of highly fossiliferous rock will be brought to the surface to be studied. We can only hope that it will happen.

Bill Groves MA, MEd, FGS
Dudley Museum and Art Gallery
January 2008

Figure 3: Cathedral Gallery.

PUBLICATIONS

CUTLER, A., OLIVER, P. G., and REID, C. G. R. 1990. *Wren's Nest National Nature Reserve. Geological Handbook and Field Guide.*

HAMBLIN, R. J. O., WARWICK, G. T. and WHITE, D. E. 1978. *Geological Handbook for the Wren's Nest National Nature Reserve.* Nature Conservancy Council.

From our Correspondents

Core values

It's a strange feeling, carrying on with one's life as the foundations of that life creak audibly beneath one's feet. So it is, now, for the polar bear in the Arctic and so, too, it sometimes seems to be for the modern – or perhaps now it should be post-modern – palaeontologist. This particular angst is, though, longer-running than the symptoms (if not the causes) of contemporary climate change. Creationism (young-Earth variety) has appeared once more, in yet another morph.

This specific example: a planned but as-yet-unrealised visitors' centre for the Giant's Causeway, and the demands, by one Creation Causeway Committee, that displays show both the standard interpretation (*i.e.* of basalts erupted some 55 million years ago, as the north Atlantic opened) and one based on the 6,000 years or so of Biblical chronology. A rather telling article in the Belfast Evening Telegraph illustrates the palpable nervousness of the local politicians – rarely has the top of a fence been clung to with such tenacity. The Stratigraphy Commission has decided, perhaps rashly, to make brief Statements on the matter, to appear in *Geoscientist* and in *ES2k*. Geological time, after all, is our trade, and perhaps even our responsibility. It is a moot point as to what might be usefully done and what, if anything, any collective statement or action on our part may or may not achieve. How does one go back to restating, yet again, that which has been obvious for over two centuries now? – that the Earth is very, *very* old.

Few people, of course, have direct personal experience of the Earth's antiquity. Science, indeed, is full of examples of things that are hard to demonstrate through everyday experience or communicable via sound-bites. The existence of such things as atoms of silicon, oxygen, carbon and hydrogen, for instance, rather than particles of earth, air, fire and water; the reality of electrons and protons (not to mention quarks and pi-mesons). The non-existence of the ether and of phlogiston. Even the demonstration of the rotation of the Earth around the Sun (rather than *vice versa*) took, in the days before spacecraft, some sophisticated observation and deduction. Yet there seem to be few pressure groups (so far, at least) calling for an even-handed approach to the treatment of phlogiston in the Science Museum, or to the idea of a universe-pervading ether in the National Space Centre.

Not yet, at any rate. But the time might come. There is the sphericity of the Earth, for example, in ancient Greece by Aristotle, and then for good measure with a circumference worked out by Eratosthenes (with just 12% error) a century later. But not everyone is convinced, as one may instructively find if one risks searching for more examples of highly alternative science (stretching that word some way beyond even its normally highly elastic limits). There is buried treasure of this kind aplenty there, on the ever-growing information hyperhighway of the Web. For instance, I wondered what became of the Flat Earth Society, which is a direct parallel to the Young Earth movement in being utterly at odds with the evidence of our senses (as augmented by satellites, orbiting cameras and so on) and our reason (always assuming such a thing exists).

Wikipedia is a mine of information concerning the Flat Earth Society. Indeed, there is so much that one cannot hope to get to the bottom of it[1]. Founded by one Samuel Birley Rowbotham, the doctrine was known as Zetetic Astronomy, and expounded in the 430 pages of Rowbotham's magnum opus, *Earth Not a Globe*. There was much detail, including a nice means of keeping the oceans in via walls of ice all around the Earth's perimeter. There were disputes with scientists and sundry shenanigans, one involving no less a figure than Alfred Russel Wallace, taking some time off from co-discovering natural selection. Rowbotham (who prided himself on sticking to the facts) and his associates in two-dimensionalism had said that a straight slow-moving river – the Bedford Level – could be sighted along for six miles as a flat plane. Wallace (a competent surveyor as well as naturalist) proved them wrong, though it took several lawsuits to establish this *legally*.

Light relief, this, from the creationism? Alas, not so. Flat-earthism crossed the Atlantic to Zion, Illinois, where the Christian Catholic Apostolic Church established a theocratic community in which this world-as-pancake credo was a *sine qua non*, being taught – exclusively – in the local schools for the first half of the twentieth century. It was (and remains) in deadly earnest, at least in some circles, and this is documented nicely by Schadewald (1981-2). He suggests that scientific creationism, geocentrism and flat-earthism represent respectively the "liberal, moderate and conservative branches of a tree that has been called Bible-Science". Geocentrism? Well, yes, that is there also, for those who think that Copernicus led us all astray. Schadewald even noted that it had its own journal, the *Bulletin of the Tychonian Society*. Search for this now on the web and it has evolved into the *Biblical Astronomer*, which combines geo-centrism, young-Earthism, young Moon-ism, an absolute belief in the Biblical scriptures and, from the production values, a reasonable budget.

Returning to slightly less distant shores, a little research shows that there seems to be not one Flat Earth Society currently extant but two. Perhaps there has been a schism. They are both, though, lively reads, and both in this case (I think) spoofs – at least in part – where the flatees seem to be having a whale of a time in following the marvels of their own logic. One of these bodies has been 'deprogramming the masses since 1547' but holds itself not responsible *inter alia* 'for the unfortunate enslavement of the Nabisco Inc factory employees by a rogue hamster insurrectionist group'; the other has sections labelled 'complete nonsense' and 'angry ranting' though the discussions page seems to include some quite serious flattery. It is enough to make one's head – approximately spherical still, one hopes – spin. Still, the protagonists here have not yet demanded that Google Earth provide an alternative model of our planet so that viewers can see both versions, and make up their own minds about which is the most plausible.

The ultimate test for the Flat Earth Hypothesis will naturally come with global warming. If the hypothesis turns out to be mistaken, then melting of polar ice will cause sea level to rise for the rest of us, as per conventional wisdom. If Rowbotham, though, had been right all along, then the melting of the ocean-restraining perimeter ice walls of the Earth would, naturally, let the oceans escape into outer space in one spectacular and unrepeatable waterfall. This would leave the rest of us high and dry and feeling a little foolish (but with a lot of ocean floor to colonize), wondering just how we could have been taken in by that treacherous phenomenon, the horizon.

[1] Topologically speaking, of course, one perhaps cannot.

But perhaps one does not have to wait quite so long (*i.e.* a few decades) to satisfy our compelling curiosity about this great question of contemporary science. For cinematic enthusiasts the question has, of course, been settled beyond doubt by the amazing evidence brought to our attention in that geophysical *tour de force* that emanated from Hollywood a few years ago: *The Core*. You might recall the plot, which, amid the opening credits, offers the same moral as that in *The Day After Tomorrow*, with the Earth imperilled by unwise human activity.

Here it is the US secret services, locked even more tightly than usual in Dr Frankenstein mode, who, in attempting to build a device to trigger earthquakes beneath The Enemy – though not pre-emptively, you understand, perish the thought – have inadvertently stopped the motion of the Earth's core ('Oh, silly me', one can imagine the fumble-fingered general saying). This makes the Earth's electromagnetic field become a little poorly, causing both the pigeons in Trafalgar Square and a returning space shuttle to fly in the wrong directions[2].

It is obvious that worse is to come, a prospect subtly underlined by a melting Golden Gate Bridge. So, what to do? Naturally, the answer is to set off nuclear explosions at the Earth's core to restart the whole caboodle. Our Heroine and our Hero and other members of the mission set off thence in a craft made out of a wonderful new substance, called something like totallyimprobabilium. Their flight ('tunneling' is not at all the right word here) takes them through mantle and core, though with a few mishaps along the way: the mission complement diminishes as steadily as those green bottles lined along the wall. Nevertheless, Hero and Heroine duly detonate explosions, re-start core, return ecologically via a kind of core-generated solar power (I lost the logic there a little, I must confess), being delivered back to the welcoming arms of the US military with the help of singing whales and a prospect, rather coyly implied, of living Happily Ever After.

In such a short space I cannot do justice to this epic (by comparison, those among you of a certain vintage may remember the Proust-summarizing competitions that used to be popular at one time). But the view it offers of deep Earth structure gives far more detail than that described by today's isotope-juggling geochemists and deep-earth seismologists; Hollywood does, after all, have a larger research budget. Among the major discoveries are that deep-earth material is of low viscosity – indeed is turbulent – and is also translucent, so that the craft can dodge the giant diamonds encountered around the core-mantle boundary[3]. There is also a fine crystal-lined geode, a kind of plutonic elephant trap, that the craft falls into, the interior of which manages still to be at atmospheric pressure. These insights and observations will no doubt modify plate tectonic and mantle plume theory for some years to come. But the take-home message is quite clear. The Earth cannot be flat. If it were, the craft would have fallen out of it entirely.

Given the sphericity, perhaps the antiquity can also be inferred. That equally joyous Hollywood oeuvre *One Million Years BC* has a leather-clad foot in each camp. Its title testifies to a minimum six-figure date for the Earth, while the plot co-posits Stone Age peoples, dinosaurs, proto-

[2] Our Heroine, first glimpsed here, rescues the day and the hardware by landing the speeding craft along a bridge-infested canal, amid showers of sparks and water and scrambling passers-by. This scene has a remarkable similarity to the one in *Porco Rosso*, Hayao Miyazaki's deftly allusive anime take on *Casablanca*, in which the aviator pig (literally a pig: evo-devotees please note for further study) and the feisty heroine escape from fascist police. *Porco Rosso* was made in 1992, while *The Core* appeared in 2002, so it is quite clear who has priority.

[3] Almost dodge: that was one of the Mishaps.

Neanderthals (militant wing) and hippo-sized tarantulas. The scriptwriters' reading had obviously been eclectic. Their take on the scriptures is naturally a matter for their own conscience, but one might forgive them for not always locating the subtlest details of current scientific opinion.

For, now, there is a thousand times more evidence available – perhaps ten thousand times more – than in the days of Alfred Wallace and Darwin and their contemporaries. And yet – and yet – out there, to the broader population, much of the evidence is effectively invisible. Libraries groan under the weight of almost literally countless volumes of journals, of memoirs and monographs and maps. Hard to get to that library, to sift through this lot? Well, now much is available on the web, and a lot for free. Most volumes of *Palaeontology*, for instance – a late and welcome addition to the canon.

Perhaps too much, in fact. Life was simpler once. In the mid to late nineteenth century, for instance. Then, that one hundredth of one percent of the stratigraphic evidence that we now collectively possess, was printed in those early volumes of the *Quarterly Journal*, and in the *Annals and Magazine of Natural History*, and in the *Geological Magazine*, and in the pioneering Geological Survey Memoirs: from Ramsey on the gnarled rocks of Wales to Clement Reid on those junior apprentice rocks, the shelly sands of the Red and Coralline Crag and the boulder clays of East Anglia.

This was primary data, yet, written in that atmospheric Victorian style, in the reach of the educated but non-specialist reader. It was quite enough, that evidence, to show the dynasties and the antiquity of the past. It certainly caught the eye of a man we have met before, a devout man – one of the cloth, indeed – rector of Eversley, Hants, creator of the *Water Babies*, chronicler of *Hereward the Wake*, and amateur geologist and one of the first popular science writers. Charles Kingsley had a wonderfully pithy take on stratigraphy, already commented on (the 'poor man's science' – ha!), and this had taken wing also in 1869.

The title is genuinely inspired: *Madame How and Lady Why*, while the subtitle 'First Lessons in Earth Lore for Children' sets the didactic tone. Didactic enough, perhaps, to explain that the copy that I discovered in the vaults of the local Oxfam shop still had many pages uncut, so I had to carefully slice them through with a razor to reveal their freight of print. The recipient of this improving book (a birthday present from one of the more high-minded aunts, one suspects) had obviously studiously ignored it for a little over a century. This is good going, even for such a notoriously persistent humour as sub-adolescent disdain. One could safely bet one's last shirt on the cheap and lurid penny dreadfuls in that urchin's possession being much better-thumbed. His[4] loss and my gain. The Rev. Kingsley's devotion to his calling and his cloth is plain from the first. This book is aimed at encouraging young boys to do Right and not Wrong and to learn the lessons of their "Father in Heaven, the Great God who made all things".

Standard Victorian piety? Well, yes, and sufficiently thickly laid on to warm the cockles of any modern fundamentalist's heart – but there is a spin to it, and one that would meet with a more confused reception among those brethren. For how, pray, does one do Right? (the capitalization, by the way, is in the original). The answer is unequivocal: "God has given you eyes … and intellect…; it is your duty to use them". And our Reverend does not send our urchin to the

[4] Girls are not mentioned; presumably the fairer sex were being encouraged to help in the kitchen and to hone their embroidery.

library – or the scriptures – to use these facilities, but out into the hills and valleys and woods and fields. It is clear that his idea of a boy doing Right is something of a mixture of Just William ("terribly wet and dirty") and the young Gerald Durrell, filling pockets with a wheat-ear, and a piece of mistletoe, and a dead adder given to him by a turf-cutter, and amassing "curiosities enough, and thoughts enough, to last him for a week".

Kingsley was confident that trying to understand the Earth on its own terms would cause no collateral damage to his faith: "God did not put this wondrous world about your young souls to tempt or mislead them". He takes a strong line with the Tree of Unreason ("It drops its venom into the finest brains and makes them call sense, nonsense; fact, fiction; and fiction, fact"). And then, thus fortified, he takes our junior proto-geologist for a journey, in something like the spirit of Jules Verne, first to 'The Glen', a kind of voyage through landscapes, from the Thames Valley (the Bracklesham Beds getting hon. mention) and then to the Alps ('valleys thousands of feet deep, among mountains thousands of feet high"). How were the latter made? Why, by "little else save water, soft and hard; that is by rain, frost and ice". The immensity of time is explicit, and Charles Lyell walks through these pages, corporeal representative of Madam How. Meanwhile, St. Paul and the Book of Job take the side of Lady Why and the mystery of why things exist at all ("who knows the mind of the Lord?"). Kingsley put Stephen Jay Gould's two magisteria of science and religion happily into adjacency a century before Gould created – as it were – that particular meaning for the term.

Then, from there, to the earthquakes and the volcanoes. It's a pity the original recipient of my copy didn't give the book a chance, for there's blood and thunder in plenty as "in Java, a whole burning mountain fell in on the night of the 11th of August, in the year 1772", or "in the year 1698, the top of a mountain in Quito fell in on a single night … pouring out floods of mud mixed with dead fish". There's ice, too, for Kingsley was an early convert to the glacial theory, and made clear just how easily a familiar landscape can be changed into something far less comforting. He lived, after all, through the Little Ice Age:

"You never stood, as I stood, in the great winter of 1837-8 on Battersea Bridge, to see the ice break up with the tide, and saw the great slabs and blocks leaping and piling up on each other's backs, and felt the bridge tremble with their shocks, and listened to the horrible grind and roar, till one got some little picture in one's mind of what must be the breaking up of an ice-floe in the Arctic regions, and what must be the danger of a ship nipped in the ice and lifted up on high…"

The man had a way with words. A little on, his descriptions delve yet farther into the past, in his ruminations on the Chalk. He knew it was akin to a deep-ocean ooze. Even before the Challenger's famous expedition of 1872-6, the naval officers of H.M.S. *Lightning* had reported, the year before he wrote, of the vast swathes of 'globigerina-mud' on the floor of the Atlantic. How long, then, did the Chalk take to accumulate? He reckoned, then, between a tenth of an inch and an inch a year (somewhat of an over-estimate, we now know). Nevertheless, he asked – how many inches are there in 13,000 feet? Do the sum, he said, and think for yourself.

Think for yourself, indeed. Unsurprisingly, Kingsley's name is mud among fundamentalist creationists. Darwin's quisling, he's called, with no little vituperation, for Kingsley thought the notion of descent with modification perfectly reasonable – even for humans and their ancestors – and praised the *Origin of Species* when it first appeared. And he didn't put humans quite as

high on the pedestal of life as some (even now) think he should have done. Earth's deep history gives an unconscionably long time before the main players – we, the people – arrive on the scene, something that might have tested the patience, one might think, even of the most equable Creator. Not so, said Kingsley, in his little book for children. For, with regard to the ancient (biological) wonders of the past, 'the Father in Heaven … was enjoying too their beauty'. This world, he reminded the reader, was 'not made for man alone'.

Kingsley was a friend of Thomas Huxley's, and the friendship may have been strained, but doesn't seem to have been broken, by his attempts to persuade Huxley out of his life-long agnosticism. Huxley's reply is preserved: a moving one, for it was written following the death of his young daughter. Kingsley's suggestion, that consolation may be found in acceptance of the Will of the Almighty, was politely but firmly refuted. It was perhaps an awkward move on Kingsley's part, and (as the creationist websites emphasize with glee) the man was not without toenails of clay. Even on my brief reading of his works, he could display a touch of prejudice against (at least) Americans, the Spanish, people of the Jewish faith, the Irish, French novels and dinosaurs. Although he lauded Humboldt, that early anti-racist, his visceral instincts might have been a shade closer to those of Agassiz, whose views on human diversity we might now consider old-fashioned. Perhaps it was the Hampshire air.

Nevertheless, his message was clear – go out there and look for the evidence: the truth of what you find won't hurt you – or your theology. Indeed, the view we sometimes have of those early days, the cartoon image of, say, Soapy Sam Wilberforce and Thomas Huxley squaring up to each other over their distant parentage, may be misleading. Martin Rudwick, who has examined these roots of stratigraphy as deeply as anyone, considers the idea of a science/religion divide then as exaggerated (Rudwick, 2006, p. 7). There's a striking parallel, from a little later, from half-way around the world, and from another religion. The Buddhist agronomist, teacher, writer, amateur geologist, social activist and poet Kenji Miyazawa was almost unknown in his lifetime, but is now acquiring quite a following in his native Japan and beyond (Pulvers, 2008).

The Buddhist teachings, of course, have quite a different time-scale to those of Old Testament Christianity. Time-units run from the very small – the ksana, one seventy-fifth of a second, to the very large, such as the mustard seed kalpa (take a container with ten-kilometre sides; fill with mustard seeds; then remove one mustard seed per century: when the container is empty, then one mustard seed kalpa – considered a minor kalpa, by the way – has elapsed) to the larger still (the asamkhya kalpa, immeasurable and infinite beyond words). Hindu time-scales, too, are long, involving such units as the *mahayuga*, a period of 4,320,000 years (Ronan, 1983, p. 191).

Miyazawa's work is suffused with the idea of time. To understand a river, he said, you need to consider simultaneously its ancient past, its present and its future. His protagonists likewise travel, dream-like, through long reaches of time in books such as *Night on the Milky Way Train*, to wander, say, on half-billion-year-old beaches. And, like Kingsley, he was emphatically a field geologist, taking his students to examine strata and search for fossils. He took his Buddhism as seriously as Kingsley took his Christianity (indeed, breaking from his father to join a more austere sect; he was an idealist, a driven man, and probably quite hard to cope with in day-to-day life). Yet, he also took the world at face value, a stance in sympathy with the Dalai Lama's recent statement that if evidence can be found that refutes some part of Buddhist teachings, then it is the teachings that must be changed, not the evidence (Pulvers, 2008). And I dimly recall reading

somewhere (but where?) of an admonition of the Buddha's not to believe anything uncritically – *not even if it was something that he, the Buddha, had said*.

This is not at all to say, for example, Buddhism right and Christianity wrong as regards timescales or indeed, the nature of the world. The greater resemblance of the former's timescale to the modern scientific one was perhaps a lucky hit (while a more jaundiced interpretation might regard it as a considerable overshoot). But perhaps a little ecumenicalism might occasionally come in useful (now *there's* a term that seems hopelessly passé in today's adversarial world, a little like Mahatma Ghandi's now oft-derided notion of non-violent protest).

Lately, there seem to be some moves towards dismantling the barricades. The US National Academy of Sciences (2008) book-length statement on evolution and creationism/Intelligent Design comprehensively demolishes the arguments of the latter, while at the same time stating clearly and repeatedly that this should have no bearing on any person's individual religious beliefs. The two magisteria are kept quite separate, and the document seems to chime nicely with the spirit of the American Constitution: that one should have freedom *of* religious belief, and that of course includes freedom, should one wish it, *from* religious belief. Meanwhile, there is the development of an Evolution Sunday (now elevated to an Evolution Weekend, which, rather touchingly, is held on the Sunday closest to Charles Darwin's birthday, 12th February), established by religious leaders so that congregations can explore the idea that science and religion might be complementary, rather than in opposition (Zimmerman, 2008).

The development of these initiatives will be interesting, to say the least. However, in terms of widening awareness of the reality (well, OK, the perceived reality *vis-à-vis* the human senses and interpretive faculties) of the four-dimensional world out there, the exploratory instincts of both Kingsley and Miyazawa would seem to be as useful today as a century (and more) ago.

If not more so. There is certainly wide amateur interest in fossils, minerals and such among the public, and there are many amateur collectors. But it is one thing to go to, say, cornucopias such as Lyme Regis or Wenlock Edge and collect a hatful of fine fossils, even when one carefully labels each of these with name, stratigraphic age and location. It is quite another to collect, systematically, from long successions of strata and to chart the changes in the fossil assemblages, wrestling all the while with those twin old adversaries of taxonomy and biostratigraphy, of deciding when to lump and when to split, and when the stratigraphic change is sufficient to infer a new category of temporal and morphological phenomenon. It is the latter activity that, really, truly, demonstrates the reality of biological change with time, and explains why stratigraphical palaeontologists may on occasion become so *vexed* that the reality of this objective experience may be denied. It's good fun too, a deeper pleasure by far than collecting for collecting's sake.

These days, biostratigraphers and taxonomists more than ever have too little time (one does not mention the funding) and far too much to do. I could plan a dozen lifetimes' work ahead of me over a cup of tea and a chocolate biscuit. The Ludlow graptolites of the Welsh Basin? Not been done for ages; about a decade should be enough for the preliminary work. Then, that complicated taxon that provides the threshold to the Silurian – *'Glyptograptus' persculptus* and kin? Well over a year's work (Blackett *et al*., in press) has shown conclusively that devoting another five years or so might provide some *really* interesting data.

And so on, and on. Now there are many amateurs out there, of all ages, with enthusiasm and a good eye and patience and a little time to spare: as individuals, local societies, schools, museums. Could they, by joining forces with the paid-up (if a trifle worn-down) academics, facilitate the extraction of the data and the science from the miserly strata? I've often wondered whether such a thing is possible, and sometimes come across (isolated) examples where things like this have worked, though examples of this sort usually involve dinosaurs. Could it be done more systematically, and perhaps with less, er, distinguished taxa?

It would take an investment of time and effort, for sure, and about a hundred times more organizational ability than I can normally muster, and almost certainly some money, too. But a kind of grassroots Campaign for Real Stratigraphy might do more than amass and analyze the volume of material necessary to tease apart evolutionary lineages, to track morphological characters through rock strata centimetre by centimetre. It might help bring a critical mass of people to grips with the deep alien seas of the Earthly past.

To have more people living in the past … at least on alternate Sunday afternoons. Now that might make for a less vexatious future for our sometimes ill-appreciated science of mysterious strata and their divers petrifactions. Madame How would acquire a wider circle of friends, even if that enigmatic Lady Why, one suspects, was to stay as aloof as ever.

Jan Zalasiewicz

REFERENCES

BLACKETT, E., PAGE, A., ZALASIEWICZ, J., WILLIAMS, M., RICKARDS, B. and DAVIES, J. In press. A refined graptolite biostratigraphy for the late Ordovician–early Silurian of central Wales. *Lethaia*.

KINGSLEY, C. 1889 (my edition). *Madame How and Lady Why*. MacMillan and Co., London and New York. 270 pp.

National Academy of Sciences/Institute of Medicine of the National Academies. 2008. *Science, Evolution and Creationism*. Washington, D.C.: The National Academies Press, 70 pp.

PURVIS, M. 2008. Staying strong in the rain. *New Scientist*, vol. **197**, no. 1242, pp. 50–51.

RONAN, C.A. 1983. *The Cambridge Illustrated History of the World's Science*. Cambridge University Press.

RUDWICK, M. 2005. *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution*. The University of Chicago Press.

SCHADEWALD, R. 1981-2. Scientific Creationism, Geocentricity and the Flat Earth. *Skeptical Inquirer*.

ZIMMERMAN, M. 2008. Let us celebrate Darwin. *New Scientist*, vol. **197**, no. 2641, p. 16.

On molecular clocks and molecular fetish

These certainly are the best of times, at least if you're in the business of elucidating the mysteries of the deep evolutionary past. We are able to mine an unprecedented number of biological and palaeontological resources with an unrivalled array of flashy tools, and we probably have more questions to seek answers to than ever before. It is not surprising then to note that our prime integrative disciplines, such as evolutionary developmental biology and palaeobiology, are in the process of defining and refining their research programmes to accommodate new challenges and opportunities. Interestingly, despite the richness of the pickings, these disciplines can't escape a degree of conceptual and empirical gluttony such that we can now witness them in battle for the rights to lay claim to pieces of coveted deep time territory. To be sure, this 'battle' should invoke an image more akin to an encounter of encrusting marine invertebrates than a head-on clash of fierce bucks, both with respect to strategy and spectacle, and possibly degree of consciousness as well, but the fact that both evo-devo and palaeobiology try to incorporate several identical topics and methods at the core of their research agendas allows a revealing glimpse of what is now generally thought to be hot or not.

What's in a name?

On the topic of topics, I'm happy to report that by this criterion one of my own favourite topics is enjoying another moment in the spotlights: ancestors[1]. As concerns methods, to single out nearly everybody's new best friend, molecular phylogenetics takes pride of place at the cradle of recent exciting advances in both fields. Being hailed as equally informative in the twin domains of tempo and mode of evolution, molecular phylogenetics allows heretofore undreamed of opportunities for virtual travel down deep time's highway to gawk at unseen ancestors and their transformations through time. In fact, molecular data and methods are considered to be of such overwhelming importance that Peterson *et al.* (2007) choose to replace democratic principles by favouritism, and rename palaeobiology *molecular palaeobiology*, giving credence to the deplorably widespread notion that some types of data and methods of analysis are manifestly more equal than others. Peterson *et al.* (2007) are motivated by a wish to "rectify" the situation that a paper by Runnegar (1986) and titled *Molecular palaeontology* "has received only 16 citations in the last 20 years." In this paper Runnegar attempted to draw attention to the manifest importance of molecular data for investigating palaeontological problems. Honouring this insight Peterson *et al.* (2007) decided "to propose a working definition and a research agenda for Molecular Palaeontology," which they rename *molecular palaeobiology*. But why invent a new name by pasting an unnecessary adjective to an already long established discipline, the research programme of which Peterson *et al.* (2007) do such an admirable job of outlining and exemplifying? Long before the publication of Runnegar's paper, the "Guide to authors" of the journal *Paleobiology* indicated that the discipline enveloped both the study of fossils and the

[1] Curiously, the recent book of John Avise on ancestral reconstructions, *Evolutionary pathways in nature*, doesn't mention 'ancestors' or 'ancestral' in the index, and both terms are decidedly rare in the paper by Peterson *et al.*, 2007, *Palaeontology* **50**: 775–809, which codifies molecular palaeobiology as a novel discipline. Perhaps this is not surprising given the frustrating dual status of ancestors as both conceptually inescapable and empirically elusive.

living, as so aptly and concisely summarized in the very word 'palaeobiology.' In particular the work of its first editor, the late Thomas Schopf, illustrated that both genes and genomes comfortably fell under palaeobiology's conceptual umbrella a decade before Runnegar's paper, as candidly admitted by Runnegar. Perhaps Runnegar's paper has attracted fewer citations than expected by Peterson *et al.* (2007) because such an integrative perspective, linking the molecular and the morphological, the fossil and the living, was already part and parcel of the thinking of many palaeobiologists. Perhaps all they needed was a prod in the direction of the data. Admittedly, molecular data has infused palaeobiology with many new possibilities, but that is scarcely a convincing reason to rename it, unless we want to embark on a further and useless exercise of newly systematizing parts of *molecular palaeobiology* as *developmental*, *morphological*, *ecological*, *organismal*, etc. Simply palaeobiology will do just fine.

This choice of one term to rule them all leaves no doubt about the greatest source of optimism about our abilities to probe deeply into the past. According to the codifying document of *molecular palaeobiology* the "discoveries made on the back of molecular phylogenetics and the attendant application of molecular clocks cannot be overstated" (Peterson *et al.*, 2007: 776). To be sure there is much truth in this statement, but I can't help but sense a shade of gullible idolatry that so often seems to piggyback on more reasoned statements of approval. Consider the very next sentence in the paper: "Over a century of debate has been laid to rest concerning the monophyly of Metazoa and the high-level relationships among the component phyla." Mmm… Molecular phylogenetics has definitely shaken things up over the last decade or so, and a new consensus view of animal phylogeny has indeed widely taken hold.

Yet, to claim that debate about high-level animal phylogeny has finally been laid to rest is either empty hyperbole based on ecstatic optimism, or the result of being content with very little indeed.

You might think that I'm simply a grumbling curmudgeon who is deeply insecure about our knowledge of metazoan phylogeny as a result of not having managed to publish my own version of the phylogeny, and that might perhaps explain a tiny fraction of my attitude. The anonymous reviewers of a paper that I recently co-authored with Tim Littlewood from the NHM in London on the topic of phylogenetic Problematica labelled sections of the paper that I had a large part in writing "defeatist" and displaying a "programmatic insistence that metazoan phylogeny is all up in the air." No, I don't think that all is still up in the air, but yes, I do think that a substantial amount is still unknown (Tim and I only felt confident to include 16 resolved nodes in our conservative consensus phylogeny of the Metazoa). Despite having thrown infinitely more data and more sophisticated techniques to the problem than previous generations could ever hope for, Nature's intransigence has so far barred us from seeing the many large details that matter. However, I don't have any ambition to be a partypooper just to make people miserable, or for the even more base reason to get myself noted. I just have a low tolerance for unfounded optimism. One of the reviewers of the above mentioned paper wrote: "There are certainly problems aplenty with Problematica but even identifying something as problematic is actually an advance." Such a degree of sanguinity I am simply not possessed of.

Optimism and scepticism

The issue is not one of seeing the glass half full or half empty, of optimism *versus* pessimism, for the latter mindset has no place in scientific research. The flipside of optimism in its extreme form

is scepticism, which is a mental trait equally critical to scientific advance. Optimism is the force that drives the empirical thrust of science. It is that elusive quality of mind that allows a tearful PhD student to dry his eyes after yet another bandless gel, to go for a beer and then to get back to the lab for more of the same. Optimism gets you into the lab, time and time again. In contrast, the value of scepticism is the state of mind that convinces a tearful PhD student to dry her eyes, to go for a beer, and then to meet with her supervisor to tell him that he can stuff the project up his ass, because it is obviously a dead-end pet project that should have been euthanized long ago. Scepticism gets you out of the lab, at least temporarily to reassess the situation.

My scepticism was triggered recently when I started reading and thinking about the benefits of using molecular sequence data in a phylogenetic framework for our understanding of the tempo and mode of evolution, two of the three pillars of *molecular palaeobiology*. In the realm of tempo, molecular data and methods allow us to infer molecular rates of evolution, which through divergence time estimates, can give us important clues about phenotypic rates of evolution as well. In the realm of mode, these data and methods are used to infer the nature of distant ancestors through the use of sophisticated methods that allow one to reconstruct ancestral character states in a probabilistic framework (by likelihood and Bayesian analyses). The ability to do these things is an important gift to the historical scientist, and it is wholly due to progress in molecular phylogenetics. Consequently, doing these things has become all the rage and the literature swells steadily with scores upon scores of papers reporting on molecular divergence time estimates and ancestral reconstructions, sometimes in the same paper. However, something didn't seem to add up. I'd love to use the molecular dataset we are compiling for malacostracan crustaceans to do these things as well, if only to prove to myself that I can be fashionable too. The problem wasn't hidden deep in the intricacies of the sophisticated methods developed to study the realms of tempo and mode in evolution. Instead, the problem is elementary, something that should easily be picked up by a novice in this area, which is perhaps the reason why I stumbled across it.

A clash of assumptions

The problem that struck me was the incompatibility of the assumptions necessary to justify the use of molecular clocks on the one hand, and the inference of morphological ancestral character states in a probabilistic framework on the other. Citing Peterson *et al.* (2007: 781) on the central assumption in the realm of tempo: "Molecular clocks require that the rate of molecular evolution be dissociated from the rate of morphological evolution." It has long been a concern that a causal link between molecular genetic and morphological evolutionary rates of change could throw a monkey wrench into attempts to date clade divergences with a molecular clock. In a rare reversal of evolutionary causality in an increasingly gene-centred world, it has been argued that the high rates of morphological change that might accompany rapid radiations may speed up molecular rates of change, causing molecular clocks to overestimate divergence times. Luckily, in line with our theoretical understanding of molecular evolution, there is no compelling evidence for such a general link, especially when general housekeeping genes and morphology are concerned. Peterson *et al.* (2007: 782) conclude: "One would suspect that any correlation [between molecular and morphological rates of evolution] … cannot lie within the standard phylogenetic markers" and indeed there is no evidence for any general link. This does not mean that the application of molecular clocks to date divergence times is smooth sailing, but at least

the molecular and morphological records of evolutionary change are independent enough so that the quirks of one may not necessarily affect the other.

Unfortunately, this happy circumstance wreaks havoc with a necessary assumption that underpins the use of molecular phylogenetic information to infer morphological ancestral character states in the realm of mode. In a move away from the intuitively attractive method of maximum parsimony, ancestral states are increasingly inferred through the use of probabilistic methods, such as likelihood and Bayesian methods. These methods have the claimed advantage of being able to use branch length information in the inference of ancestral states, and they do this by using branch length as a proxy for the opportunity of change of a character. Relatively longer branches offer a relatively greater opportunity for change. What is the unit of these branch lengths? In the words of one of the first seminal papers on this topic: "Genetic distances uncorrected for molecular clock assumptions may be the best estimate of the 'opportunity for change' in the sense of indicating the total amount of evolution between pairs of species" (Pagel, 1994: 42). This idea caught immediately, and we now see sophisticated likelihood and Bayesian methods being used to infer morphological, behavioral, ecological, and even biogeographical ancestral character states incorporating molecular branch length information. Oh yes, almost an unnecessary afterthought: this assumes that evolutionary change in morphology (and the other non-molecular 'characters') and molecules *is* correlated. This is in complete contradiction to the necessary assumption of using molecular clocks. Either that, or I'm missing something. After all I'm a novice in this area.

Evidently, in this situation you can't have your cake and eat it too. Either morphological and molecular genetic evolutionary change are correlated, potentially justifying the use of molecular branch lengths to inform morphological ancestral character state reconstructions, or they are not correlated, as required by the application of molecular clocks. Current evidence is decidedly in favour of the latter, but this does not prevent the community as a whole from double dipping, flipping between different assumptions as required by different kinds of analyses. Individual workers even exploit the same molecular phylogenetic data set both to infer molecular divergence time estimates of a rapid radiation, and then to use the molecular branch lengths to inform ancestral character state reconstruction of morphology (*e.g.* Tavares *et al.*, 2006). I have no doubt that in individual cases molecular branch lengths may be informative about the opportunity for evolutionary change in morphology, but a general link is unsupported.

The shrine of statistics

The burden of proof lies squarely with those who want to use molecular branch lengths to inform morphological ancestral reconstructions. The general justification for doing this is almost absurdly weak. In their important paper on Bayesian estimation of ancestral character states Pagel *et al.* (2004: 675) write: "Branch lengths in units of genetic divergence may usefully record the underlying opportunity for trait evolution (Pagel, 1994)." Critically, the only paper cited in support of this argument is Pagel (1994). The strongest justification offered by Pagel (1994) scarcely transcends wishful thinking: "Genetic distances uncorrected for molecular clock assumptions may be the best estimate of the 'opportunity for change' in the sense of indicating the total amount of evolution between pairs of species (p. 42)." Obviously, this is not nearly enough to neutralize the conflicting evidence gathered in support of the use of molecular clock dating, let alone to built a positive case beyond the mere possibility of an informative link between the amount and/or rates of molecular genetic and morphological evolution.

The probable reason why molecular branch lengths became incorporated into morphological ancestral state reconstruction is not hard to find. As stated in Pagel (1994), phylogenies with branch length information became increasingly available in the early 1990s, and they could conceivably be useful. Critical studies of the relationship between molecular and morphological rates of change were still a thing of the future, so there was no reason not to try and incorporate molecular branch lengths. If you can do it, do it. The current use of these methods is much more problematic given that the necessary assumption of a reliable correlation between evolutionary change in molecular phylogenetic markers and morphology remains unsupported. But it is not difficult to see why such is nonetheless the case: the beguiling glare of the shrine of statistics. The attraction of probabilistic methods is almost irresistible. Even very smart people (or perhaps they especially since they understand the statistics) are lured by the promise of quantification and "rich statistical" tools (Ree & Smith, 2008: 4). This points to an interesting tension: the nature of the subject matter and the methods used to study it. We are often arrogant about the value of the first, but insecure about the second, and we are sometimes willing to use inappropriate methods as a result. I will explore this topic in my next essay.

Let us end with a stark irony. The allure of probabilistic methods is that they promise to deliver a quantitative handle on the uncertainty of our ancestral inferences. As summed up by Cunningham *et al.* (1997: 365): "Furthermore, the results of the ML analyses show that there could be considerable uncertainty in ancestral reconstructions." Well, the use of parsimony notwithstanding, this is no news to anyone attempting to infer the deep evolutionary past. Unfortunately, in attempting to introduce a very sophisticated method to provide a quantitative estimate of ancestral uncertainty, we overlooked a much more fundamental uncertainty in the assumption underpinning the method.

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REFERENCES

CUNNINGHAM, C. W. *et al*. 1998. Reconstructing ancestral character states:a critical reappraisal. TREE, **13**, 361–366.

PAGEL, M. 1994. Detecting correlated evolution on phylogenies: a general method for the comparative analysis of discrete characters. *Proc. Roy. Soc. Lond. B*, **255**, 36–45.

PAGEL, M. *et al*. 2004. Bayesian estimation of ancestral character states on phylogenies. *Syst. Biol.,* **53**, 673–684.

PETERSON, K. J. *et al*. 2007. Molecular palaeobiology. *Palaeontology*, **50**, 775–809.

REE, R. H., SMITH, S. A. 2008. Maximum likelihood inference of geographic range evolution by dispersal, local extinction, and cladogenesis. *Syst. Biol.,* **57**, 4–14.

RUNNEGAR, B. 1986. Molecular palaeontology. *Palaeontology* **29**: 1–24.

TAVARES, E. S. *et al*. 2006. Phylogenetic relationships and historical biogeography of Neotropical parrots (Psittaciformes: Psittacidae: Arini) inferred from mitochondrial and nuclear DNA sequences. *Syst. Biol.* **55**, 454–470.

PalaeoMath 101
Multidimensional Scaling and Ordination

This column is devoted to completing our discussion of basic multivariate data analysis by tying up a bit of a loose end. In previous columns I've approached the description of various bivariate regression and multivariate analysis methods from a variable-centred point-of-view, at least for the most part. That is to say, I've focused on describing how the geometry of the calculations allows us to sense, summarize, and understand relations among variables across the example datasets. The obvious exceptions have been my discussions of principal coordinate (PCoord) and *Q*-mode factor analysis (*Newsletter* **61**), as the explicit goals of both these techniques is to construct a picture of similarity relations between the objects from which measurements and/or observations were obtained.

Nevertheless, I'm sure it has not escaped your attention that the resolutely *r*-mode methods of principal components analysis and factor analysis (newsletters **58** and **59** respectively) also produce pictures of similarity relations among objects in the form of scatterplots of those objects within the space formed by the new component or factor variables. Correspondence analysis yields similar plots of between-object similarity based on frequency data, with the added advantage of enabling geometric relations between variables to be represented in the same space (see *Newsletter* **62**)[1]. Likewise, canonical variates (*Newsletter* **65**) are convenient for displaying relations between objects in spaces that emphasize differences between *a priori*-defined groups. The spaces formed by partial least squares analysis axes (*Newsletter* **63**) are, again, used to construct images of between-object similarities, though in this case the focus of the procedure is the degree to which different datasets exhibited the same inter-object similarity structure.

The *r*-mode/*Q*-mode distinction is real, but actually pertains to the means by which each technique's goals are achieved. All these approaches provide critical information about the structure of covariation among variables *and* can be used to obtain a visual sense of the structure of similarity relations among objects. Consequently, their use allows us first to optimize, then to interpret the nature of the geometric spaces within which we portray object similarity patterns. This gives us the power to test a wide range of hypotheses because we can see—and so understand—the nature of relations between variables *and* objects. But this power comes at a subtle and little-understood price.

The feature that gives PCA, PCoord, factor analysis, correspondence analysis, CVA and PLS their power to bridge the gap between variables and objects is their common dependence on eigenanalysis. Eigenanalysis is a method for estimating the major directions of variation in sets of numbers. While the assessment of variation in terms of both its relative directions and magnitudes is a logical and common-sense approach to understanding the behaviour of variable

[1] It is possible to scale PCA and factor axes to portray relations between object and variables in the spaces so formed (these are called 'biplots'), but this represents a step beyond the calculation of principal components or factor axes *sensu stricto*. Such scaling is a fundamental part of correspondence analysis.

sets, is this the only—or even the most appropriate—approach we could use to understand *similarity* relations between objects?

Note that cluster analysis (*Newsletter* **66**) is very different in this respect from the eigenanalysis group of techniques. Cluster analysis provides a means whereby object-based similarity relations can be represented, but does not do so by assessing the structure of relations among variables. Rather, it treats each object as a set of descriptions (= the state of the variables the object manifests) and simply calculates a measure of between-object similarity, usually in terms of a distance. Once the structure of inter-object distance relations has been estimated cluster analysis summarizes that structure, but does so in a manner that provides no direct insight into the nature of relations between the variables. In other words, cluster analysis provides an answer to the question of how similarity relations are organized across objects in a dataset, but has a very limited capacity to help us understand why that answer was obtained in terms of pattern relations among the original variables. Should this be a cause for concern?

The only reasonable answer to this question is 'It depends'. If the hypothesis we are testing can be resolved solely by determining the structure of between-object similarity relations there may be no need to understand the nature of the space within which those similarity relations are portrayed. How the space related to the original variables, or whether it has been optimized in terms of the representation of major patterns of variation across the dataset as a whole, may be irrelevant. But one thing that doesn't change is the need to have some way of sensing how 'good' the resulting picture of between-object similarity relations is.

Of course, the eigenanalysis family of techniques provides this quality-control information through the eigenvalues. These are the lengths of the major and minor axes of a hyperdimensional spheroid fit to the variables when represented in a variance–covariance space (Fig. 1). For sets of highly correlated variables, the first few eigenvectors will typically subsume a much greater proportion of the overall variance than any single variable axis. If these vectors are then used to portray inter-object similarity relations, a 'good' result will typically be that in which the overwhelming majority of the observed variation is represented by 2–3 eigenvector-based axes. Decision criteria vary depending on the problem under investigation, but most analysts would feel that being able to summarize 90 to 95 percent of the observed variation in 2–3 eigenvectors is accurate for the purpose of authoritative interpretation. Note, this feature of eigenanalysis is delivered by the technique's ability to summarize the structure of covariance relations among variables. It has nothing to do with assessments of inter-object similarity *per se*.

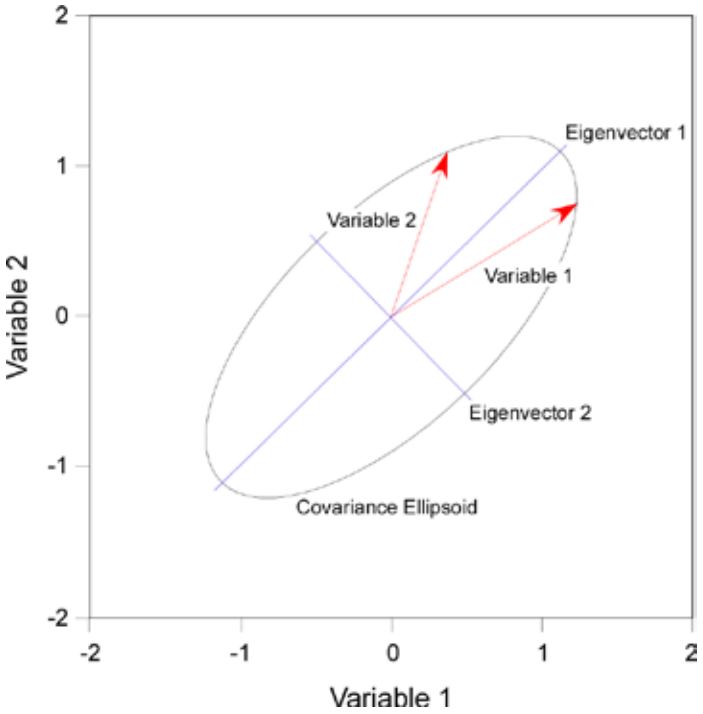

Figure 1. Geometric relations between variables and eigenvectors. Eigenvectors are the major axes of a covariance spheroid (ellipsoid in two dimensions) centred at the origin of a variance–covariance space and recursively fit to the swarm of vectors representing the variance–covariance structure of a set of variables. The eigenvector coefficients are the cosines of the angles between the eigenvectors and the variable vectors. The eigenvalues are the lengths of the eigenvectors. The sum of these lengths is proportional to the total amount of variance across all variables in the system.

As I've alluded to above, cluster analysis has no parallel to the eigenanalysis in terms of numerical quantities that summarize the amount (*e.g.*, eigenvalues) and kind (*e.g.*, eigenvector coefficients) of information present along the axis against which the cluster pattern is formed. Under agglomerative clustering this is typically done by estimating the amount of overall distortion inherent in the portrayal of those relations as a dendrogram. Operationally this is accomplished via back-calculation of an implied similarity matrix and comparison of that to the original similarity matrix using the cophenetic correlation coefficient (see *Newsletter* **66**), which provides a very rough assessment of the overall distortion. As we have seen, force-fitting a hierarchical model to the data in order to distinguish clusters of objects can result in substantial distortion being introduced. Partition clustering approaches (*e.g.*, *K*-means clustering) are often better in this respect as they do not attempt to fit a hierarchical model to the data (and so avoid generating distortions). However, these approaches assume the data exhibit subgroup-level structure and will always find that structure regardless of whether it is the dominant pattern in any particular dataset.

In other words, trying to portray the pattern of high-dimensional data in low-dimensional spaces will always involve distortion. But let's go back to first principles for a moment to regain our perspective. The objects in a dataset exhibit patterns of attributes that exist at (potentially) all scales. If distributions of attributes are strongly clustered there will be a clear distinction between large-scale (*e.g.*, between groups) and small-scale (*e.g.*, within-groups) patterns. Canonical variates analysis takes explicit advantage of this distinction by using a two-step eigenanalysis procedure to focus the analysis on portraying between-groups differences. However, even though small-scale patterns play a role in determining the orientation of eigenvectors, the resulting vector orientations will always be most closely aligned with the large-scale patterns present in the data. If all the data in an analysis are normally distributed, this difference between large- and small-scale patterning may not be that important—hence many multivariate statisticians' love of qualifying their statements in terms of normality assumptions. But many (most) biological and palaeontological datasets exhibit distributions that are far from normal. In those cases where the focus of the analysis is on the portrayal of inter-object similarity relations, is cluster analysis *or* eigenanalysis the best we can do?

Of course, the answer to this question is 'No!'. The name of the technique that can help us in this regard is multidimensional scaling, or MDS for short. Like cluster analysis, MDS is actually a family of techniques with many different variants on the common theme. Also like cluster analysis, MDS can be used to analyse an astounding variety of data. Best of all, MDS makes no prior assumptions about the nature of similarity relations present in the data (*e.g.*, hierarchical or non-hierarchical), the scales of similarity patterning they contain, the distribution of the data within variables, or the presence/absence of well-defined sub-group structure within the overall dataset.

The term 'multidimensional scaling' means different things to different people (see below). In this column I'm going to refer to it as a specific type of numerical procedure that has seven basic steps.

1. A *Q*-mode distance matrix δ is calculated between all pairs of objects across a set of variables and/or observations where δ_{ij} is the distance between object *i* and object *j*.
2. These objects are then arranged in a configuration within a *k*-dimensional space. The typical starting configuration is random, but may also be the configuration of the first *k* principal coordinates.
3. A new distance matrix d is calculated between all pairs of objects across the *k* dimensions of configuration space where d_{ij} is the distance between object *i* and object *j*.
4. A regression of d on δ is performed. The purpose of this regression is to specify the functional relation between the configuration space and the original (high-dimensional) distance data. Based on this regression the quantity $\hat{d}$ is then determined using the following equation.

$$\hat{d}_{ij} = a\delta_{ij} + b + \varepsilon_{ij} \qquad (13.1)$$

where *a* and *b* are constants (*e.g.*, the slope and *y*-intercept of a d on δ linear regression) and ε is the error associated with the regression. This quantity ($\hat{d}$) is called the 'disparity'.

5. A test is made of the fit between the disparity distances and the configuration distances in the *k*-dimensional space. This goodness of fit is summed into a single statistic that represents the amount of distortion represented by the test configuration of points in the *k*-dimensional space.
6. The disparity values ($\hat{d}$) are then substituted for the configuration distance values (d) and used to calculate a new configuration space.
7. Steps 4–6 are repeated until the test performed at step 5 indicates no further improvement in the goodness-of-fit of the configuration space on the original distance data matrix can be achieved, or until a predetermined iteration limit is reached, whichever comes first.

Note first how similar this fitting procedure is—at least in principle—to the procedure for obtaining an eigenanalysis (see *Newsletter* **58**). If only two variables are involved the equation of the first eigenvector (= first principal component) can be calculated directly. This is identical to calculating the slope of a major axis regression (see *Newsletter* **56**). For all higher dimensional datasets the first eigenvector must be estimated using an iterative procedure that compares the goodness of fit of a test vector to the major dimensions of variation within the sample. The orientation of subsequent eigenvectors are fit in the same way subject to the additional constraint that they must be orthogonal to the orientation of all preceding eigenvectors.

The MDS approach uses a similar strategy to estimate the configuration of points in the *k*-dimensional space. But note that the MDS algorithm (1) is restricted to assessing the fit across a pre-determined set of dimensions (*e.g.*, does not try to use all possible dimensions to obtain a perfect solution), (2) assesses the fit between the disparity and configuration distances globally, across the entire scale of distances present in the dataset, and (3) places no constraints on the orientation of the solution vectors. Thus, unlike strictly eigenanalysis-based methods, no preference is given to fits across large-scale patterns in the data; and, like CVA axes, there is no guarantee the final MDS axes will be aligned with major patterns of variation in the original data or even that they will be orthogonal to one another in the space of the original variables.

Of course, the goodness-of-fit test is very important to the outcome of the procedure. While there are alternatives, most MDS programs take Kruskal's (1964a) Stress (1) statistic as a reference point to obtain this estimate.

$$S = \sqrt{\sum_{i=1}^{n}\sum_{j>i}^{n}\left(\delta_{ij} - d_{ij}\right)^2 \Big/ \sum_{i=1}^{n}\sum_{j>i}^{n} d_{ij}^2} \qquad (13.2)$$

This is a scaled sum-of-squared-differences estimator.

Let's take a look at an MDS analysis now. But instead of jumping head-first into the trilobite data, let's analyze a dataset about which we can develop some expectations using intuition alone. For this purpose the analysis of geographic map distances presents a compelling target of opportunity. For our example, let's use an area with which many UK palaeontologists are reasonably familiar, the Isle of Wight.

Figure 2 shows a simple map of the Isle of Wight with the location of 13 named places marked, and Table 1 shows a road distance triangle for these locations.

Figure 2. Isle of Wight with selected locations marked. Modified from Google Map (2008).

Table 1. Road distances (in miles) between selected Isle of Wight locations (see Fig. 2).

	Bembridge	Blackgang	Brightstone	Cowes	Newport	Northwood	Ryde	Sandown	Seaview	Shalfleet	Shanklin	Totland	Ventnor
Bembridge	0.0												
Blackgang	18.0	0.0											
Brightstone	17.8	5.9	0.0										
Cowes	1.7	13.7	12.2	0.0									
Newport	10.7	9.0	7.1	5.0	0.0								
Northwood	14.0	12.4	10.2	1.6	3.2	0.0							
Ryde	6.9	16.2	13.6	11.4	6.4	9.6	0.0						
Sandown	5.1	10.4	15.4	14.0	8.9	12.3	6.4	0.0					
Seaview	3.9	17.3	15.8	15.2	9.0	12.3	3.0	6.3	0.0				
Shalfleet	17.0	11.1	4.9	7.5	6.1	8.1	12.3	15.0	16.2	0.0			
Shanklin	7.3	9.5	12.0	14.2	9.1	12.4	8.6	2.2	8.5	15.1	0.0		
Totland	23.2	12.6	8.3	14.1	12.4	14.3	18.7	21.2	22.5	6.3	21.4	0.0	
Ventnor	11.0	6.0	12.6	15.7	10.7	14.1	12.1	5.9	12.1	16.9	3.6	19.3	0.0

Given that the road distance matrix locates each destination relative to every other, we should be able to use MDS to reconstruct the map shown in Figure 2 from the data present in Table 1. Some error will be generated owing to the fact that road distances are not the same as straight-line map distances. This discrepancy will help make an important point about MDS a bit later on. Nonetheless, given the scattered nature of these locations across the island, the rank order of road distances should provide relatively accurate estimates of their map distances from one another.

Since MDS is a computation-intensive, iterative procedure I'm not able to take you through all the individual calculations performed. A sample of the first few steps following the simple MDS procedure outlined in Jackson (1991) is provided in the *PalaeoMath 101* spreadsheet (see url below). Indeed, because the initial configuration of points can be random—in which case it will differ with each analysis depending on the value used to seed the random number generator—the calculations will differ in their details with each run of the program, even for the same dataset! What we can do (below) is discuss what options were selected for the analysis, why, and how those affect the results we obtain.

The first option we need to specify when implementing MDS analysis is the dimensionality of the solution. That's actually an easy decision for the Isle of Wight data. Even though we are working with a 13 x 13 matrix of distances, we have good reason to suspect the correct dimension of the solution is 2. After all, these are distances taken from a flat map and the result we're after is a reconstruction of that map.

In point of fact, virtually all MDS analyses try to fit the data into a two-dimensional or three-dimensional space for the simple reason that these spaces are able to be visualized using standard graphing methods. The MDS procedure can find solutions in high dimensional spaces. But given that the point of MDS is to visualize similarity relations existing in datasets, there usually seems little point in creating solutions that can't be visualized in their entirety. Naturally this principle also applies to other multivariate methods (*e.g.*, PCA, PCoord, Correspondence Analysis) when these are used to achieve a data-scaling purpose. Regardless, the choice of the solution's dimensionality is more obvious with MDS since this value must be specified by the user at the outset of an analysis. Also, because it is an iterative procedure, the first two dimensions of a two-dimensional MDS solution will not necessarily bear any relation to the first two dimensions of a three-dimensional MDS solution.

The second option needing specification is the regression model the algorithm will use to estimate the disparity distance values. Since distances are ratio-type variables, with a true scale and true zero point, we could draw on analogy with PCoord analysis and use a linear regression as a basis for fitting the configuration of data points to the distance matrix. Selection of a linear regression model means we will try to match between-object (= inter-location) distances as closely as possible to the original distance matrix shown in Table 1 (see Fig. 3). Under this model, our result would be an example of 'metric MDS', for we are using all the information present in the configuration and basis distance matrices to scale the data. I'll have more to say about this decision shortly.

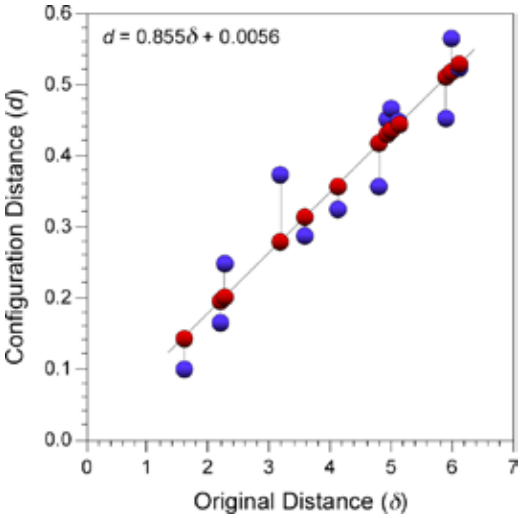

Figure 3. Example linear regression of MDS configuration distances (k=2) on the original distances for the first 13 between-location comparisons in the Isle of Wight data (see Table 1). Blue symbols represent raw data values for this fitting cycle. Red symbols represent disparity distances ($\hat{d}$) determined as a result of the regression analysis. Regression residuals are indicative of the error associated with this fitting iteration.

There are a few other decisions that must be made, but these will differ between application programs. Because I'm using the MDS procedures included in the *XL-Stat* program package to perform these example calculations I have the ability to select between several stress statistics, though for simplicity and consistency I chose the Kruskal's Stress (1) index. It is also worth noting that *XL-Stat* employs a stress majorization algorithm based on de Leeuw's (1977) iterative majorization in order to adjust positions of objects in the configuration space during refinement of the MDS solution. This approach has been shown to yield results that converge on the optimal configuration more quickly than Kruskal's (1964a) steepest descent approach.

Figure 4 shows results of the two-dimensional, metric MDS representation of the Isle of Wight distance matrix (Table 1).

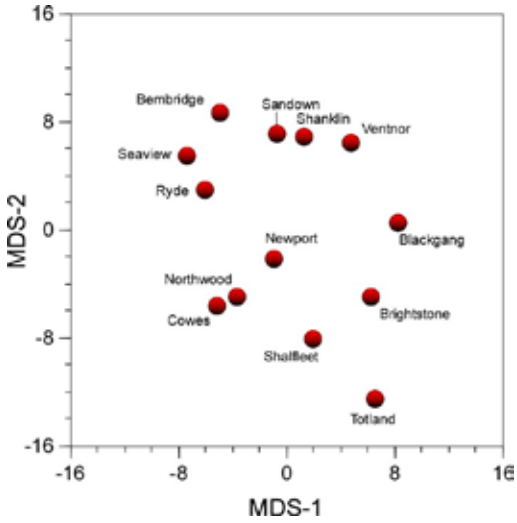

Figure 4. Metric MDS configuration space (k=2) for the Isle of Wight location distance data.

Inspection of the diagram reveals that all locations are in their correct relative positions. However, note that the MDS-1 axis is not aligned with the major axis of the point distribution, as it would be of this was a PCA or PCoord space. There are two reasons for this. First, the final point configuration is to some extent dependent on the initial configuration (= configuration from which the iterative procedure begins). Because the *XL-Stat* package uses a random configuration as the starting point, there is no guarantee the first MDS axis will lie close to the first PCA/PCoord axis.

Note also there are no equations for the MDS axes that can be used to relate the MDS space back to the space of the original variables. This is because the MDS space represents a series of adjustments of the relative point spacing in the context of the original or starting configuration space. Essentially, information is added piecemeal to the MDS solution by the sequence of regression-based adjustments (see Fig. 3) with the final configuration bearing no simple relation to the space of the original variables. This might be seen as a difficulty when it comes to interpretation and it is truly what separates MDS from PCA/PCoord. But this piecemeal procedure is also what gives MDS its power. If a simple relation between the configuration space and the variable spaces were desired, a decision would have to be made regarding what aspect of the original variable space to align the MDS axes with. By using iterative regression the focus remains on achieving the best global fit of the configuration space to the original data.

In order to present the results of an MDS analysis in a form that more closely resembles a PCA/PCoord result, you can perform a PCA on the raw MDS coordinate values (see Fig. 4). In addition to looking more like a PCA result, this procedure also ensures that the MDS–PCA axes are uncorrelated with one another. If you use this secondary PCA procedure, note that the eigenvalues refer to the amount of variance exhibited by the MDS configuration space scores, not the variance present in the original data. If the dimensionality of the PCA and MDS spaces is the same, the total percent variance expressed by these hybrid MDS–PCA axes will always be 100.

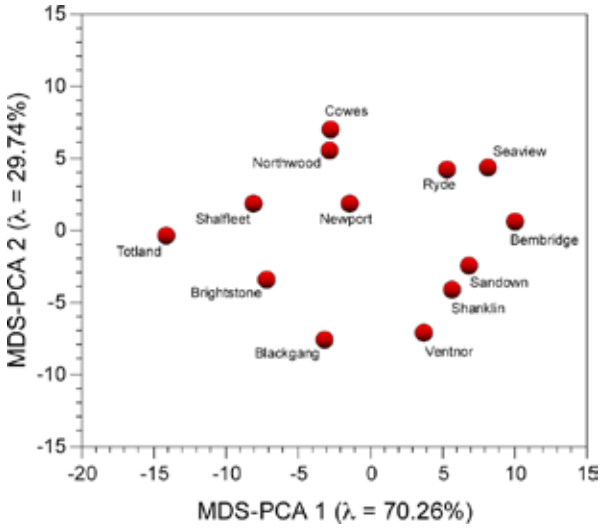

Figure 5. PCA-metric MDS configuration space (k=2) for the Isle of Wight location distance data.

Comparison of figures 2 and 5 shows some obvious distortions. Shanklin has been placed a bit too close to Sandown and Northwood is too close to the chord joining Cowes and Newport. To a large extent these distortions are only apparent, resulting from the fact that road distances were used to fix the relative locations instead of simple Euclidean distances. Of course, except for artificial map examples such as this we won't know what the MDS configuration for a set of data 'should' look like. Setting these issues aside, we can say that, to a very high degree, the MDS procedure was able to reconstruct a surprisingly accurate map of our 13 locations across the Isle of Wight from road distance data. But how accurate is this configuration, really?

Two accuracy measures are available in MDS. The first is the final value of the stress statistic used to assess the quality of the point configuration during configuration space adjustment. For the Isle of Wight data this value is 0.070. Since a perfect solution would have a stress coefficient of 0.0, and any stress value less that 0.1 is usually considered 'good', our metric MDS result would be considered 'good' if this had been an actual analysis. The point distribution certainly agrees well with a qualitative 'eyeball' test, comparing figures 2 and 5. But the stress statistic is a measure of overall distortion, akin to the cophenetic correlation coefficient of a cluster analysis. What the stress statistic doesn't do is to provide information about the degree to which our data match the expectations of the linear model we've used to refine the configuration or whether the model had trouble representing data from a particular range within the overall scaling problem.

These assessments can be made by looking at relations between the original distances (δ), the final configuration distances (d) and the disparities ($\hat{d}$). Graphs of these quantities are known as Shepard diagrams, after R. N. Shepard, one of the founders of modern MDS. Figure 6 shows the relationship used to assess the goodness of fit of the result in terms of the final configuration distances and the disparities.

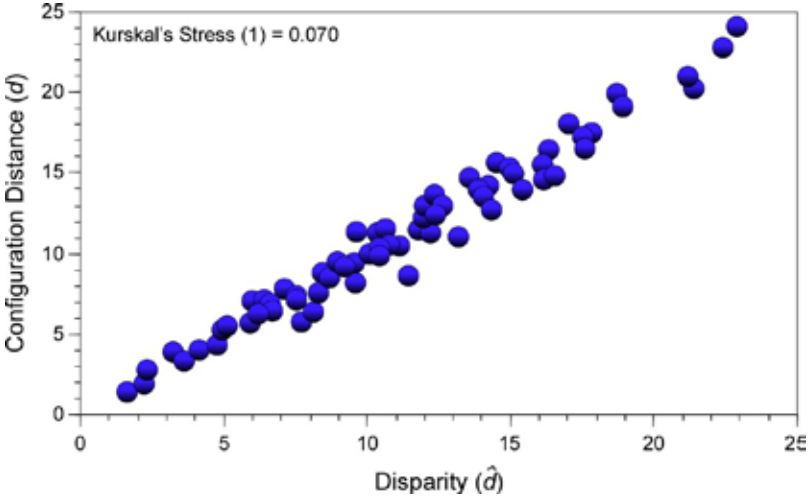

Figure 6. Shepard diagram for the Isle of Wight metric MDS result (k=2).

Note how well the MDS disparity predicts the final configuration distance. In a perfect analysis the predicted distance would agree perfectly with the configuration distance, and all the points would fall along a straight line. Our metric MDS result isn't perfect, but it certainly provides evidence that a high-quality fit has been achieved across the entire range of scales present in the dataset.

Recall, the metric MDS model uses linear regression to guide its search for an optimal configuration (Fig. 3). This is an obvious choice, but it is not the only option available. Indeed, linear regression is one of the most restrictive choices we could make. We would use a metric MDS approach if we had high confidence in the quality and type of our original data. Certainly we do have confidence in the data type. The distances we've calculated are true metric distances. They are not, for example, 'distances' inferred from a set of ordinal variables whose quantitative relations to one another are unknown. We can use MDS to analyze ordinal data, but in that instance the metric MDS model would not be our best choice.

What about the quality of our data? Remember these are road distances, not Euclidean distances. On the Isle of Wight, road tracks are much denser on the eastern side of the island (see Google maps 2008). Also, as there are no bridges across the inlet extending from Cowes to Newport, this represents a natural barrier forcing routes between locations on the eastern and western sides of the island to detour through Newport, occasionally adding significant distance to the trip. As a result the road distance data represent an estimate of the distribution of locations across the island, but it's a biased estimate, strongly influenced by natural barriers to travel and idiosyncrasies in the island's transportation network. In more palaeontologically realistic examples, we often deal with proxy variables, variables that measure some quantity we are interested in, but only in an indirect manner. In such situations we might suspect there is substantial error in the data, so much so that we would be ill-advised to slavishly apply the metric-MDS (regression-based) model that treats the original distance data as an error-free standard. What to do?

Fortunately, there is a wide range of alternative models we can use with MDS to explore the configuration space. Full discussion of the ins and outs of all fitting models is well beyond the scope of this essay. However, one of the most commonly used, flexible and innovative 'non-metric' models is isotonic (also called monotonic) regression.

Isotonic regression of two variables (say y on x) reorders both such that the x-values are uniformly increasing, then adjusts the values of y such that those values increase or remain constant relative to the x values. This is accomplished by finding all pairs of y-values in which the second is smaller than the first and replacing both with their average. Figure 7 uses the same data analyzed in Figure 3 as an example of isotonic regression.

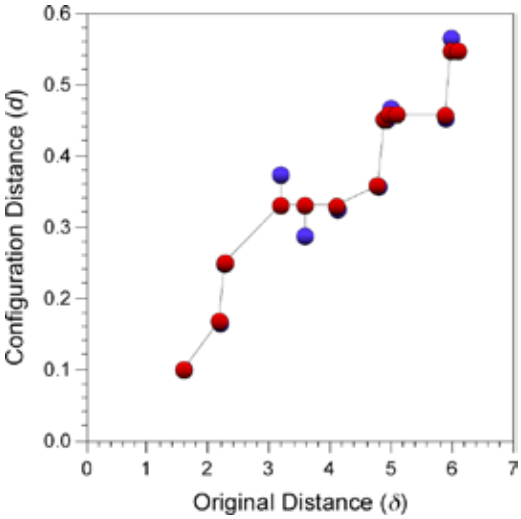

Figure 7. Example isotonic regression of MDS configuration distances (k=2) on the original distances for the first 13 between-location comparisons in the Isle of Wight data (see Table 1). Blue symbols represent raw data values for this fitting cycle. Red symbols represent disparity distances ($\hat{d}$) determined as a result of the regression. Regression residuals are indicative of the error associated with this fitting iteration. Note how much less error is generated by the isotonic, as opposed to the linear regression (see Fig. 3). This results from the more flexible, non-linear character of the isotonic model. Non-metric MDS using isotonic regression usually results in a better fit of the configuration space to the original data, irrespective of data type.

As can be seen from the figure, isotonic regression results in the specification of smaller deviations between configuration distances (d) and the disparities ($\hat{d}$), thereby minimizing the overall stress of the result. When isotonic regression is employed the technique is referred to as 'non-metric multidimensional scaling'. Generally speaking, the greater flexibility of the isotonic regression approach will lead to less adjustment of the configuration space, and so lower stress values. When applied to the Isle of Wight location data the magnitude of this improvement can be appreciated readily (see figs 8 and 9).

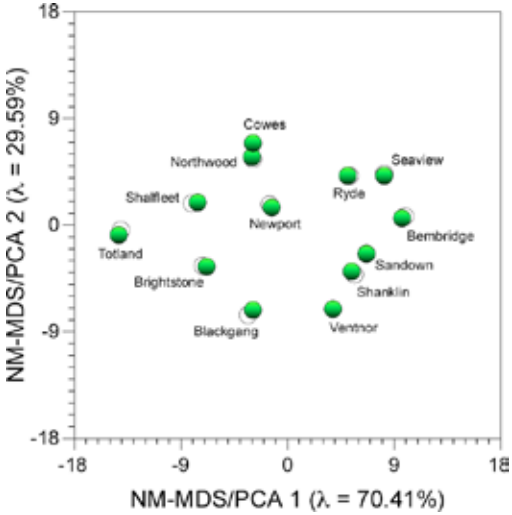

Figure 8. Non-metric MDS configuration space (k=2) for the Isle of Wight location distance data. Closed symbols represent non-metric MDS configuration, open symbols represent metric MDS configuration (see Fig. 4). See text for discussion.

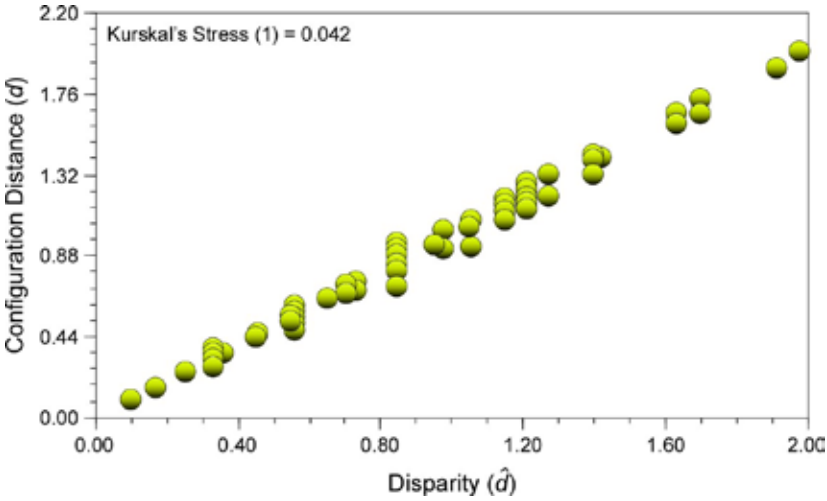

Figure 9. Shepard diagram for the Isle of Wight non-metric MDS result (k=2).

As can be seen clearly in Figure 8, use of isotonic regression to estimate the final MDS configuration space led to different relative positions in over half of the points in the Isle of Wight data. While these differences may not seem large, Figure 9 shows they reduced the amount of distortion in the overall result by almost 50 percent. Qualitatively speaking, this moves the result from the 'good' to the 'excellent' range. But even more importantly, use of the non-metric approach resulted in a better 'fit' between the data we have collected and the analytic approach

we have chosen. This is the real goal we're after, to have the analysis capitalize on the strengths, and compensate for the weaknesses inherent in the data. The fact that this match yielded something close to the best possible result is satisfying, but getting a 'close-to-perfect' result isn't the point of data analysis. Understanding the system of observations is.

The example analysis result should not be taken to indicate that non-metric MDS is the correct choice for all MDS situations. Far from it. For example, if I had used straight-line map distances between Isle of Wight locations, the metric MDS approach would arguably have been more appropriate for those data. Nevertheless, non-metric MDS often represents the best choice for the greatest range of data we typically come across in palaeontology, provided our interest is confined to understanding the character of inter-object similarity.

Now we are in a position to apply MDS to our trilobite data. Table 2 represents the Euclidean distance matrix calculated from our three trilobite variables.

Table 2. Euclidean distance matrix for trilobite data

Genera	*Acaste*	*Balizoma*	*Calymene*	*Ceraurus*	*Cheirurus*	*Cybantyx*	*Cybeloides*	*Dalmanites*	*Deiphon*	*Ormathops*
Acaste	0.00									
Balizoma	8.84	0.00								
Calymene	30.30	38.58	0.00							
Ceraurus	2.60	6.92	31.70	0.00						
Cheirurus	13.32	19.92	20.06	13.67	0.00					
Cybantyx	16.99	24.42	14.90	17.78	5.82	0.00				
Cybeloides	4.64	11.40	27.23	4.75	8.97	13.11	0.00			
Dalmanites	11.22	19.25	19.48	12.38	6.21	6.29	8.11	0.00		
Deiphon	6.40	9.44	30.19	4.81	10.68	15.68	4.01	11.60	0.00	
Ormathops	9.40	1.18	38.79	7.28	19.95	24.47	11.59	19.43	9.39	0.00
Phacopidina	4.95	8.20	30.76	3.00	11.83	16.31	3.75	11.61	2.25	8.19
Phacops	6.29	13.62	25.22	7.03	7.20	11.49	2.75	6.85	5.72	13.90
Placoparia	16.87	24.88	13.77	18.04	7.26	2.74	13.50	5.92	16.53	25.04
Pricyclopyge	22.46	29.42	12.48	23.02	10.14	5.69	18.34	11.90	20.39	29.35
Ptychoparia	40.30	48.78	10.75	41.87	30.76	25.41	37.55	29.60	40.71	49.02
Rhenops	37.46	45.16	9.44	38.47	26.08	20.82	33.88	26.26	36.44	45.18
Sphaerexochus	0.91	9.01	29.88	2.41	12.55	16.40	3.83	10.77	5.58	9.51
Toxochasmops	24.66	32.90	6.26	26.06	14.44	9.93	21.57	14.23	24.46	33.16
Trimerus	71.39	79.47	41.13	72.66	60.07	55.13	68.07	60.39	70.66	79.58
Zacanthoides	27.89	35.75	4.75	28.99	16.70	11.42	24.38	16.80	27.05	35.84

	Phacopidina	*Phacops*	*Placoparia*	*Pricyclopyge*	*Ptychoparia*	*Rhenops*	*Sphaerexochus*	*Toxochasmops*	*Trimerus*	*Zacanthoides*
Phacopidina	0.00									
Phacops	6.22	0.00								
Placoparia	17.00	11.67	0.00							
Pricyclopyge	21.22	16.81	7.29	0.00						
Ptychoparia	41.12	35.62	24.19	22.63	0.00					
Rhenops	37.07	32.18	20.69	16.33	10.18	0.00				
Sphaerexochus	4.30	5.52	16.37	21.83	39.97	36.97	0.00			
Toxochasmops	25.15	19.37	8.51	9.23	16.79	14.73	24.19	0.00		
Trimerus	71.43	66.07	54.62	50.72	32.04	34.78	70.94	46.94	0.00	
Zacanthoides	27.71	22.53	11.03	8.00	14.66	9.81	27.39	5.70	43.74	0.00

These are the same data we used to illustrate PCoord analysis and Q-mode factor analysis (see *Newsletter* **61**). There, our goal was to represent inter-object similarity relations using an eigenanalysis-based approaches, which aligned the PCoord and factor spaces with the directions of greatest distance (= dissimilarity) across these data as a whole. This time, I'll use MDS to focus the analysis on the more general question of simply representing inter-object similarity relations in a low-dimensional space.

Because these distances are based on a small number of variables ($m = 3$), I'm going to draw a flat map of between-object similarity relations by setting dimensionality to 2. What about the accuracy of the variables? Here it gets interesting. In order to obtain the body length, glabellar length, and glabellar width distances I had to select landmark points on the trilobite images I used to obtain the original data. I then measured the Euclidean distances between those points. So far so good. But what about the landmark points themselves?

If I'm going to regard my distances as being correct I'll need to assume there's no parallax in the images. This is certainly incorrect for some if not all. While I have no way of quantifying the amount of parallax-based distortion, the most reasonable assumption would be that parallax varies across the image set. Also, in order to ensure strict comparability of the distances I'd have to know that I always selected the same points on all the specimens. While I'm confident I've selected approximately the same points, I can't *guarantee* I have. I also don't quite understand what 'same' means in this context. From a geometric point-of-view the points would need to correspond topologically whereas, from a biological point-of-view they would need to correspond functionally and/or represent homologous locations. All these definitional criteria are valid possibilities, and none need to be the same point. The fact of the matter is, in all the confusion of actually collecting the data, I did my best to select comparable points, but can't really be certain which points I selected, why, or whether another person collecting the same data would

select exactly the same points and get exactly the same distance matrix. Given this, the situation is looking suspiciously close to the Isle of Wight road distance data; metric data with varying levels of inconsistency and approximation arising from multiple factors. To be safe, it's probably better to use a non-metric MDS approach.

Figure 10 shows the results of a non-metric MDS analysis of the Table 2 data ($k = 2$). On the same plot I've shown the projected positions of the PCoord scores of these same data from the *Mind Your Rs and Qs* column (*Newsletter* **61**) to illustrate the similarities and differences between the two approaches.

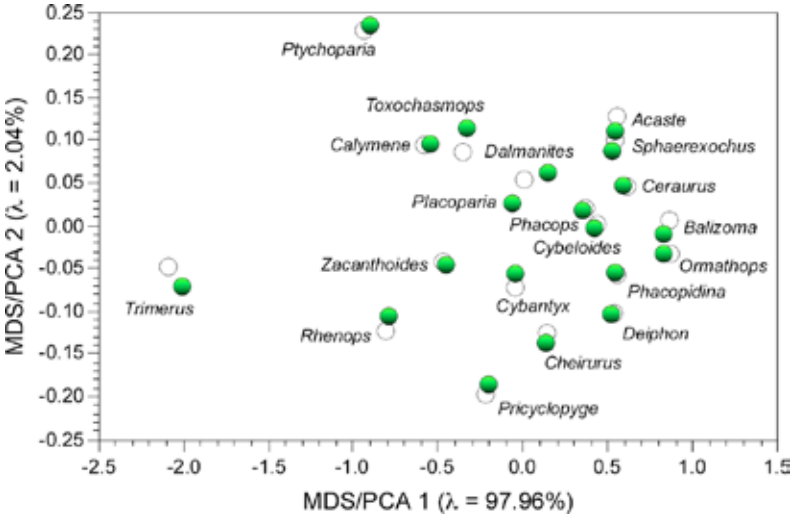

Figure 10. Non-metric MDS configuration space (k=2) for the trilobite distance data (Table 2). Closed symbols represent non-metric MDS configuration, open symbols represent projected positions PCoord scores for these same data configuration. See text for discussion.

Note how the relative positions of virtually all objects have been adjusted by the MDS analysis, some only slightly, but others substantially. For this particular dataset it's unlikely that the interpretation of the PCoord and MDS results would be very different. But recall this is a small and very well-behaved dataset. Differences between results for larger, more complex data could be much greater, certainly large enough to make a difference in their detailed interpretation, possibly sufficient to make a difference to general interpretation.

What about distortion? The Shepard plot for the trilobite non-metric MDS results is shown in Figure 11.

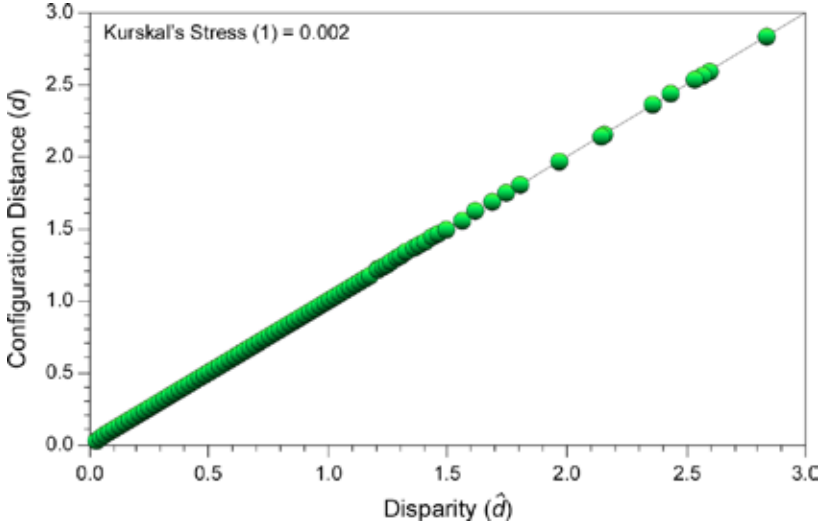

Figure 11. Shepard diagram for the trilobite non-metric MDS result (k=2).

The very low value of Kruskal's Stress (1) index and the high degree of conformance between the configuration distance and disparity across the entire range of the distance data provide direct confirmation of the high quality of the MDS result. For comparison the stress (1) value for the PCoord result can also be calculated from the reproduced distance matrix. That value (0.103), while acceptable (see above), is markedly suboptimal with respect to the non-metric MDS result.

Which distribution of points is correct? They both are! The relative point distributions are different because they are providing different information about the data: the PCoord result provides information about the distribution of points in a space aligned with the major dimensions of object dissimilarity. The MDS result provides information about the overall representation of inter-object distance at all scales. Both results have their place in data analysis strategies. But the really odd thing is, many data analysts interpret PCoord *and* PCA results—recalling that a PCoord analysis of a Euclidean distance matrix is the dual of a covariance-based PCA—as if they were absolutely accurate representations of overall inter-object distances. They are not the same and should not be described as such. The MDS approach delivers the globally optimised representation to a much greater degree than PCA/PCoord.

While I've presented MDS as a *Q*-mode method, it is possible to perform the analysis in the *r*-mode as well, though this is much less common. To do this the focus of the regression is the *r*-mode covariance or correlation matrix rather than the *Q*-mode distance matrix, but in all other respects the procedure, and the results in terms of minimizing distortion at all scales, are similar.

The origin of the MDS approach can be traced to the work by Torgerson (1952, 1958), Shepard (1962, 1966) and Kruskal (1964a, b), Young (1970) and others, with many of the important methodological improvements developed at Bell Laboratories (see Green *et al.* 1989). Despite the rarity of its application in systematic and palaeontological contexts (see Rohlf 1970 for an example), it is used routinely in many other fields, notably in social science, psychology,

chemistry, and various fields related to economics, marketing, and advertising. Its use in these contexts is driven primarily by the need to analyze the datasets containing 'many state' variables (*e.g.*, qualitative comparisons, customer survey results) in a PCA-like, non-hierarchical manner. The MDS approach is well-suited to such analyses, which of course are not uncommon in a wide range of physical and biological contexts, including palaeontology. But what I hope I've shown in this essay is that the advantages of MDS are much greater than simply being able to handle a wide range of data and produce PCA-like plots. The MDS approach focuses on a different, and somewhat more generalized question than PCA and other eigenanalysis-based approaches focus on. It's a question that's commonly asked of data in our field.

In a larger sense though, all the methods I've discussed throughout this column can be thought of as 'multidimensional scaling' methods. Scaling, in its mathematical sense, refers to the act of representing some relation between objects on a numerical axis or scale. Any time we compare objects numerically using more than a single variable, we are engaging in an act of multidimensional scaling. A better term for the aspect of data analysis most authors refer to when they discuss scaling is 'ordination' (see Manley 1994). As a consequence of this somewhat inconvenient generality of the term scaling, the technical literature on MDS is quite complex, with different authors drawing the boundary between MDS and 'not MDS' approaches at different places. Chatfield and Collins (1980) regard PCA as a type of MDS whereas Jackson (1991) does not. Both Jackson (1991) and Davis (2002), in turn, regard correspondence analysis as a form of MDS, whereas Pielou (1984) does not. Perhaps the best way to think of MDS is as the most generalized, and arguably the most accurate, of the set of scaling or ordination techniques. It certainly deserves to be much more widely used across the broad range of situations encountered in routine palaeontological data analysis.

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REFERENCES

CHATFIELD, C. and COLLINS, A. J. 1980. *Introduction to multivariate analysis*. Chapman and Hall, London. 246 pp.

DAVIS, J. C. 2002. *Statistics and data analysis in geology (third edition)*. John Wiley and Sons, New York. 638 pp.

DE LEEUW, J. 1977. *Applications of convex analysis to multidimensional scaling*. In J. R. Barra, F. Brodeau, G. Romier, and B. Van Custem, eds. *Recent developments in statistics*. Elsevier/North Holland, Amsterdam. 133–145.

GREEN, P. E., Camone, F. J. Jr. and Smith, S. M. 1989. *Multidimensional scaling: concepts and applications*. Allyn and Bacon, Needham Heights, Massachusetts. 407 pp.

JACKSON, J. E. 1991. *A user's guide to principal components*. John Wiley & Sons, New York. 592 pp.

KRUSKAL, J. B. 1964a. Multidimensional scaling by optimizing goodness-of-fit to a non-metric hypothesis. *Psychometrica*, **29**, 1–27.

KRUSKAL, J. B. 1964b. Nonmetric multidimensional scaling: a numerical method. *Psychometrica*, **29**, 115–129.

MANLEY, B. F. J. 1994. *Multivariate statistical methods: a primer*. Chapman & Hall, Bury St. Edmonds, Suffolk. 215 pp.

PIELOU, E. C. 1984. *The interpretation of ecological data*. John Wiley & Sons, New York. 263 pp.

ROHLF, F. J. 1970. Adaptive hierarchical clustering schemes. *Systematic Zoology*, **19**, 58–82.

SHEPARD, R. N. 1962. The analysis of proximities: multidimensional scaling with an unknown distance function, *Psychometrica*, **27**, 125–140 (I); 219–246 (II).

SHEPARD, R. N. 1966. Metric structures in ordinal data. *Journal of Mathematical Psychology*, **3**, 287–315.

TORGERSON, W. S. 1952. Multidimensional scaling I: theory and method. *Psychometrica*, **17**, 401–419.

TORGERSON, W. S. 1958. *Theory and methods of scaling*. John Wiley and Sons, Inc., New York. 460 pp.

YOUNG, F. W. 1970. Nonmetric multidimensional scaling: recovery of metric information. *Psychometrica*, **46**, 357–388.

Don't forget the *44777 101* web page, at:

<**http://www.palass.org/modules.php?name=palaeo_math&page=1**>

Meeting REPORTS

Progressive Palaeontology 2007
University of Bristol *12 – 14 April 2007*

This year the Progressive Palaeontology meeting had more attendees than ever, 62 registered and more on top, and this in spite of the shift to Easter break instead of June, and the actual meeting falling on Friday the 13th! The venue being Bristol – with the largest palaeontology department in the country – did contribute to this somewhat, but more than half of the attendees did travel to Bristol just for the pleasure of meeting their fellow postgraduates, and to present their research.

The meeting kicked off with an informal pub gathering in the Berkeley Pub just across the road from the Earth Sciences department. No great ambiance or music here, but its size – along with the good location and cheap beer and food – made it an obvious choice. **Graeme Lloyd**, the head of the organizing committee, and **Sarda Sahney**, a committee member, set up a reception desk in the pub for those eager to obtain their badges and abstract booklets early, or just wanting to avoid waking up early to register before the talks commenced the following morning.

On Friday 13th, the conference was officially opened by **Phil Donoghue** on behalf of the department, and by **Mike Bassett**, the president of the Palaeontological Association. Unfortunately Mike could not stay for the whole day, as he needed to dash back to Cardiff, but he expressed his pleasure about the ever growing number of people taking up study of palaeontology, and that so many had chosen to attend this meeting, the 3rd Prog Pal organized in Bristol.

photo: Manabu Sakamoto

The delegates of Prog Pal 2007 in the Wills Memorial Building entrance hall.

The first session, moderated by committee member **Laura Säilä**, commenced with a talk by **Ceri-Wyn Thomas** (Univ. of Bristol), who told us about her research on the taphonomy and preservation of fossil embryos from China. This was followed by a brief but entertaining presentation from **Xavier Panades I Blas** (Univ. of Bolton) on the difficulties of identifying the producers of megaloolithic oospecies and how the preservation of modern eggs was going to help with resolving this. Next in line was **Imran A. Rahman** (Imperial College London) with his captivating presentation about the functional morphology of mitrate appendages, showing they were most likely used for locomotion. Then **Phillip D. Mannion** (University College London) told us about the environmental and geological controls on sauropodomorph diversity, and **Jennifer Morris** (Cardiff University) about the taphonomic constraints on terrestrial fossil assemblages from Brecon Beacon. **Michael P. Taylor** (Univ. of Portsmouth) presented the last talk of the morning session about the problems in sauropod systematics when using highly fragmentary specimens, which he called a 'cladistic horror story'.

The following tea break gave us a chance to admire the posters by **Marco Brendalise de Andrade** (Univ. of Bristol) on *Chimaerasuchus*, 'one of the most amazing fossil crocodiles known'; **Tom Challands** (Univ. of Durham) on climate change during the pre-glacial Ordovician greenhouse; **Robert Daly** (Univ. of Aberdeen) on palynology and palaeoecology of the Eastern Europe palaeogene; **Dominic P. Maloney** (Univ. of Durham) on deep marine trace fossils and changes on palaeoclimate in the Ordovician; **Bert Van Bocxlaer** (Ghent University) on evidence against punctuated equilibrium from Cenozoic fresh water molluscs; and a late entry by **Thomas Harvey** (Univ. of Cambridge) on coenobial organization in Early Cambrian acritarchs.

The second session was moderated by committee member **Sandra Jasinoski**, and its first talk was by **Marco Brendalise de Andrade**, who continued with the topic of fossil crocodiles, this time talking about the evolution of notosuchian crocodylomorphs and a new species of *Sphagesaurus* from Brazil. Next in line were **Phil Jardine** (Univ. of Birmingham), talking on Palaeocene vegetation and climate, **Mark Young** (Univ. of Bristol) with his talk on the evolution and biomechanics of sauropod dinosaur skulls, and **Clare White** (Univ. of London, Royal Holloway) who talked about the alarming decline and importance of living reef corals, and what we can learn from the Cenozoic fossil record of reef corals. **Cat Burgess** (Univ. of Cardiff) then introduced us to the world of Milankovich scale cyclicity in the Eocene Southern Ocean sediment and microfossils, and how these possibly correlate with global changes in climate. The session was finished by **Rob Sansom** (Univ. of Bristol) who talked about the origin and early loss of paired fins in Osteostraci and stem-gnathostomes, and how his work has led to the construction of the first comprehensive phylogeny for the Osteostraci and related taxa.

After having lunch in various establishments on Park Road, or indeed outside in the park, the first afternoon session, moderated by **Rob Samson**, kicked off with a presentation by **John Cunningham** (Univ. of Liverpool) on the evolution of developmental strategy in spatangoid sea urchins and how switches in larval mode are regulated. **Manabu Sakamoto** (Univ. of Bristol) then told us how bite force in predatory animals is proportional to body mass, and **Dan Oakley** (Univ. of Bristol) presented his work on charcoalified wood from the Cretaceous, a topic that has not been researched much in the past. This was followed by a talk by **Sarah Joomun** (Univ. of London, Royal Holloway) on the dental microwear of two Oligocene perissodactyl mammals, *Plagiolophus* and *Palaeotherium*, and how the amount of wear is greater in *Palaeotherium*, indicating a more abrasive diet. We then

moved back to microfossils as **Tom Duncley** (UCL) told us about the Tanzania Drilling Project which is yielding a great diversity of nannofossils from the Eocene–Oligocene boundary of the Tanzanian coast, preserved in such detail that it can be considered a conservation-lagerstätte. **Steve Brusatte** (Univ. of Bristol) closed this session with his talk on allosauroid phylogeny, in which he expressed his pride in talking about theropods after so many sauropod talks. Results from his new allosauroid phylogeny are consistent with the stratigraphic record and the break-up sequence of Pangaea.

After another tea break, the last session, moderated by **Sarda Sahney**, got under way. **Mark Bell** (Univ. of Bristol) talked about gigantism and testing Cope's rule within phylogenetic lineages of Cambrian–Ordovician trilobites. He concluded that although there was a trend towards a larger body size in some individual lineages, this was not caused by an active driving mechanism but was more likely the consequence of decreased diversity or increased morphospace. **Peter Falkingham** (Univ. of Manchester) then enthusiastically presented his work on FEA and 3-D dinosaur tracks. He also talked about the importance of correct interpretation of tracks, and making soil specific models with modern animals for comparison. The theme stayed with dinosaur tracks, as we listened to the '21st century dinosaur hunter' **Karl Bates** (Univ. of Manchester) when he told us about using LIDAR (Light Detection And Range Imaging) in creating 3-D models of trackways with high accuracy. He also showed us a cool virtual fieldtrip of Fumanya made with LIDAR. We then moved on to organic preservation in the Forteau Formation of Western Newfoundland as **Thomas Harvey** (Univ. of Cambridge) told us about the amazing diversity of microfossils there, and how similar preservation might be widespread if we just looked closely at more 'macrosites'. Then it was back to dinosaurs with **Laura Porro** (Univ. of Cambridge) and her talk about feeding in *Heterodontosaurus*, the only ornithischian dinosaur discussed on the day. According to Laura, they were 'chewing, chewing all day long', but we also learned how FEA analysis has helped in reconstructing the jaw movements of 'hets' during their mastication process. Then last, but not least, was a talk by **Adam Stuart-Smith** (Univ. College Dublin) on the Lower Jurassic plesiosaurs and the reconstruction of *Rhomaleosaurus*. He told us how *R. cramptoni* got a facelift (as the specimen was finally removed from a board obscuring the palate) and how there are actually only two species of rhomaleosaurs *sensu stricto*.

With the oral presentations finished, the delegation had a nice stroll through the Clifton area towards the Bristol Zoo Garden, where the reception was being held. Unfortunately, a zoo excursion was not part of the programme but the terrace of the reception building opened into the zoo, and animal noises created a great ambience. Winners of the several prizes, including 'the most compelling talk' for **Imran A. Rahman** and 'best poster' for **Marco Brendalise de Andrade**, were announced while we wined and dined. Menu of the evening included such delicacies as tuna with spicy avocado salsa, Thai curry chicken brochettes and toasted rosemary foccacia. Afterwards we sloped off to the nearby Channing's pub with its lovely, big garden, although many delegates stayed on until well after the garden was closed.

Nevertheless, a sunny Saturday morning dawned, and a bus load of us headed towards the coast to visit Aust Cliff and Manor Farm, the fossil locations of the day. On the way we only had one wrong turn, and in his 'safe & healthy' announcement, **Manabu Sakamoto** told us to run away from, not into, the cliff if anyone shouted a warning. We unloaded the bus with our hard-hats in tow, and before embarking on fossil searching, had a good introduction to Aust Cliff from **Simon Carpenter** and **Nick Large** who have been collecting there for years. They brought along some fossils they had found at Aust Cliff previously so we would know what to look for. We did not find any big fossils but

photo: Manabu Sakamoto

Simon Carpenter giving an introduction to Aust Cliff field location.

an impressive number of coprolites, shark fin spines, fish and shark teeth, and bits of a crocodile like creature called *Pachystropheus* were spotted and collected. The trip continued to Manor Farm, where **Mike Curtis** showed us a collection of microfossils found there and illustrated how the tiny fish teeth show a change in faunal diversity throughout the sequence. At this location, fossils were collected from a slag pile while some attendees just chilled out in the sun. We also met a local

photo: Laura Säilä

Looking for fossils and relaxing in the sun at Manor Farm location.

collector, Nick, who had been collecting at Manor Farm for fifty years. At 65, he was still collecting and carrying a huge block of rock to process at home. Before the return to Bristol, we enjoyed lunch at the delightful Boar's Head pub nearby, where many a shandy and burger were consumed.

Thus finished the 2007 Progressive Palaeontology conference, which again proved to be an inspiring opportunity for postgraduate students to present their work and meet their peers. The conference organizers would like to thank the Palaeontological Association, the Bristol University Alumni Foundation, Oxford University Press, Cambridge University Press and Blackwell's for sponsoring Prog Pal 2007. Thanks also to Simon Carpenter, Mike Curtis and Nick Large for leading the field trip, to the Manor farm owners for allowing us access to the site, and to everyone who was involved in organizing this meeting.

Laura Säilä

PalAss 2007
51st Annual Meeting of the Palaeontological Association
Uppsala, Sweden *16 – 19 December 2006*

With Christmas coming and not much time left to celebrate the 250th anniversary of Linnaeus' birth, Palass headed to Uppsala, the Linnaeus *alma mater*, for the 2007 Annual Meeting. My train sped across snow-clad lands towards the city, shrouded by mists and lit by the low Winter sun. I was in Sweden, home of Ikea, Abba and Eilert Pilarm, the internationally-renowned septagenarian Elvis impersonator. Note pad in hand I headed to the city conference centre and enrolled for the Special Seminar.

With Linnaeus in mind, this year's seminar focused on the origin of major groups, with addresses combining palaeontological, developmental, neontological and genetic data in an overview of life on Earth that saw us go from bacteria to *Homo* in just one afternoon. Following introductory remarks from conference organiser **Graham Budd** (Uppsala), **Anthony Poole** (Stockholm) gave us a brief history of slime in his talk on the origin of the three domains of life, arguing that RNA processing may have been secondarily lost in Archaea and Bacteria. Moving through the eukaryotes to the Ecdysozoans **Gregory Edgecombe** (NHM) emphasised the importance of problematic Cambrian lobopods for our understanding of the arthropod ancestor. We stayed with speakers from the NHM for the next talk as **Andrew Smith** (NHM) showed that pentametry arose in echinoderms as a consequence of mouth rotation related to their relatively unique development which sees their larvae attaching to the substrate head first.

After a quick refreshment break, we reconvened to hear an animated **Per Ahlberg** (Uppsala) talking on tetrapod origins, accompanied with every gesticulation the four-limbed bauplan could offer. With one of Linnaeus' crowning glories being the sexual classification of plants it seemed only appropriate for **Else Marie Friis** (Swedish Museum of Natural History) to address us on the evolution of angiosperms. Following this talk, illustrated with wonderful CT-scanned fossil flowers, **Svante Pääbo** (Max-Plank, Leipzig) rounded off the Special Seminar with a talk entitled 'Neanderthal Genomics'. As he explained the sophisticated techniques he used to extract DNA from fossil bones, it quickly became apparent that 'Neanderthal' was used as a noun rather than an adjective in this

photo: Lucy Wilson

Uppsala Botanic Gardens

case. But later, when he compared his data with human DNA, we learnt that some humans were more 'neanderthal' than others, and we hadn't even had the drinks reception yet!

After icebreaker drinks in the University Museum of Evolution, delegates departed towards dinner, bed or perhaps the fleshpots of Uppsala. Having avoided the fleshpots, and managing to scoff down a frozen banana bought from a roadside grocer for breakfast, I arrived back at the *Konsert & Kongress* centre in good time for the morning session. The session kicked off with **Andreas Maas** (Ulm) unveiling a possible juvenile nemathelminth from the Cambrian 'Orsten' of Australia, before **Martin Brazeau** (Uppsala) spoke on the early evolution of jawed vertebrates. We then moved on from problems with the fossil record of primitive fish to problems with the fossil record *per se* as **Al McGowan** (NHM) showed that the Phanerozoic marine fossil record seems to be biased towards occurrences from the UK and North America. **Mark Laflamme** (Queen's, Ontario) exploited differences in style of preservation to reconstruct a new Ediacaran frond, before **Susannah Porter** (UC Santa Barbara) showed how changes in sea-level chemistry dictated whether the first biomineralisers in any clade used calcite or aragonite with which to build their shells. Then to round off the session, **Andrea Snelling** (BGS & Leicester) took graptolites into the fourth dimension using medical imaging techniques to illustrate the temporal evolution of a three-dimensionally preserved graptolite community. Hurrah!

At this point the meeting divided, with the next six sessions run with thematic parallel sessions. And while a reviewer should give the reader an impression of what it was like to be at the meeting, I feel rather unable to comment on sessions and talks I did not see. So given my deep-time predilections, it is more than possible that anyone with a taste for land plants, skeletons or anything that happened after the Early Palaeozoic could well feel that they are reading the report of a different meeting! That said, I for one really enjoyed the focused sessions and the extra depth and breadth that they allowed.

It was clear that the meeting had attracted a large number of Ediacaran and Cambrian workers, with three sessions devoted to this interval. **Dima Grazdhankin** (Novosibirsk) and **Uwe Baltasar** (Uppsala) began in the beginning, talking respectively on the palaeoecology and preservation of a limestone-hosted Ediacaran fauna from Siberia. I then slipped across into the *Ecology, taphonomy and biogeography* session to hear **Sarah Joomun** (Royal Holloway) talk on dietary change in mammals associated with the onset of icehouse conditions at the Oligocene–Eocene boundary, before **Christian Neumann** (Humboldt Univeristät) used computer tomography to reveal endosymbionts in fossil echinoderms. Returning from the small but packed *Lilla Salen* lecture theatre to the huge though almost empty *Stora Salen* lecture theatre, I was greeted by **Liam Herringshaw** (Aberdeen) donning the Madonna-esque microphone headset and quipping "Hello Wembley" before discussing Spatangopsis, an enigmatic early Cambrian fossil of uncertain provenance.

Liam Herringshaw. More tea, vicar?

In between watching **Ma Xiaoya** (Leicester) discuss a new priapulid-like worm from Chengjiang and **Phoebe Cohen** (Harvard) compare the microstructures of Ediacaran acritarchs and fairy shrimp eggs, I returned to *Lilla Salen*. By now the parallel sessions were running out of sync and some kind of rhythmic gymnastics class was going on on the other side of the lecture theatre's very thin wall. So it was to musical accompaniment and the attenuated sounds of a keep fit class that **Mark Williams** (Leicester) presented details of exceptionally preserved ostracodes from an Antarctic lake of Miocene age.

After lunch **Christian Skovsted** (Uppsala) showed the first evidence of an articulated tommotid and **Erik Sperling** (Yale) used MicroRNA evidence to help resolve the phylogenetic position of the brachiopods. Then **Tom Harvey** (Cambridge) presented remarkable microfossil evidence of sophisticated feeding strategies in Early Cambrian crustaceans. We moved into the lab when **Emma Hammarlund** (University of Southern Denmark) described an actuopalaeontological experiment to test how ambient sulphate concentration affected decay in shrimps. The final two talks of the session focused on recent finds from the Burgess Shale with **Jean-Bernard Caron** (ROM) discussing the affinities of the sclerite-bearing 'halwaxiids' before **Allison Daley** (Uppsala) presented her new reconstruction of the stem-group arthropod *Hurdia* in all of its circular-jawed glory.

Following tea came the AGM and annual address. This year **Adrian Lister** (NHM) spoke on *Evolution in the Ice Age*. This well-illustrated talk used morphologic, genetic and palaeogeographic data to assess how environmental factors have influenced the Quaternary mammalian evolution. Having started with a brief overview examining migrations and refugia in response to climate change, the talk moved to case studies. First we heard about dwarfism in island populations of red deer, hippos and elephants before moving on to evidence of allopatric speciation and migration in the mammoth lineage.

Having browsed posters and enjoyed the glög at the drinks reception, I headed off towards *Norrlands Nation* for the Annual Dinner. With **Nick Butterfield** (Cambridge) in tow confidently chirruping in my ear "I know this place, there's no need for a map" we made swift progress through

the frosty night. We got to a grand lodge which Nick claimed was "definitely the place", hung up our coats in the cloak roam and sidled into the main hall. The tables were laid for a lavish feast, and just before we were about to take our seats, I heard a familiar voice. "Oh shit," it said, "we're in the wrong ------- place." And, as I looked around, I quickly realised that rather than being in a room full of familiar faces from Palass we had instead inadvertently stumbled into a Masonic Lodge. Making a swift exit we eventually found *Norrlands Nation* where we enjoyed a fine dinner of good food, plentiful wine and toasts sung by the Scandinavian contingent. After the meal, **Mike Bassett** (Cardiff) led the toasts before presenting the Lapworth Medal to **Tony Hallam** (Birmingham) for his contribution to our understating of Jurassic palaeobiology and palaeoenviroments as well as mass extinctions. After this came drinking, dancing and a few drams in the now familiar Birmingham postgrad post-kicking out party.

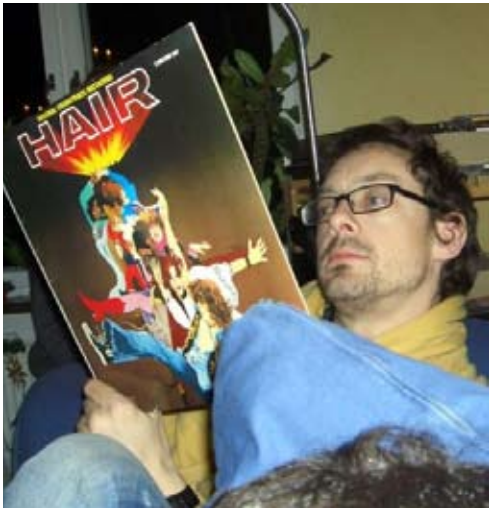
I spent the next morning in the session on *Evolutionary patterns*, which began with **Graham Lloyd** (Bristol) using a protein-domain based analysis of the Tree of Life database showing that Bacteria, Archaea and Metazoa are easily separated, unlike plants, fungi and basal eukaryotes which form a discrete cluster. This analysis also showed distinct bursts of protein evolution at the origins of eukaryotes, mammals and humans. Staying with hominoids, **James Tarver** (Bristol) tested whether supposed evolutionary shifts in the apes and old world monkeys reflect the pattern of evolution or sampling bias in the fossil record. We moved from the land to the sea as **John Cunningham** (Liverpool) asked if switches to non-planktotrophic larval development were concentrated in particular intervals of geological history, and showed that many non-planktotrophic taxa originated in the Campanian–Maastrichtian but not in the rest of the Cretaceous. The second half of the session saw Kenneth De Baets (Zürich) examining evolutionary trends in Devonian ammonoids, and Mark Bell (Bristol) examining gigantism and feeding habits in trilobites, before Jonathan Krieger (NHM) re-evaluated disparity measuring techniques.

After coffee, I returned to the Cambrian and Ediacaran super-session where **Mónica Martí Mus** (Universidad de Extremadura) spoke on the earliest molluscs and **Jih-Pai Lin** (Ohio State) addressed the taphonomy of Cambrian gogiid echinoderms from Guizhou, China. I took the stage next, focusing on the metamorphism of Burgess Shale fossils. **Marco Vecoli** (Lille) illustrated spore-like microfossils from the Cambrian of Algeria and **Maria Dies Álvarez** (NHM) unveiled the first chemostratigraphy for the Cambrian of Spain. **Nick Butterfield** (Cambridge) rounded

photo: Tim Kearsey

Uppsala Cathedral

off the session by airing his views on early lophotrochozoans. Though it would be premature to say there was any consensus on early lophotrochozoan evolution, it seemed that whatever consensus there was, Nick disagreed with it.



Graham Budd: Organiser.

Returning late from a slap-up lunch, I caught the end of a talk by **Jan Rasmussen** (Copenhagen) on fossil cephalopod diversity decreases during the Late Ordovician of Greenland. The next talk in the Palaeozoic faunas session came from **Leonid Popov** (Cardiff), who detailed rhynchonellid faunas from the Early Ordovician of Iran. We went from brachiopods to 'calcichordates' as **Imran Rahman** (Imperial) presented new 3D reconstructions of *Ctenocystis*, which might help contain the affinity of these problematic fossils. Staying with problematica, **Jakob Vinther** (Yale) unveiled an exceptionally preserved machaeridian which showed evidence for a polychaete-like body below its shelly plates. **Tom Challands** (Durham) then used chitinozoans from the Welsh Basin to examine oceanographic events and environmental change at the onset of the Hirnantian glaciation. The final presentation came from **Christian Rasmussen** (Copenhagen) who described the Greenland brachiopod fauna. His talk was originally entitled '*Virgiana* Billings 1857: on top of the world after 150 years', however, having had problems with his serial grinder he spoke instead on *Pentameroidea* M'Coy 1844, which had been on top of the world for 163 years.

We returned to single session format for the final set of talks, which began with **Ole Graverson** (Copenhagen) using techniques from structural geology to examine dinosaur locomotion. **Paul Upchurch** (UCL) then evaluated palaeobiogeographic algorithms using trilobites and dinosaurs. The next two talks focused on the late Ordovician with Wilson speaking on cystoids and **Dave Harper** (Copenhagen) examining the spatial heterogeneity of the Hirnantian mass extinction. **Vivi Vajda** (Lund) then used palynomorphs to reconstruct the environment of plesiosaur remains from New Zealand, before we returned once more to the Cambrian to wrap the meeting up. **Bob Gaines** (Ponoma) presented his detailed, globe-trotting study of Burgess Shale-type preservation showing that this taphonomic mode is principally one of organic preservation.

The meeting came to a close with **Mike Bassett** (Cardiff) presenting the President's prize to **Laura Porro** (Cambridge) for her talk on dinosaur jaw mechanics, whilst the Council prize went to **Martin Smith** (Cambridge) for his poster on early land plants. Congratulations to both of them. Those of us who know **Graham Budd** (Uppsala) will realise that, for a man like him, organising a smoothly-run meeting like this is a task that requires a large number of diligent and efficient volunteers to do most of the work. So many thanks to Graham and all his many helpers. I for one thought it was a very good meeting.

Alex Page

MYSTERY FOSSIL 12

In contrast to my Editorial in *Newsletter* **66**, it appears that there are, in fact, still plenty of palaeontological mysteries out there! The latest mystery fossils, illustrated below and opposite, were found by Jesper Milàn (Copenhagen, Denmark) in a local fossil collector's. They were collected about 20 years ago in the debris along a glacier in the Karakoram Pass between India and Tibet, and Jesper has recently seen a third specimen collected in Ladakh, Kashmir. There is no information about the stratigraphic level(s) they originate from, but the fossils were found together with two well-preserved dinosaur eggs.

Jesper tells me that a CT scan of the fossils showed no internal structures. The surface is evenly covered by small ornamented tubercles 1–2 mm in size, and there is no indication that the fossils have had a stalk or have been attached to something. He has shown the fossils to all kinds of palaeontologists and palaeobotanists, and got replies ranging from some kind of nut or seed, to sponges or some weird echinoderm (each tubercle actually has some weak pentagonal symmetry).

If anybody has any ideas what these may be then please send an email to me via <**newsletter@palass.org**>.

Richard Twitchett


0
1
2
3
4 cm


0
1
2 mm

Darwin: Patron Saint of Evolutionists?

Darwin's birthday has just passed and has aroused considerable interest in the media. The *Guardian* (09/02/2008) included a supplement that combined excerpts from *On the Origin of Species* with commentaries from the perspective of various academic disciplines including biology, history and theology about the importance and interpretation of Darwin's work. A plan has also been announced to redecorate the ceiling of a gallery in the Natural History Museum, London, with art inspired by the theories of Charles Darwin, to tie in with the 200th anniversary of his birth (Radio 4 *Today* programme 11/2/2008) and *Sunday Times* (10/2/2008, <**http://entertainment.timesonline.co.uk/tol/arts_and_entertainment/visual_arts/article3341869.ece**>).

So should palaeontologists be cheered that Darwin is being so lionized in the wider cultural sphere?

On the Origin of Species is a tremendously important book and rightly enjoys a place in the wider history of ideas, and it is encouraging that a major national newspaper should publish a supplement dedicated to it. What concerns me about primers or digests that offer to lead a reader through a work is that they can unwittingly constrain the ability of readers to engage with the book itself and decide which parts of a book are important to them.

Alain De Botton, who has written several excellent books on the application of philosophy to the problems of modern life, gives an example of this phenomenon in the chapter 'On Curiousity' in his 2002 book *The Art of Travel*. The chapter juxtaposes De Botton's experience of a trip to Madrid, and his sense of having his own exploration of the city channelled and curtailed by guidebooks about Madrid that he had brought with him, with a discussion of Alexander von Humboldt's expedition to South America. De Botton contrasts von Humboldt's expedition with his own voyage of discovery round Madrid. De Botton had a sense that everything was known about Madrid and the discovery of new facts was impossible. In one of De Botton's guidebooks the diameter of a large dome in the Iglesia de San Francisco El Grande was given to the nearest metre, whereas Von Humboldt landed on a continent about which Europeans knew little; even the major Spanish naval base at Havana was incorrectly plotted on Spanish naval charts.

What deeply bothered De Botton was the sense that the guidebooks, through their use of language and liberal use of superlatives, told one what to think of the architecture, what was important about it, and most importantly what should be valued. De Botton found that none of the questions that interested him, such as the apparent lack of vegetables in the Spanish diet and the origins of the baroque surnames of many of the Spanish people he met at the conference he had attended, were answered in any guidebook.

The *Guardian* supplement included a leader by Richard Dawkins on the explanatory power of Natural Selection, information on the impact which *On the Origin of Species* had had on Victorian culture and society when it was published, and a piece on misconceptions about Darwin's work and ideas. Alison Pearn, who works on the Darwin Correspondence Project, used some of Darwin's letters to portray life at Down House. James Randerson contributed a short piece

on Darwin's anticipation of the argument of Intelligent Design. For light relief a selection of cartoons satirizing Darwin's ideas was reproduced. The theologian Richard Harries wrote on the compatibility of religious faith and evolution. The final section by Laurence Hurst discussed DNA, the mechanism of heredity that Darwin famously failed to identify in *On the Origin of Species*.

Thus the guide, like De Botton's guidebooks, emphasizes certain views about Darwin's ideas from commentators who are prominent in UK public intellectual life. Other contributors might have chosen to emphasize other aspects of Darwin's work. Although there are excerpts from *On the Origin of Species* in the Guide, and links to various Darwin websites including Darwin Online (<**http://www.darwin-online.org.uk/**>, a comprehensive, searchable archive of Darwin's work), I cannot help but think that readers who have not read *On the Origin of Species* are having their thoughts channelled in exactly the way that De Botton experienced in Madrid. Should we not be encouraging people to read the original work for themselves before coming to criticism and interpretation of which sections are important or relevant today?

A counter-argument would be that this approach is often used in universities, where somebody who knows the subject will present an overview of a subject in their lectures. However, this argument misses the point that at university the ideal is that lectures will supply the overview and help students develop the specialist vocabulary they will need to interact with the primary literature in their subject, but they should still read widely and critically. In the sciences they should make their own observations and conduct experiments if possible. Otherwise universities would return to the state of atrophy that they were in during the period before the Renaissance, when they existed mainly to preserve and pass on classical and biblical knowledge, not to serve as research institutions. There is a balance to be struck between helping readers engage with a text in any field and transmitting our own notions about which ideas are important in the text. We need to be aware of our own agendas and prejudices. This extends beyond texts to encompass other aspects of palaeontology, such as the selection of specimens for display in museum galleries and the aspects of palaeobiology evolution that we chose to highlight in such displays or select as topics for Science Week.

This leads me on to the project at the NHM to repaint a gallery ceiling with Darwin-inspired themes. The NHM has often been described as cathedral-like, and I recall Michael Coates referring to the NHM as 'the Temple of Systematics' in a jocular introduction to a seminar. Indeed, the first director, Richard Owen, regarded the museum as a means of displaying the diversity of God's creation to the public. The opening of the *Sunday Times* article describes the proposed project as a 'riposte' for evolutionary scientists to Michelangelo's work in the Sistine Chapel.

I am baffled as to why 'evolutionary scientists' (thankfully the *Sunday Times* did not use 'evolutionists') should feel a need to have a 'riposte' to Michelangelo. The ceiling of the Sistine Chapel is a series of frescoes that relates biblical stories, just as the stained glass windows of many parish churches do, but on the grandest scale. The fresco that I presume that the *Sunday Times* thinks evolutionary scientists need to make a 'riposte' to is 'God creates Adam', which is probably the most famous of the frescoes. It shows the vital spark leaping from God to Adam and represents the understanding of the origin of humanity at that point in time. This does not detract from the admiration of the technical skill, perseverance and beauty that many people,

evolutionary scientists included, feel for the work. But this raises the question of why the story has been reported in this way. After all, there are a number of painted ceilings in the NHM including the Gilded Canopy, which features a vast range of botanical specimens. Why is the Gilded Canopy not reported as a riposte to the Sistine Chapel? All journalism is, at heart, about telling a story, and sadly it seems that the plan to commemorate Darwin's bicentenary with a piece of art can only be framed in terms of a spurious contest with the Sistine Chapel that is in turn a proxy for the war of science versus religion.

Mary Midgley (1985) has discussed the problems of the co-option of evolution as a religion with all of the dramas and morality plays that can be constructed from the history of life, and I have written previously in the *Newsletter* about John Gray's contention that science has replaced religion for many people by generating a sense of progress. The reporting in the *Sunday Times* suggests that Darwin is to be enshrined as a secular deity. Scientists should be vigilant of how their work is used in society and not just the technological applications. We should care how our ideas are co-opted in public intellectual life and for what ends.

The *Guardian* supplement, a balanced and measured production, chooses to highlight certain themes and parts of *On the Origin of Species*, and a greater proportion of the articles in the supplement are actually about the cultural significance of the work rather than its scientific content. Perhaps there is some merit to this. Huge advances in evolutionary biology have taken place since the science was established, and great changes in how scientific findings are reported. I cannot imagine that today's *Nature* and *Science* papers tersely reporting the latest advances will be commended for their writing style by future generations, but the possibility is there for a broad audience to read, appreciate and understand *On the Origin of Species* for themselves. Darwin intended the work to be read by a wide audience.

Perhaps the best way to celebrate Darwin's bicentenary would be to get more people to read his work. Go on, take over your local Book Club next February.

Al McGowan
Newsletter Reporter

REFERENCES

DE BOTTON, A. 2002. *The art of travel*. Penguin, London.

MIDGELY, M. 1985. *Evolution as a religion*. Routledge, London.

Update on Eagle Owls: UK fossil and historical bird category established

My first article as Newsletter reporter (*Newsletter* **61**) used the Eagle Owl as an example of a living species that was part of the fauna and flora of the British Isles in the past, as demonstrated by fossil evidence, but is now regarded by some as a non-native species.

In a recent presentation to the Department of Palaeontology, Natural History Museum, London, on the general topic "Quaternary birds: what do they tell us?" Dr John Stewart discussed the decision by the British Ornithological Union (BOU) to erect a category for birds known from historical and fossil records, aptly titled Category F, which is overseen by a subcommittee of the BOU that had its first meeting in January 2007. Category F has many subdivisions that combine information on both the period(s) from which a species is known and the type of evidence (documentary and/or bone). The BOU, via its Category F Sub-committee, is in the process of compiling a substantial database for it to utilise in assessing the presence of bird species from the palaeontological record to more recent times.

For the fine details of the subdivisions of Category F see <**http://www.bou.org.uk/reccats.html**>. Stewart (2007) presented a detailed review of putative Eagle Owl material from various sites in the British Isles that confirmed the presence of Eagle Owls after the last glaciation.

Al McGowan
Newsletter Reporter

REFERENCE

STEWART, J.R. 2007. The fossil and archaeological record of the Eagle Owl in Britain. *British Birds*, **100**, 481–486.

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

Please find below a list of known meetings from other bodies. Help us to help you! *Send announcements of forthcoming meetings to:* Meetings co-ordinator (<**meetings@palass.org**>). The Palaeontological Association Future Meetings website is updated regularly; it is at <**http://www.palass.org/modules.php?name=palaeo&sec=meetings&page=55**>.

EGU General Assembly Scientific Session: Fossil Lagerstätten and exceptional biotas: key to understanding past ecosystems and biological interactions
Vienna, Austria *13 – 18 April 2008*

Fossil Lagerstätten preserve sclerotized, soft-bodied organisms and trace fossils that are not otherwise preserved in the usual fossil record. These "evolutionary windows" offer not only an exceptional record of ancient biodiversity but also provide the unique opportunity to reconstruct past biological systems at the level of organisms, communities and ecosystem, with remarkable accuracy. A precise knowledge of the functioning of past ecosystems is crucial and prerequisite to the study of major scientific issues such as the impact of environmental perturbations (*e.g.* climatic variations, changes in ocean/atmosphere chemistry) on biological systems, biotic recoveries, and evolutionary processes.

The purpose of this session will be to highlight current research strategies both analytical and methodological that provide key information on the functionning of ancient ecosystems (*e.g.* trophic structure, energy and biomass transfer, nutrient and food sources, animal interactions such as prey–predator relationships, feeding strategies, exploitation of ecological niches). We seek submissions on key steps of the evolution of marine, freshwater and terrestrial ecosystems, based on the study of Lagerstätten and exceptional biotas.

Please let us know if you would be interested in participating in this SSP session and feel free to contact us for any information or suggestions. General and updated information concerning EGU 2008 is available at the meeting website <**http://meetings.copernicus.org/egu2008/**> or contact Jean Vannier, e-mail <**jean.vannier@univ-lyon1.fr**>.

Second Palaeontographical Society Annual Address
Natural History Museum, London *16 April 2008*

The second Annual Address of the Palaeontographical Society is to be delivered by Dr David B. Norman, Director of the Sedgwick Museum of Earth Sciences, University of Cambridge. The topic of the address will be "Envisioning dinosaurs – a Palaeontographical legacy". The Address will commence at 4:30pm and will be held in the Flett Lecture Theatre of the Natural History Museum. Tea and coffee will be provided beforehand from 4pm in the lecture theatre foyer. Numbers are limited, with preference given to members of the Society, but non-members are also encouraged to attend. Non-members that are interested in attending should contact the Co-Secretary of the Society (Dr Paul Barrett, e-mail <**p.barrett@nhm.ac.uk**>) in advance to book a place.

The Triassic climate: Workshop on Triassic palaeoclimatology
Bolzano/Bozen, Italy *3 – 7 June 2008*

"The climate during the Triassic? That's easy … everything was warm and dry…" … or, at least this is what you generally find when, in textbooks, you look for a description of the Triassic climate. But it wasn't probably so. Although valuable studies on Triassic climate exist, researchers from various regions and fields of Earth Sciences worked alone or in small groups, dealing mostly with short time intervals. There is a need of a more comprehensive picture of the Triassic climate through time and space, which could only stem from the interaction of research groups that have worked, so far, in isolation.

The aim of this workshop is to provide a forum for researchers interested in the Triassic palaeoclimate. Participants will be invited to present methodological approaches and significant case histories of palaeoclimatic and palaeoenvironmental reconstructions at regional and global scale. Studies involving new interdisciplinary methods are particularly welcome.

There are further details on the meeting website **http://trias.geodolomiti.net/** or from Evelyn Kustatscher, e-mail <**Evelyn.Kustatscher@naturmuseum.it**>.

5ª Reunion de Tafonomia y Fosilizacion, TAPHOS´08 – 3rd International Meeting on Taphonomy and Fossilization
Granada, Spain *12 – 14 June 2008*

The meeting will consist of two days for oral communications and poster presentations and one day for a field trip. If you would like to participate in the meeting or for any query, please contact Dr Julio Aguirre, e-mail <**jaguirre@ugr.es**>.

8th International Congress on Rudists (IRC 8)
Izmir, Turkey *23 – 25 June 2008*

The meeting will be held at the Dokuz Eylul University-Izmir, and dedicated to Turkish rudist specialist Necdet Karacabey-Öztemür who made very valuable palaeontological studies on the rudists of Turkey. The theme of the congress is "Cretaceous Rudists and Carbonate Platforms". The congress includes major sessions and field trips as follows:

A Major sessions

1 Palaeogeography and Depositional Environments of Cretaceous Carbonate Platforms

2 Origins, Events and Demise of Rudist Palaeocommunities

3 MacGillavry session: Taxonomic and Phylogenetic Studies in Preparation for the Revision of Rudist Section in the Bivalvia Treatise (organization by P.W.Skelton)

B Field Trips

- Pre-meeting field trip (1): Campanian–Maastrichtian rudist-bearing mixed siliciclastic–carbonate transgressive–regressive system tracts of the eastern and southeastern Anatolia: Faunal correlation, depositional facies and palaeobiogeographic significance.
- Post-meeting field trip (2): Rudist-bearing marbles of the metamorphic Menderes Massif and the Upper Cretaceous rudistid limestones of the Bey Da_lar? (western Taurides) carbonate platforms.
- Post-meeting field trip (3): Lower Cretaceous rudist faunas from the Zonguldak region, western Pontides (northern Anatolia).

The presentation and examination of the rich rudist material collected by Dr Sacit Özer (DEU-Izmir) from the Pontide belt (northern Anatolia), the Anatolian and Arabian platforms (central-eastern and southeastern Anatolia), metamorphic Menderes Massif and western and central Tauride platform will be available during the meeting at the congress centre.

The congress will also contain effective social events such as selected historical and touristic regions and Turkish folkloric activities.

For more information, please consult the meeting's web site at <**http://web.deu.edu.tr/irc8/**>, or contact the chairman of the organizing committee at <**sacit.ozer@deu.edu.tr**> or the secretary at <**bilal.sari@deu.edu.tr**>.

Mid-Mesozoic Life and Environments
Cognac, France *25 – 27 June 2008*

In 1999, the meeting "Life and environments in Purbeck Times" has been a successful event for the palaeontologists working on Mid-Mesozoic. The intention of this symposium was to propose a synthesis of the knowledge of the Purbeck environments and organisms on the base of the historical and recent discoveries from the Purbeck Limestone Group, in Southern England. Consequently to the discovery and the exploitation of the French early Cretaceous site of Cherves-de-Cognac, and considering that general knowledge has increased during this last decade, we propose to organize a symposium dealing with the Oxfordian–Albian interval.

The contact for registration forms and further details is Jean-Michel Mazin, UMR CNRS 5125 PEPS, Université Claude Bernard Lyon 1, Campus de la Doua, 2, rue Dubois - Géode, 69622 VILLEURBANNE Cedex, France; tel 00.33.(0)4.72.43.36.43, e-mail <**jean-michel.mazin@univ-lyon1.fr**>.

International Congress: Palaeozoic Climates
Lille, France *23 – 31 August 2008*

Climate change is currently one of the most debated and discussed scientific topics. Ancient climate changes are extremely useful to understand the global changes that we live with today. The scientific meeting on Palaeozoic Climates is focused not only on ancient climate and sea-level

changes (Ordovician glaciation, end-Devonian extinction, Late Palaeozoic glaciation; greenhouse-icehouse transitions), but also on their modelling, their understanding and their impact on biodiversity.

The Congress will serve as the closing meeting of the International Geoscience Programme (IGCP) n° 503 'Ordovician Palaeogeography and Palaeoclimate', and is also related to the IGCP n° 497 'The Rheic Ocean: its Origin, Evolution and Correlatives', and IGCP n° 499 'Devonian land-sea interaction: evolution of ecosystems and climate'.

The pre-conference excursion will visit outcrops and sections of the Cambrian to Silurian sections of Belgium. The post-conference excursion will allow participants to visit some of the famous sections of the Belgian Upper Palaeozoic, including those from localities such as Givet, Frasnes, Famenne, Tournai, Namur, Dinant, and others, including outcrops in the classical section of the Meuse Valley.

The conference topics are designed to address various subjects related to Palaeozoic Palaeogeography, Palaeoclimate and Palaeoecology, including all geological systems from the Cambrian to the Permian. The major aim of the congress is to analyze and understand the factors driving diversifications, extinctions and radiations of Palaeozoic faunas and floras.

The congress is an event of the International Year of Planet Earth, aiming at contributing to the scientific topic Earth & Life – the Origins of Diversity and Climate Change.

The meeting, organized by the CNRS research unit UMR 8157 Géosystèmes, will take place in the city centre of Lille. Scientific sessions will be organized at the Catholic University of Lille (UCL) in the Institut Supérieur d'Agriculture (ISA) buildings. Some events will take place on the campus of the Université des Sciences et Technologies (USTL), close to Lille, at Villeneuve d'Ascq. Lille, in northern France, can easily be reached from London (90 minutes), Paris (60 minutes) and Brussels (40 minutes) by high speed trains (Eurostar, TGV, Thalys).

Keynote speakers will include Robin Cocks (Natural History Museum, London) on Lower Palaeozoic palaeogeography; Yves Goddéris (Univ. Toulouse, France) on Global biogeochemical cycles; Michael Joachimski (Univ. Erlangen, Germany) on Upper Palaeozoic carbon and oxygen isotopes;Arnold I. Miller (Univ. Cincinnati, Ohio, USA) on Palaeoenvironmental impact on diversity over time; Christian Klug (Univ. Zürich, Switzerland) on Evolution of the marine food web in the Devonian;Alexander Nützel (Bayerische Staatssammlung, München, Germany) on Evolution of planktotrophy; Alberto Pérez-Huerta (Univ. Glasgow, UK) on Palaeoclimatic impact on Late Carboniferous marine ecosystems; Kevin J. Peterson (Dartmouth College, Hanover, NH, USA) on Molecular palaeobiology; Matthew R. Saltzmann (Univ. Columbus, Ohio, USA) on Lower Palaeozoic carbon and oxygen isotopes; Jörg Schneider (Univ. Freiberg, Germany) on Upper Palaeozoic ecosystems; and Charles Wellman (Univ. Sheffield, UK) on Land plant evolution and terrestrialization.

Talks will be included during the five days of the conference and each will last 20 minutes (including five minutes of discussion). Talks on Lower Palaeozoic topics will be concentrated on the sessions of Monday and Tuesday, 25th and 26th. Talks on Upper Palaeozoic topics will be concentrated on the sessions of Thursday and Friday, 28th and 29th. Parallel sessions will be avoided. Talks of general interest will be placed in the general session of Wednesday 27th.

Abstracts, not exceeding one A4 page, should be sent to the address below by 1st May 2008. State whether the abstract is for an oral or poster presentation. In case of multi-authored talks, please,

indicate the speaker. Abstracts should be written in correct English. The organizing Committee reserves the right to accept or refuse any submission. Abstracts are only accepted for print and included in the programme if the registration fee is paid before the registration deadline (1st May 2008, and should be submitted by e-mail to <Bjorn.Kroger@univ-lille1.fr>.

Two geological field trips will be organized. On 23–24 August, a pre-conference excursion to the Lower Palaeozoic of Belgium (Brabant, Condroz, Ardennes), led by J. Verniers (Gent), T. Servais (Lille), T. Vandenbroucke (Gent) and others. On 30–31 August, a post-conference excursion to the Upper Palaeozoic of Belgium and northern France (Avesnois, Meuse Valley) led by B. Hubert, B. Mistiaen, T. Servais (Lille) and others.

Grant aid is available from both the organizing committee and IGCP 503. IGCP 503 supports members from developing countries and students to assist the congress at Lille. In addition, the organizing committee is providing support that will preferably be given to (young) scientists travelling from outside the European Union. Applications for grant aid should be made to Thomas Servais, e-mail <Thomas.Servais@univ-lille1.fr>.

For full information see <http://www.univ-lille1.fr/geosciences/

Please send your registration before 1st May 2008, preferably by e-mail, to: Thomas Servais , USTL - Sciences de la Terre, UMR 8157 Géosystèmes, Cité Scientifique SN5, F-59655 Villeneuve d'Ascq cedex, France, fax (+33) (0)3 20 43 69 00, <e-mail **Thomas.Servais@univ-lille1.fr**>.

International Federation of Palynological Societies
Bonn, Germany 30 *August – 6 September 2008*

The next International Palynological Congress will be August 2008 in Bonn (Germany). For details refer to <**http://www.palaeobotany.org/modules.php?name=iop&sec=meetings&page=12**>.

The Second International Congress on Ichnology
Cracow, Poland *1 – 5 September 2008*

Following the successful First ICI, held at Trelew, Argentina in 2004, number 2 is being organized in Europe. Papers are invited on all subjects ichnological, including bioturbation, bioerosion, ichnofacies and ichnofabrics, leaf mines, coprolites, ichnotaxonomy and fringe areas. Field trips to the Carpathian and Holy Cross Mountains will be included. Intending participants are asked to visit the web page and to pre-register at <**http://www.uj.edu.pl/ING/ichnia08/**>.

For further information, please contact Alfred Uchman at <**alfred.uchman@uj.edu.pl**>, Cluj-Napoca, Romania, e-mail <**sorin@bioge.ubbcluj.ro**>, or Mike Kaminski, UCL, e-mail <**m.kaminski@ucl.ac.uk**>.

56th Symposium of Vertebrate Palaeontology and Comparative Anatomy, and 17th Symposium of Palaeontological Preparation and Conservation
Dublin, Ireland *2 – 6 September 2008*

We are proud to announce that the 17th Symposium of Palaeontological Preparation and Conservation (SPPC) will be held in Dublin (Republic of Ireland) on 2nd September, followed by the 56th Symposium of Vertebrate Palaeontology and Comparative Anatomy (SVPCA) on 3–6 September.

Both events will be hosted jointly by University College Dublin (UCD) and the Natural History Division of the National Museum of Ireland (NMINH) through their collaborative programme 'Collections-based Biology in Dublin' (CoBiD); see <**http://www.ucd.ie/cobid**>.

Presentations and posters associated with the SPPC will be held in the headquarters of the Geological Survey of Ireland (GSI) located in the Beggars Bush complex, Haddington Road, Dublin 2. The main venue for the SVPCA meeting will be the National Museum of Ireland's Archaeology and History Museum on Kildare Street, Dublin 2. These venues are a short walk from one another across the beautiful Georgian southside of Dublin City.

The Beggars Bush complex also houses the Museum's Natural History research collections (including palaeontological and geological specimens). Access to these collections, as well as to those housed in the Geology Museum of Trinity College Dublin, will be available throughout the meeting. Maps and instructions for these venues will be provided in the 2nd Circular that will be mailed in mid March.

The annual Jones-Fenleigh auction to benefit student participation at the SVPCA will take place during the meeting, as will the annual conference dinner. Several other conference events and receptions are planned. A number of fieldtrip options will be offered within Dublin, the County Dublin area and further afield in Ireland. More details will be provided in the 2nd Circular.

If you would like to express an interest in attending either of these meetings and to receive the 2nd circular, please send an email to <**dublin2008@svpca.org**>.

8th International Workshop on Agglutinated Foraminifera
Cluj-Napoca, Romania *September 7 – 13 2008*

The Grzybowski Foundation and the Department of Geology, Babes-Bolyai University are pleased to announce the dates of the next International Workshop on Agglutinated Foraminifera. The workshop is open to all participants interested in the taxonomy, ecology, evolution and stratigraphy of the Agglutinated Foraminifera, and follows workshops previously held in Amsterdam, Vienna, Tübingen, Kraków, Plymouth, Prague, and Urbino over the last 27 years. The workshop will consist of three days of technical sessions, followed by a field excursion in the spectacular Transylvanian Basin and Southern Carpathians.

The meeting will be held in the Department of Geology, Babes-Bolyai University, situated in the former Roman town of Cluj-Napoca, Romania. The conference room offers modern projection facilities, and lunchtime meals will be taken in the University Restaurant opposite the Geology Department. Microscopes will be available for working groups and demonstration purposes.

Costs:
The registration fee for the conference is estimated to be approx. €120 euros, and a discount will be given to student participants. The fee will cover conference materials, refreshments at the meeting, and the welcoming reception. Field trip costs will be calculated separately. The Grzybowski Foundation will make available a limited number of travel grants for participants from eastern European countries. Accommodation will be at local hotels near the central square, at the discount rate of approximately €50 a night. Full details of costs will be made available in the second circular.

Preliminary Programme:
Sunday 7th September: arrival and welcoming reception
Monday 8th September to Wednesday 10th: Technical Sessions
Wednesday 10th September: Conference Dinner
Thursday 11th September to Saturday 13th: Field Excursion (Transylvania, Carpathians).

Information and Registration:
Sorin Filipescu, Department of Geology, Babes-Bolyai University, str. Kogalniceanu 1, 400084 Cluj-Napoca, Romania, e-mail <**sorin@bioge.ubbcluj.ro**> or Mike Kaminski, UCL, e-mail <**m.kaminski@ucl.ac.uk**.>.

An International Conference on the Cambrian Explosion
Banff, Alberta *August 3 – 7 2009*

We invite you to attend a special Conference on the **Cambrian Explosion** to commemorate the **100th anniversary of the discovery of the Burgess Shale by Charles Doolittle Walcott**. We cordially extend this invitation to all geologists, palaeontologists, geochemists and biologists interested in the profound organismal, ecological and environmental changes that occurred during the Precambrian–Cambrian transition. Moreover, we think that this meeting would be of great interest to historians of geology and anyone curious about the origins of animals.

For further details visit the meeting website at
<**http://www.geology.utoronto.ca/facultycaron/Walcott2009.htm**>.

International Scientific and Organizing Committee (as of April 2007)

Co-Chairs:
Dr Jean Bernard Caron (Royal Ontario Museum, Toronto), <**jcaron@rom.on.ca**>
Dr Doug Erwin (Smithsonian Institution, Washington), <**ERWIND@si.edu**>
David Rudkin (Royal Ontario Museum, Toronto), <**davidru@rom.on.ca**>

Members:
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Dr Stephen Dornbos (University of Wisconsin-Milwaukee), <**sdornbos@uwm.edu**>
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Dr Charles Henderson (University of Calgary), <**cmhender@ucalgary.ca**>

Dr Paul Johnston (Mount Royal College, Calgary), <**pajohnston@mtroyal.ca**>
Kimberley Johnston (Palaeontographica Canadiana), <**kimberley@paleos.ca**>
Dr George Pemberton (University of Alberta), <**george.pemberton@ualberta.ca**>
Dr Jean Vannier (Université Claude Bernard Lyon 1), <**jean.vannier@univ-lyon1.fr**>
Dr Xingliang Zhang (Department of Geology, Northwest University,Xian),
<**xlzhang@pub.xaonline.com**>
Dr Maoyan Zhu (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences),
<**myzhu@nigpas.ac.cn**>

5th International Symposium on Lithographic Limestone and Plattenkalk
Basel, Switzerland *17 – 22 August 2009*

The 5th International Symposium on Lithographic Limestone and Plattenkalk will be held at the Naturhistorisches Museum Basel (<**http://www.nmb.bs.ch/**>), on 17–22 August 2009. Following the former editions (Lyon, 1991; Cuenca, 1995; Bergamo, 1999; Eichstätt/Solnhofen, 2005), we are pleased to organise the 5th conference in Basel, close to the Late Jurassic fossil localities of Solothurn and Porrentruy (northwestern Switzerland).

The symposium will consist of three days of presentations (plenary speakers, regular sessions, and posters) on 18–20 August. This multidisciplinary meeting is planned to address various aspects in the study of lithographic limestones and plattenkalk deposits, dealing with palaeontology (taxonomy, palaeoecology, taphonomy), geology (stratigraphy, sedimentology, palaeoenvironments), and also mineralogy and petrology of related Fossil-Lagerstätten.

In addition to the scientific sessions, three excursions will be organised in Germany and Switzerland:

- Frauenweiler (Germany), Monday 17th: Pre-symposium excursion to the Frauenweiler clay pit (Oligocene) famous for fossil fishes and the oldest hummingbirds co-organised by Eberhard "Dino" Frey (Staatliches Museum für Naturkunde, Karlsruhe).
- Porrentruy (Canton Jura), Friday 21st: Post-symposium excursion to Porrentruy. Several dinosaur tracksites have been discovered in sub-lithographic limestones (biolaminites) of Late Kimmeridgian age, along the future course of the "Transjurane" highway (<**http://www.palaeojura.ch/**>). In addition, many fish, turtle and crocodilian remains have been unearthed in coeval marls. Aperitif and dinner will be offered in close vicinity of a dinosaur tracksite and footprints can be observed by night using artificial illumination.
- Solothurn (Canton Solothurn), Saturday 22nd: Post-symposium excursion to Solothurn and surrounding areas. We will visit the well-known outcrops of Solothurn Turtle Limestone (Late Kimmeridgian) and the Lommiswil dinosaur tracksite. Further, a visit is planned to the Natural History Museum of Solothurn (<**http://www.naturmuseum-so.ch/**>) where many fish, turtle and mesosuchian crocodilian remains are housed.

For further details and registration information contact Antoinette Hitz, Naturhistorisches Museum Basel, Secretary Department of Geosciences, Augustinergasse 2, 4001 Basel, Switzerland, tel +41 61 266 55 26, fax +41 61 266 55 46, e-mail <**antoinette.hitz@bs.ch**>.

International Symposium on the Cretaceous System
Plymouth, UK *6 – 12 September 2009*

The International Symposium on the Cretaceous System will be held at the University of Plymouth, on 6–12 September 2009. The conference will be followed by a number of field excursions visiting Cretaceous locations in the UK. Themes for the meeting may include: 200th Anniversary of the birth of Charles Darwin, sequence stratigraphy and sea level change, Cretaceous oil and gas exploration in the N.W. European Continental Shelf, Cretaceous stratigraphy, palaeontology, isotope stratigraphy, biotic and other events, regional geology and palaeoclimates. Papers will be solicited for peer-reviewed publication with submission of manuscripts at the meeting.

For more information contact Prof Malcolm Hart, School of Earth, Ocean & Environmental Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, e-mail <**mhart@plymouth.ac.uk**>, or Dr Gregory Price, e-mail <**g.price@plymouth.ac.uk**>.

For further details visit the meeting website: <**http://www2.plymouth.ac.uk/science/cretaceous/**>

Southeast Asian Gateway Evolution
Royal Holloway, University of London, UK *14 – 17 September 2009*

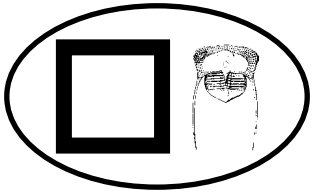
This major multidisciplinary meeting will focus on the geological and biological history of the Gateway region, and include discussion of geology, tectonics, oceanography, climate, biogeography and biodiversity. For details visit the meeting website at <http://sage2009.rhul.ac.uk/>.

The convenors are Robert Hall, Royal Holloway, e-mail <**sage2009@gl.rhul.ac.uk**>, and Ken Johnson, Natural History Museum, e-mail <**sage2009@nhm.ac.uk**>.

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

Outside The Box

A palaeontologist digs the foundations



> "With an eyeful of the future, and a bellyful of the past,
> How beautiful the present when you know it cannae last"
>
> Derek W. Dick (1999)

I seem to have spent an unhealthy amount of time thinking up analogies for life as a palaeontologist in the seven years since I finished my PhD. It seems to me, for instance, that our likelihood of succeeding in palaeontology is a lot like the chances of an aardvark humerus surviving to be found by one of us as a fossil. I've also spent a similarly unhealthy amount of time thinking up names for my analogies, and this one I like to call the '*Taphonomy of Palaeontologists*'. It fits together like this.

As palaeontologists we know only too well that a tiny fraction of what has ever crawled, walked, burrowed, swam, floated, or flown across the face of the planet survives to be found. The odds of that aardvark humerus really are stacked up against it being found as a fossil. It firstly needs to avoid being crunched up by scavengers or whatever 'nasty' did for its original owner, and if it's unlucky enough to stay on the surface it will be weathered to dust in only a few years. Rapid burial does help, but the humerus must also somehow shrug off microbial bioerosion in the sediment, avoid being reworked and abraded to dust, and it also needs to be deposited where mineral-rich pore fluids ensure that it actually fossilises.

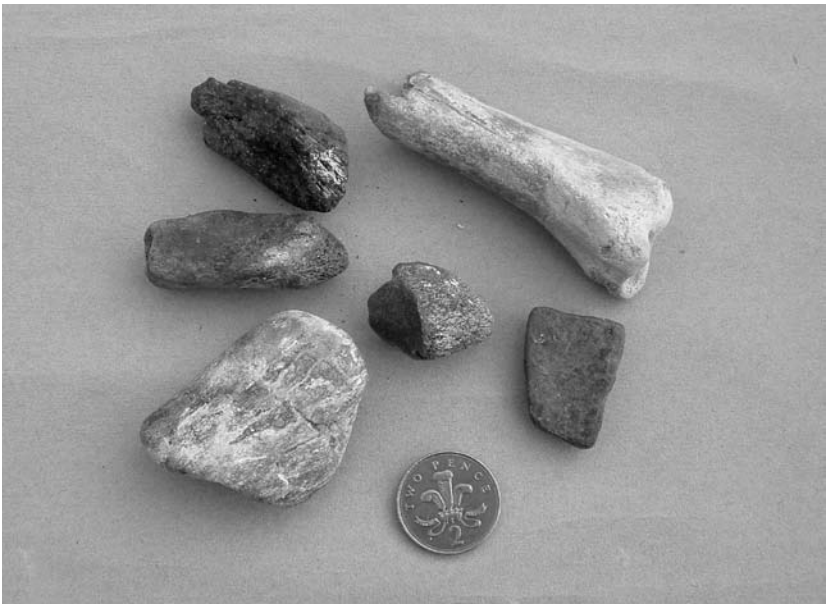
At every stage it may sustain damage that weakens its chances of long term survival; a weathered or microbioeroded bone is less likely to survive compaction and reworking than a strong pristine example. The original robustness of the bone obviously also makes a big difference to its survival potential; our aardvark humerus should fare better than the humerus of a sparrow. Some elements and some taxa are therefore likely to be better represented than others in the fossil record. Those destructive filters continue to act even after our bone becomes a fossil. In the end, a few worthless flakes of bone or a well-rounded bone pebble may be all that remains.

The same relationship appears to hold true for life as an academic, with a variety of factors acting as 'academic taphonomic filters' preventing progression to a permanent job in palaeontology. Financial security has to be one of the most powerful of these filters. I suspect that the introduction of tuition fees and loans to pay for them will be a major generator of debt, particularly for those smashing rocks on a geology degree where compulsory fieldwork adds an additional cost. The level of debt built up by the time a student graduates must have an effect on a graduate's ability or willingness to complete postgraduate study. Any undergraduate dept is likely to increase by the end of an MSc or PhD, particularly as finding funding for this kind of postgraduate study becomes harder.

Even after finishing, debt can block career progress. Mobility is crucial because palaeontology-related postdoctoral positions are thin on the ground, yet debt or the absence of any financial

buffer can make relocating to another area to take up a short postdoctoral position far harder. Older entrants into Higher Education are also often restricted by having families or other ties, and can find it difficult to move to take up a succession of short-term contracts. Age can also exclude older researchers from eligibility for some kinds of research funding, perhaps because 'early career' researchers have traditionally been assumed to enter Higher Education straight from school via college with no major breaks in education.

One way or another, these academic 'taphonomic' filters serve to weed out all but the most fortunate or most tenacious contenders. Logically, the last man or woman standing from any cohort *should* stand a better chance of succeeding as the field of candidates thins over time. This is not always the case, and promising new entrants may be favoured over old campaigners, much as we would ignore one of those bone pebbles in favour of a fresher, less worn specimen.



Who could not resist collecting these elegant and shapely bone pebbles? Such well worn specimens are often over looked, but make a striking addition to anyone's gravel driveway.

If my *Taphonomy of Palaeontologists* analogy seems rather depressing, I would like to point out that many of us *have* succeeded by not giving up. After all, not all bone pebbles get left on the beach. To try when the odds are against you invites the possibility of failure, but *not* to try guarantees it. When looking for jobs we need to 'stay on the radar', and that is easier done with an academic address for publishing and applying for jobs. Finding some other way to stay in academia can therefore be useful. The experience we gain while studying can be turned to our advantage to do this. What I have to say comes from my own experience as a bone pebble; even bone pebbles have uses as paperweights.

Two years ago I was coming to the end of a postdoc contract at the Natural History Museum and getting very concerned about what to do next. All of the grant and job applications I had put out

up to that point had come to nothing, and I knew that it would be another six months before I would learn if the grant application I had in the system at that time would be successful. Before starting the job at the Museum I had spent a year and a half working as a cleaner and a porter in a psychiatric hospital, and was expecting to have to go back to something similar as a stop gap until the grant or something else came up.

As it turned out, I learned of a tutor post at Portsmouth University and decided to try for that. The post actually involved setting up a new course for pre-sessional students about to start a Foundation Degree, with tutoring as a secondary role. At the time – and probably like many of you reading this – I had never heard of a Foundation Degree, and figured it must be something like the Access and Foundation year courses designed as an alternative to traditional A-levels as an entry route into a Bachelor's Degree. In fact, the Foundation Degree (Fd) is something quite different. Introduced in 2001, the Fd was intended to provide a more 'hands on' alternative to a BA or BSc, in that much of the learning is work-based. In many ways, the Fd is similar to the NVQ, except that it is a degree in its own right, and also can be used as a way to get onto a BSc or BA, assuming a suitable course is available. Most Fds are delivered part time over two or three years, making them ideal for mature students with families and jobs. Currently Fds are restricted to more 'practical' subjects, with more esoteric fields such as geology still well served by traditional Bachelor's courses.

One way Fds are radically different from Bachelor's Degrees is that, because of their work-based nature, it is possible to qualify for an Fd based on relevant 'experiential learning' gained in the workplace, rather than traditional academic exam grades. Like many UK universities, Portsmouth professes a strong commitment to attracting students from non-traditional backgrounds (so called 'widening participation', or WP students), and the Fd is an obvious way to increase numbers of applications from this target group. The downside of this is that these students often have not been in education for many years, and even when they were, they may not have been 'top of the class'. Consequently, they are very likely to be in need of a great deal of basic support in the areas of maths and academic writing.

To meet this demand, Portsmouth University was fortunate enough to be granted HEFCE funding to set up a Centre for Excellence in Teaching and Learning (CETL) devoted solely to Fd students. The new CETL featured a purpose-built drop-in centre with tutors offering support in person and by phone and e-mail 11.5 hours a day, five days a week, with perpetual 'virtual' support via a website. The name of the new CETL, Foundation Direct, was probably intended to sound flashy and dynamic, but as Hunterian Museum's Jeff Liston pointed out in his assiduous way, it sounded far more like a mail order make-up supplier.

I have to say that I was surprised to be offered the job (not least because I publicly refuse to admit to knowing anything about make-up), but it later became clear that I was just the kind of person they needed to do the job. It turned out that the pre-sessional course I was to design was intended only for the healthcare-related courses, where nearly all of the applicants are well and truly 'mature'. As a mature entrant to Higher Education back in 1994 (but via A-levels), I had experienced many of the problems that our mature students faced, although I did not have a family at the time. My experience allowed me to get a better handle on the academic problems these students face, while my time working in the health service allowed me an insight into how the NHS works (and how it doesn't).

For me, my time at Foundation Direct was very useful. I already knew that I enjoyed teaching, but one-to-one tutoring in basic academic skills is a very different kettle of fish to standing up and talking about a subject we love and know well. Tutoring at this level fundamentally involves listening to a student's problem and getting them to work out the solution for themselves (with a little guidance from the tutor), rather than simply supplying them with the solution. This way the student's confidence in their own abilities will grow, and since lack of confidence is a major factor implicated in student drop-outs, building confidence is obviously something we have to address. I realised that, no matter how humorous, inspirational and accessible I tried to make my lectures, my method of teaching was nonetheless 'lecturing at' rather than 'teaching to'. In this respect, my teaching practices have certainly improved as a result of taking this job. Designing and delivering the pre-sessional course as a short level 0 unit also allowed me to gain a good insight into the mechanics of putting together a unit and the process of getting it accredited.

The intrinsic interest of research eventually enticed me back to the Natural History Museum for a short eight-month contract. Even though I traded a contract with two years and eight months of tutoring for one with only eight months, there was never any contest. It might not be the sensible or logical thing to do, but when I decided on a career in palaeontology I already knew how difficult the job situation is and had resigned myself to a future of short term contracts, probably in different countries. The chance to be back at the 'Cathedral of Natural History' was just too good to pass up. Perhaps the next time I find myself back at that psychiatric hospital it will not be as a member of staff, but who cares? Bone pebbles have to end up somewhere.

Stig Walsh

Sylvester-Bradley REPORTS

Chitinozoan palaeoecological dynamics during end-Ordovician climate change

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Chitinozoans are microfossils of unknown biological affinity and little is known about their palaeoecology. They are relatively large and abundant in a wide variety of Ordovician marine environments and commonly occur in graptolite-rich sediments, but also persist where graptolites are absent. Since their formal naming and description by the German palynologist Alfred Eisenack in 1931, their potential for biostratigraphical purposes has been realized and biozone schemes have been erected for nearly all of the major palaeocontinents from the Ordovician to the Devonian. The most recent scheme, and one that is still being revised, is for Avalonia (Vandenbroucke and Vanmeirhaeghe, 2007).

Despite their wide application, the palaeoecology of these organisms remains enigmatic and we cannot be certain of the robustness of these biostratigraphical schemes. For instance, the occurrence and distribution of marine organisms is controlled in modern oceans by numerous biotic and abiotic processes that are intricately interlinked, and we have no reason to assume any differently for the Palaeozoic. Unfortunately for biostratigraphy, organisms are strongly controlled by facies distribution, and the distribution of facies, both litho- and bio-, is directly controlled by climate – so we can expect even the best biozonation scheme to break down in some part of the world at some point in time. The opportunity exists in Wales to investigate the pattern of ecological replacement in chitinozoa in a well-constrained environmental context, and also to contribute to the existing Avalonian chitinozoan biozonation scheme.

The aims of this study were:

1) To contribute to the ongoing development of an Avalonian chitinozoan biozonation from new Upper Katian (Ashgill) data from central-southern Wales.

2) To test hypotheses of ecological structure and facies control on chitinozoan distribution. These hypotheses are:
   - Chitinozoa are constrained ecologically by water column stratification in the Welsh Basin during the Ashgill. This has been demonstrated for graptolites in the Caradoc and Hirnantian (Williams *et al*., 2003; Finney *et al*., 2007).
   - Chitinozoa biozones can be facies controlled and diachronous.

The Welsh Basin not only provides a nearly complete section through the Upper Katian (Ashgill) but one where the mechanisms for change in basin hydrodynamics are well understood. Four repeated dysoxic-anoxic organic-rich events punctuate a background of burrow-mottled oxic-

dysoxic grey shales (Fig. 1). These events occurred during short periods of invigorated upwelling, increased organic matter productivity and expansion of the oxygen minimum zone, and preclude diachroneity of this facies throughout the basin.

Figure 1. *The contact between organic-poor grey shales and organic-rich black shales which marks the displacement of several chitinozoan taxa out of the basin environment. (Locality: Traeth Penbryn, Penbryn, Ceredigion).*

Data was collected over two field seasons from sections representing a basin to shelf transect between the coast north of Cardigan, Ceredigion (basin facies) and further inland in the type Llandovery region, Powys (shelf-break to shelf facies). A Sylvester-Bradley award allowed me to spend one week visiting the University of Ghent Palaeontology Research Unit in January 2007 to view holotype chitinozoan material for comparison and to aid identification of the Upper Katian chitinozoa I had collected. The resources for chitinozoan research at the University of Ghent are second to none, and the extensive library they hold on nearly every chitinozoan paper ever published along with their vast catalogue of taxa listing synonymies is an extremely valuable archive.

I was specifically interested in viewing holotype material for two taxa that give their names to Avalonian chitinozoan Biozones, *Spinachitina fossensis* Vanmeirhaeghe, 2004 and *Bursachitina umbilicata* Vandenbroucke, 2005. Also during my visit, it proved invaluable for me to view specimens of taxa associated with each of these newly-defined zones and to gain an impression of the range of preservation, particularly for index taxa.

My data set comprises a total of fifty-three taxa from a yield of 1,414 chitinozoans recovered from 64 samples. One new taxon has been recognised and is currently being described. The preservation of chitinozoans varies from poor, crushed and broken specimens typically found in grey shales to slightly worn three-dimensional vesicles maintaining diagnostic features.

Results show a good concordance with the developing Avalonian chitinozoan biozonation scheme of Vandenbroucke and Vanmeirhaeghe (2007). The Baltoscandian–Avalonian *Tanuchitina bergstroemi* Biozone is present and the endemic Avalonian index taxon *Spinachitina fossensis* was recorded for the first time from Wales (Fig. 2), allowing confident correlation between basin and shelf-break sections. Further to this, the overlying index taxon *Bursachitina umbilicata* was also recorded from basin deposits but, uniquely, it seems associated with periods of organic-rich deposition.

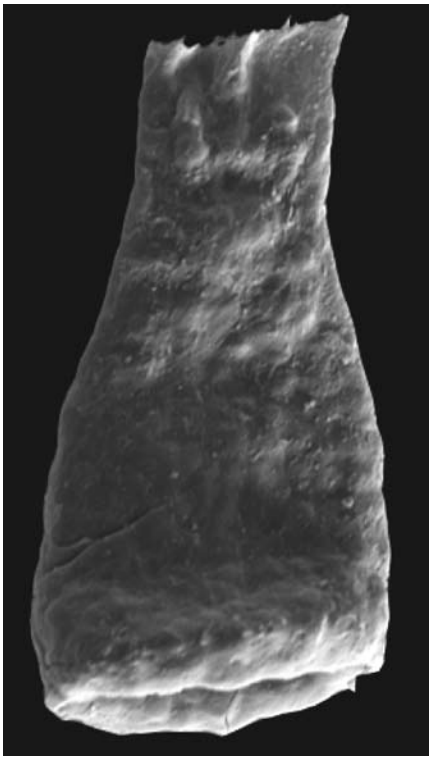

Figure 2 Spinachitina fossensis *Vanmeirhaeghe and Verniers 2004 from the anoxic organic-rich facies of the Nantmel Mudstones Formation, Traeth Penbryn, Ceredigion, Wales. This eponymous index taxon is diachronous between the basin and shelf-break sections of the Welsh Basin (scale bar = 72 μm).*

For chitinozoan palaeoecology, I considered the approaches of Williams *et al*. (2003) and more recently Finney and Berry (2007) who recognised that glacioeustatic induced changes in basin hydrography displaced graptolite biotopes allowing remaining graptolite taxa to fluorish. From this study, I have now been able to apply a similar model to chitinozoan assemblages in the Welsh Basin and recognize that facies-dependent depth stratification of chitinozoa was primarily controlled by water column oxygenation as well as glacioeustatic sea-level. The results suggest that chitinozoa are planktonic forms, like graptoloids, and can be used as powerful tools for investigating oceanographic dynamics in open water and restricted settings. Further detailed results from this study of the responses of chitinozoan assemblages to hydrographic processes were presented at the Palaeontological Association Annual Meeting in Uppsala in December 2007.

Acknowledgements

I am grateful to the Palaeontological Association for awarding me a Sylvester-Bradley Award allowing me to visit Ghent University, helping me complete this work. I would also like to acknowledge the kind hospitality of Jacques Vernier and Jan Vanmeirhaeghe of the Palaeontological Research Unit at the Univesity of Ghent during my visit and especially Thijs Vandenbroucke for accommodation and for showing me the sights and sounds of Ghent.

REFERENCES

EISENACK, A. 1931. Neue Mikrofossilien des baltischen Silurs. *Naturwissenschaften* **18(42)**, 880–881.

FINNEY, S. C., BERRY, W. B. N. and COOPER, J. D. 2007. The influence of denitrifying seawater on graptolite extinction and diversification during the Hirnantian (latest Ordovician) mass extinction event. *Lethaia,* **40**, 281–291.

VANDENBROUCKE, T. R. A., RICKARDS, B. and VERNIERS, J. 2005. Upper Ordovician chitinozoan biostratigraphy from the type Ashgill area (Cautley district) and the Pus Gill (Dufton district, Cross Fell Inlier), Cumbria, Northern England. *Geological Magazine*, **142(6)**, 783–807.

VANDENBROUCKE, T. R. A. and VANMEIRHAEGHE, J. 2007. An emerging chitinozoan biozonation for Avalonia. *Acta Palaeontologica Sinica*, **46**, 497–501.

VANMEIRHAEGHE, J. and VERNIERS, J. 2004. Chitinozoan bio-and lithostratigraphical study of the Ashgill Fosses and Génicot Formations (Condroz Inlier, Belgium). *Review of Palaeobotany and Palynology* **130(1-4)**, 241–267.

WILLIAMS, M., DAVIES, J. R., WATERS, R. A., RUSHTON, A. W. A. and WILBY, P. R. 2003. Stratigraphical and palaeoecological importance of Caradoc (Upper Ordovician) graptolites from the Cardigan area, southwest Wales. *Geological Magazine*, **140(5)**, 549–571.

Life in the Pleistocene Leaf Litter: The Ancient Terrestrial Arthropods of Jamaica

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Accurate reconstruction of ancient terrestrial ecosystems requires exceptional preservation of diverse taxa; a rare and palaeontologically exciting occurrence. In the Antillean region, Cenozoic terrestrial faunas almost invariably preserve only those taxa with robust skeletons, vertebrate bones and/or gastropod shells, in karst depressions and caves. Other members of the fauna, notably the arthropods, are not preserved and remain unknown because of the very low preservation potential of their poorly mineralized hard parts. The best known exception is the mid-Cenozoic amber of the Dominican Republic (Wu 1996).

Extant terrestrial arthropods are common in Jamaica, but they are rare and poorly known as fossils, and await investigation by systematists. The Red Hills Road Cave (RHRC), parish of St. Andrew, Jamaica, is close to Kingston and just 45 minutes drive from the campus of the University of the West Indies (UWI), Mona. This site preserves an exceptionally diverse fauna of terrestrial vertebrates and invertebrates, dated at about 30,000 years b.p. Vertebrates (Savage 1990) include amphibians, reptiles (including iguana), birds such as the extinct Jamaican flightless ibis, bats and the (now rare) Jamaican hutia (McFarlane and Blake 2005). The terrestrial gastropod fauna is exceptionally diverse (62 species), including both arboreal and ground-dwelling forms (Paul and Donovan 2006). Exceptionally, the RHRC also includes a moderately diverse arthropod assemblage, preserved in unusual circumstances (taphonomy interpreted by Donovan and Veltkamp 1994). What is already known of these arthropods suggests that they are mainly derived from the leaf litter. Taxa known at the beginning of 2007 included at least four species of millipedes, a non-marine decapod, isopods, ostracodes and the pupae of dipterans(?).

The Pleistocene arthropods of RHRC need to be adequately monographed before the sediment of the cave, now exposed to the elements, is lost due to tropical erosion. In consequence, fieldwork in Jamaica in late April 2007 was devoted to bulk processing of unlithified sediment from the RHRC. In fact, there were (and still are) large quantities of unprocessed sediment from this site in the Geology Museum of the Department of Geography & Geology, UWI, Mona. Unfortunately, my collaborator on this project, Professor Trevor Jackson, went into hospital for emergency surgery the day I arrived in Kingston. Discussion with members of the Department indicated that the most time effective methodology would be to process the existing bulk sample, which would both help retard erosion at the RHRC and make available valuable museum space. For this work the Department kindly made available all facilities of their Sedimentology Laboratory.

After wet sieving and drying, a bulk sample of 45 kg of concentrated and highly fossiliferous sediment was produced, divided into a coarser and finer size range. Although dominated by bones and gastropods, arthropods are present. The coarser sediment yielded about 20 fragments of millipedes and some fingers of decapod crustaceans to picking with the naked eye while spread for air drying in Jamaica; further elements have been picked subsequently. The finer fraction, awaiting processing, will, it is anticipated, yield ostracodes and isopods.

Further, Professor Simon Mitchell (UWI) was able to provide a monospecific assemblage of many hundreds of decapod claws and free fingers from a cave, now quarried away, in the parish of St. Elizabeth in western Jamaica. This material has proved to be conspecific with the decapod of the RHRC and represents a new species of the land crab *Sesarma* (*Sesarma*) Say (Collins *et al*. 2009) (Figure 2 herein). Systematic papers on other elements of the fauna will be completed as adequate samples are accumulated through picking.

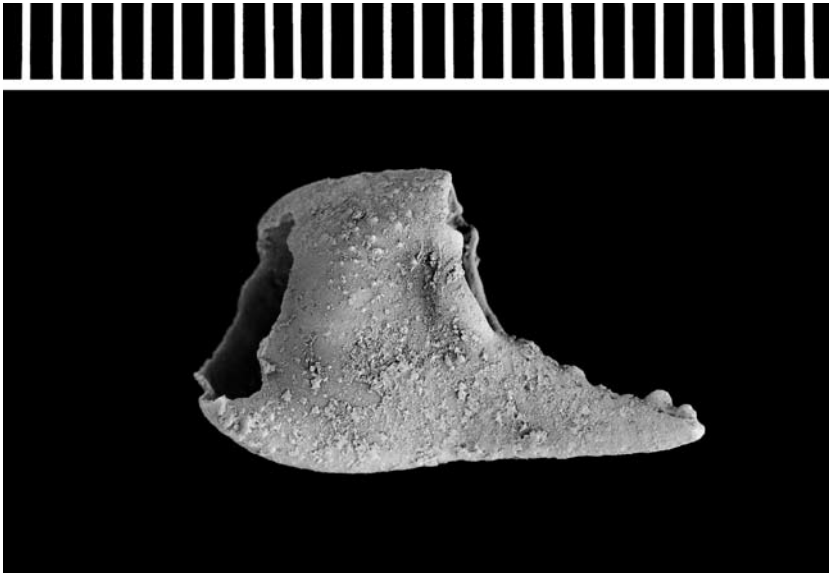

Figure 1. Sesarma (Sesarma) sp. nov. (Collins et al. *2009). Left propodus, inner surface. Scale in mm.*

Acknowledgements

S.K.D. gratefully acknowledges the financial support for his field research in Jamaica provided by the Sylvester-Bradley Fund of the Palaeontological Association and the Nationaal Natuurhistorisch Museum, Leiden. Mr Ian Brown, Professor Simon Mitchell and Dr Tom Stemann (all Department of Geography and Geology, UWI, Mona) facilitated my research in the Department and Geology Museum. Mr Phil Crabb (Photographic Unit, The Natural History Museum, London) kindly provided the image.

REFERENCES

COLLINS, J. S. H., MITCHELL, S. F. and DONOVAN, S. K. 2009 (in press). A new species of land crab, *Sesarma* Say (Decapoda, Brachyura), from the Pleistocene of Jamaica. *Scripta Geologica*.

DONOVAN, S. K. and VELTKAMP, C. J. 1994. Unusual preservation of late Quaternary millipedes from Jamaica. *Lethaia*, **27**, 355–362.

McFARLANE, D. A. and BLAKE, J. 2005. The Late Pleistocene hutias (*Geocapromys brownii*) of Red Hills Fissure, Jamaica. *Geological Journal*, **40**, 399–404.

PAUL, C. R. C. and DONOVAN, S. K. 2006. Quaternary land snails (Mollusca: Gastropoda) from the Red Hills Road Cave, Jamaica. *Bulletin of the Mizunami Fossil Museum*, **32**, 109–144.

SAVAGE, R. J. G. 1990. Preliminary report on the vertebrate fauna of the Red Hills Road cave, St. Andrew, Jamaica. *Journal of the Geological Society of Jamaica*, **27**, 33–35.

WU, R. J. C. 1996. *Secrets of a Lost World: Dominican Amber and its Inclusions*. Privately published, Santo Domingo, 222 pp.

Revision of Mesozoic and Cenozoic chimaeroid fishes (Holocephali, Chimaeroidei) in British museums

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Chimaeroid fishes, of the suborder Chimaeroidei, are a compact group of holocephalian cartilaginous fishes (Holocephali). In the Recent fauna, this suborder is represented by three families, six genera and about 30 species (Didier, 1995), that mainly inhabit deep water (rhinochimaerids, chimaerids) or near-shore environments (callorhynchids). In the fossil record, the Chimaeroidei is known from the early Mesozoic (Pliensbachian, early Jurassic: Ward & Duffin, 1989). The principal fossil chimaeroid material are isolated dental plates (two pairs in the upper jaw – vomerine and palatine plates; one pair in the lower jaw – mandibular plates); rarer are fin spines and frontal claspers, extremely rare are egg case imprints and partial/complete skeletons (Late Jurassic, Germany; Late Cretaceous, Lebanon). The most commonly and best preserved material are the dentitions, which are used for taxonomy.

"Fossil beaks" were first identified by William Buckland in 1835 as dental plates of chimaeroid fishes (Holocephali, Chimaeroidei). After that, during the 19th century many British chimaeroid remains were collected and many new genera and species were published by famous palaeontologists: Agassiz (1843), Egerton (1843), Newton (1878) and Woodward (1891, 1911). As a result, 48 nominal chimaeroid species (33% of all known fossil chimaeroid species; see Stahl 1999) were described based on material from Jurassic, Cretaceous and Palaeogene of the UK. During the 20th century, relatively little new fossil chimaeroid material was collected in the UK, resulting in an absence of any significant publications or revisions in the last 100 years.

However, during this time (and especially in the two last decades), our knowledge of Mesozoic and Cenozoic chimaeroid fishes has increased greatly, based on new material from territories of the former USSR (Russia mainly, but also Ukraine, Kazakhstan, Uzbekistan and Kyrgyzstan). Some of the Russian localities are very rich in chimaeroid material: 5,000+ remains of nine genera and ten species were collected from the Albian–Cenomanian of Stoilenskii and Lebedinskii quarries in Belgorod Province, Russia (Popov & Averianov, 2001). In the course of study of this plentiful material, new methods and approaches (ontogenetic series, dentition reconstructions *etc*.) were applied to chimaeroid material resulting in better understanding of ontogeny and variability of chimaeroid dentitions and review of the systematics and phylogeny of the group (Popov, 2004). This new information is a valuable tool for the re-examination of old British collections.

The Sylvester-Bradley Award allowed me to visit and study British chimaeroid collections. During two and a half months of research (two trips: February and mid-September to October, 2007), all available collections with chimaeroid remains (total 1,800+ specimens) were studied. These included the following institutions: Natural History Museum in London (850+ specimens), Oxford University Museum (50), British Geological Survey, Keyworth, Nottingham (250+), Sedgwick Museum of Earth Sciences, Cambridge University (480+), Booth Museum of Natural History, Brighton (13), Yorkshire Museum, York (60), plus several private collections (Mr. David Ward, Orpington; Mr. Evangelos Matheau-Raven, Peterborough, *etc*.).

The stratigraphical range of the material studied was Early Jurassic (Pliensbachian) to Pliocene, and the geographical distribution was worldwide. All available chimaeroid material was recorded, measured and photographed in order to create a database (with the possibility of making it web-based in the future) for further comparison and revision. Research equipment consisted of two digital cameras (Nikon Coolpix 8400, Canon Ixus 75), tripod, laptop, binocular and measuring instruments (*e.g.* trammel). Photography was usually accompanied by hand drawings with morphological interpretations of specimens studied and remarks. The study of numerous chimaeroid material allowed me to construct ontogenetic series of dentitions to separate taxonomic, ontogenetic characters and morphological intraspecific variability (very high for fossil chimaeroids!) for each nominal species. The analysis of the collection data is still in progress, so some preliminary results are described briefly below.

A large number of chimaeroid fish remains were re-determined in all the collections studied. Data on the British Mesozoic (Jurassic, 25+ localities; Cretaceous, 50+) and Cenozoic (15+) chimaeroid localities were summarized. The taxonomic composition and stratigraphic distribution of the British chimaeroids were revised – significantly in some cases: *e.g.* ten nominal chimaeroid species (*Ganodus oweni*, *G. bucklandi, G. dentatus, G. falcatus, G. neglectus, Ischyodus colei*, *etc*.) from the Bathonian Stonesfield Slate can be reduced to three species and three genera, including a new one. The stratigraphical distribution of some chimaeroid taxa in the British Jurassic and Cretaceous can be extended: a Callovian species of *Pachymylus* was recorded from the British Bathonian (Great Oolite); the Kimmeridgian species '*Brachymylus' minor* Woodward (probably a different genus) was recorded for the Callovian lower Oxford Clay; the Tithonian species *Ischyodus townsendi* Buckland was recorded in the Albian (Gault Clay); callorhynchids (elephant fishes) and some "edaphodontid" genera (*Elasmodus etc*.) were recorded from the British Cretaceous for the first time.

On the other hand, the stratigraphic distributions of several taxa were reduced (*e.g.* '*Ischyodus' incisus* Newton is restricted to Cenomanian Lower Chalk. All Albian '*Ischyodus' incisus* records (Newton, 1878; Woodward, 1891) can be assigned to the genus *Lebediodon* Nessov & Averianov, 1996. The latter genus, previously considered endemic to the mid-Cretaceous of European Russia, was recorded from the British Cretaceous for the first time (Popov, 2007). Several new genera and species will be described from the British Jurassic and Cretaceous, *e.g.* new Albian–Cenomanian *Callorhynchus* species (Popov, in press). The Kimmeridgian chimaeroid complex consists of dentitions of a *Harriotta*-like genus; the first true record of Rhinochimaeridae dentitions in the global Jurassic.

On the whole, the taxonomic composition of the British Jurassic and, especially, Cretaceous chimaeroid fishes is more diverse (particularly at the genus level) than previously regarded, and includes new taxa. The rich and taxonomically diverse chimaeroid assemblage from the Cambridge Greensand is comparable to the late Albian – early Cenomanian chimaeroid complex from Belgorod Province, Russia (Popov & Averianov 2001), but differs from the latter in being more diverse in 'edaphodontids' (*Edaphodon* species), more restricted in callorhynchids with the absence of *Brachymylus* and

rhinochimaerids (*Belgorodon*). Provisional results of the revision of British Cretaceous chimaeroids will be reported on the upcoming international meeting "Evolution and diversity of Chondrichthyans" (Warsaw, 28th July – 2nd August 2008, <**http://www.geo.uw.edu.pl/IGP/IGP/Sharks2008/index.htm**>).

Some results allow a review of the composition of the Eastern-European and Asian chimaeroids faunas and a correction of earlier phylogenetic ideas by the author (Popov, 2004). For example, after study of type material for *Ischyodus latus* Newton (BGS collection), the Russian Cenomanian *Ischyodus* species attributed earlier to this species (Popov & Ivanov, 1996) will be redescribed as a new species.

At the same time, some dentitions in the collections studied need to undergo additional preparation to show the character states. To resolve remaining taxonomic and stratigraphic questions, additional collecting with more precise stratigraphic data is needed, especially for the Chalk formation – most post-Cenomanian occurrences constitute at present questionable records, so the Upper Cretaceous chimaeroid composition of some genera (*e.g. Edaphodon*) is still unclear. The study of chimaeroid fishes from coeval formations (*e.g.* in Belgium) will probably help to solve this problem.

The results for British Cenozoic chimaeroids are more modest due to the relatively small amount of chimaeroid material and to the existence of several good revisions (Gurr, 1963; Ward, 1973, 1980; *etc.*), but some nomenclatural and diagnostic changes will also be made. In addition, the study of Australian, American and Antarctic chimaeroid material deposited in the BMNH was undertaken and it will also result in a more precise understanding of the phylogeny and evolution of the Chimaeroidei during Mesozoic and Cenozoic.

Acknowledgements

I am most happy to thank the Palaeontological Association for the Sylvester-Bradley Award that made this research possible. I am greatly indebted to David and Alison Ward for their hospitality during my stay in London and support during all stages of this research; to Dr Charlie Underwood (Birkbeck College, London) and Prof. Evgenii Pervushov (Saratov University) for support of the research, to Dr Chris Duffin (Sutton, Surrey) for useful discussions about chimaeroid fishes and providing access to photographs of chimaeroid plates from the BM (Brighton) collection. The following persons kindly gave me access to chimaeroid collections under their care: Dr Zerina Johanson and Ms Alison Longbottom (NHM, London), Dr Dan Pemberton (SM, Cambridge), Dr Mike Howe (BGS, Keyworth), Mr Paul Jeffery (OUM, Oxford), Dr Camilla Nichol (Yorkshire Museum, York), Mr David Ward (Orpington) and Mr Evangelos Matheau-Raven, Peterborough; collections assistants at the Sedgwick Museum (Cambridge); Mr Matt Lowe (now of the Museum of

The author, visiting the Natural History Museum, London, studying chimaeroid collections, September 2007.

Zoology, Cambridge University) and Mr Matt Riley were helpful with collections of the SM, and Ms Louise Neep with collections of BGS. My English was improved by David J. Ward. To all, my sincere thanks. Partial funding for a second trip to England (mid September–October 2007) was made by the President of Russia's grant MK-2843.2007.5.

REFERENCES

AGASSIZ, L. 1843. (1833–1843). *Recherches sur les poissons fossils*. – **3**, p. viii + 390 + 32, (Petitpierre), Neuchâtel and Soleure.

BUCKLAND, W. 1835. A notice on the fossil beaks of four extinct species of fishes, referable to the genus Chimaera, which occur in the Oolitic and Cretaceous formations of England. *Proceedings of the Geological Society*, London. **2** (42): 205–206. London.

GURR P. R. 1963. [for 1962]. A new fish fauna from the Woolwich Bottom Bed (Sparnacian) of Herne Bay, Kent *Proceedings of the Geologists' Association*. **73**: 419–447.

DIDIER, D. A. 1995. Phylogenetic Systematics of Extant Chimaeroid Fishes (Holocephali, Chimaeroidei). *American Museum Novitates*, **3119**: 1–86.

EGERTON, P. G. 1843. On some new species of fossil chimaeroid fishes, with remarks on their general affinities. *Proceedings of the Geological Society, London*, **4** (94): 153–157.

NEWTON, E. T. 1878. The chimaeroid fishes of the British Cretaceous rocks. *Memoir of the Geological Survey. United Kingdom*, **4**:1–62. London.

POPOV, E. V. 2004. *Cretaceous and Paleocene chimaeroid fishes (Holocephali, Chimaeroidei) from the south of European Russia (morphology, systematic, stratigraphical distribution).* Ph.D. thesis. pp. 1–430. Saratov State University. Saratov. [in Russian]

POPOV, E. V. 2007. The first records of the Cretaceous chimaeroid fish genus *Lebediodon* Nessov and Averianov, 1996 (Holocephali, Chimaeroidei, 'Edaphodontidae') from Western Europe. In: G. E. Budd & al. (eds.) *The Palaeontological Association, 51st Annual Meeting. Abstracts*, p. 80. Uppsala.

POPOV, E. V., in press. A new chimaeroid species of the genus *Callorhinchus* (Holocephali: Chimaeroidei) from the Albian–Cenomanian of Russia and England. Paleontol. J., MAIK "Nauka/Interperiodica".

POPOV, E. V. and AVERIANOV, A. V. 2001. Early Cretaceous holocephalans from Belgorod Province, Russia: the Mesozoic success of a Paleozoic group. In: "Obruchev Symposium Evolutionary Palaeoichthyology". Programme and Abstracts Volume. *Palaeontological Institute of the RAS*, pp. 41–42. Moscow.

POPOV, E. V. and IVANOV, A. V. 1996. "Vacillating trends" in the morphogenesis of the Cretaceous–Paleogene Ischyodus species (Chimaeroidei, Edaphodontidae). In: "*Geological sciences – 96*": The collection of materials of the scientific conference, "College" Publishing, pp. 53–57. Saratov: [In Russian]

STAHL, B. J. 1999. *Handbook of Paleoichthyology. Part 4. Chondrichthyes III. Holocephali.* H-P Schultze (Ed.), pp. 1–164. Verlag Dr. Friedrich Pfeil; Munchen.

WARD, D. J. 1973. The English Palaeogene Chimaeroid Fishes *Proceedings of the Geologists' Association.* **84**(3): 315–330.

WARD, D. J. 1980. The distribution of sharks, rays and chimaeroids in the English Palaeogene. *Tertiary Research* **3**(1): 13–19.

WARD, D. J. and DUFFIN, C. J. 1989. Mesozoic Chimaeroids 1. A new chimaeroid from the Early Jurassic of Gloucestershire, England. *Mesozoic Research*, **2** (2): 45–51. Leiden.

WOODWARD, A. S. 1891. *Catalogue of the fossil fishes in the British Museum (Natural History).* Pt. **2**, pp. 1–567. London.

WOODWARD, A. S. 1911. The *Fossil Fishes of the English Chalk.* Palaeontological Society Monograph, Part. VI. p. 185–224. London.

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Book Reviews

The Age of Everything. How Science Explores the Past

Matthew Hedman (2007) The University of Chicago Press, Chicago, ISBN 978-0226322926 (hardback) £14.00.

The title of this book is an irresistible come-on for a geologist, especially this reviewer, who has had a life-long interest in geochronology. The publisher's blurb promises that the book will lay bare the tricks of the scientist's trade revealing how we reconstruct the distant past. I cannot wait. This is heady stuff. Someone has written our collective biography.

The author is an astronomer / physicist and evidently an enthusiastic and effective teacher – the introduction includes an attractive diagram showing a series of pseudo-stratigraphic sections each 50 times longer than its neighbour to illustrate the "timescales of the universe". He also offers a list of "useful" "rules of thumb" to help the reader to get to grips with the central theme – how the collective "we" know the age of "things". I like this – we need all the help we can get to appreciate the vastness of time and to put our miserable insignificant selves into context. We are thus reminded that recorded history is about twenty times as long as the history of the United States. Many of us could probably calculate that the last giant dinosaurs ("giant", presumably to exclude the birds) are about ten times as old as the earliest bipedal hominids, but are the data sufficiently robust to accept that human ancestors have been walking upright for about thirty times as long as modern humans have been around?

If Hedman's purpose is to explain how Science quantifies the past, he chooses a strange example in Chapter 1 – the mysterious hieroglyphic Mayan Calendar – to whet our appetites. No doubt deciphering the Mayan chronology was an epigraphic tour de force and a great achievement – but it was hardly Science: we have no proof, no independent record. There is no doubting, as Hedman reminds us, that accurate dates provide a fascinating insight into the otherwise obscure world of the Maya. But an internally consistent record of events is not enough. It is still a relative chronology and difficult, if not impossible, to test.

Chapter 3 fares little better, being an account of the drift rate test of astronomical alignments of the great pyramids of Egypt. Intuitively, it all seems to make sense but again, it is not scientific dating.

In the following three chapters, Hedman is on firmer scientific ground and treats the reader to a splendid account of the science behind ^{14}C dating, including an amusing account (in chapter 5) of his own undergraduate insight into the subject. In addition to calculating a "radiocarbon" age given the fact that a particular piece of charcoal has a relative activity of 0.18, Young Hedman

offers several issues for consideration – contamination, natural fluctuation in the production of ^{14}C and the possible time gap between the death of the tree and its ending up in the fire! Elder Hedman deals with all of these issues in some depth, ending in Chapter 6 with a re-assessment of the evidence for the earliest human activity in the Americas. If you ever need to argue with a Creationist, these and the following chapters provide excellent ammunition.

Chapter 7 provides a good account of potassium-argon dating especially as applied to the classic hominid fossil sites, and is followed by a very clear account of the molecular dating method including its assumptions and limitations. By now I am warming to Hedman's Science. Chapter 9 is a little too concise considering the subject is the dating of meteorites and the age of the solar system. Here we have Hedman's rather idiosyncratic but effective explanation of the isochron method of dating, illustrated using the Rb-Sr isotopic system. There follows an all too brief account of attempts to date events in the first few million years of the solar system – the joys of CAIs and ^{26}Al – and a cursory yet effective account of the exquisite precision recently achieved by the likes of Yuri Amelin using the U-Pb dating method. I detect the heavy hand of an editor and wish (s)he had intervened in Chapter 2. How many Mayan Tzolki'ns equal one interplanetary collision, or one self-melting planetismal?

The final three chapters take us into cosmology – Hedman's own professional field. You have to admire an author who can lucidly introduce General Relativity, explain and illustrate the results of the Sloan Digital Sky Survey and set aside the popular misconception that the galactic redshifts are akin to an approaching celestial fire engine – all in one chapter. We learn that by independent methods there are limits to the age – 13.5 billion years to be precise – of at least our part of the universe.

All in all, what we have is a rounded illustration of Hedman's attempt to convey the scale of time and the different approaches that Science has used to calibrate it. A final chapter might have taken the opportunity to evaluate the success (or otherwise) of the enterprise. A geologist, for example, would surely have told us that different methods provide persuasive agreement in determining the ages of key events in Earth history, that we have at our disposal a calibrated geological timescale firmly founded in stratigraphy. At the very least the sceptic needs to know that, routinely, when we apply the appropriate methods, our results conform to the most rigorous test of all – they fit the field relationships!

But, would I recommend this book? Yes! Hedman entertains and informs in an engaging style. Moreover each chapter provides appropriate key references and suggestions for further reading. Having decided that I like the overall result, I am inclined to speculate that the author was not responsible for the publisher's blurb. All in all, the book succeeds in getting across how scientific dating is done, but makes no claim that this is its exclusive purpose. At only £14 the book is very good value and could be the perfect birthday present, not least for the chronologically challenged.

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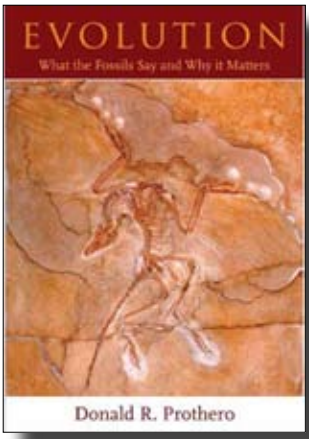
Evolution: What the Fossils Say and Why It Matters

Donald R. Prothero (2007). Columbia University Press, New York,
ISBN 978-023113962-5 (hardback) $29.50 / £17.50.

Where do I start my review? Well, I suppose, with a question: why did I want to read this book, and once I had, were my expectations of it fulfilled? The first question is simple to answer. The illustrations that appear throughout the book appeared (along with an all too brief synopsis) on P. Z. Myers' excellent blog *Pharyngula*. Seeing this, I thought that this book would provide just the information on evolution that I needed for a course I was giving on evolution and vertebrate zoology. By the time the book became available in the UK, I had completed the course. However, the front cover bears a photo of the Berlin Archaeopteryx (always enough to part me from my money), so I got it anyway. I am very pleased that I did, which I suppose answers the second question.



When my copy arrived, I started it immediately, but wait a moment – the first 140 pages do not mention fossils in much detail! The reason is simple; this book is not a tome on fitting fossils onto trees, leaving it at that. Donald Prothero has set out to demonstrate the primacy of evolution as a means to understand the world around us, the plants and animals that we see in it, and he has done a great job.

The first part of the book, the relatively fossil free 140 pages, goes straight to the heart of the problem facing Evolutionary Biology today. This is of course religious fundamentalism, and its enfant terrible, Intelligent Design. Prothero elegantly frames the questions that arise from the misunderstandings that relate to all things Darwinian, while explaining such events as the Scopes Monkey Trial, and the work of the Institute of Creation Research (the ICR), and Intelligent Design-Creation Science (surely an oxymoron). Along the way Prothero provides an interesting window through which to observe US politics, and his experiences of debating ID luminaries in the public arena. This first section of the book is really fascinating. Without doubt the ICR will say this is an unwarranted attack on their 'good work', showing an obvious pro-evolution bias.

However, if Prothero's experiences are the norm, it seems that there is little that proponents of ID have not done to discredit evolutionary science. Whether it is using 20 year old, out of date, material, a basic misconception about what evolutionary biology is saying about the world, or working from the premise that evolutionary scientists are the mouthpiece of the 'evil one', ID-ers are out there trying to win hearts and minds with a strategy of shock and awe (modern day fire and brimstone). Prothero provides quotations from many of ID's strongest advocates and US politicians, who state plainly that no amount of evidence will make them turn away from scripture. Clearly, this is a worrying situation to be in, because Evolution is not consistent with biblical literalism. Trying to make sense of Noah's flood by studying 'Flood Geology' is nonsensical. However, this being the case, there are US biology teachers unwilling to teach evolution for fear of reprisals from parents, and many US politicians who would have creationism taught as historical fact to five-year olds. Alongside this, part 1 also gives a concise outline of the philosophy of science, and the history of the theory that eventually found itself in Darwin's capable hands.

Part 2 and the remainder of the book should do for ID once and for all. Prothero describes how something that the unholy grail that ID-ers call for evolutionary biologists to provide them with, if our claims be true, is transitional forms. If fish became amphibians, where are the 'fishibian' fossils to support this idea?

Well, as if to answer immediately, Prothero sets the rest of the book off with a subtitle – 'Part II: Evolution? The Fossils Say YES!' – and a picture of *Tiktaalik*, surely the transitional form that ID-ers want? Prothero seems to have answered 'what the fossils say' in a single picture, but why stop at one picture when the fossil record is so good? ID-ers are never happy. Give them one missing link, and soon they will be wanting more. Missing links are awkward; find one, and you automatically generate room for two more. As Prothero explains: if you have a branching tree there is one gap between any two taxa. However, if you provide the missing link (for example between 'fish' and 'amphibians', that is, *Tiktaalik*) you are asked for two more missing links, those between fish and *Tiktaalik*, and between *Tiktaalik* and amphibians. To the ID-er evolution is still unsupported. Prothero explains well that the transitional form is really only an organism with more derived characters than the taxon below it in the tree, but fewer such characters than the taxon directly above it. There is no smooth smear from organism to organism, and the idea of a ladder of evolutionary progress is also inaccurate, evolution is actually more 'bush-like'. Prothero uses this part (almost two thirds) of the book to fill out some of the most interesting of evolution's bushy bits. This second part of the book was what I had expected from the outset. Chapter by chapter, different groups are described and the quality of their fossil records substantiated. Small-shelly fossils; the fish-amphibian transition; hoofed mammals; artiodactyls to whales; perissodactyls to horses; dinosaurs to birds; and man, are all analysed, and all have surprisingly good fossil records. Of course, none are good enough to convince those who won't be convinced, but it is a great place to start if you want to try communicating science to people with an open mind.

Colour illustrations of various fossil taxa are confined to the dozen or so central plates, but the book is full of pictures, diagrams and reconstructions, both original and refigured and redrawn, mostly by Carl Buell. This does make the book accessible to anyone that wants to pick it up.

My main criticism is when molecular biology is discussed. In many cases molecular biology corresponds with the morphological evidence well, but not always. Unlike the way Prothero describes in the book, molecular biology has shown that urochordates have usurped amphioxus for the title of sister to the vertebrates, and hemichordates now sit in a similar position with the echinoderms (the Ambulacraria). This is a small concern in the general scheme of things but, if science changes as new evidence comes to light (as it undoubtedly does) and this is claimed in the text, it would have been good to see this here.

Overall this book is excellent. It sets out the agenda of ID/creation science and provides data that can be used to combat it. Why, do you ask, is such a book relevant to those, for example, in the UK? My answer is simple. ID is here, and we do not have the luxury of the separation of church and state enshrined in our constitution. This has been the single reason that ID has always failed to gain recognition in the US, because it has been seen for what it is – "religion wearing a labcoat" – so it is illegal to teach it in US schools. With the increase in donations being accepted from the owners of car dealerships, fast food outlets or other businesses to fund public (state) schools in the UK, and potentially influence the curriculum taught, businessmen with their own agendas may subvert the teaching of good science.

Prothero explains the issues in this debate, and why the public does not understand evolution. Time and again, he pulls at the threads in the arguments woven by the ID-ers until they fall apart. The take-home message from this book is simply this, get out there and talk to people – yes, the general public – because if you don't engage, someone else will. It is our job to educate. I will be recommending this book to students, and indeed anyone with an interest in evolution, and will be passing my review copy to a colleague. This text will help when framing the ID/Evolution debate for lectures to both undergraduates and the public alike. However, even if you don't want to go outside and debate ID-ers in public, you should read this book. It explains clearly the issues that science educators are coming up against more and more often, when simply trying to do a job.

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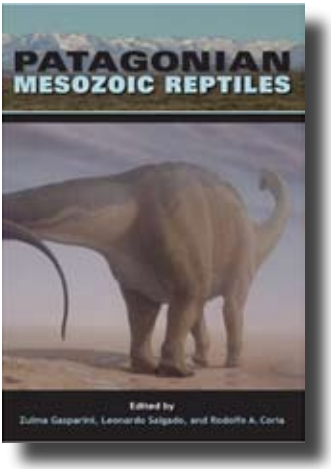
Patagonian Mesozoic Reptiles

Zulma Gasparini, Leonardo Salgado and Rodolfo A. Coria (eds) (2007). Indiana University Press, Bloomington and Indianapolis. 374pp. ISBN 978-0-253-34857-9, $49.95US (hardback).



While the Mesozoic strata of Patagonia are particularly well known for their diverse and often spectacular dinosaurs, they have also yielded a phenomenally rich record of other Mesozoic reptiles, including turtles, squamates, plesiosaurs, ichthyosaurs, crocodilians and pterosaurs. In this multi-authored volume (another contribution to Indiana University Press' *Life of the Past* series), Gasparini, Salgado and Coria have edited a collection of 14 papers on the region's Mesozoic reptiles, and on their geological context and history of discovery. The volume is well illustrated, and an excellent selection of colour plates – featuring life restorations, specimen photos and palaeogeographical maps – is included.

Patagonia has a long and rich history of palaeontological exploration, and in the first chapter of the volume Leonardo Salgado reviews the contributions of Florentino Ameghino, Francisco Moreno, Richard Lydekker, Santiago Ross, their contemporaries and successors, as well as the recent contributions of José Bonaparte and colleagues. The 19th and 20th century palaeontological exploration of Patagonia went hand in hand with exploration in general. The belief that Patagonia was a sort of savage 'lost world' inhabited by primitive people and living prehistoric beasts, including living ground sloths and plesiosaurs, fuelled the imaginations of explorers, scientists and the general public. Luis Spalletti and Juan Franzese provide a well-illustrated and useful overview of Patagonia's palaeogeography.

An impressive list of Mesozoic testudines are known from Patagonia: they include notoemydids, chelids, podocnemidoids, meiolaniids and pancheloniids. As you might have guessed from the term

pancheloniid, the author of this chapter (Marcelo de la Fuente) adopts and uses the phylogenetic nomenclature used for turtles by Joyce *et al.* (2004). In the following chapter, Adriana Albino reviews Patagonia's Mesozoic sphenodontians and squamates: the chapter should therefore have been titled 'Lepidosauria' but instead bears the name 'Lepidosauromorpha'. This is slightly surprising as, while the term Lepidosauromorpha is still used (*e.g.*, Müller 2003), its content is often now very different from that originally envisioned.

Patagonia's Mesozoic lepidosaurs include a diverse assemblage of madtsoiid snakes, the controversial *Dinilysia*, and indeterminate iguanian and mosasaur remains. One of Patagonia's best represented fossil lepidosaurs is the particularly large Upper Cretaceous sphenodontian *Kaikaifilusaurus calvoi*, known from multiple skeletons from the Cenomanian Candeleros Formation. Prior to reading Albino's chapter, I hadn't realised that this is the same thing as *Priosphenodon avelasi*, the name that Apesteguía and Novas (2003) coined for this taxon in a paper that was published in *Nature* about a month after *Kaikaifilusaurus* was. *Kaikaifilusaurus* was based on a single lower jaw.

One of the most interesting aspects of Cretaceous palaeoecology demonstrated by Patagonian fossils is that the Mesozoic wasn't a dinosaurs-only theme park where other terrestrial animals were restricted to small body size and a furtive life in the shadows, as is so often stated. Semi-terrestrial and terrestrial crocodilians (or crocodyliforms, whichever you prefer) were diverse, and abundant, *and* reached large size during the Cretaceous; Patagonian fossils in particular have demonstrated this. Diego Pol and Zulma Gasparini here review Patagonia's metriorhynchids, notosuchians, sebecosuchians and peirosaurids. Some of these animals were morphologically bizarre, with dental and cranial specialisations demonstrating diverse lifestyles including herbivory.

Pterosaurs are reviewed by Laura Codorniú and Zulma Gasparini: the Patagonian pterosaur record is not exceptionally diverse – and indeed some groups are only represented by indeterminate fragments – but the incredible Loma del Pterodaustro quarry has more than made up for this by revealing a wealth of palaeobiological data on the multi-toothed filter-feeding ctenochasmatoid *Pterodaustro*. *Puntanipterus globosus*, supposedly diagnosed by detailed features of its tibiotarsus, is argued here to be synonymous with *Pterodaustro*, as relatively uncrushed tibiotarsi of *Pterodaustro* are essentially identical to the *Puntanipterus* holotype. New comments are provided on tiny *Herbstosaurus*: the authors are sceptical of Unwin's (1995, 2003) proposal that this taxon is a dsungaripteroid. Unfortunate errors over measurements mean that MOZ 3625P, an indeterminate subadult pterodactyloid from the Vaca Muerta Formation, is said to have a wingspan of either 109.74 mm or 105.75 mm [sic, p. 154], depending on how the wingspan is estimated. This would make MOZ 3625P the tiniest pterodactyloid currently recognised, but, alas, the scale bar in Codorniú and Gasparini's Fig. 6.8, and their description later on the same page of a 1.10 m wingspan in the same specimen, demonstrates that these are typographical errors. An ornithocheiroid fragment and various indeterminate pterodactyloid remains are also described; most tantalizing is their frustratingly brief mention of an azhdarchid ulna from the Turonian–Coniacian Portezuelo Formation. One recent discovery that the authors weren't able to include in their review is that of an apparently basal pterosaur in the Candeleros Formation at the famous 'La Buitrera' locality (Apesteguia *et al.* 2007). If this identification is correct it shows, contrary to all expectations, that 'rhamphorhynchoid' pterosaurs persisted until the Upper Cretaceous.

Ornithischian dinosaurs are reviewed by Rodolfo Coria and Andrea Cambiaso. Patagonia's ornithischian diversity is not on a par with that of its saurischians: there are a few thyreophoran fragments, a partial maxilla from a heterodontosaurid, and about six ornithopods. Also worthy of note is the controversial *Notoceratops bonarelli*, originally described as a ceratopsian but, as noted here, is probably not. The only known specimen is now lost, which never helps (in his chapter on the history of research in Patagonia, Salgado notes that Augusto Tapia originally found more pieces of the *Notoceratops* skeleton, but failed to collect them). Why Patagonian ornithischians are low in diversity compared to those of Laurasian strata is an interesting question. Does it reflect biogeographical control, or occupation of the relevant ecological niches by members of other clades? Coria and Cambiaso suggest that it doesn't and merely reflects biases in the fossil record. They do not elaborate on this cryptic suggestion when I really think they should have. A single cervical vertebra from the La Amarga Formation was identified by Bonaparte (1996) as stegosaurian: Coria and Cambiaso note that the similarity between the specimen and definite stegosaur vertebrae is indeed striking, but the La Amarga specimen differs from indisputable specimens in having a far narrower neural canal, which makes me nervous about the identification. The Laguna Colorado Formation heterodontosaurid is referred here to *Heterodontosaurus*, making this one of few ornithischian genera reliably reported from more than one continent.

The Cretaceous strata of Patagonia are particularly well known for their sauropodomorphs, and yes I do mean sauropodomorphs and not sauropods because – in addition to Jurassic cetiosaur-grade taxa and Cretaceous titanosaurs – Patagonia has also yielded the plateosaur *Mussaurus*. In their review, Leonardo Salgado and José Bonaparte briefly survey Patagonia's sauropodomorphs: much of this feels familiar in view of papers by Salgado & Coria (2005) and Coria & Salgado (2005). And, oh no, not another taxonomic name for a titanosaur clade: the new name Saltasaurini is coined here for 'the less [sic] inclusive clade containing *Saltasaurus loricatus* and *Neuquensaurus australis*' (p. 213). Given that titanosaur cladograms currently vary from one study to the next, I do not feel that the coining of new clade names is proving useful.

Somewhat odd is Salgado and Bonaparte's quoting of Bonaparte's 1999 statement (here translated into English) in which Bonaparte proposed that dicraeosaurids might 'correspond to the level of *Patagosaurus* or an even more primitive one'. It was the small size, reduced pneumaticity compared to other neosauropods and a relatively low number of cervical vertebrae that led Bonaparte to this singular conclusion: as Salgado and Bonaparte state here, this view has not been supported in any recent studies (all of which have found dicraeosaurids to be the sister-taxon to Diplodocidae), but their discussion of Bonaparte's proposal as a 'last word' on this group implies that it deserves merit. It probably doesn't.

Rodolfo Coria reviews non-avian theropods. As with some of the other chapters in the volume, there is little new here if you're familiar with the primary literature. Patagonian theropods include some of the most exciting of recently described dinosaurs: the fantastic abelisaurs *Carnotaurus*, *Aucasaurus* and *Velocisaurus*, the immense carcharodontosaurids *Giganotosaurus* and *Tyrannotitan*, the long-skulled unenlagiine maniraptorans, the alvarezsaurids *Alvarezsaurus* and *Patagonykus*, and others. But Coria's chapter is confused by statements that are both contradictory and incorrect, and, in my opinion, make this the most problematical contribution in the book.

In discussing the maniraptorans *Neuquenraptor*, *Unenlagia comahuensis* and *U. paynemili*, Coria first notes that the close association of three similar, closely related taxa within the same unit (the

Portezuelo Formation) is surprising and indicative of high diversity. I remain perplexed why some palaeontologists often state that the presence of more than two similar contemporaneous species is at all unusual given that several or many close relatives are usually contemporaneous in modern faunas. Coria also implies, however, that *Neuquenraptor* and *Unenlagia* might be synonymous, and furthermore argues that 'there is no support to distinguish between' *U. comahuensis* and *U. paynemili* (p. 252). Elsewhere in the text however, Coria argues that *U. paynemili* was not convincingly shown by its describers (Calvo *et al.* 2004) to be referable to *Unenlagia*, and he notes that Novas and Puerta (1997) suggested that *U. paynemili* might represent a distinct genus. The section ends with the assertion that *U. paynemili* should be regarded as a *nomen vanum*, by which I assume that Coria means that the taxon should be regarded as a *nomen dubium*. By now you might be confused as to what Coria really makes of this taxon … or taxa, and I know I am.

While phylogenetic analyses have found pretty good support for the placement of unenlagiines within Dromaeosauridae, Coria suggests that the resemblances between the South American and Laurasian taxa might actually be due to convergence. It's fine to speculate about such a possibility I suppose, but it should always be made clear that convergence shouldn't be invoked simply because it *might* have occurred, but rather only when character analysis finds it to be the best conclusion based on the data. Some rather unique spellings are used for taxonomic names in this chapter, my favourite being *Deynokeirus* [sic] for *Deinocheirus*, and a skeletal reconstruction of *Unenlagia comahuensis* is not credited to its creator, Jaime Headden.

Finally among dinosaurs, the birds are briefly reviewed by Luis Chiappe. Patagonia's Mesozoic birds include the enantiornithine *Neuquenornis*, the stem-ornithuromorphans *Patagopteryx* and *Limenavis*, and the diver *Neogaeornis*. Less well known is a possible galliform from the Portezuelo Formation (represented only by a coracoid), the second Mesozoic record of this clade.

Ichthyosaurs have been known from Patagonia since the 1890s and good remains have been reported since the 1930s. Marta Fernández here covers the Jurassic and Cretaceous ichthyosaurs from the region, three of which were named during the 1990s (*Chacaicosaurus cayi*, *Caypullisaurus bonapartei* and *Mollesaurus periallus*). *Chacaicosaurus* is here referred to *Stenopterygius* on the basis of forelimb and skull features. *Caypullisaurus* apparently crossed the Cretaceous–Jurassic boundary as it is present in both the Tithonian and Berriasian. *Mollesaurus* – argued by Maisch and Matzke (2000) to be synonymous with *Ophthalmosaurus* – is shown to differ from *Ophthalmosaurus* in many significant details, but the proportionally small sclerotic ring in the holotype (the key character used by McGowan and Motani (2003) to show that Maisch and Matzke had erred in their synonymisation) is argued by Fernández to be an unimportant consequence of ontogeny. That sounds unlikely given that proportional sclerotic ring size doesn't seem to change markedly during ichthyosaur ontogeny.

Stenopterygius and *Ophthalmosaurus* give the ichthyosaur assemblage of Patagonia a 'European' feel. This doesn't entirely reflect my Eurocentric bias as a strong biogeographical link between Jurassic Europe and South America is inferred on the basis of other faunal similarities; having said that, pelagic taxa like *Ophthalmosaurus* apparently had a near-global distribution in the Jurassic. A similar comment could be made about the plesiosaurs if, that is, the identification of *Liopleurodon* and *Pliosaurus* in Patagonia is correct. Other Patagonian plesiosaurs include the Middle Jurassic *Simolestes*-like *Maresaurus*, the polycotylid *Sulcusuchus*, and the unusual polyodont *Aristonectes*. The Maastrichtian elasmosaurids *Tuarangisaurus* and *Mauisaurus* are shared, respectively, with Australia

and New Zealand. Gasparini reviews all of these taxa, and provides discussion of their biogeography and distribution. The volume ends with Jorge Calvo's review of tracks, and with an overview of Mesozoic Patagonian reptiles produced by the volume's editors.

Overall it's good to see a book on Mesozoic reptiles that does more than just cover the dinosaurs, and it's nice to see the diversity of fossil turtles, squamates, crocodyliforms and marine reptiles promoted. New data and interpretations of Patagonian pterosaur, ichthyosaur and plesiosaur taxa will mean that this volume should certainly be consulted by workers who specialise on these groups, and people interested in Mesozoic faunas and fossil reptiles in general should find it useful. Weaknesses include the fact that the English is a bit shaky in some of the chapters, if not downright confusing in others, and the editing was inadequate to non-existent in places.

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REFERENCES

APESTEGUÍA, S. and NOVAS, F. 2003. Large Cretaceous sphenodontian from Patagonia provides insight into lepidosaur evolution in Gondwana. *Nature*, **425**, 609–612.

APESTEGUÍA, S., ÖSI, A. and HALUZA, A. 2007. New pterosaur remains from the Late Cretaceous of Argentina and an evaluation of the Late Cretaceous South American record. In HONE, D. (ed) Flugsaurier – the Wellnhofer Pterosaur Meeting. Bavarian State Collection for Palaeontology (Munich), unpaginated.

BONAPARTE, J. F. 1996. Cretaceous tetrapods of Argentina. *Muncher Geowissenschaften, Abhandlungen*, **30**, 73–130.

CALVO, J. O., PORFIRI, J. D. and KELLNER, A. W. A. 2004. On a new maniraptoran dinosaur (Theropoda) from the Upper Cretaceous of Neuquén, Argentina. *Arquivos do Museu Nacional, Rio de Janeiro*, **62**, 549–566.

CORIA, R. A. and SALGADO, L. 2005. Mid-Cretaceous turnover of saurischian dinosaur communities: evidence from the Neuquén Basin. In VEIGA, G. D., SPALLETTI, L. A., HOWELL, J. A. and SCHWARZ, E. (eds) The Neuquén Basin, Argentina: A Case Study in Sequence Stratigraphy and Basin Dynamics. *Geological Society, London, Special Publications*, **252**, 317–327.

JOYCE, W. G., PARHAM, J. F. and GAUTHIER, J. A. 2004. Developing a protocol for the conversion of rank-based taxon names to phylogenetically defined clade names, as exemplified by turtles. *Journal of Paleontology*, **78**, 989–1013.

MAISCH, M. W. and MATZKE, A. T. 2000. The Ichthyosauria. *Stuttgarter Beiträge zur Naturkunde Serie B (Geologie und Paläontologie)*, **298**, 1–159.

MCGOWAN, C. and MOTANI, R. 2003. *Handbook of Paleoherpetology*. Part 8: Ichthyopterygia. Verlag Dr. Friedrich Pfeil, München.

MÜLLER, J. 2003. Early loss and multiple return of the lower temporal arcade in diapsid reptiles. *Naturwissenschaften*, **90**, 473–476.

NOVAS, F. and PUERTA, P. F. 1997. New evidence concerning avian origins from the Late Cretaceous of Patagonia. *Nature*, **387**, 390–392.

SALGADO, L. and CORIA, R. A. 2005. Sauropods of Patagonia: systematic update and notes on global sauropod evolution. In TIDWELL, V. and CARPENTER, K. (eds) *Thunder-Lizards: The Sauropodomorph Dinosaurs*. Indiana University Press (Bloomington & Indianapolis), pp. 430–453.

UNWIN, D. M. 1995. Preliminary results of a phylogenetic analysis of the Pterosauria (Diapsida: Archosauria). In SUN, A. and WANG, Y. (eds) *Sixth Symposium on Mesozoic Terrestrial Ecosystems and Biota, Short Papers*. China Ocean Press (Beijing), pp. 69–72.

UNWIN, D. M. 2003. On the phylogeny and evolutionary history of pterosaurs. In BUFFETAUT, E. and MAZIN, J.-M. (eds) Evolution and Palaeobiology of Pterosaurs. *Geological Society Special Publication* **217**. The Geological Society of London, pp. 139–190.

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VOLUME 51 • PART 1

CONTENTS

Palaeontology

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Deadline for copy for Issue No. 68 is 16th June 2008.

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