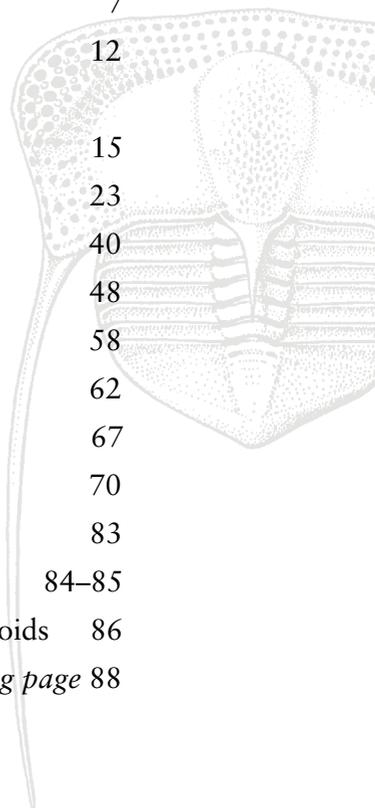


The Palaeontology Newsletter

81

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Reminder: The deadline for copy for Issue no 82 is 11th February 2013.

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

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Editorial

My first year as editor draws to a close with *Newsletter* 81, the biggest job of the year, as the Annual Meeting section needs to be compiled alongside the regular elements of the *Newsletter*. The arrival of this Newsletter either by post or by PDF download from the Pal Ass website heralds the coming of the Annual Meeting, which is the time when Council have the greatest opportunity to hear from members of the Association. So if there is something you want the Association to do, or – even better – something you want to do for the Association, speak to us in Dublin if you're there. A list of Council members can be found in the Newsletter, along with many other items relating to Association business and activities.

The Annual Meeting will see the launch of the first issue of *Virtual Palaeontology*, continuing the trend to moving more and more activity to cyberspace. Tim Palmer has sent an article explaining how to access the online back numbers of *Palaeontology*, and Progressive Palaeontology 2012 made audio files available of all talks. *Palaeocast* has started to broadcast podcasts on palaeontological topics with financial support from the Association.

As Newsletter Editor, I have to consider, as have the last few editors, the pros and cons of continuing to distribute a printed version of the *Newsletter* alongside the PDF version that is downloadable from the website, and I plan to present a short report to Council on this issue next year. I would wish to be able to do this with some indications of the thoughts of the membership about the matter.

Producing the print version of the *Newsletter* obviously has attendant costs for the Association beyond those of producing an electronic version. Cory Doctorow, a writer, blogger and advocate of using free ebooks to enhance the sales of printed books, argues that people use electronic and printed versions of the same texts differently, and at present this is the model we operate for the *Newsletter*. A text search for 'ammonoid' in the electronic version of the Annual Meeting abstracts is easier and more accurate in a PDF than a skim through the printed version. Yet many people, including the session chairs, will rely on printed versions of the material at the meeting. We can send electronic copies of the *Newsletter* to anyone who is interested anywhere in the world, at nearly zero cost. In short, my position is that both formats are useful, although in different contexts.

So it is over to you, as members of the Association, to let me know what you think about maintaining the current situation. Tim Palmer has pointed out to me that only one member has opted out of receiving a print copy of the *Newsletter*, but admits that we don't know if this is because people enjoy and value the *Newsletter* or simply can't be bothered to email him to opt out. An intermediate option might be to send out print copies of the *Newsletter* only for the Annual Meeting edition, which would offer some savings. The only downside, as Nick Stroud, our production editor, observed when we discussed this issue, is that the picture being built up in slices, like an image stack in the latest virtual dissection techniques, wouldn't be completed. Can you guess what it is yet?

Al McGowan

University of Glasgow

Newsletter Editor

<newsletter@palass.org>



Association Business

Annual Meeting 2012

Notification is given of the 56th Annual General Meeting and Annual Address.

This will be held at the University College Dublin on 17th December 2012, following the scientific sessions.

AGENDA

1. Apologies for absence
2. Minutes of the 55th AGM, Plymouth University
3. Trustees Annual Report for 2011
4. Accounts and Balance Sheet for 2011
5. Election of Council and vote of thanks to retiring members
6. Report on Council Awards
7. Annual address

DRAFT AGM MINUTES 2011

Minutes of the Annual General Meeting held on Sunday 18th December 2011 at Plymouth University.

1. **Apologies for absence:** Prof D. Batten.
2. **Minutes:** Agreed a correct record.
3. **Trustees Annual Report for 2010.** Proposed by Mr D. Ward and seconded by Dr T. Servais, the report was agreed by unanimous vote of the meeting.
4. **Accounts and Balance Sheet for 2010.** Proposed by Prof. G. D. Sevastopoulo and seconded by Mr W. Fone, the accounts were agreed by unanimous vote of the meeting.
5. **Election of Council and vote of thanks to retiring members**

Prof. J. E. Francis extended a vote of thanks to the following members of Council who were retiring from their positions this year: Dr P. Orr, Dr H. Armstrong, Prof. M. P. Smith, Dr R. J. Twitchett, Dr D. Schmidt, Dr C. Underwood, Dr C. Buttler.

The following members of Council were elected to serve on Council. President: Prof. J. Francis; President elect: Prof. M. J. Benton; Vice Presidents: Dr H. A. Armstrong and Prof. J. W. Cope; Treasurer: Mr P. Winrow; Secretary: Dr R. J. Twitchett; Chair of Publications Board: Dr P. Orr; Editor: Dr E. Rayfield and Prof. M. A. Purnell; Newsletters: Dr L. Herringshaw; Newsletters Editor: Dr A. McGowan; Web Officer: Dr M. Sutton; Meeting Coordinator: Dr T. Vandenbroucke; Ordinary Members: Prof. M. P. Smith, Dr C. Klug, Dr R. Owens, Dr P. Upchurch, Dr W. Renema and Mr. D. Ward. Dr F. Gill and Dr C. Buttler were co-opted to assist with outreach. Dr Orr will organise the Annual Meeting in 2012 at the University College Dublin.



6. Association Awards

The following awards were made: Lapworth Medal to Prof. R. A. Aldridge; President's Medal to Dr G. Edgecombe (Natural History Museum); Hodson Award to Dr R. Butler (Ludwig Maximilian University, Munich); and the Mary Anning award to Mr C. Duffin and Mr D. Brockhurst. Honorary Life membership was awarded to Prof D. J. Batten, Dr P. Lane. Under the Small Grants Scheme, the following awards were announced: Sylvester-Bradley Awards to P. Andreev, S. Brusatte, B. Henrick, M. Hoffmeister, P. Hull and O. Reyes; Callomon Award to J. Ortega-Hernández; and Whittington Award to A. Otero. Research Grants were awarded to Dr D. Loydell (University of Portsmouth), Dr H. Hughes (Plymouth University), and Dr A. Daley (Natural History Museum). The President's Award was made to Alexander Liu (University of Cambridge) and the Council Poster Prize was presented to Samantha Giles (University of Bristol).

The Annual Address entitled "Climate and Evolution in the Cenozoic Oceans" was given by Prof. P. N. Pearson (University of Cardiff).

The other papers for the AGM – the Trustees' Report and the Statement of Accounts – were published in Newsletter 80, and are included at the back of the Annual Meeting supplement which forms the second half of this Newsletter.

NOMINATIONS FOR COUNCIL

At the AGM in December 2012, vacancies will occur on Council for Vice-President and Newsletter Reporter. The following nominations were received by the deadline of 1st October:

Vice President: Dr Andrew B. Smith

Newsletter Reporter: Dr Liam Herringshaw

ANNUAL ADDRESS 2012

'New views on the origin of our species', by Prof. Chris Stringer (Department of Earth Sciences, Natural History Museum, London SW7 5BD).

Abstract: Views on modern human origins have undergone many fluctuations in the last 50 years as the fossil record and techniques of investigation have developed. Multiregional continuity (*i.e.* several centres of origin, on different continents) was arguably the dominant model when I began my doctoral research in 1970, but by 2000 the impact of more accurate chronologies and fast-growing genetic data had swung the pendulum towards a purely African origin for *Homo sapiens*, with any non-African input regarded as of negligible importance. However the most recent genomic-scale studies of recent humans and fossil samples have revealed a small but significant signal of introgression from archaic humans into early modern humans in both Africa and Eurasia. These inputs appear to have derived from separate episodes of interbreeding with (in Eurasia) Neanderthals and a newly recognised ancient Asian population known as Denisovans, and (in Africa) a currently unidentified archaic source. The impact of these new complexities on evolutionary and species models is still being absorbed by old and new generations of researchers.

Richard J. Twitchett

<secretary@palass.org>



AWARDS and GRANTS

Lapworth Medal

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; they are 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.



Nominations must be supported by a resumé (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 to not necessarily make an award in any one year. Details and nomination forms are available on the Association Website at <www.palass.org>. Deadline is **1st May 2013**. The Medal is presented at the Annual Meeting.

President's Medal

The President's Medal is a mid-career award for a palaeontologist in recognition of outstanding contributions in his/her earlier career, coupled with an expectation that they are not too old to contribute significantly to the subject in their further work.

Nominations are invited by **1st March 2013**, 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 to not necessarily make an award in any one year. Details and nomination forms are available on the Association Website.

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 on the online application form. If the application is successful, we will require that the support of the Association is acknowledged, preferably with reproduction of the Association's logo, in the Meeting literature. Such requests will be considered by Council at its March and October Meetings each year. Enquiries may be made to <secretary@palass.org>. Requests should be sent by **1st March** or **1st October** 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. If the application is successful, we will require that the support of the Association is acknowledged, preferably with reproduction of the Association's logo, in the Meeting literature. Application should be made in good time by the scientific organizer(s) of the meeting on the online application form. Such requests will be considered by Council at its March and October Meetings each year. Completed requests should be made at least six months in advance of the event in question and should be sent by **1st March** or **1st October** each year. Enquiries may be made to <secretary@palass.org>.

Annual Meeting attendance

The Palaeontological Association runs a programme of travel grants to assist student members (doctoral and earlier) presenting talks and posters at the Annual Meeting. For the Dublin meeting, grants of up to £100 (or the Euro equivalent) will be available to student presenters who are travelling from outside the UK and Ireland. 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, by e-mail once the organisers have confirmed that their presentation is accepted, and before 1st December 2012. Entitle the e-mail 'Travel Grant Request'. No awards will be made to those who have not followed this procedure.

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 March**.



ASSOCIATION MEETINGS



56th Annual Meeting of the Palaeontological Association

University College Dublin, Ireland 16 – 18 December 2012

The 56th Annual Meeting of the Palaeontological Association will be held at University College Dublin, Ireland, organised by Patrick Orr, Aoife Braiden and colleagues from UCD School of Geological Sciences.

All the information required for the Annual Meeting is provided in the supplement on the coloured pages in this Newsletter.

The Meeting will begin with a symposium on Sunday 16th December, in the Astra Hall, UCD Student Centre, followed in the evening by the Annual Address and an Icebreaker reception. The topic for the Annual Symposium this year is '*Taphonomy and the fidelity of the fossil record*'. The keynote speakers are:

- Prof. Derek Briggs (Dept of Geology and Geophysics, Yale University),
- Dr Alan Channing (Dept of Earth and Ocean Sciences, Cardiff University)
- Prof. Susan Kidwell (Dept of the Geophysical Sciences, University of Chicago)
- Dr Maria McNamara (Dept of Geology and Geophysics, Yale University and UCD School of Geological Sciences, University College Dublin)
- Dr Rob Sansom (Dept of Biology and Biochemistry, University of Bath)
- Dr Clive Trueman (National Oceanography Centre, Southampton)

The Annual Address '*New views on the origin of our species*' will be given by Prof. Chris Stringer (Department of Earth Sciences, Natural History Museum, London, England). It will be followed by the Icebreaker reception.

Please note that options to purchase food will be extremely limited on the UCD campus on the Sunday. A 'light meal' option will be available between the Symposium and the Annual Address, and this *must* be purchased at the time of registering for the conference.

Monday 17th – Tuesday 18th: Conference and UCD Earth Institute Lecture

The Conference itself will commence on Monday 17th December with a full day of talks and posters, and the Association AGM. In the evening there will be a drinks reception followed by the Annual Dinner. Tuesday 18th December will comprise a dedicated poster session and talks. The time allocated to each talk is 15 minutes.

Our meeting concludes on Tuesday 18th December with an early evening lecture by Prof. Andy Knoll (Department of Organismic and Evolutionary Biology, Harvard University) on '*Systems Paleobiology: Physiology as the link between biological and environmental history*'. We are extremely grateful to the UCD Earth Institute (<www.ucd.ie/earth>) for their sponsorship of this lecture, which is being held in collaboration with the British Sedimentological Research Group (www.bsrp.org.uk); their Annual Meeting will also be hosted by UCD School of Geological Sciences and is to be held between 18th and 20th December – so why not come to Dublin for both?!



Registration and booking

The final deadline for registration is Friday 16th November 2012.

Registration, booking and payment (by credit card) is through online forms available on the Palaeontological Association website (<<http://www.palass.org/>>). Please note that all these transactions will be in sterling (£: GBP). Accommodation must be booked separately. The cost of registration is the same as last year. Early registration is €110.00 (approximately £90.00, US\$140.00) for ordinary and retired members; €75.00 (approximately £60.00, US\$95.00) for students; and €145.00 (approximately £120.00, US\$185.00) for non-members. *Registration costs include sandwich lunches on Monday and Tuesday, the reception on Sunday evening, full registration package and tea/coffee breaks.*

The Annual Dinner event costs €60.00 (approximately £50.00; US\$75.00). It will be held in the Old Jameson Distillery, Smithfield (<http://www.tours.jamesonwhiskey.com/>). The evening's festivities will include a drinks reception, tour of the distillery and whiskey sampling, followed by a four-course meal. The evening will conclude with an after-hours 'get-together' hosted for us by the adjacent Generator Hostel, Dublin.

Contacts

Please check the Association's website <www.palass.org> for all details and updates. To contact local organisers Patrick Orr and Aoife Braiden please e-mail <annualmeeting@palass.org>.

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 Dublin 2012 meeting, grants of less than £100 (or the € equivalent) will be available to student presenters who are travelling from outside Britain and Ireland. The actual amount available will depend on the number of applicants and the distance travelled. Payment of these awards is given as a disbursement at the meeting, not as an advance payment. Students interested in applying for a PalAss travel grant should contact the Executive Officer, Dr Tim Palmer (<palass@palass.org>) once the organisers have confirmed that their presentation is accepted, and before **1st December 2012**. Entitle the e-mail "Travel Grant Request". No awards can be made to those who have not followed this procedure.

Why not make a stay of it?

Dublin at any time of the year is an excellent destination for a short break; why not come a few days early and see what the city has to offer? Alternatively, if anyone travelling with you is not enthralled by the idea of three days at a PalAss conference there is plenty to do. We'll provide further details in the next *Newsletter* (and are happy to advise if we can). In the meantime, try

- <<http://www.discoverireland.ie/Places-To-Go/Discover-Dublin>>
- <<http://www.visitdublin.com/>>

Acknowledgements

We express our thanks to our sponsors and exhibitors for their invaluable support (see pages 10-11).

We look forward to seeing you in Dublin in December!



Acknowledgements

We express our appreciation to our sponsors and exhibitors for their invaluable support of the Annual Meeting.



**Geological Survey
of Northern Ireland**



Teck



TREATISE
on Invertebrate Paleontology



(continued over the page ...)



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The
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Society





Progressive Palaeontology

Leeds 2013

22nd-24th May

School of Earth and Environment,
University of Leeds

Join us for the annual **Progressive Palaeontology** conference; a great opportunity for early-career palaeontologists to share their research. The programme next year includes an icebreaker reception, a day of presentations (this year streamed live by *Palaeocast*) and posters followed by the annual dinner, and finally a fieldtrip to explore the palaeontology of Yorkshire.

Email progpal@palass.org, or for further details and updates visit palass.org, friend us on Facebook (**Prog Pal 2013**), or follow us on Twitter [@ProgPal2013](https://twitter.com/ProgPal2013).



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'Palaeontology' (ISSN 0031-0239) and how to read it

As you doubtless know, *Palaeontology* is the Association's principal journal and is sent free to all subscribing and honorary members, unless they have chosen otherwise. The following information might be useful to some more recent members.

Publication started in 1958 and we are now up to the end of Volume 55. From Volume 1 to Volume 40 there were usually four parts per volume; from Volume 41 onwards there have been six parts per volume. From Volume 48, the page size has been A4, and a full volume typically consists of 1,272 pages. Above this number of pages, the Association has to pay substantially increased production costs.

All volumes, including the current one, are available online, free to members. All papers in Volumes 1 – 41 can be read at the Association's Website at <www.palass.org>. Non-members can get free access to these earlier papers from the same source. Volumes 42 to the present can be read through the Wiley Online Library at the Wiley website. This can only be accessed via a link in the Members' Area at www.palass.org, so any members who want to use this source should make sure that they know their up-to-date username and password for entering the Members' Area. If you renew your subscription online yearly through the renewals page in this Members' Area, then you will know the access details and your membership will automatically renew on our electronic database for the year in question. In this case there will be no problem with accessing the Wiley website. Any person who pays their subscription by cheque or Banker's Order, or who has a free subscription, may find that their subscription appears to have expired when they try to enter the Members' Area. This can easily be reset by us (please e-mail <palass@palass.org>), but subscription payment by credit or debit card via the renewals page, as described above, avoids this problem.

Any member who does not want to receive the paper copy of the journal should either tell us (palass@palass.org), or should tick the appropriate box when renewing online. Currently there is no price reduction for this.

Occasionally, retiring members offer us long runs of the earlier volumes. We do not have room to take these and store them, and there is not a great demand for them. However, if anyone does want paper copies from earlier years, we can sometimes put people in touch. All transfer arrangements should be handled by the individuals concerned. The Association does have a few copies of some earlier parts (at £10 + p & p) if any member seeks replacements.

Tim Palmer
Executive Officer



Meetings update—

****New**:** *Postgraduate Travel Fund*

A couple of months ago, the Association launched a new scheme providing modest funding to assist with travel expenses for postgraduate students attending international conferences.

We are offering financial assistance to postgraduate students who are members of the Association for travel to international scientific meetings that are not otherwise supported by the Association (*e.g.*, through the Grants-in-Aid scheme). The award is specifically for travel and is a maximum of £200. Awardees are expected to give a presentation that falls within the scope of the Association's charitable aims.

Applications should be made online no later than two months prior to the beginning of the conference. For more information, including eligibility criteria and details on how to apply, please have a look at the new rubric on the website. The number of grants is limited (per meeting and per year) and they are spread uniformly over the year.

We encourage all our postgraduate student members to take advantage of this opportunity!

Palaeontological Association sponsored session at the AGU Fall Meeting on the Anthropocene

The Association is proud to sponsor a session of this year's Fall Meeting of the American Geophysical Union (3–7 December, San Francisco). The session is entitled 'The Anthropocene: Confronting the Prospects of a +4°C World'. Conveners are Peter Frumhoff, Mark Williams, Michael Ellis and Jay Gulledge.

The Anthropocene has been debated as a new epoch of geological time (*e.g.*, Williams *et al.* 2011, *Phil. Trans. Royal Soc. A*, vol. 369). To discuss this idea further the Anthropocene session at the AGU Fall meeting (on Friday 7th December in Moscone South) includes invited contributions from **Jan Zalasiewicz** on the Temporal and Spatial scales of an Anthropocene Series, and from **Anthony Barnosky** on palaeontological evidence for defining the Anthropocene. The session will include themes as diverse and important as Davor Vidas' presentation on The Anthropocene and International Law. With sponsorship from the Palaeontological Association, and a dedicated keynote presentation under our auspices, we ensure that the palaeontological and biostratigraphical dimensions of the Anthropocene remain in the spotlight. The session aims to cement relationships that will raise awareness regarding the biodiversity aspects of the Anthropocene.

Thijs Vandenbroucke
Meetings coordinator



Edward Forbes Prize

The Palaeontographical Society invites applications for the newly instituted Edward Forbes Prize¹, which aims to recognise outstanding contributions by early-career researchers in the field of taxonomic and systematic palaeontology (encompassing invertebrates, vertebrates, palaeobotany and microfossils). The Prize, which is to be awarded for publication excellence, comprises £250 and a one-year membership of the Society. The Prize will be awarded at the Society's Annual General Meeting each year.

Criteria for eligibility:

1. Papers should deal with the taxonomy and/or systematics of a group of fossil organisms from the British Isles and must appear in a peer-reviewed publication, such as a journal, monograph series or book chapter. In some cases, applicants may need to provide evidence that an article was peer-reviewed (in the case of some book chapters, for example). Papers whose primary focus is on a related subject area (*e.g.*, palaeoceanography, palaeoclimatology, geochemistry) will not be considered.
2. Papers should either be the sole work of the applicant or the applicant should be the lead author on the publication. Where there is more than one author, the applicant must produce letters from the other co-authors stating that the lead author was responsible for leading the work. These letters should be submitted with the main application.
3. Early career stage researchers are considered to be those currently engaged in post-graduate research (Master's or PhD), under the age of 35, or within ten years of the completion date of a PhD. Letters of support are required from the supervisor of the work to confirm the applicant's eligibility. Such letters should be submitted with the main application.
4. Submitted papers must be written in English and sent to the Prize Committee as either a reprint-quality PDF (preferred) or as a hard copy (four copies required in the latter instance).

We invite submissions for the 2013 award on the basis of any eligible article that was published in 2011 or 2012. Applications should be addressed to the Secretary, Prof. Steve Donovan (e-mail <steve.donovan@ncbnaturalis.nl>), and must be received by the closing date of 1st March 2013. The decision of the Prize Committee will be announced at the Society's AGM in April 2013. The successful applicant will be informed in advance, so that they may attend the meeting if they wish.

¹ Edward Forbes (1815–1854) was an early supporter of the Palaeontographical Society, and palaeontologist to the fledgling Geological Survey before taking up the Professorship of Natural History at Edinburgh University. His beautifully illustrated publications in the *Memoirs of the Geological Survey* and his Palaeontographical Society monograph were milestones in the documentation of British fossil invertebrates. (By coincidence the next article in this Newsletter is about Edward Forbes...)



From our Correspondents

Mystery mountain of Mars

He had a lovely character, by all accounts – gentle, sensitive, non-confrontational and yet with a fine appetite for irreverence and ribaldry. He died young, aged only 39, in 1854. Only the good die young, it's said. That may not be statistically watertight (think of Billy the Kid, for instance) but it's a shame that he of all people had to conform to the sentiments of that gloomy proverb. What is less commonly stated is that the good and the well-liked tend to garner and retain support for their ideas – even after those ideas should have long been exploded by an accumulation of cold, hard¹ and contrary data.

But then, Edward Forbes made many friends in his short life. Biologist and naturalist at heart, he became a palaeontologist by profession – the first, indeed, to be specifically so employed by the Geological Survey. And no less a personage than Sir Archibald Geikie, giant of Victorian geology and director of the Survey over two decades, wrote the greater part of his biography², a massive and highly discursive (even rambling, one might say in these impatient and focussed times) volume, that nevertheless pens a fine picture of a quite singular character.

Forbes was born a Manxman, and an early digression in his biography concerns the character of that island and the three-legged symbol that represents it (each leg, allegedly, being poised to kick out at one of the three more powerful neighbours – England, Scotland and Ireland – that surround it). Was there something special about the Isle of Man that shaped the character of Forbes, a man often regarded as central to the development of marine biology? No, is the reluctant answer, but quite a few pages are taken up in discussion before that conclusion is made.

His enthusiasm for the natural world originated in early childhood, and simply carried on without pause throughout his life. Other careers had been mapped out. First – as an artist, for he had a fine talent for sketching and caricature. However, that did not translate into any great interest or skill in more serious painterly business, so that went by the board. Then, he enrolled as a medical student in Edinburgh. That also went nowhere, and Geikie laments the lack of any comment on medical studies in Forbes's diaries over that period – although there is a very good deal in those diaries on shells, flowers, insects, collecting expeditions and suchlike. Had he studied in the serious times of today, Forbes would surely have been regarded as an outrageously irresponsible student, and been sent bushels of sternly written official letters. However, he blithely went on following his interests. Things eventually worked out for him.



Edward Forbes (courtesy of the British Geological Survey)

¹ Or in this case wet and wriggly data – but we'll come to that anon.

² It had been started by George Wilson, a colleague of Forbes's – but he died with the biography only part-written.



The medical studies quietly forgotten, he became a kind of itinerant naturalist, supported by a small allowance from his father, and becoming involved in such things as the 1839 meeting of the British Association at Birmingham. Something of his inimitable influence upon the world of science can be seen in the way that he threw himself into the science, but had no truck with the formal dinners and procedure-bound meetings that attended them. Therefore, he promptly decamped to a local pub, the Red Lion, taking a sizeable portion of attendees with him (to the extent that 'the tenement could scarcely hold the guests'), where they ate cheaply on beef washed down with 'potations of beer', the discussion of science being interspersed with jokes and songs. This was the start of the 'Red Lions', of which Forbes was the focus and moving spirit, and which continued as a kind of alternative assembly at BA meetings until Forbes's death and after. In proof of their 'leonine relationship', as Geikie put it, they signified their assent or disapproval of any point by growls and roars 'more or less audible' and – where extra emphasis was required – by a vigorous waving of coat-tails (for which Forbes's 'rampant coat-tail was a model for the younger lions').

This was still a few years before he was taken on as the Survey's palaeontologist where – despite the distractions posed by continuing spiritual leadership of the Red Lions – he worked solidly enough to author no fewer than *ten* papers in the inaugural issue of the *Quarterly Journal of the Geological Society of London*. He was to become President of the Geological Society in time, too.

However, to the wider world, he is mainly known as a strong candidate to be father of the science of marine biology. A competitor for that title might be mooted as Thomas Huxley, who made his reputation on the scientific work he carried out in 1854–60 on the *HMS Rattlesnake*. That could well be so. But, characteristically, it was Forbes who gave help to Huxley before, during and after that voyage – and who arranged for the scientific results to be published, something that enabled Huxley to become a Royal Society member at the tender age of 25. Forbes could therefore – though he did not live long enough to see the *Origin of Species* appear in print – be said to be spiritual godfather to the man who, more than any other, fought for Darwin's ideas in those turbulent early days.

Forbes's place in the pantheon is secure – and this in spite of his being the author of one of the most spectacularly wrong scientific hypotheses to have emerged in those days. It's a lovely, wide-ranging idea – but then Forbes, for all his meticulous and detailed work, did tend towards the high, wide and handsome when it came to pulling the threads together. It's a reflection of the spirit of the Red Lions, perhaps. The vision he posited was of a world where life is held within narrow boundaries – and many people found it compelling enough to ignore evidence to the contrary for decades.

This was the azoic hypothesis – the idea that the sea's depths, beyond a few hundred metres, were not some fabulous abode of serpents and krakens, but were just dead. Forbes imagined the ocean depths lifeless, a place of dark and cold and crushing pressure, with the teeming life confined to the warm and sunlit surface waters. This was not based on some theoretical calculation – or on prejudice. The idea came out of hard data, collected over 18 months of solid work in difficult conditions.

In 1841, Forbes was engaged on a marine surveying mission. The *HMS Beacon* was sailing the Mediterranean. Among other tasks, it was gathering dredge samples from the bottom of the



Aegean Sea. It was Forbes's job to identify, classify and describe the organisms that were dredged up. The collection of such samples was slow and laborious work – but enough were collected for a pattern to emerge. In shallow water, life was abundant and diverse. As water depths increased, it became progressively more rare and less diverse. Forbes proposed his grand idea³ – that life disappeared where the water became a little more than half a kilometre deep.

The idea took hold – and seemed eminently reasonable. After all – did not life essentially disappear as one approached the tops of high mountains? Having the same pattern repeated in the ocean depths had a nice symmetry to it. Forbes clearly had an infectious enthusiasm for this concept (as he did for everything else in natural history), and knew more about marine biology, then, than anybody else.

The azoic hypothesis took hold, and persisted for over three decades. Yet, evidence to counter it was available pretty much from the very beginning – and even before it, as the idea's chroniclers⁴ point out. One Captain John Ross, making soundings around Baffin Bay in 1818, had pulled worms and starfish from over half a kilometre down. Incontrovertible evidence? Perhaps, but Ross could not quite be given a glowing character reference. He reported a range of underwater mountains that turned out not to be, as it were, there – and he fell into dispute with his shipmates over who should get the credit – or, whatever credit remained – for the work accomplished in the voyage.

Other such evidence turned up from time to time – most strikingly in 1860 when Charles Wallich, an ex-surgeon turned naturalist, on board ship off Greenland, reported a sounding line dragged from over two kilometre's water depth with 13 starfishes attached to it. Wallich knew that this should sound the death knell for the azoic hypothesis, and loudly said so. But – nobody paid much attention to him. Wallich was, by all accounts, an irascible man with a talent for making enemies, not least among the community that he was trying to influence. Those 13 starfish proved unlucky for him, and simply left him yet more bitter at the injustices he perceived had been done to him. (It was only later that the azoic concept was eventually dragged down by further weight of evidence.)

Neither Wallich nor Ross would have been regarded as promising new recruits to the Red Lions – nor, one suspects, would they have wanted any truck with such cheerful irreverence. They were the polar opposites of Forbes, a man who was a good scientist (the data he obtained from the Mediterranean did suggest that life fell off steeply at depth: it was a pity only that the data was unrepresentative of the ocean as a whole). He was also a transparently positive, enthusiastic and likeable man. This large aspect of his character, one suspects, helped keep the azoic hypothesis afloat for longer than might have been the case for the brainchild of a more churlish man.

The deep oceans, we now know, fairly teem with life, kept alive by a combination of appropriate metabolism and a reasonable food supply – from marine snow to whale fall – derived from the more productive waters above. There is so much life there, indeed, that it provides a fair food source for certain bipedal primates that are currently top dog in the world's food chain. Constant dredging for shrimp off the Spanish coast in the Mediterranean, in waters up to 800 m deep has, amazingly, smoothed the bottom topography so much as to clearly show up on new contour

³ It was not *quite* his idea. Henry De La Beche, an early Director of the Geological Survey, and a predecessor of Geikie in this post, had suggested the idea earlier, but with little evidence to back it up.

⁴ The whole story is in Anderson & Rice (2006). Recommended.



maps of the sea floor⁵. Human terraforming of the Earth now clearly extends from landscapes to subseascapes, as the new stratigraphy made by our species unfolds.

Microbial life on our planet, we now know, reaches yet further – far below even the deepest sea floor, to colonise ancient strata (and even the fractures and joints in volcanic rock) to a depth of a couple of kilometres or more. It is wafted, too, high into the atmosphere to be carried by fierce stratospheric winds. It survives the bitter cold of the Antarctic dry valleys, and can nestle against volcanic springs at temperatures exceeding 100°C. And it is prolific, too, this submicroscopic biota. Put all the viruses on Earth end to end – a fiddly task, granted – and they would stretch out for some 10 million light years, which is about 100 times the diameter of our galaxy⁶.

That's about as surreal an image as one can hope to encounter – but reminds us that the search for life's frontier has moved on, to worlds beyond Earth. And here we are effectively where scientists were in Edward Forbes's day, as they considered the far corners of the Earth. Is life rare out there, or commonplace – or just confined to ... home? All of those possibilities have been expressed recently, and the truth of the matter is that we just don't know.

In a few places, though, there is melancholy certainty. Venus, in this respect, has been a bitter disappointment to all those reared on sci-fi stories of alien derring-do amid steamy Venusian jungles. Those imagined jungles, mind, had the most reputable of scientific pedigrees, being postulated by Svante Arrhenius, no less, who calculated them as something akin to the Carboniferous coal forests⁷. Then, the likes of Edgar Rice Burroughs, taking a break from writing the *Tarzan* epics, peopled those Venusian forests with noble civilizations, ignoble civilizations, pirates, princesses and occasional visiting and heroic (of course) – if slightly dim – Earthling astronauts⁸.

But, as the first Venera space-probes penetrated those opaque clouds to, very quickly, succumb to furnace-like heat and crushing pressures, it became clear that the greatest chemist of his generation had been out by about 400°C of ambient surface temperature. (Meanwhile, Burroughs presumably saw the royalties keep on rolling in – a story's a story, after all).

Arrhenius fared better with Mars, in contesting Percy Lowell's literally fabulous promotion of canals and canal-building civilizations. He calculated – rightly – that Mars, so distant from the sun, should have a deep-frozen surface. And, with the crude spectroscopic measurements of that planet's atmosphere then available, he stated – also correctly – that there was no thick, heat-trapping atmosphere that could compensate for the scant heat received from the sun. Later, James Lovelock dismissed the idea of life on the red planet on the basis of some eminently reasonable principles: the atmosphere, he said, is not only thin but (unlike Earth's) is in chemical equilibrium with the solid surface. Hence, there is no functional, metabolizing biosphere to push the atmosphere out of that equilibrium.

Nevertheless, today the Curiosity rover is trundling along the surface of Mars, within the walls of Gale Crater, its human drivers in Houston hoping that its visual and chemical senses will

⁵ Puig *et al.* (2012).

⁶ The figure's loosely adapted from the data in Hamilton (2006); the figure actually quoted there is 250 million light years for Earth's total viral genetic code, laid end to end...

⁷ Arrhenius, S. (1918).

⁸ Carson Napier, the terrestrial hero of these Burroughs stories, came to Venus by accident: he had aimed for Mars but took a wrong turn: the sequence of events is explained in exquisite detail in the imperishable *Pirates of Venus*.



detect a current life so faint as not to perceptibly disturb that chemical equilibrium, or a past life fossilizable enough to be glimpsed within the strata. To do this, Curiosity will ascend a gargantuan stratigraphy – a stratigraphy that seems, on the face of it, to be entirely out of place. For, just how do you get a five-mile high mountain of strata in the middle of a meteorite crater?

Mount Sharp, it has been called, or – in appropriate use of mostly dead language on a mostly dead planet – Aeolis Mons. It rises 5 kilometres above the surface of the crater, overtopping all but the most southerly of the crater walls. It's about as an unlikely phenomenon as I can think of – something to come from the imaginative pen of Tolkien or of Edgar Rice Burroughs, a storybook mountain on a far planet, rather than a piece of sober, sensible geology.

An over-developed rebound structure from the impact? Clearly not, as there is well-behaved, undisturbed, large-scale, subhorizontal layering present within the mountain. This must have been clear from the satellite imagery used by the NASA planners (and was a major reason for sending the spacecraft there). It is nicely seen in the first panoramic photographs taken by the rover itself too. That is well and good and will be fascinating to examine at close quarters over the months and years to come as Curiosity, at its 4 miles per hour, heads for the summit.

Given this stratigraphy, the mountain must be younger than the crater – unless the impactor was shaped like a gigantic, slender but dense hula-hoop landing *perfectly flat* upon the Martian landscape, and with pinpoint precision around a pre-existing mountain.

Rapidly drawing a veil over that idea, which we dedicate to the memory of E.R. Burroughs, we must conclude that the crater formed first, and was then filled with sediment. Indeed, it would have been over-filled with sediment, which piled up to that 5 kilometres and more. Following that, the exterior of this sedimentary mass must have been carefully removed by erosion, leaving the central core of strata intact as our mysterious mountain, while that erosion also delicately exhumed the crater walls. That is easy enough to say in print – and indeed it is more or less the interpretation suggested in the latest geological resumé⁹ that I could find of this fairytale structure.

That, though, begs so many questions as to leave this innocent bystander, at least, stranded helplessly in the farthest reaches of the Dismal Swamp of Incomprehension.

Take the making of the stratigraphy, first. Almost the last and least question is *how* deposition took place – whether by wind or water or from volcanic fallout. All these questions will be fairly answered, one is sure, as Curiosity ambles from crag to crag, armed with camera, hand lens and sophisticated chemical analytical hardware. These answers, too, will certainly help resolve the question over whether Mars, in those early days that correspond to Earth's Hadean eon, had more or less long-lived oceans, lakes, rivers and deltas; or, whether it has always been essentially deep-frozen, with occasional floods of scalding water in the wake of giant meteorite impacts that flash-melted large areas of permafrost. (I quite like a middle view, which posits short warm, wet intervals, linked to brief episodes of volcanically-driven climatic warming – though that is more out of temperamental wishy-washyness than out of any sensible knowledge of the subject).

But was it just the crater that was so filled by sediment? That would seem to need the help of industrious teams of Martians, armed Percy Lowell-style with winches and dump trucks to fashion

⁹ Anderson & Bell III 2010.



such a towering stack of strata. That is unlikely (more's the pity) which suggests that the entire landscape, crater and all, was buried by thick masses of sediment. In some ways, that makes sense, given the position of Gale Crater near the boundary between the southern Highlands (as sediment source) and the northern lowlands (as some kind of regional sedimentary basin). That in turn implies some quite muscular sedimentation taking place early on, in line with the more active scenarios of Mars's history.

And, some time after that, one has to somehow find a means of removing the greater part of this stratal pile, very carefully, to leave that finely preserved crater with its central, singular mountain-mass at its heart.

Could you imagine such a thing on Earth? Lay down a five-kilometre-thick pile of sediment, of almost any sort, and there would be sufficient compaction and diagenesis through the greater part of it to make for thoroughgoing lithification. The strata would become pretty much as hard as the rock that they were laid down upon. One could later erode through it, for sure – but the erosion should rip through cover and basement alike to give some kind of irregular planar slice through the structure, rather than allowing the crater to be so neatly exhumed.

One conclusion, therefore, might be that diagenesis, in those Martian conditions of low gravity, low thermal gradient and thick permafrost (and therefore no liquid water) combine to keep those strata mostly loose and un lithified, and easily erodable. But, even sweeping all of that putatively loose sediment off the crater is not easy to envisage. What would do the sweeping? Water – from those late Martian flood outbursts, perhaps? That would surely have ripped through that neat crater structure. Wind, then? – for that is one geological process that is known to have been continually active these past three billion years, to wind-sculpt landscapes and drive dunefields (that are alarmingly similar to Earthly dunefields, despite being driven by an atmosphere a hundred times as thin).

Wind erosion, though, only works for particles of sand or granule size or smaller, while pebbles, cobbles and such are only moved by exceptionally fierce winds. In deposits of mixed clast size, the finer stuff is blown away from between the coarser clasts. With enough wind-deflation, these big clasts eventually come together to form an armoured pavement, which protects the sediment below from further erosion. It is mostly these kinds of pebbly/bouldery surfaces that appear in images from the Mars landers, including in those early images from Curiosity.

So why did that not happen, to produce some kind of armoured plain (rather than a five-kilometre mountain) within the crater? Were there not enough large clasts in that enormous pile of strata, away from the crater floor? (Curiosity's curiosity should resolve that question, as it climbs ever higher). If that were the case, then that would place some nice constraints on the type and mode of sedimentation.

All in all, it seems to be a conundrum of the first order. All should be revealed over the coming few years, as the rover takes our vicarious eyes from rock exposure to rock exposure up that mighty mountain. The strata will be fascinating, for sure, but with that two-billion-dollar plus price tag, it would be fossils of some sort that would make the best scientific repayment. What might we expect the petrified Martians to look like?



With due respect to Edgar Rice Burroughs (who wrote a Martian series also, so as to cover all bases), the prototype Martian is unlikely to be bipedal, noble/malevolent according to the demands of the plot and, in those rare but crucial cases, sufficiently lissom to provide interplanetary romantic interest for the visiting Earthling astronaut. More prosaically, microbial is the standard model of life that has served the Earth well for most of its history. Everything else (us included) is pretty much a detail, and a recently-arrived detail, at that. So, one might imagine the microbe to be a universal standard, with or without DNA. So, if Gale crater was once a lake, cue possible microbial mat structures, with all those laminated and wrinkly textures – perhaps with fully-grown stromatolites as a bonus. Now – not everything laminated is microbial – or leaves obvious microbial fossils, as shown by the extreme rarity of overt microbial traces in the almost certainly microbially mediated Banded Iron Formations of the Precambrian. At a guess, finely laminated sediments of some sort will turn up somewhere on that mountain – and they will spark discussions of whether they are fossils or pseudofossils (one would guess, too, that any such discussions are almost bound to follow hallowed palaeontological tradition, and stay tantalizingly unresolved for years).

What might the next stage of development of fossilized alien look like? There's unlikely to be anything like this on Mars, true – there just wasn't enough time for much in the way of organic evolution. But, propelled by the spirit of Burroughs, one might perhaps speculate a little more widely, in the interests of concocting a generalised cosmic consumer of the ubiquitous microbe. It won't be anything like my own favourite fossil group, the graptolites, I'm sure. These are too complex, too delicate, too fantastical: one couldn't make those creatures up – why, even the alien princess is a more valid extraterrestrial model.

But after idle though entertaining discussions with my colleague Mark Williams, one wonders if a prototype primary consumer (universal version applicable to planets near and far) might not be modelled on an ostracod. These sensible crustaceans – the most common Earthly fossil arthropod of all, by far – stick to being generalist detritus-feeders, by and large. The little shell is a very good idea – not only anti-predatory but also something that can help to control internal humidity and chemistry. The size, at a millimetre or so, is just right. And they are sensationally fecund. No wonder they have spread just about everywhere on Earth over the last half-billion years, and made hay after mass extinctions while other fussier organisms were still down and (in many cases) out.

What would they have made of that down at the Red Lion, one wonders? The interstellar ostracod as standard alien, a hypothesis proposed in ten risqué verses, to growls for and against, and massed coat-tails a-flutter? The very idea's enough to make the Hollywood moguls weep, but perhaps such a micro-beast should be high on the astrobiologists' hit-list. Let's hope Curiosity's hand lens stays nicely in focus.

Jan Zalasiewicz

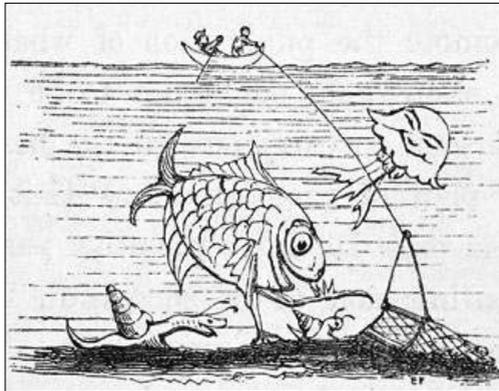
Acknowledgement

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A typical Forbes sketch. This one illustrating his dredging operations in the Aegean appeared in his 'Natural History of the European Seas'.



PalaeoMath 101

Going Round the Bend II: Extended Eigenshape Analysis

In the last essay I explained the basics of eigenshape analysis and compared/contrasted that method to both Fourier and *Procrustes* approaches to shape characterization and analysis. The mathematics of eigenshape analysis has much more in common with *Procrustes*-based approaches (e.g., relative warps, *Procrustes* PCA) than with Fourier-based approaches despite the fact that its canonical shape functions—the Zahn & Roskies (1972) Φ and Φ^* shape functions—were developed originally to solve a problem in Fourier shape characterization (see MacLeod 2011).

While there is no question that eigenshape analysis *can* be used to represent the form of boundary outlines, questions have been raised regarding the extent to which eigenshape-like approaches in particular, and outline-based approaches more generally, portray the forms to which they are applied accurately. Interestingly, this criticism raises an important set of issues that pertain as much to landmark-based morphometric methods as they do to outline-based methods. Even more importantly, addressing some of the concerns that have been raised in this area has driven the development of eigenshape analysis to become a much more comprehensive and flexible tool than the one proposed originally by Lohmann (1983, see also Lohmann and Schweitzer 1990).

The crux of the problem many morphometricians have with outline-based analysis methods in general has been well described by Bookstein (1991) and is illustrated in Figure 1. In the absence of information about which points on a boundary outline curve in one specimen correspond to which points on a boundary outline curve in another specimen, all boundary outline curve sampling protocols contain a degree of ambiguity with regard to how forms or shapes within a sample are to be matched. This matters because the degree to which two forms or shapes are judged to be similar to, or different from, one another is controlled entirely by the manner in which the points used to represent their forms or shapes are matched.



Figure 1. Variations in the shape ‘distance’ estimates (d) for the same forms under different semilandmark sampling schemes.

In terms of landmark analysis the question of how best to match forms also arises, but in a somewhat different context. Figure 2 shows the point-level correspondences between two fish morphologies characterized using a landmark-based measurement system. Landmarks are usually regarded as being more definite and so less subject to disagreements among investigators

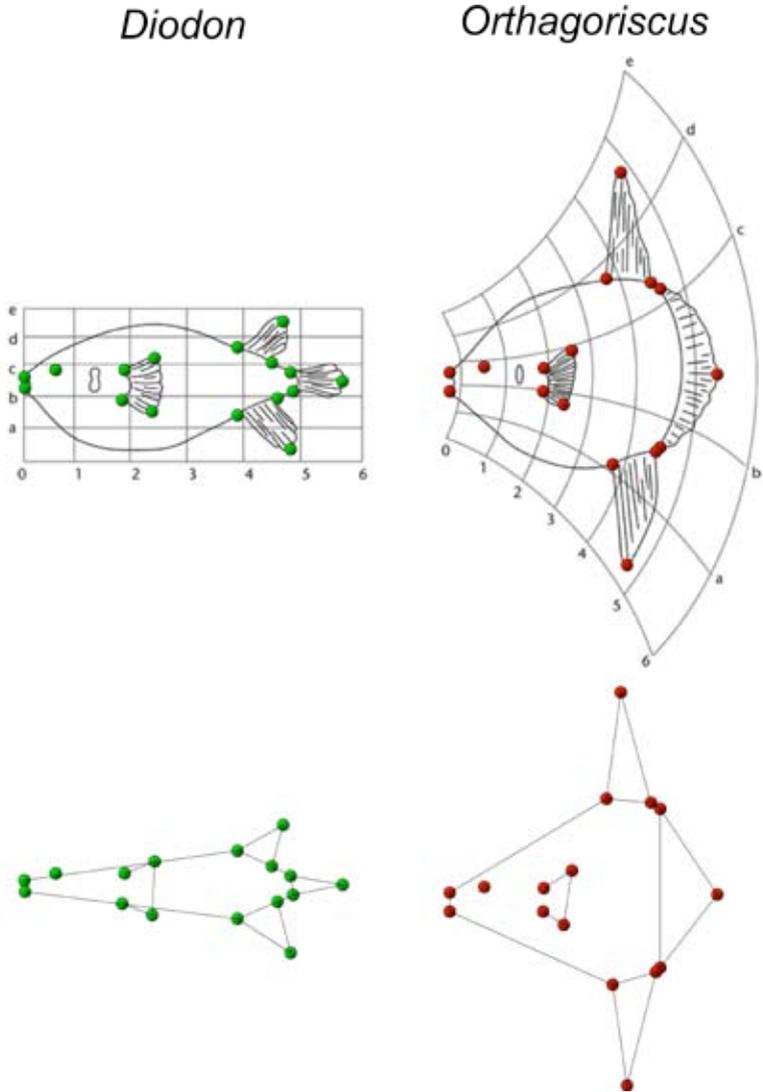


Figure 2. Landmark representations of the two actinopterygian fish morphologies used by d'Arcy Thompson (1917) to illustrate his transformation grid approach to shape comparison. While a comparison of topologically corresponding landmarks between forms is sufficient to infer the general geometric character of the implied shape transition, it is also the case that the necessary abbreviation of the shape engendered by using only the few topologically relocatable landmark points common to both forms fails to capture critical aspects of the morphology (e.g., depth of the body, shape of the dorsal and anal fins, shape of the tail) leading to errors in both the overall and localized assessment of shape similarity across the form. These errors are of comparable magnitude, and comparable biological importance, to the errors induced by not knowing how to match semi-landmark points located along the outlines of two forms (see Fig. 1).



about how they should be matched. However, it is simply not the case that, in all instances, it is clear exactly how landmark locations on one specimen correspond to landmark locations on another specimen.

Imprecision and inconsistency in the placement of landmark points is especially problematic in the case of type 2 landmarks (e.g., extremal points, maximum of curvature) and type 3 landmarks (semilandmarks) which often comprise the bulk of the points used in a landmark-based morphometric analysis (see Fig. 2 for examples). In the case of type 2 landmarks, despite the precise definition of this category, in most cases the positions of type 2 landmarks are judged 'by eye'. Also, as the definition of this type of landmark is logically bound up with an assessment of the positions of other points on the form, type 2 landmarks are actually a special case of type 3 landmarks, which is the same category used to define the locations of boundary outline landmarks. Accordingly, the problem of landmark matching is not so different in principle among 'landmark-based' and 'outline-based' approaches to shape characterization. In practice, more of these arbitrary matching decisions are necessary in the latter simply because more (semi)landmarks are used in the analysis. But is this a deficiency or an advantage?

It should be noted at this point that the number of landmarks available for use in a landmark-based investigation is usually so small relative to the amount of shape information available in the specimen or image as a whole that there is the ever-present danger of gross under-representation of the true shape of the specimen and so the pattern of similarity existing across a sample of forms (see Fig. 2). This issue does not arise in those instances where there is a clear biological reason to track spatial changes in a few specific points across a set of specimens (e.g., investigations of functional morphology). Nevertheless, in the vast majority of morphometric investigations what is required is a measure of overall geometric similarity for the shapes under consideration. It is in these (common) instances that representation of shape similarity via comparisons between a small number of landmark points may be misleading in terms of representing the overall amount and overall character of shape similarities or differences in a sample; especially so if a substantial proportion of the landmarks are located in regions of the form that have no particular significance with respect to the biological hypotheses under evaluation. In criticising outline-based approaches to shape analysis I can't help but feel many morphometricians have failed to take a critical look at their own (landmark) data in terms of their realized ability to represent shapes that are pertinent to the biological problems they are trying to solve. This situation is improving, though, as the number of morphometricians interested in boundary outline analyses grows, as the software tools for undertaking outline-based analyses improve (e.g., Bookstein 1996, 1997; Green 1996), and as the morphometrics community becomes more open to extending morphometric procedures to new types of morphological data (e.g., Gunz *et al.* 2005, MacLeod 2008, Polly 2008, Gunz *et al.* 2009) and to new fields of inquiry (e.g., MacLeod *et al.* In press).

In the context of eigenshape analysis the outline shape registration problem is easy to visualize. Figure 3 shows a sequence of 51 semilandmark points that have been used to quantify the outline shapes of two specimens of the planktonic foraminifer *Globorotalia truncatulinoides*, each specimen having been oriented in apertural view. Even though the boundary outline digitization process began at the same point on each specimen's outline (point 0), many points in the semilandmark sequence fall on different biological structures. Accordingly, in such data there exists an artificial

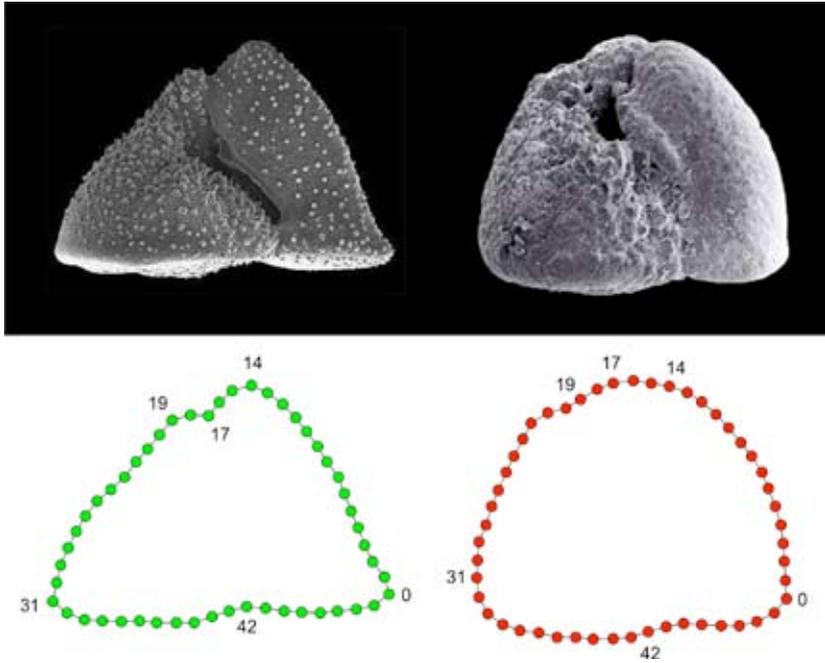


Figure 3. Two specimens of the planktonic foraminifer species *G. truncatulinoides* (upper) whose outlines in apertural view have been quantified geometrically by 50 intervals between semilandmark points. For both specimens digitization began at a landmark (point 0) that was judged to be topologically homologous on both specimens. As digitization proceeded however, other equally homologous locations are represented by semilandmarks whose position varies in the point sequence. This lack of sequence correspondence introduces error into shape similarity calculations based on these data.

mismatch between points of equivalent topological position in these sequences of semilandmark points. As a result, the geometric difference estimated between these shapes can be divided into two factors: a factor arising from genuine differences in the boundary outline shapes and a factor arising from the mismatch between semi-landmark points with respect to localized biological structures. It is biologically valid to be interested in the true shape differences that characterize the former category (say the form of the ultimate chambers of different foraminifer shells), but less so if the semilandmark sequences being used to represent the spatial position of complex biological structures do not enforce a strict and biologically comparable matching between semilandmark sequences at least in the regions where the correct matching pattern is known.

Of course, this effect is only noticeable when we have subordinate biological structures that provide evidence of shape correspondence *along the outline*. In some cases such structures will be lacking. When this occurs the analyst has no choice but to accept that some degree of potential mismatch between the semilandmark digitization sequence and the underlying biology will exist and contribute to the overall estimate of shape difference. However, absence of evidence for biological correspondence among outline segments is just that ... absence



of evidence. If there is no way to determine how points along a boundary outline sequence 'should' match up in terms of the underlying biology, the task of the morphometrician becomes one of representing the curve or curve segment in a manner that minimizes the number of *ad hoc* semilandmark matching hypotheses. In particular, when such situations arise it is not appropriate, in my opinion, to pretend such information exists or, even worse, to force semilandmark data to conform to some esoteric matching pattern mandated by (say) employing non-biological constraints to mask this fundamental lack of biological evidence. [Note: I will return to this topic in the next column when I discuss the sliding semilandmark procedure.] Nonetheless, if evidence for subordinate structural correspondences along boundary outlines exists—as it almost inevitably does in the context of most biological and/or palaeontological investigations—these correspondences can and should be used in designing the measurement schemes that sample the outline and quantify its biological structure across the sample. Of the outline analysis procedures available to date, only eigenshape has developed a procedure that allows this type of information to be accessed and utilised in a shape analysis investigation.

The solution to the dilemma of mismatch between semilandmark sequences and the underlying biological structure of organismal outlines is simple in principle. The form of each specimen's boundary outline can be represented by collecting a sequence of semilandmark points along the outline's trace. Although these points do not need to be equally spaced along the outline, calculations are simplified greatly if they are and this convention has become a useful standard (see Fig. 3). Next a series of landmarks representing points of corresponding or equivalent locations on the boundary outline are designated. These points are used to subdivide the outline into topologically equivalent segments. Each outline segment consists of three parts. The two ends of the segment are defined by landmark points at which strict biological and (semilandmark) sequence conformity is enforced. Between these points lies a region of uncertainty with regard to the correct matching of semilandmark point locations across the sample, but one that derives from a genuine lack of the biological information necessary to realize a specific inter-point matching scheme. In this region the most reasonable matching system to employ—the one that requires the fewest *ad hoc* hypotheses to justify—is one that samples the boundary evenly, using a set of equally spaced semilandmark points that are matched simply, according to their position in the outline segment sequence. Once these three sets of data have been collected it is a relatively simple matter to interpolate any given number of semilandmark points within each landmark-bounded outline segment in order to represent the form of the boundary outline curve in that region to any given accuracy standard. Extending this procedure to all segments into which the boundary outline has been subdivided results in (1) all outlines across the sample being represented by the same number of corresponding segments and (2) each corresponding segment of each outline across all objects in the sample being represented by the same number of semilandmark points.

To illustrate this procedure, outlines for the two *G. truncatulinoides* specimens shown in Figure 3 were digitized to a resolution of 200 semilandmark points. Then, in addition to the starting landmark (point 0 in Fig. 3, henceforth Landmark 1), the following landmarks were chosen to subdivide the boundary outline into segments: the umbilical tip of the ultimate chamber (Landmark 2), the peripheral margin of the antepenultimate chamber along the test outline (Landmark 3), the angular bend (= imperforate keel) representing the intersection of the umbilical



and spiral sides along the left-hand margin of the outline (Landmark 4), and the intersection between the coiled chambers of the lateral margin of the penultimate chamber of the spiral side test periphery (Landmark 5). These five landmarks were then used to divide the outlines of both specimens into five topologically corresponding outline segments. Finally, a sequence of ten semilandmark point segments was used to represent the form of the inter-landmark boundary in each outline segment. Results of this sampling procedure are shown in Figure 4. Treating the set of Φ shape function coefficients derived from this semilandmark sampling scheme as a column vector, it is a simple matter to obtain an overall measure of shape distinction between any two outlines as either a covariance or a Euclidean distance which, in the latter case for these two *G. truncatulinooides* outlines, is 2.3560. This should be compared with the distance calculated between these two outlines prior to shape registration (see Fig. 3), which is 2.3086.

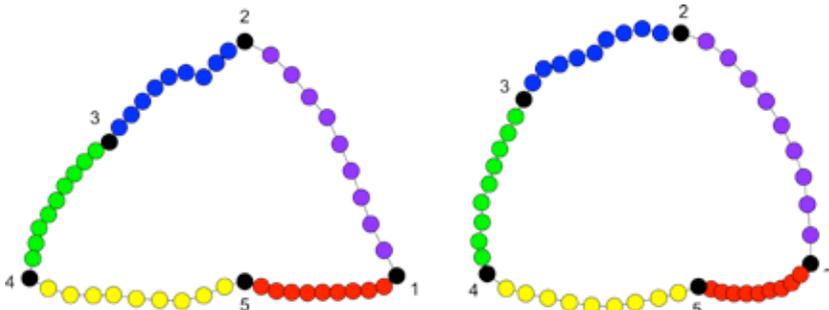


Figure 4. Results of the outline segment approach to characterizing shape variation in two planktonic foraminifer specimens. Coloured symbols represent corresponding (= topologically homologous) outline segments whose end-points are defined by landmarks (black symbols). The numbers refer to landmark identifiers (see text). In this scheme an equal number of semilandmarks was used to quantify shape variation in each outline segment.

Note that in the case of these *G. truncatulinooides* specimens, outline registration using landmark data resulted in the two curves increasing their shape-based distinctiveness. This is typically the case when using a sampling scheme that respects landmark-matching information where that is available, as well as one that is highly desirable in terms of maximizing the sensitivity of a morphometric analysis to accurate representation of the structure of form/shape differences among forms.

In the foregoing example an arbitrary decision was made to quantify the form of each of the outline segments using an equal number of semilandmark point locations. While it might be argued that this sort of outline sampling scheme is justified insofar as each outline segment is accorded the same degree of influence in determining the result, it can be appreciated from inspection of Figure 4 that some outline segments are more complex than others (e.g., compare the nature of the boundary outline curves between landmark points 2 and 3 to the outline segment that lies between landmarks 3 and 4). Enforcement of an equal weighing scheme such as that represented by Figure 4 ensures that some outline segments will be over-represented in terms of the number of semilandmark points required to quantify the segment's form while others may be under-represented.

In order to ensure that a uniform standard of shape representation is applied to each outline segment it is possible to use an iterative procedure to estimate the number of equally-spaced semilandmark points required to quantify the form of a boundary outline curve or curve segment to any specified degree of precision. This procedure can be approached in a number of ways, the simplest of which is to use the curve's perimeter as an index of geometric accuracy.

Figure 5 shows a simple illustration of the perimeter-based semilandmark-based curve estimation procedure. Taking an entire *G. truncatulinoides* outline as represented by 200 raw coordinate values as a starting point, the perimeter of this complex curve can be calculated as the sum of Euclidean distances between adjacent landmarks. By increasing the number of equally-spaced semilandmarks used to estimate the curve the overall accuracy of the representation increases as the estimated perimeter approaches the value of the measured perimeter. The rate of accuracy increase is surprisingly rapid and a point is usually reached quite quickly after which the inclusion of additional points makes little difference to the overall accuracy of the boundary outline form estimate.

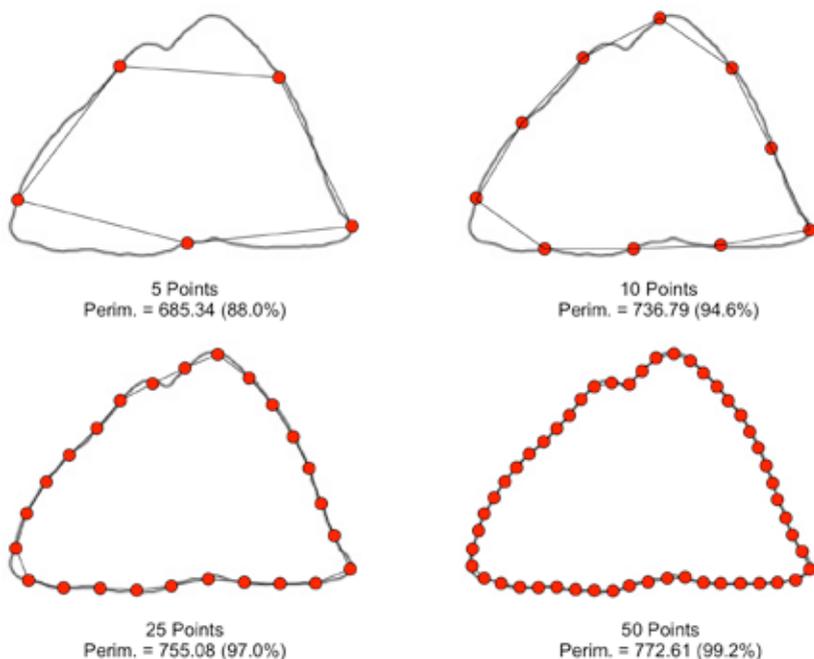


Figure 5. Results of a perimeter-based, iterative search for the optimal number of equally-spaced semilandmark points to use to represent a complex curve—in this case a *G. truncatulinoides* outline—to a qualifiable accuracy level. Percentage values indicate the proportion of the total perimeter (based on $n = 200$ raw coordinate points) that is represented by the estimated perimeter where $n < 200$. Note that even comparatively small numbers of semilandmark points can achieve a remarkably faithful representation of the form.

While Figure 5 provides an example of semilandmark point estimation applied to an entire outline—and while this application is eminently appropriate and useful for situations in which



an entire outline needs to be analysed as a single segment—it is possible to apply this same procedure to the geometric representation of separate outline segments (see Fig. 4). In both cases all outline curves or corresponding curve segments across a sample would be assessed in the manner shown in Figure 5, and the number of semilandmark points required to represent the most complex shape in the sample to the desired accuracy level (*e.g.*, 95.0%, 97.5%, 99.0%) determined. Then, all outline curves or corresponding curve segments included in the sample are re-estimated using this semilandmark resolution. The re-estimation step is necessary because the same outline curve sampling scheme must be applied to all specimens in the sample and the resolution required by the most shape-rich outline curve or curve segment in the sample employed in order to ensure that the fidelity with which geometric information is represented in the dataset conforms to a uniform minimum standard.

Of course, relatively straight curves will require fewer semilandmarks to represent their forms and more complex curves will require a greater number. Thus, the number of semilandmark points used to represent different outline segments will vary across the set of shapes, with a greater proportion of data coming from portions of the shapes that show the greatest geometric complexity across the sample. This variation has the effect of allowing the more geometrically complex regions of the form to exert a differential influence on the results of subsequent multivariate analyses of these data by virtue of the fact that more data are included from more geometrically complex regions than from geometrically simpler regions; an influence MacLeod (1999) termed ‘complexity weighting’.

While the imposition of any weighting scheme may strike some readers as being undesirable, from a geometric point of view the differential weighting of some regions of the form relative to others is unavoidable. In Figure 3 note that the ‘lower’ region of the *G. truncatulinooides* shape between semilandmarks 31 and 0 (= the sharply-angled periphery where the spiral and umbilical sides of the test meet) is rather straight when seen in apertural view. However, when strict equality in semilandmark spacing is enforced, fully a third of the shape data sampled comes from this relatively featureless part of the form. Representing what is little more than a straight line using a large number of semilandmark points is, in effect, a weighting scheme that differentially accentuates shape similarity. A complexity weighted sampling scheme applied to these data (see below) would reduce the number of semilandmark points assigned to the representation of this curve segment relative to the segments that represent the other two limbs of the test, which is where the overwhelming majority of systematically and taxonomically important components of the shape variation within this species resides. Still, and as we have seen above, complexity weighting is an option for any eigenshape analysis; one that can be taken up, ignored or modified as the investigator deems most appropriate to address the scientific problem at hand. My point is that, in the context of eigenshape analysis, and unlike current implementation of any form of Fourier analysis, these options exist. Judicious use of complexity or equal-weighting schemes can be used by the morphometrician, in effect, to ‘tune’ an outline analysis to be either sensitive to shape differences or sensitive to shape similarities among objects in a sample.

The subdivision of biologically complex outlines into segments at landmarks located on the boundary outline, along with specification of an intra-boundary segment representation scheme, has been termed ‘extended eigenshape analysis’ by MacLeod (1999) in order to distinguish it from Lohmann’s original procedure under which the entire object boundary was treated as a single



segment and an arbitrary number of semilandmarks (usually 200) used to quantify the form of this outline curve. Extended eigenshape analysis is best thought of as a hybrid procedure that makes use of the information contained in both landmarks and boundary outline semilandmarks to inform a shape analysis-based investigation. This form-characterization strategy respects the inherent strengths of both landmark and outline data, and achieves a geometrically detailed representation of each specimen's entire geometry insofar as that can be expressed meaningfully by the form of the boundary outline.

In order to illustrate use of the extended eigenshape procedure a selection of 24 outlines of *G. truncatulinoides* specimens oriented in apertural view were obtained from Lohmann (1983, see Fig. 6). These outlines were digitized at an initial resolution of 100 semilandmark points per outline in order to quantify their form. As these outlines lack evidence for the positions of landmarks 3 and 5 that were used to quantify the two example *G. truncatulinoides* specimens in Figure 4 for all specimens in the sample, these two landmarks were dropped from the analysis. This, of course, illustrates another practical disadvantage of adopting a strictly landmark-based approach to form or shape characterization—the requirement that all landmarks be visible and able to be located on all specimens in the sample; a requirement that often results in a very small number of valid landmarks that can be used to quantify shape variation across all specimens in a sample (see also Figure 2).

Accordingly, using landmark points corresponding to the right-most intersection of the umbilical and spiral test faces, the umbilical termination of the ultimate chamber, and the left-most intersection of the umbilical and spiral test faces of each specimen's outline, each outline was subdivided into three segments (Fig. 7). Applying complexity weighting to the sampling and representation of each of these three segments at an accuracy standard of 97.5% of the raw semilandmark perimeter value resulted in the umbilical trace of the ultimate chamber periphery (shown in red in Fig. 7) being represented by 21 semilandmark points (31.8% of the total), the trace of the spiral side topography (shown in blue in Fig. 7) being represented by 14 semilandmark points (21.2%), and the complex curve representing aspects of the shape of the umbilicus and the contributions of pre-ultimate chambers in the final test whorl (shown in green in Fig. 7) being represented by 31 semilandmark points (47.0%). Despite the fact that the green outline segment is complex both geometrically and biologically, the form of the periphery in this region of the *G. truncatulinoides* test is a key feature used by systematists routinely to characterise different populations of these species and, in some cases, to place specimens into subspecies categories (see Kennet and Srinivasan 1983). In this respect the ability of extended eigenshape analysis to represent the form of shape relations in morphologically and biologically complex regions of the specimens under consideration in a manner that mimics the way a human taxonomist would analyse such regions should be seen as an advantage of the employment of eigenshape analysis for practical morphometric analyses. It is also worth pointing out here that shape variation in the spiral side topography of these tests is much less complex than shape variation in the two umbilical regions, so has been down-graded in terms of its influence in subsequent analyses and interpretations (see below) by virtue of its smaller proportion of representation in the dataset.

Once the form of each specimen in the dataset had been sampled in the manner shown in Figure 7 the resultant semilandmark coordinate data were used to calculate each specimen's Φ

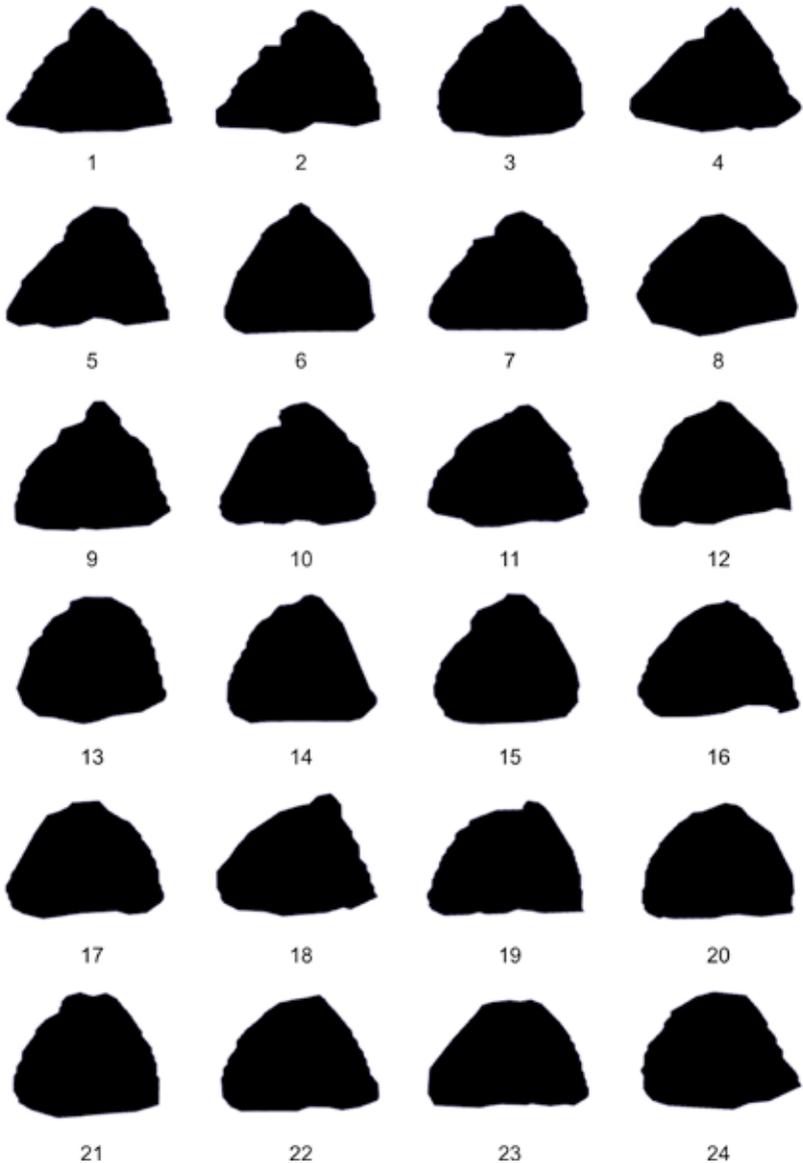


Figure 6. Silhouettes of *G. truncatulinoides* specimens used to illustrate the extended eigenshape analysis procedure. These represent scans of the specimens used by Lohmann (1983) to illustrate use of the original eigenshape method of shape analysis.

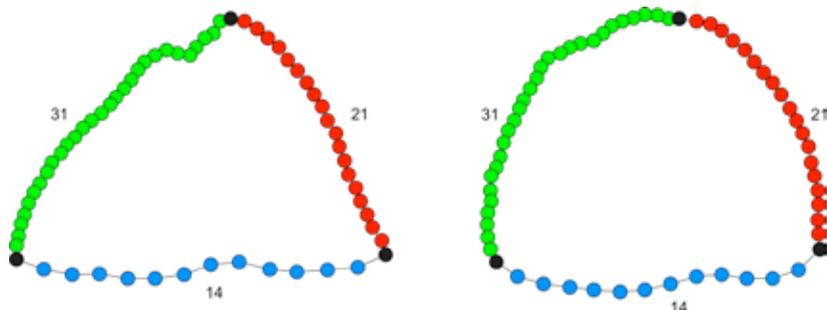


Figure 7. Outline semilandmark sampling scheme used for quantifying the sample of *G. truncatulinoides* test shapes shown in Figure 6. Under this scheme the outline is subdivided into three homologous segments at three landmarks visible in the outline when the specimen is oriented in apertural view (see Fig. 3): the right-most intersection of the umbilical and spiral test faces, the umbilical termination of the ultimate chamber, and the left-most intersection of the umbilical and spiral test faces. Based on the geometric complexity of these outline curve segments across the sample (Fig. 6) 21, 31 and 14 equally-spaced semilandmarks were required to represent the shape of these three segments to a consistent accuracy, 97.5% of perimeter length. This sampling scheme emphasizes shape variation (as opposed to shape similarity) in the subsequent multivariate analysis of these data.

shape function. This operation corrects the raw semilandmark data for extraneous differences in position and rotation as well as sequestering size information from shape information. Careful inspection of Figure 7 shows that, in addition to the shape-related changes in net angular change in the vectors between adjacent semilandmark points, each outline segment across the sample also differs in characteristic spacing between adjacent landmarks. If these inter-landmark spacing data are included in the dataset subjected to subsequent numerical analysis, it is the *form* (= shape + size) of the specimens that is the subject of comparison. Alternatively, if these inter-landmark spacing data are excluded from the dataset subjected to subsequent numerical analysis, it is the *shape* of the specimens that is the subject of the comparison. [Note: in the former case the correlation matrix should be used to estimate the form similarity structure for the sample, in the latter the covariance matrix should be used to estimate the shape similarity structure for the sample.] For this demonstration the pure shape analysis option was selected. Nevertheless, the ease with which extended eigenshape analysis—and indeed standard eigenshape analysis—support both types of comparisons is an inherent (and underexploited) feature of the eigenshape approach.

Once the set of Φ shape functions had been obtained for all 24 *G. truncatulinoides* specimens these were used to calculate a shape covariance matrix which was then subjected to principal component analysis (PCA) in the same manner as a standard eigenshape analysis (see MacLeod 2012). This procedure organizes the representation of shape variation in the sample in a series of orthogonal vectors (= eigenshapes) expressing the predominant trends in shape variation present in the sample. The scatter of shapes projected in the subspace formed by the first three extended eigenshapes is shown in Figure 8 along with the equivalent result for a standard eigenshape analysis of the same outlines.



The effect of achieving a more biologically constrained matching between semilandmark points is evident on these plots in two ways. First, the amount of shape variation represented on the first few eigenshape axes differs strongly, especially on eigenshape axis 1. In the standard eigenshape result the first eigenshape accounts for 17.19% of the total shape variation observed for the sample whereas, in the extended eigenshape result, this figure stands at 22.03%. However, while shape variation was maximized along the first eigenshape in the extended analysis, variation along extended eigenshapes 2 and 3 is lower than for the comparable standard eigenshape results. These patterns are consistent with the purpose of extended eigenshape, which is to focus the analysis on biologically justified comparisons between shapes and minimize the 'shape leakage' that occurs when information regarding biologically appropriate semilandmark point matchings is lacking. As a consequence the extended eigenshape procedure typically results in more shape variation being loaded onto the first shape variation axis and less onto subsequent axes.

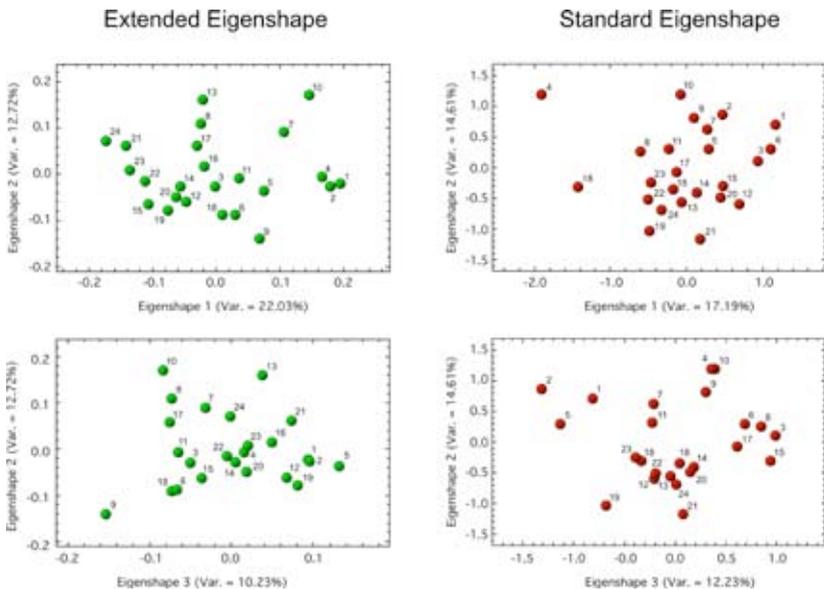


Figure 8. Scatterplots of shape samples using the extended (left) and standard (right) eigenshape protocols that have been projected into the subspaces formed by the first three eigenvectors (= eigenshapes) of the shape covariance matrices calculated from the Zahn & Roskies Φ shape functions. See text for discussion.

Second, the ordination of shapes within the two spaces is very different. Subordinate shape groups present under one shape sampling protocol (e.g., shapes 1, 2 and 4 in the extended eigenshape result) do not cluster together in the other. Shape outliers present in one analysis (e.g., 7, 9 and 10 in the extended eigenshape result) are not outliers in the standard eigenshape result. These distinctions reflect fundamental differences in the shape trends being expressed in the two analyses. Both are 'correct' in that they are both accurate reflections of the major trends in shape variance quantified under the two different sampling schemes. But their differences serve to underscore the importance of selecting the right sampling scheme for the biological problem at hand. For the *G. truncatulinoides* shape sample in Figure 6 the extended eigenshape



result should be regarded as the more accurate because it incorporates more of the biological information available than the standard eigenshape result and because there is a consensus among planktonic foraminiferal taxonomists regarding the validity and importance of the three landmark points used to subdivide the outlines.

While it is possible to get a sense of what these shape variation trends might be by comparing the shape of specimens that plot at the extreme ends of the along-axis distributions shown in Figure 8 with the shapes themselves (Fig. 6), this comparison can be achieved in a more accurate and intuitive manner by modelling along-axis shape variation for both results and comparing the model sequences (tables 1 and 2).

Table 1. Along-axis shape models through the subspace defined by the first three principal components (= eigenshapes) of the *G. truncatulinoides* extended eigenshape shape covariance matrix calculated from the Zahn and Roskies Φ shape functions. These models were calculated for five equally-spaced coordinate locations within the extended eigenshape space (Fig. 8 [left]) that ranged from the most extreme negative (-2) to the most extreme positive (+2) projected location of a sample specimen on each axis. The middle model in this sequence falls near, but not at, the mean outline shape for the sample. Plots of an overlay of these models along each axis are included to facilitate geometric interpretation of the along-axis shape trends.

Axis	-2	-1	'Mean'	+1	+2	Overlay
Extended Eigenshape 1						
Extended Eigenshape 2						
Extended Eigenshape 3						

Looking at the extended and standard eigenshape along-axis models it is clear that the shape transformation represented by extended eigenshape 1 is very similar to the shape transformation represented by standard eigenshape 2, albeit reversed in polarity.¹ In both cases shapes characterized by a pointed umbilical regional created by a differentially developed ultimate chamber, and an acutely angled (keeled) spiral periphery, occupy one end of these axes and are readily distinguished from those characterized by a relatively flat umbilical area as a result of under-development of the ultimate chamber with a more broadly rounded left-side spiral periphery, which occupy the other extreme. Outline shapes that occupy the central region of these axes exhibit the broadly equilateral triangular form of the sample mean shape. Interestingly, the third eigenshape axis represents very similar shape transformations in both the extended and standard datasets. Here, shapes that exhibit a differentially developed ultimate chamber whose umbilical ends occupy a central position, and whose spiral peripheries are broadly rounded, project to the low ends of both axes; whorl shapes with more acutely angled spiral peripheries and ultimate chambers whose umbilical ends verge toward the right, project

¹ Recall that polarity directions for eigenvectors are arbitrary.



Table 2. Align-axis shape models through the subspace defined by the first three principal components (= eigenshapes) of the *G. truncatulinoides* standard eigenshape shape covariance matrix calculated from the Zahn and Roskies Φ shape functions. These models were calculated for five equally-spaced coordinate locations within the standard eigenshape space (Fig. 8 [right]) that ranged from the most extreme negative (-2) to the most extreme positive (+2) projected location of a sample specimen on each axis. The middle model in this sequence falls near, but not at, the mean outline shape for the sample. Plots of an overlay of these models along each axis are included to facilitate geometric interpretation of the along-axis shape trends.

Axis	-2	-1	'Mean'	+1	+2	Overlay
Standard Eigenshape 1						
Standard Eigenshape 2						
Standard Eigenshape 3						

to the high ends of both axes. However, the shape transformations that characterize standard eigenshape 1 and extended eigenshape 2 are unique to each result. In the case of the former, shapes that are relatively elongate parallel to the tests' spiral axis project to positions low on standard eigenshape 1 and those that exhibit a degree of test compression in the direction of the spiral axis project to positions high on standard eigenshape 1. In terms of extended eigenshape 2, the shape distinction represented by this axis separates tests whose ultimate chambers exhibit pointed umbilical ends (low projected positions) from those whose umbilical ends are relatively flattened (high projected positions). In addition, tests that project high on this axis are slightly more inflated than those that project to low positions.

These distinctions are fairly straightforward and easy to appreciate via use of the along-axis shape models. However, the real story—in terms of characteristic differences between the standard and extended eigenshape outline sampling protocols—is more readily understood by examining the overlaid along-axis models (= last column in tables 1 and 2). Note that, in the set of standard eigenshape results, along-axis shape distinctions occupy broad regions of the outline whereas, in the case of the extended eigenshape results, along-axis shape distinctions are much more localized and differentially focused in extended eigenshape 1. This difference in the general character of these two geometric subspaces arises because, in the case of the standard eigenshape results, true biological shape differences are being combined with apparent shape differences due to the mismatching of biological structures. This situation comes about because no control is exerted on the nature of semilandmark matching beyond that of starting the outline digitization sequence at a topologically equivalent landmark across all specimens in the sample. The extended eigenshape outline sampling procedure mitigates against the gross mismatching of semilandmarks throughout the outline sequence by periodically re-calibrating the matching



sequence at multiple landmark positions along the boundary outline. The effect of this recalibration is to emphasize differences in shape that have a biological cause and to force these to be expressed on the first few eigenshape axes. The overall result of employing the extended eigenshape procedure is both a more efficient and a more specific summary of shape deviation patterns contained within a sample that can be interpreted with greater biological confidence.

Last, but by no means least, once the lessons of combining the strengths of landmarks and boundary outline semilandmarks have been learned, the last step in the generalization of the eigenshape procedure, and its formal linkage to standard geometric morphometric methods, is for the data analyst to free themselves from the implicit restriction of eigenshape analysis to problems that only consider the form of boundary outlines. In principle we would like to be able to include any geometric data from any structure in our morphometric investigations irrespective of (1) how many boundary outlines are of interest and/or (2) whether all landmarks lie on boundary outlines. Conceptually we would like to compare the equivalent of line drawings of complex biological structures consisting of isolated point locations continuous, closed curves and discontinuous curves terminated at specific landmark points. Such complex assemblages of geometric data cannot be accommodated under the standard or extended eigenshape procedures because both are tied to representation of the shape through use of the Zahn and Roskies Φ and Φ^* shape functions or some equivalent (e.g., Bookstein's, 1978, tangent angle shape function).

However, the outline sampling protocols described above do not depend on the use of any particular outline-based shape function in order to be applied. Indeed, transformation of these semilandmark data into the format of a shape function takes place after these data have been interpolated and assembled into topologically corresponding outline segments. Moreover, there exists a fully generalized procedure for transforming any geometric data that can be represented by any type of landmark—including sets of semilandmarks—into its equivalent shape coordinate space: the method of *Procrustes* superposition and alignment.

Use of *Procrustes* shape coordinates as the basis for an eigenshape-style analysis was first explored explicitly by Sampson *et al.* (1996) and later by MacLeod (2001). More recently this approach has been used to analyse evolution and adaptation in carnivore crania (see Figueirido *et al.* 2011). The combination of extended eigenshape-like sampling strategies with *Procrustes* shape coordinate transformations represents a true synthesis between strictly landmark-based and strictly outline-based approaches by regarding these as conceptual end-members of the complete spectrum of data combinations and alignment strategies. Owing to this spectrum's inherent flexibility, it is possible to address morphometric problems of any complexity required by the scientific hypotheses and the data at hand, while allowing the data analyst to retain complete control over the level of data resolution required to perform hypothesis tests, control over the data used to realize shape coordinate alignment, and control over which data are allowed to participate in which phases of the analysis (e.g., some data might be carried through the alignment stage analysis passively) so long as the overall strategy/procedure can be justified in terms of the morphological task under consideration and the scientific questions being asked.

Software for performing an extended eigenshape analysis is readily available. I maintain stand-alone, public-domain applications for Windows and Apple Macintosh platforms and have written new *Mathematica*[™] notebook scripts to perform all the analyses described in this essay.



In addition, public domain standard and extended eigenshape routines are available in the Morpho-Tools website (<<http://www.morpho-tools.net/>>).

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

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



>> **Future** Meetings of Other Bodies



Linnean Society Palaeobotany Specialist Group's Annual Meeting

The Linnean Society, Burlington House, London 31 October 2012

Please contact Peta Hayes (e-mail <p.hayes@nhm.ac.uk>) at the Natural History Museum, London, for more information or to offer a talk.



Linnean Society Palynology Specialist Group's Annual Meeting: Understanding Pollen and Spore Diversity

The Linnean Society, Burlington House, London 1 November 2012

The Palynology Group meeting is open to anyone with an interest in pollen or spores. The November meeting aims to bring together researchers working on all aspects of pollen and spore diversity, including morphology, development, and the fossil record. There is no registration fee as the meeting is generously supported by funding from the Linnean Society. Some travel funding is available for student/postdoc speakers. The meeting will be followed by a wine reception in the Linnean Society Library.

Speakers include: Wolfram Kuerschner (Oslo), Late Triassic *Classopollis*; Julia Tratt (Bath), Degradation of the callose tetrad wall; Safia Belhadj (Djelfa), *Pistacia atlantica* pollen morphology and Sam Slater (Sheffield), The megaspore *Reticuspinotriletes ravenscariensis*. More speakers are needed: can you offer a talk on neo- or palaeopalynology? Posters are also welcome.

Please contact Carol Furness (e-mail <c.furness@kew.org>) at the Royal Botanic Gardens, Kew, for more information or to register.



2012 GSA Annual Meeting & Exposition

Charlotte, North Carolina 4 – 7 November 2012

Session: The Future of Quantitative Paleontology: Biometry, Computer Vision & Machine Learning

Taxonomic data play a crucial role in understanding Earth history. Accurate identifications and classifications are necessary to document the origin and radiation of major groups, estimate historical patterns of taxonomic richness and diversity, and provide age estimates for various evolutionary and geological events.

This topical session will draw together contributions from researchers who are developing and/or applying tools from fields such as digital imaging, pattern recognition, computer vision and machine learning, to classification problems in palaeontology and allied sciences. We welcome contributions from researchers working on organisms from all branches of the tree of life and all parts of the stratigraphic column.

Further details can be found at <http://www.nhm.ac.uk/hosted_sites/paleonet/GSA/>.



Session: Quantitative Cenozoic Terrestrial Climate Reconstructions in the Northern Hemisphere: Evidence from Paleo-Proxies and Beyond

Recent advances in quantitative Cenozoic palaeoclimate reconstructions have greatly improved our understanding of climate change in terrestrial environments in the Northern Hemisphere thanks to technical improvements in the use of palaeo-proxies (fossils) and Earth System modelling. Progress has been made largely on regional scales, and most recently, data cover partly allows for continent-wide study and interpretation of palaeoclimate and vegetation patterns, *e.g.* between single regions of Eurasia covered by the NECLIME – Neogene Climate of Eurasia network.

To get an insight on Cenozoic climate change on a larger scale and/or bring multiple results together from different fields, we invite contributions based on palaeo-proxies and modelling experiments dealing with Cenozoic terrestrial climates in the Northern Hemisphere.

Please contact the session Advocate, Dr Yusheng (Christopher) Liu, e-mail <liuc@etsu.edu> for more information.



The Micropalaeontological Society Annual General Meeting and Warm Worlds Symposium

The British Geological Survey, Keyworth, Nottingham 11 – 13 November 2012

The TMS are delighted to announce that, in a change from the traditional one-day AGM meeting, we will be holding a two-day conference at the British Geological Survey, Keyworth, Nottingham. There will also be additional optional activities such as a pre-meeting field excursion and conference meal during our time in Nottingham.

The event will include guest lectures from both academia and industry. In addition, open sessions are scheduled for short (*ca.* 10 minute) talks as well as a poster session on any topic related to micropalaeontology. We therefore encourage participants wishing to attend to also submit abstracts for the oral and/or poster sessions.

If you have any questions relating to the conference please contact one of the event convenors, Jim Riding (e-mail <jbri@bgs.ac.uk>) or Sev Kender (e-mail <sev.kender@bgs.ac.uk>) or visit the meeting website at <<http://www.tmsoc.org/agm2012.htm>>.



Annual International Conference on Geological and Earth Sciences (GEOS 2012)

Hotel Fort Canning, Singapore 3 – 4 December 2012

Topics of interest include, but are not limited to: Mineralogy, Petrology, Geochemistry, Geomorphology, Palaeontology, Stratigraphy, Structural geology *etc.* For a complete list view the 'Call for Papers' section of the conference website <<http://www.geoeearth.org/CallforPapers.html>>.

Best Paper and Best Student Paper awards will be conferred at the conference, and there is the opportunity to submit papers for the conference proceedings publication.

For further details see the conference website at <<http://www.geoeearth.org/>>.



6th International Symposium on Lithographic Limestone and Plattenkalk
Museo del Desierto, Saltillo, Mexico 4 – 8 March 2013

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

Please consider submitting manuscripts for the LAK conference proceedings. These are planned to be published in the “Revista Mexicana de Ciencias Geológicas” which is indexed in several citation indices, including the Science Citation Index. Impact Factor (2010) is 1.136. The “Revista” is an open access journal. Please submit your manuscript at the conference or via e-mail to <ISLLP2013@geow.uni-heidelberg.de>.

For more information visit the conference website at <<http://isllpsaltillo.uni-hd.de/>> or e-mail <ISLLP2013@geow.uni-heidelberg.de>.

Registration deadline: 1st November 2012. Abstract submission deadline: 1st December 2012.



Microfossils III: Geologic Problem Solving with Microfossils
University of Houston, Houston, Texas, USA 10 – 13 March 2013

The North American Micropaleontology Section of the Society for Sedimentary Geology (SEPM) announces the 3rd Geological Problem Solving with Microfossils conference (a.k.a. Microfossils III). The mission of Microfossils III is to bring together a diverse range of geoscientists to focus on the use of microfossil disciplines to solve geologic problems.

The conference activities include: oral and poster technical presentations, a regional pre-meeting field-trip, post-meeting short courses, ice breaker, and plenary dinner at the Houston Museum of Natural Science. Tentative session themes include: The Microfossil record of Major Oceanic Events; Microfossils and Unconventional Resources: The New Frontier; High-resolution Biostratigraphy, Chronostratigraphy, and Geochronology; Reconstructing Past Environments Using Microfossils; Paralic and Lacustrine Micropaleontology; Microfossils and Biofacies Analysis: Applications and Challenges; Palaeoclimate, Palaeoceanography, and Relative Sea-level Change; Taxonomy, Phylogeny, and Evolution; New Technologies and Techniques in Microfossil Studies.

Please contact Dr Mark Leckie (e-mail <MLeckie@geo.umass.edu>) for more information, or look at the NAMS website at <<http://www.sepm.org/nams>>.

Abstract submission deadline: 11th November 2012.

**SAGE 2013: 2nd Southeast Asian Gateway Evolution**

Museum für Naturkunde Berlin, Humboldt University Berlin

11 – 15 March 2013

The Museum für Naturkunde Berlin and the Humboldt University will host the second international conference on Southeast Asian Gateway Evolution (SAGE 2013).

This meeting focuses on the origin, diversification and conservation of Southeast Asia's megadiverse fauna and flora against the background of the region's complex geology and climate history. We aim to attract climatologists, biogeographers, palaeontologists and geologists to this multidisciplinary meeting and look forward to welcoming you in Berlin in March 2013.

For more information check the conference website at <<http://www.sage2013.org/>>.

**1st International Winter School on Evolution**

Ciência Viva Knowledge Pavilion, Lisbon, Portugal

11 – 15 March 2013

We are happy to inform you that registration is now open for the 1st International Winter School on Evolution. Courses are open to international Master, PhD and Post-doctoral students in the exact, life, human and sociocultural evolutionary sciences. The courses run from Monday to Friday, with parallel sessions whereby visiting staff provide a 10-hour course (2 hours a day) on critical aspects of biological and sociocultural evolution. The courses are centered around the following modules.

Module 1: Macroevolution and the Major Evolutionary Transitions (taught by Bruce Lieberman, Folmer Bokma, Eörs Szathmáry).

Module 2: Language Evolution (taught by William Croft, Mónica Tamariz, Daniel Dor).

Module 3: Symbiogenesis, Lateral Gene Transfer and Virolution (taught by Douglas Zook, William Martin, Michael Arnold).

All courses are taught at a level accessible to Masters, PhD and post-doctoral students in the exact, life, human and sociocultural evolutionary sciences. Students of evolutionary biology, microbiology, palaeontology, evolutionary linguistics, evolutionary anthropology, and philosophy of biology will especially benefit from these courses. Students will be provided with a mandatory reading list which will form the basis of lectures and discussions. There are neither examinations nor paper assignments. The course fee is €350 euro for the whole week, regardless of the number of courses you choose. You can enroll for a specific module (therefore following a 30-hour course on the subject) or you may choose three courses of your specific interest. Places are limited, we therefore advise you to enroll as quickly as possible.

The School is organized by the Applied Evolutionary Epistemology Lab of the Centre for Philosophy of Science of the University of Lisbon, in collaboration with Ciência Viva and with the support of the John Templeton Foundation.

Download the poster from <<http://evolutionschool.fc.ul.pt/winter/docs/winter.pdf>>.

Subscribe to the Winter School mailing list at <<http://eepurl.com/n2ELH>>.

Websites: <<http://evolutionschool.fc.ul.pt/>>, <<http://appeel.fc.ul.pt/>>



Volcanism, Impacts and Mass Extinctions: Causes and Effects
The Natural History Museum, London 27 – 29 March 2013

London's Natural History Museum will host an international, multi-disciplinary conference that brings together researchers across the geological, geophysical and biological disciplines to assess the state of research into the causes of mass extinction events. The main goal of this conference will be to evaluate the respective roles of volcanism, bolide impacts, sea level fluctuations and associated climate and environmental changes in major episodes of species extinction.

For more information check the conference website at <<http://massextinction.princeton.edu/>>.



The 6th International Congress on Fossil Insects, Arthropods and Amber
Byblos, Lebanon 14 – 18 April 2013

The Lebanese University, Faculty of Sciences II, and Municipality of the city of Byblos together with the International Palaeontomological Society invite you to the 6th International Congress on Fossil Insects, Arthropods and Amber in Lebanon. This congress will take place in Byblos, the ancient biblical city that gave the alphabet to the World.

A series of scientific sessions and special group meetings will be organised. The mid-conference field excursion will visit the Jeita cave archaeological site, and the post-conference field excursion will visit the Lower Cretaceous outcrops (containing amber) of Mdeyrij-Hammana, Central Lebanon, and Jezzine, Southern Lebanon.

The conference venue will be in the *ontoch* (monastery) of Saint John-Mark (built in 1766), Byblos city. The opening ceremony will be held in the Lebanese University, Faculty of Sciences II, Fanar. The official language of the congress is English.

Selected papers submitted for the Congress will be published by Brill in special issues of *Insect Systematics & Evolution* and *Terrestrial Arthropod Reviews*, and in a book that will contain papers dealing with geology, chemistry and taphonomy of amber and fossil insects outcrops (see <<http://brill.nl/ise>> and <<http://brill.nl/tar>>).

Please contact Prof. Dany Azar (e-mail <azar@mnhn.fr>) for more information.

Deadline for original manuscript submission: 1st October 2012. Abstract submission deadline: 31st January 2013.



Rio Ptero 2013 – International Symposium on Pterosaurs
Museu Nacional/UFRJ, Rio de Janeiro, Brazil 23 – 26 May 2013

We will accept contributions on pterosaurs and related topics. You will be able to examine pterosaurs and other fossils in the collections of Museu Nacional (MN/UFRJ) and Museu de Ciências da Terra (DNPM) while in Rio. Palaeoartists who wish to exhibit their work during the course of the meeting are also welcome.



For more information please visit the conference website at

<http://www.museunacional.ufrj.br/riopterosaur/museu_nacional.html>. Submit abstracts (formatted as per instructions on the website) by e-mailing <riopterosaur@gmail.com>.

Abstract submission deadline: 15th December 2012. Registration now open.



2nd International Congress of Agora Paleobotanica

Ariño, NE Spain 9 – 13 July 2013

A CONGRESS IN THE COUNTRYSIDE is an international meeting supported by the Agora Paleobotanica which will last for four days in Ariño, a small village in Teruel region, northeastern Spain. Agora Paleobotanica is a new organization originating from the OFP (Phrancophone Organization of Palaeobotany).

The meeting provides an open forum for all that is exciting and new in the fields of palaeobotany and palynology conducted by palaeobotanists of the Southwest European region. It also offers a range of field-trips visiting different Early Cretaceous sites of primitive angiosperms of Albian–Cenomanian age, such as the Castellote Cretaceous trunk site, Dinopolis museum with a large number of palaeontological remains including dinosaurs and Miocene macroflora site (Konservat-Lagerstätten) in Rubielos de Mora.

Full details at <<http://www.grupopaleobotanicaiberica.es/eventos/congresos/arino2013.htm>>. Please e-mail <arino2013@grupopaleobotanicaiberica.es> for further information.



10th North American Paleontological Convention

Venue TBA Summer 2013

Please send your proposals for the meeting venue to Mark Wilson (e-mail <mwilson@wooster.edu>, Department of Geology, The College of Wooster, Wooster, OH 44691).

Check the Paleontological Society website at <<http://www.paleosoc.org/>> for updates.



2nd International Joint Congress APLE-APLF on “Pollen Diversity and Function in a Changing Environment”

Madrid, Spain 17 – 20 September 2013

The Spanish and French Palynological Societies, APLE and APLF, will join for their next Symposium in Madrid from 17th to 20th September, 2013. Under the general title of “Pollen Diversity and Function in a Changing Environment” and organized by CSIC and Complutense University palynologists, the two societies will present and discuss their recent findings on relevant palynological topics.

Further information will be available in due course on the APLE (<<http://apple.usal.es/>>) and APLF (<http://laplf.org/>) websites.



46th Annual Meeting of AASP – The Palynological Society. Joint meeting with DINO 10 and the North American Micropaleontology Section (NAMS)
San Francisco, USA 20 – 24 October 2013

Further information will be available in due course on the AASP – The Palynological Society website at <<http://www.palynology.org/>>, or contact Lanny Fisk (e-mail <Lanny@PaleoResource.com>).



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

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

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

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

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



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

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

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

Delegates will have the opportunity to enjoy a wide range of conference excursions to rich and well-known Argentinean palaeontological sites involving a combination of scientific and touristic attractions. The schedule of field-trips covers superbly exposed sedimentary successions,



representing a great diversity of marine and continental palaeoenvironments, and encompasses nearly all of the stratigraphic record.

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

Please see the conference website at <<http://www.ipc4mendoza2014.org.ar/>> for further details.

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



Meeting REPORTS



Progressive Palaeontology 2012

University of Cambridge, UK 23 – 25 May 2012

This year, the University of Cambridge had the immense honour of welcoming more than 60 up-and-coming young palaeontologists filled with excitement and determination to show the harvest of many hours of rock-solid research (pun completely intended) to Progressive Palaeontology 2012. The reception at the Sedgwick Museum of Earth Sciences, sponsored through the generosity of Taylor & Francis, broke the ice right away. The delegates feasted on a jolly combination of food, beverages and light scientific chit-chat that is best enjoyed among colleagues, especially under the gentle stare of the sclerotic rings of several diapsids specimens that guard the museum corridors.

The following morning, proceedings were kicked off by the opening remarks of Prof. **Simon Conway Morris**, celebrating a renaissance of palaeontology in light of novel contemporary techniques and his belief that “the interesting finds are still to be made.” The first session ‘Palaeozoic palaeobiology and phylogeny’ was chaired by **Javier Ortega-Hernández** and began with **Oliver Kneivitt**’s (Leicester) presentation about his comparative work on the organic preservation of the eyes of the conodont *Wurmiella excavata* from the Silurian Eramosa Lagerstätte of Ontario, Canada. **David Legg** (Imperial) followed this up with his talk on the phylogeny and evolution of stem-group arthropods which generated a heated conversation during questions, after which **Sam Giles** (Oxford) introduced the vertebrates (more specifically the interrelationships of the earliest ray-finned fish) and **Laura Soul**, also from Oxford, finished the session off with her presentation ‘Modelling the impact of phylogeny of interpretations of extinction in deep time.’

Morning tea offered the first opportunity to view the posters, which were hung in the Earth Science Department’s foyer, including the ‘Best Poster’ winner ‘Evolution of the actinopterygian dermal skeleton’ by **Edine Pape**, and runner-up **Alex Dunhill**’s ‘The Phanerozoic of Great Britain: Biodiversity, sampling proxies and the quality of the fossil record’. Both winners are affiliated with the University of Bristol.

The second session of talks, ‘Palaeobiology and functional morphology’, was begun by **Sam Bennett** (Royal Holloway) who presented his research on ichthyosaur ontogeny but defended his decision to include ‘sexual dimorphism’ in his talk’s title because he’d “learnt from experience that if you incorporate the word ‘sex’ into the title of your talk, more people listen.” **Gabriela Sobral** (Berlin) was the first to showcase microCT skills with her recently published work on the braincase re-description of *Dysalotosaurus lettowvorbecki*. The *in silico* theme continued with **Andrew Cuff**’s (Bristol) work on ornithomimosaurs, adding a flavour of finite-element analysis which was continued on in **Stephan Lautenschlager**’s talk (Bristol) on the dietary preferences of *Erlikosaurus andrewsi*. Moving post-cranially, **Rachel Mitchell** (Glasgow) presented her undergraduate work on theropod limb bones from Morocco, after which **Tom Stubbs** (Bristol) talked about his research on the adaptive radiation of crurotarsans in the aftermath of the end-Triassic extinction.



The first session after lunch, 'Mesozoic and Cenozoic palaeoecology' chaired by **Caroline Sogot**, began with Leicester-based proxies – first dental microwear for inferring diet (complete with utterly surreal *Lord of the Rings* references) from **Laurent Darras**, followed up by **Nicola Clark**'s work on using oxygen isotopes from bivalves to interpret Neogene Antarctic shelf marine environments. Bivalves remained the theme as **Aleksandra Skawina** (Warsaw) presented her research on the anatomy and evolution of Triassic unionoids from Poland. **Katy Prentice** (Imperial) won Runner-Up for 'Best Talk' for her presentation 'Surface ocean productivity across the Eocene/Oligocene transition,' and overall 'Best Talk' winner **John Clarke** (Oxford) followed with his highly polished talk on his work on teleost and holostean diversification.

A triptych of presentations broadly concerned with public outreach and communication started with **Ross Mounce** (of BBC Radio 3's *Nightwaves* fame) talking about his affiliation with The Open Knowledge Foundation promoting open knowledge, followed by **Imran Rahman** extolling the virtues of the web-based (open access) journal *Palaeontology [online]*, and was concluded by **Dave Marshall** advertising the new podcast series "*Palaeocast*," co-developed by himself and **Joe Keating** (of which four episodes are now available online).

Holly Barden (Manchester) threw a curveball with her talk on the peculiar geochemistry of the 'beetroot stone' *Solenopora jurassica*, earning her the status of joint runner-up for the 'Best Talk' award. Sedimentology was united with palaeoecology in **Naomi Jordan**'s (Imperial) talk on the taphonomy of the Early Jurassic Blue Lias Formation and **Pete Heintzman** (Royal Holloway) brought us all the way back to zoology with a bang with his work on the ancient DNA of two species of Ice Age beetle, discussing what could be inferred from them in reconstructing past climatic events (for which he won 'Best Abstract'). Finally, **Peter Adamson** (Bristol) drew the talks to a close with the presentation of his new abiogenic model of the precipitation of the mineralised skeleton of *Namacalathus*.

As the day came to an end, the River Cam witnessed an exodus of delegates with bulging minds but empty stomachs as we walked past the Mathematical Bridge, made famous by naive Cambridge undergraduates who were once unable to replicate the intellectual prowess of Sir Isaac Newton (or so the legend goes), heading towards the lovely Newnham College for the annual dinner. The main hall served its purpose well, and the prizes, generously donated by Cambridge University Press and staff from the University, were announced and accompanied by thunderous



applause. In addition to the mouth-watering three-course dinner, a small dinosaur companion greeted each of the delegates, and as the evening carried on we marvelled at the appearance of a rare creature – half dinosaur and half Chloe Marquart, covered from head to toe with party hats; such unusual a sight to see!



On the last day, 25 delegates joined us for an early departure in search of fossils and excitement on the Jurassic Oxford Clay. We arrived promptly at King's Dyke and, after a small warning about how not to get smashed by a nearby crane, literally dug into one of our most primal passions: fossil hunting! Plenty of cephalopods and bivalves made the site a wonder to collect in, but the highlight of the day was the discovery of a fragmentary ichthyosaur bone. After a brief lunch at the site we carried on to



Yaxley to spend the rest of the day looking for tiny pyritized ammonites in the embankment. As the sun started to fade, we took the opportunity for a final group photograph before departing back to Cambridge with our pockets full of small palaeontological goodies.

Finally, we are proud to offer anyone the opportunity to listen to almost all of the talks that were presented at Progressive Palaeontology 2012 at <<http://progpal2012.tumblr.com/>>. We felt that allowing anyone to attend the conference virtually this year was in keeping with the current rumblings within academia and academic publishing. All the speakers featured on the site agreed to have their talks recorded and shared online. As Progressive Palaeontology is a conference for young researchers, some of the information and results discussed may not have been published yet, and for this reason we decided against recording visuals. However, we all agreed that the gains



brought about by sharing the conference with the whole world online meant that this was (of course) the right thing to do. We look forward to seeing more international conferences offering access to talks online when, for instance, delegates are unable to travel the large distances to foreign universities (and we were pleased to see the organisers of this year's SVPCA held in Oxford followed suit).

Now all that's left is for us to wish the organizers of next year's Progressive Palaeontology all the best and we look forward to seeing everyone again, up North, in lovely Leeds.

Javier Ortega-Hernández and Nick Crumpton
University of Cambridge
<jo3014@cam.ac.uk>; <njc71@cam.ac.uk>

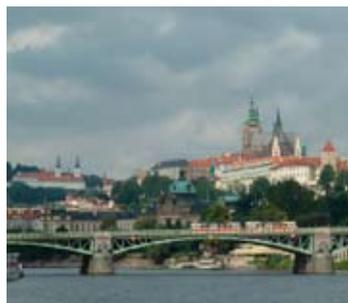
**The 5th Conference on Trilobites and their Relatives**

Prague, Czech Republic 1 – 4 July 2012

The 5th International Conference on Trilobites and their Relatives was held from 1st to 4th July at the Charles University in Prague, superbly organised by Petr Budil and Oldrich Fatka, with the aid of several younger colleagues.

Before the conference there was a three-day field-trip in the Cambrian to Devonian sediments south west of Prague, and a very fine trip it was, giving a magnificent opportunity for the participants to visit new and classic localities, armed with an admirable, and specially prepared Excursion Guide, full of information and beautifully produced. The first two days were devoted to the Cambrian, the third to the Ordovician and the last day to the Siluro–Devonian. So, a group of some 20 people assembled, and on the first day, 26th June, in very pleasant weather, we visited the Cambrian of the Pribram-Jince Basin, recovering many typical Middle Cambrian fossils. On the second day the Skrye-Tyrovice Basin was visited, with lunch in the restaurant U Trilobitu, near the famous bronze bust of Barrande. A memorable stop was a new exposure where we hunted, and found, juveniles of *Sao hirsuta*. On 28th June we studied a graptolitic section in the Ordovician Dobrovitva Formation with cyclopygids and other trilobites, and sundry other localities in the Ordovician. But the most fascinating visit of all was to the Ordovician ironstone mine of Chrustenice, which once employed some 400 workers; we walked all the way into the mine, excellently guided, and came back by a miners' train. The final day involved a visit to the vast quarry at Kosov, in Silurian limestones, amazingly fossiliferous, with successive trilobite faunas at different levels, the real gems being the tiny odontopleurid *Diacanthaspis (Acantholomina) minuta*. Several fine Devonian quarries were visited, with the great Koneprusy reef complex visible from afar, and finally the excursion ended, without a hitch at any time, with beer and sausages in an old quarry south of Prague.

The first day of lectures, held in the elegant Geology building of Charles University, began with a splendid presentation by **David Bruton** on the life and work of the late Harry Whittington, surely one of the greatest single influences on research into trilobites and their relatives of all time. Then there followed a series of five talks in the field of *Biostratigraphy and palaeogeography* (only the presenter's name is given henceforward). Firstly we heard **Richard Fortey** expound on the magnificent



Prague

trilobite fauna of the early Ordovician Kirtonryggen Formation in Spitzbergen, following Richard's 1970s work on the overlying Valhallfonna Formation. This was followed by several regional presentations. **I. R. Gilbert** resolved a paradoxical clash between stratigraphic records of trilobites and conodonts in Middle Cambrian of India (the 'conodonts' were actually acrotretid brachiopods of conical form), then **Tania Pegel** and **A. L. Makarovka** gave meticulously detailed presentations on Cambrian trilobite associations of the Siberian platform. The last speaker of the morning, **Juan-Carlos Gutierrez-Marco et al.**, related new discoveries of telephiniids from the Central Andean basin.

In the afternoon came the first three of ten papers under the umbrella of Evolution and systematics. **J. H. Collette** discussed the distribution of sauikiid trilobites, an inshore group, curiously found



in both Gondwana and Laurentia. Did they island-hop? New morphometric analysis, when completed, should tell. **Petr Budil** described articulated juvenile phacopids from the Prague Basin, normally extremely rare, and finally **A. Bignon**, described how morphometric analysis has been used in elucidating evolutionary modifications of ontogeny in *Dechenella* to distinguish rate modifications from allometric re-patterning.

But on the Monday we had something quite different, a cultural trip in the form of a Vltava river cruise from the city centre to Barrande's Rock several kilometres south along the river. We passed under the marvellous bridges, below the great castle, alongside elegant baroque houses and past Ordovician to Devonian cliffs; for anyone previously unfamiliar with this incomparable city (yes, it is even finer than Edinburgh) this must have been inspiring. We had not, however, expected to meet Joachim Barrande in person. But there he was, strolling contentedly along the deck, with his mutton-chop whiskers, black suit and white cravat, and a very fine figure he made. We can only hope that Petr Budil, for such it was, did not feel too hot in this outfit! At Barrande's Rock, exposing highly folded Lower Devonian sediments, we toasted our departed hero in champagne before returning to the shore. Then we went by bus to a lovely deep valley with a barbecue for sausages, and of course, excellent Czech beer in quantity. And for those who wished, a further walk along the valley with a few fossils to be collected. What a great day!



J. Barrande (P. Budil)

So, back to the scientific programme on the Tuesday morning. Still on the same theme we heard **Brenda Hunda** discussing stability of clinal regimes on calymenids in the Upper Ordovician of Cincinnati, followed by **Lukas Laibl** on the ontogeny of *Sao hirsuta* – which we may remember was the first trilobite of all whose ontogeny was described, by Barrande in 1852, our knowledge now transformed by morphometrics and SEM photography. Then **Michael Mergl** described magnificent odontopleurids from the Katian of Bohemia and their ancestors and relatives. So, agnostine trilobites from Russia were ably revised by **Elena Naimark**, **Helga Parnaste** described the morphology of the Ordovician cheirurid *Evropeites*, and **Diego Garcia-Bellido** spoke on *Svobodapeltis* and other effaced trilobites from the Mediterranean region. The Famennian *Osmolskabole* from the Moravian Karst was discussed by **Rudy Lerosey-Aubril**, important for its bearing on the origin of cyrtosymbolines. The next theme, with only two presentations, was *Taphonomy and Lagerstätten*, with **John Paterson** elaborating on arthropod diversity in the Emu Bay, Burgess Shale-type Lagerstätte, including taphonomy, and **Gian Luigi Pillola** discussing the palaeoecology of the strange *Tariccoia*, edemmic to Sardinia, and inhabiting quiet shallow water with locally unfavourable conditions.

The next theme was *Non-trilobite arthropods*. **Derek Briggs** described an exceptionally preserved Silurian xiphosure and its bearing on limb evolution in this group. **A. C. Daley** talked about the morphology of *Anomalocaris*, focusing on the oral cone and noting that the Emu Bay Lagerstätte provides insights not available from the material of the Burgess Shale. As a complete change the cirripede *Stramentum* from the Bohemian Cretaceous was discussed in detail by **M. Kocova Veselska**.

On the final day, the temperature and humidity rose sharply, but that did not deter us from enjoying another fascinating session. **J. C. Lamsdell** addressed the problem of the relationships of trilobites,



testing the arachnomorphan and lamellipaedian hypotheses, and concluding that trilobites are most probably allied to the Crustacea or pancrustacean/tetraconate stem lineage. **Stepan Rak** spoke on the late Ordovician Bohemian marelomorph *Furca*, with new reconstructions. **Derek Siveter** reported on a new great appendage arthropod from the Silurian Lagerstätte from Herefordshire, England, yet another magnificent creature reconstructed by computer. Finally **J. Ortega-Fernandez** used genetic data from living centipedes to attack the problem of trilobite segmentation, reviving an old model in which tergite borders do not correspond directly to underlying body segments.

The final theme was *Paleobiology and paleoecology*. **Jorge Esteve**, referring to the Spanish Middle Cambrian Purujosa assemblage in which so many specimens are enrolled, discussed enrolment and caudalisation in Cambrian trilobites. **Olda Fatka** followed with evidence of predation, with lethal shell damage, on Barrandian conocoryphids, and **S. Gibb** reported on the ichnofossil *Rusophycus carleyi*, suggesting that it has a definite stratigraphic potential, especially in otherwise unfossiliferous rocks. In the last session **Nigel Hughes** returned to the renowned Silurian *Aulacopleura konickii*, attacking in even greater detail the old problem of developmental instability in thoracic number. **Brigitte Schoenemann** revealed new information on sublensar sensory structures in phacopid trilobites, from CT scanning; the nearest equivalent is the eye of the living *Limulus*. Finally **Rudy Lerosey-Aubril** gave new information on the intestines of trilobites, in their various forms.

We have not the space to discuss the various poster presentations but there were many, well-displayed, and all highly interesting. At the end of the meeting there followed a discussion on where and when to hold the next meeting: Estonia (probably, since there were more votes) or Cincinnati (also popular). But it needs to be five years ahead, rather than four, since as on this occasion, there would otherwise be many conflicting conferences elsewhere; we had only about 60 participants altogether. But it was excellent even so, and nowhere was more magnificent than the great Kaiserstein Palace in the town centre to which we repaired for a fantastic Annual Dinner. Barrande himself was no stranger to this wonderful palace, and the dinner was in keeping. We owe endless thanks to Petr, Olda and their team for such magnificent organisation – and we are sure that Joachim Barrande himself would have been proud.

The post-conference field-trip went to Sardinia, and probably because Prague–Sardinia is not one of the main routes in Europe, all participants found themselves in one plane, and landed on 5th July at Cagliari – cordially welcomed by Gian Luigi Pillola and his team. The participants came from Australia, Canada, Estonia, Germany, Norway and the USA, and there was a nice welcoming party at the Geological Department of



The Cambrian of Canalgrande, Sardinia

the University of Cagliari in the evening. To the Lower Cambrian Matoppa and Punta Manna Formations near Gonnessa in the SW of the island next day, to start to explore Sardinia's geology and to hunt for trilobites and other fossils, especially the archaeocyathan-fauna, and various trilobites of the genus *Dolerolenus* and other genera could be found. The Nuraghe Seruci near Gonnessa, a fort-like settlement almost 4,000 years old, was visited in the warm evening light, and rounded off the first day's events. The second day started from the hotel in the picturesque harbour



city of Portoscuso – where the participants were housed – to the Middle to Upper Cambrian. The Cambrian series presented themselves impressively as bright cliffs protruding from turquoise water into a marvellous blue sky at Canalgrande. The tectonic structure “Cabitza Syncline” showed its uppermost Lower Cambrian to Tremadocian succession to its visitors excellently, in a magic Mediterranean macchian landscape. The “Bring a Trilobite of your Country” event in the evening at the Palaeontological Museum PAS, and a guided tour through the adjacent coal mine, was concluded by a fine dinner.

The third day was devoted to the Ordovician, and the rich and diversified fauna for example of the *Tarricoia arrusensis* beds and the Punta Pedrona sections (Fluminimagiore) yielded nice trilobites, brachiopods and other fossils for the participants. A highlight in the hot afternoon was a visit to the impressive dripstone cave “Grotte di Su Mannu”. This last day and excursion ended in “Le Tavernae di Castello” at Cagliari and a final drink at G. L. Pillola’s home. He had been an excellent host, and all participants thank him and very much for his brilliant work on Sardinian Palaeontology, himself and his team for the excellent field guides supplied, the well-prepared locations, fine meals, and the highly informative tours.

So, to all the organisers, for this memorable and magnificent conference, we owe our profound thanks.

Euan Clarkson

Brigitte Schoenemann



Statistical Approaches to Palaeobiological Questions at the International Statistical Ecology Conference 2012

Sundvollen, Norway 4 July 2012

The International Statistical Ecology Conference brings together ecologists, statisticians and wildlife managers to discuss topics of interest to ecological statisticians and numerical biologists. Mark-recapture approaches, distance sampling methods, other abundance estimation techniques, survey design and analysis for estimating population trends, modelling of spatial trends in animal density, integrated population modelling, stochastic population dynamics modelling, stochastic multispecies modelling, and stochastic modelling of animal movement are some of the topics usually discussed in the ISEC meetings. This year, the third biennial ISEC was held at Sundvollen, close to Oslo in Norway. What was special about this year’s ISEC was the invited session titled “Statistical Approaches to Palaeobiological Questions” organized and chaired by **Lee Hsiang Liow** (University of Oslo, Norway). The purpose of this session was to open a window to the world of palaeontology to ecologists and statisticians.

Liow opened the session by giving a brief overview of the types of questions paleobiologists seek to answer. She pointed out that incomplete and biased sampling pervades palaeontological data and that analyses of such data may often benefit from using a hierarchical modelling philosophy, including capture-recapture approaches and occupancy modelling. **Bjarte Hannisdal** (University of Bergen, Norway) presented a powerful time series approach first developed in physics, called Information Transfer. Non-linearity, temporal auto-correlation and the covariation among time series



of interest plague our analyses of often short time series of palaeo-environmental proxies and the time-averaged and spotty fossil record of organisms. Hannisdal's approach not only controls for these issues but also allows one to infer the directionality information flow among time series of interest.

Graeme Lloyd (University of Oxford, UK) then presented patterns of changing diversity through the Phanerozoic in three very different fossil records, namely the open ocean, shelf and terrestrial records, highlighting their similarities and differences, especially where their sampling biases are concerned. **Thomas Ezard** (University of Surrey but now at University of Southampton, UK) then focused on the deep-sea record of planktonic foraminifera, where he used both phylogenetic and stratigraphic information in building continuous time models of speciation and extinction. In this group of plankton, competition regulated speciation more strongly than climate did, but climate exerted more control on extinction. **Folmer Bokma** (University of Umeå, Sweden) also stressed the importance of phylogenetic information, and discussed the ways to integrate inference from molecular data with morphological data derived from extinct organisms. He promoted the use of a flexible Bayesian framework. **Pasquale Raia** (University of Naples Federico II, Italy) continued to discuss phylogenetic structure and the non-independence of taxonomic data while discussing the diversification of mammals. Both morphology and ecology influence the distribution of stratigraphic duration and geographic range. Finally, **Bob O'Hara** (Biodiversity and Climate Research Centre, Frankfurt, Germany) closed the session by discussing possible ways of applying capture-recapture approaches to fossil mammal occurrence records, where turnover probabilities and sampling probabilities can be estimated simultaneously in the same model.

This session was both well-attended and well-received by the other participants at ISEC. A lively discussion among the invitees on the issue of the need to increase the quality of statistical education among palaeobiologists and especially the new generation of students entering the field closed the stimulating day of presentations.

Lee Hsiang Liow

University of Oslo





2012 British Science Festival

Aberdeen 4 – 9 September 2012

“Energizing Minds” was the theme of the 2012 British Science Festival, held in Aberdeen from 4th to 9th September. Bill Bryson and Brian Cox were the big name attractions, but palaeontology made its presence felt with a number of talks and presentations.

The Association sponsored a session titled ‘Our Fossil-Fuelled Future’, with the aim of showcasing why palaeontology still matters in the modern world. The first fossiliferous feature of the Festival, however, was a talk given by **Maria McNamara** (Yale/Bristol) on the colour of fossil insects.

Perhaps unfortunately, as she spoke at lunchtime on the first day of the event, Maria’s presentation did not get as big an audience as it deserved. Nonetheless, with crowd participation a key component (not least getting a cluster of audience members to come up and do a form of waggle dance), she gave a very engaging run-through of why colour is rarely preserved in the rock record, and why – even when it is – it can be very misleading.

The PalAss-sponsored event was the following morning, and about 50 people attended the session. Although palaeontology is no longer a major area of research or teaching interest at the University of Aberdeen, three junior members of the Department of Geology & Petroleum Geology volunteered to give talks on the role fossils have to play in their research.

After I’d introduced what PalAss was, what we do, and the aims of the session, it was time for our first speaker: **Abby Othman Wilson** on ‘The Rotten Origins of Fossil Fuels’. Abby has recently completed her Ph. D. on high-resolution biomarker analysis of Devonian lacustrine deposits in the Orcadian Basin. To begin her talk, she explained what fossil fuels were, and used familiar foodstuffs to explain what components of organic matter form the best types of fuel.

The organic matters in question were bananas (to represent sugars and carbs), butter (lipids), and beef (proteins). Figuring that explanation is never as powerful as demonstration, Abby went about setting them on fire, and not without a little trepidation, as it wasn’t clear if the risk assessment covered the possibility of incinerating the old lady sitting in the front row. I apologize for the ageism, but that would have been the wrong kind of fossil-fuelled future.

Thankfully, all the combustion occurred firmly in the flasks, and Abby and her audience remained at room temperature. She also proved that lipids were the best source material, enabling her to move on to explaining how the decay of living cells led to the formation of fossil fuels, and finally, the importance of biomarkers as chemical fossils. From there, Abby discussed her own work on unravelling a detailed picture of Devonian climate change from the Achanarras lake sediments of Caithness.

Next up, **Richard Callow** talked about ‘Burrowing for Oil’. Rich is a postdoctoral fellow in the Slopes Group, studying the impact of ichnology on turbidite sedimentology and petroleum geology. He presented a broad examination of the sedimentological and ecological importance of trace fossils, and why we should care about them. His next step was to explain how trace fossils in marine sandstones can change the permeability of reservoirs, and why oil companies are interested in such research.

From shorefaces to deltas to submarine fans and channel levees, burrowing organisms are widely distributed in marine sandbodies, and different ichnofabrics produce different effects on sediment



properties. Rich explained the importance of perforating fabrics (*e.g.* vertical, tubular *Skolithos* burrows), mixing fabrics (*e.g.* *Scolicia* burrows made by deposit-feeding sea urchins), cleaning fabrics (*e.g.* grain-selective, core-and-halo burrows such as *Phycosiphon*), and heterogenizing fabrics (*e.g.* the complex, mud pellet-lined galleries of *Ophiomorpha*). Ichnology is becoming increasingly valuable in unconventional settings and in second-generation reservoirs, where a better understanding of heterogeneity leads to more efficient hydrocarbon capture.

Another Aberdeen postdoc, **Rob Daly**, was third to take the stage, discussing 'Pollen & Spores: Miniature Windows into the Past'. This allowed our session's only mention of dinos – dinoflagellates – as Rob explained his palynological research interests. After explaining a bit about the subject in general, he moved on to two of his own case studies: sites from Cretaceous–Palaeogene boundary strata in Alaska and Ukraine.

The Alaskan study area was a polar, coal-forming wetland in a very warm period, whilst the Ukrainian samples came from lake sediments that accumulated inside the Boltysh impact crater. Rob explained the importance of the palynology of the sites to an understanding of ecosystem response to severe environmental perturbations, and thus our present period of climate change.

To complete the session, a non-Aberdonian speaker – **Haydon Bailey** (Network Stratigraphic/The Micropalaeontological Society) – discussed 'Microfossils and Megabucks'. Haydon emphasized that micropalaeontological skills can be immensely valuable in the oil industry, with billions of pounds of profit depending upon identifying the correct intervals to drill in. By his conservative calculations, Haydon said that accurate 'biosteering' in one North Sea field generated more than \$100m of added value in one year alone. Multiplied across many fields and many years, the figure began to run into the billions of dollars.

Haydon then lamented the fact that micropalaeontology was now so rarely taught in British university Earth Science departments, despite many industry experts being close to retirement. With the value that palaeontology adds to their profit margins, the petroleum industry should be providing funds towards redressing the issue, Haydon argued. He did note, though, that the University of Birmingham has just begun a new M. Sc. course in the subject, and that he will be teaching on it, so perhaps this is a step in the right direction.

There was a bit of time for discussions after the session finished, then everyone was free to go off and enjoy the rest of the Festival. Talks on everything from boson particles to Formula 1 cars were available, but the palaeontology wasn't over. Later in the week, **Victoria Herridge** gave the Charles Lyell lecture on dwarf elephants and climate change, and **Richard Fortey** talked about 'Survivors' as part of a Catastrophes session. Unfortunately I was unable to see either of those events as I had to return home, but reports suggest that both were very well-received.

My inopportune scarping meant I also missed the animatronic *T. rex* that appeared outside the geology department the following day, but it looks like I'm going to be involved in BSF 2013, in Newcastle, so maybe the owners can be persuaded to bring it along again. If not, I'm sure we'll find more than enough high-calibre fossil content; if you're interested in getting involved, drop me a line at <reporter@palass.org>.

Liam Herringshaw
Durham University



— OBITUARY —

Stanley Purdie Wood

23 December 1939 – 9 September 2012

An Appreciation

Over the past 40 years one man has changed our understanding of Carboniferous palaeontology in the UK more than any other. By careful, systematic and dedicated fieldwork, Stanley Wood discovered an extraordinary wealth of new fossils and provided palaeontologists with the opportunity to study new material, explore new sites, test old hypotheses, and change the way we think about the history of life on Earth.

Born in Scotland in 1939, Stan left school at 14. After a spell in the dockyards at Leith, he saw the world in the Merchant Navy. On returning home he worked first for the engineering firm Brown Brothers and then became an insurance salesman in Edinburgh. As a boy he had a keen interest in antiquities, and in particular the Roman occupation of Scotland, but in the late 1960s he developed a fascination for fossils and in 1969 started collecting. With guidance from Charles Waterston and Mahala Andrews at the Royal Scottish Museum, he visited localities made famous by nineteenth century collectors. Eventually, having 'got his eye in', he started to amass a large collection of Lower Carboniferous fishes from exposures on the foreshore of the Firth of Forth and abandoned quarries around Edinburgh.

In the early 1970s this collection was purchased by the Royal Scottish Museum. It contained a number of complete fossil sharks, the first whole body specimens to have been found in the UK for nearly 100 years. These specimens were subsequently studied by John Dick for a PhD under the supervision of Alec Panchen at the University of Newcastle upon Tyne. This was the start of a very productive relationship between Stan and Alec, which resulted in material collected by Stan being studied by two subsequent Newcastle PhD students, Tim Smithson and Mike Coates, and by Alec himself.

Having done his apprenticeship collecting at well-known sites, Stan began to look further afield. His first major success was in 1974 at the Dora Open Cast Coal Mine near Cowdenbeath in Fife. Here he discovered a rich bone bed containing the first Carboniferous tetrapod fossils found in the UK for nearly 100 years. Stan directed the recovery of more than three tons of rock before mining operations prevented further collecting. The discovery was announced in 1977 in *Nature* with Stan as a co-author. The tetrapod fossils were studied by Alec Panchen and formed the basis of my own PhD. Alec secured a grant to support the research and Stan was appointed to his first job in palaeontology as Research Technician from 1976 to 1979. During this time he successfully completed a science degree with the Open University.

While working with Alec, Stan spent a lot of time in the field seeking out new sites and re-discovering old ones. The most important of these was Foulden in the Scottish Borders. This site was first discovered by a young local collector, T. M. Owens, and many fossils were collected from it between



1910 and 1912. Mr Owens died in 1912 and the location of Foulden was lost. Its rediscovery led to Stan establishing another important professional relationship, this time with Ian Rolfe at the Hunterian Museum, Glasgow. Ian secured funds to employ Stan for two years, and his first project was to support a multidisciplinary research team that undertook a detailed investigation of the geology and palaeoecology of Foulden and a thorough description of its fauna and flora. The results were published in 1985 in a series of 12 papers in *Transactions of the Royal Society of Edinburgh: Earth Sciences*, with Stan one of the contributing authors.

Stan's most important discovery whilst based at the Hunterian Museum was a new basal Upper Carboniferous site at Bearsden in the suburbs of Glasgow containing a rich fauna of exquisitely preserved crustaceans, bony fishes and sharks. This discovery was announced in *Nature* by Stan in 1982, and celebrated in the BBC documentary 'Stan, Stan the Fossil Man'. Subsequently, the bony fishes were studied by Mike Coates for a PhD, supervised by Alec Panchen. The crustaceans were studied by Neil Clark for a PhD at the University of Glasgow. In recognition of these discoveries, Stan was awarded the Worth Prize by the Geological Society of London in 1983.

During the early 1980s jobs were hard to find, particularly jobs in palaeontology. Stan realized that if he was to continue to make a living working with fossils he would need to set up his own business. He established Mr Wood's Fossils in 1983 and began by preparing and selling material he had collected at Bearsden. But his passion was seeking out new fossil sites and finding animals and plants new to science. In 1984 his optimism and hard work were rewarded with an extraordinary discovery. At the East Kirkton Quarry in the Bathgate Hills of West Lothian between Edinburgh and Glasgow, he found Lower Carboniferous rocks yielding complete skeletons of the earliest known terrestrial tetrapods and arthropods, as well as new, anatomically preserved plants. Unusually in the Scottish Carboniferous the sediments had been affected by hydrothermal activity, which preserved delicate anatomical features, especially of the plants, in fine detail. The discovery was announced by Stan in *Nature* in 1985.

Over the next five years Stan systematically collected and prepared material from East Kirkton Quarry. A research team was assembled by Ian Rolfe to work on the collection and in 1992 they presented their results at an international conference held at the Royal Society of Edinburgh. The conference volume, published in 1994 in *Transactions of the Royal Society of Edinburgh: Earth Sciences*, included 28 papers by authors from around the world and was a major milestone in our understanding of the morphology, palaeobiology and interrelationships of the earliest known community of land animals and plants. Since then, further specimens collected by Stan have been prepared and these continue to generate papers in high-profile journals, including letters to *Nature*.

In the following ten years Stan continued to explore the Carboniferous of Scotland. He opened up a quarry at Mumbie near Glencartholm and collected new and unusual Lower Carboniferous sharks and arthropods as well as adding to our understanding of the radiation of Lower Carboniferous bony fishes. He also collected from coastal exposures at Tantallon Castle near North Berwick and recovered still undescribed early tetrapod elements. At the same time, he prepared material collected years before, and some of this has since been worked on by a new generation of PhD students under the direction of Jenny Clack at the University of Cambridge. In recognition of the enormous contribution he has made to palaeontology over the past four decades, in 2009 Stan received the Marsh Award for Palaeontology.



Stan was a wonderful communicator and was always in demand as a speaker to geology clubs and societies across the country. His enthusiasm for fossils was infectious, and children of all ages would sit rapt listening to his stories. Over the years he worked closely with museum- and university-based researchers to develop and realize the potential of his new sites, and to ensure that the fossils he discovered were incorporated into public collections and available for future study. He was a member of the working group that prepared the Scottish Fossil Code.

Most recently Stan began to explore the Lower Carboniferous of the Scottish Borders. Now based in Selkirk and approaching his 70th birthday, he used his enormous experience to investigate the deposits laid down during 'Romer's Gap', a period of some 15 my at the base of the Carboniferous, hitherto characterized by a world-wide break in the fossil record of early tetrapods and terrestrial arthropods. He concentrated his efforts on the rocks exposed in the banks and bed of a tributary of the River Tweed, Whiteadder Water, near the village of Chirnside. Here he recovered important new material including some of the oldest tetrapods so far discovered in the UK, together with myriapods, scorpions, crustaceans and fishes. These discoveries were announced earlier this year in the *Proceedings of the National Academy of Sciences-USA* with Stan as one of the co-authors. They now form the core of a major new multidisciplinary research project led by Jenny Clack, and involving colleagues from across Europe and North America, into the recovery after the End-Devonian Extinction Event and the radiation of animals and plants in the Early Carboniferous.

Stan was diagnosed with lung cancer in May 2011. This didn't temper his interest and enthusiasm and he continued to look for new fossils, this time in the Old Red Sandstone around Jedburgh. In the last few months, when confined to a wheel chair, he entered an extraordinarily productive period, returning to the collection of fossils he had made at Mumbie Quarry. With a will and determination that astonished his carers, he prepared them all and, to his delight, discovered two new species of bony fish as reward for his efforts.

Through his discoveries over the past 40 years, Stan has greatly extended our understanding of the diversity, relationships and habits of a vast variety of ancient animals and plants. Our current knowledge of vertebrate evolution in the late Palaeozoic would be much the poorer without the contributions from Stan. He has greatly enhanced the collections of our national museums, helped many of us get started in our palaeontology careers, provided research material for generations to come, and demonstrated that with care and patience there is still a wealth of new fossils to be discovered on these shores.

Tim Smithson

20 September 2012





Sylvester-Bradley REPORT

A review of the Peruvian Neogene penguins

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General background

Penguins are a remarkable group of birds, occupying a niche as specialised swimmers and divers, and strongly associated in their evolution with southern polar latitudes. South America has been recognized as one of the richest areas with fossil penguins worldwide, but until the late twentieth century this record was limited to the outcrops of the Argentinian Patagonia. Only at the beginning of this century were the first species from Peru and Chile described, and currently a minimum of seventeen palaeospecies have been recognised for South America. (For a more extensive introduction to the South American fossil penguins see Chavez-Hoffmeister, 2012.)

In this context, the Peruvian record is one of the most remarkable for extraordinary quality and chronological extent, with a range from Middle Eocene to the present. The Eocene record is concentrated in the Paracas and Otuma Formations, and includes some of the most complete and best-preserved Paleogene penguins known, including skulls and dermal structures such as feathers and scales (Clarke *et al.*, 2007; Clarke *et al.*, 2010).

On the other hand, the Neogene record is almost restricted to the Pisco Formation (Middle Miocene–Pliocene), with the exception of a single specimen reported from the Middle Miocene of Chilcatay Formation (Acosta Hospitaleche and Stucchi, 2005). Since 2002, three new species of fossil penguins have been described from the Pisco Formation, all belonging to the extant genus *Spheniscus* (“banded” or “tuxedo” penguins). The oldest species is *S. muizoni* Göhlich, 2007 from the locality of Cerro La Bruja (Middle Miocene), whose holotype consists of a partial postcranial skeleton (MNHN PPI 147) and belongs to the Muséum National d’Histoire Naturelle (MNHN), Paris, France. The next species *S. megaramphus* Stucchi *et al.*, 2003 comes from the locality of Montemar Norte (Late Miocene), and its holotype (MUSM 175) and referred materials consist of isolated cranial remains. The youngest species described is *S. urbinai* Stucchi, 2002; this is based on several partial skeletons and has been reported from the localities of El Jahuay, Aguada de Lomas, Montemar, Sacaco Sur and Sacaco (Late Miocene to Pliocene). The type specimens of both species belong to the Museo de Historia Natural de la Universidad de San Marcos (MUSM), Lima, Peru. Additionally, Stucchi (2007) suggested the existence of at least another three indeterminate species based on size criteria and stratigraphic distribution.

These species include associated skeletons in excellent condition, offering a unique opportunity for the realization of detailed anatomical and phylogenetic studies. However, the original researches



on these species lacked a phylogenetic analysis, or even a detailed anatomical description in the case of *S. megaramphus* and particularly *S. urbinai*. On the other hand, the lack of postcranial elements has hindered the comparison of *S. megaramphus* with *S. urbinai*, which is of great importance because these species are apparently abundant in the Miocene formations of Peru and Chile and are of similar size and age.

The project

My PhD researches in Bristol are funded by a grant from CONICYT, the Chilean science-funding agency. Unfortunately, this grant does not cover costs of travel and fieldwork, so the Sylvester-Bradley Award has been essential to permit me to travel to see key specimens. Key work for my project in Peru was facilitated by MUSM researchers.

My aims are to resolve the deficiencies found in the literature and present new specimens that contribute significantly to our knowledge of these species. These grants allowed me to make a one-month stay reviewing the collections of the MUSM in Peru during April 2012. This funding also covers a visit to the collection of the MNHN in France, in order to include the holotype of *Spheniscus muizoni* in the phylogenetic analysis, and this will happen soon. The final results of this review will be presented during the first half of 2013 as a monographic study.

The stay in Lima was between 8th April and 5th May 2012. During this period, the work concentrated on the preparation of specimens, elaboration of moulds, sampling of character states and anatomical description of the specimens. The specimens of *S. urbinai* include the holotype (MUSM 401) and paratypes (MUSM 269, 402–405) together with two new articulated skeletons (MUSM 898 and 899) and two associated skeletons (MUSM 1026 and 1027). For *S. megaramphus* the specimens include the holotype (MUSM 175) and paratypes (MUSM 362–365) plus three new skulls (MUSM 794, 795, 797 and 802) and the first known skeletons associated with this species (MUSM 800 and two specimens still in preparation). It is important to note that one of the new skeletons, the Hueco La Zorra specimen, is extraordinarily well preserved, consisting of an articulated skeleton with preservation of the keratin cover of beak and claws (Fig. 1). Additionally, a partial skeleton assigned to *Spheniscus* sp. 3 (*sensu* Stucchi 2007) was reviewed.



Fig. 1. Hueco La Zorra specimen of *Spheniscus megaramphus*.

This trip to Lima also allowed me to complete between May and June 2012 a self-financed visit to the collections of the Museo Paleontológico Egidio Feruglio in Trelew, Argentina; the Museo de La Plata in La Plata, Argentina; and the Museo Nacional de Historia Natural in Santiago, Chile; reviewing the fossil penguin collections including type materials and specimens from Seymour Island, Antarctica.



Preliminary results

The new specimens, and the detailed observation of the original specimens, allow us to identify the existence of characters that give a better discrimination of these species. Despite the fact that the general anatomy of these specimens closely resembles the living species of *Spheniscus*, there are subtle postcranial characters that distinguish the fossil taxa. Some, like the weak projection of the proximal margin of the tricripital fossa in the humerus, had been previously mentioned (Göhlich, 2007; Ksepka *et al.*, 2006), but other characters related to the shape of the pelvis or the proportion of appendicular bones are identified for the first time. In the skull the differences are more obvious, especially at the level of the rostrum, with two distinctive morphologies: the “megaramphus-type” and the “urbinai-type”. The first one represents a more elongate, slender and straight rostrum (Fig. 2B) whereas the second is slightly shorter, more robust and sinuous (Fig. 2A). These two extreme morphologies have been used as the main characters to discriminate *Spheniscus megaramphus* from *S. urbinai* (Stucchi 2002; Stucchi *et al.* 2003; Chavez-Hoffmeister 2007), but from the observations made on the specimens it is possible to suggest that the “megaramphus-type” might represent more than one species.

Two distinctive morphotypes are identified in the set of specimens originally assigned to *S. megaramphus*. Only the isolated skull MUSM 795 and the Hueco La Zorra specimen are equivalent in size and proportions to the holotype, while all the other specimens including the paratypes are consistently smaller (Fig. 3). A direct comparison of the postcranial elements available for both morphs shows that the smaller set is close to the size range suggested for *Spheniscus* sp. 2 and *Spheniscus* sp. 3 (*sensu* Stucchi 2007), whereas *S. megaramphus* is even bigger and more robust than *S. urbinai*. Nevertheless, the morphology of both groups is almost identical and the states of characters are exactly the same.

The same difference in size can be seen in the rostrums assigned to *S. megaramphus* from the Bahia Inglesa Formation in Chile (Chavez-Hoffmeister, 2007). Among these specimens, only MPC 1008 is equivalent in size to the holotype whereas MPC 1009 and MPC 1010 are approximately 25% smaller. It is also interesting that most of the appendicular specimens assigned to *Spheniscus* in the Bahia Inglesa Formation are smaller than the equivalent elements in *S. urbinai* (Chavez-Hoffmeister 2008). This suggests that the most common morphotype recorded in Chile is the smaller “megaramphus-type”.

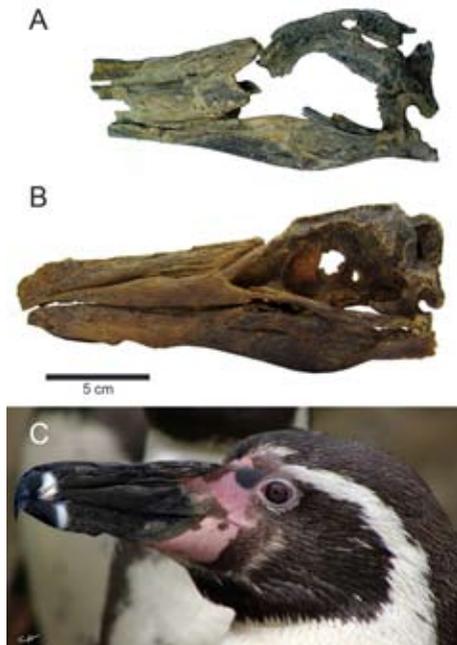


Fig. 2. Comparison of the skulls of (A) *Spheniscus urbinai* MUSM 401 and (B) the Hueco La Zorra specimen of *S. megaramphus*; and (C) reconstruction of *S. megaramphus* based on the Hueco La Zorra specimen.

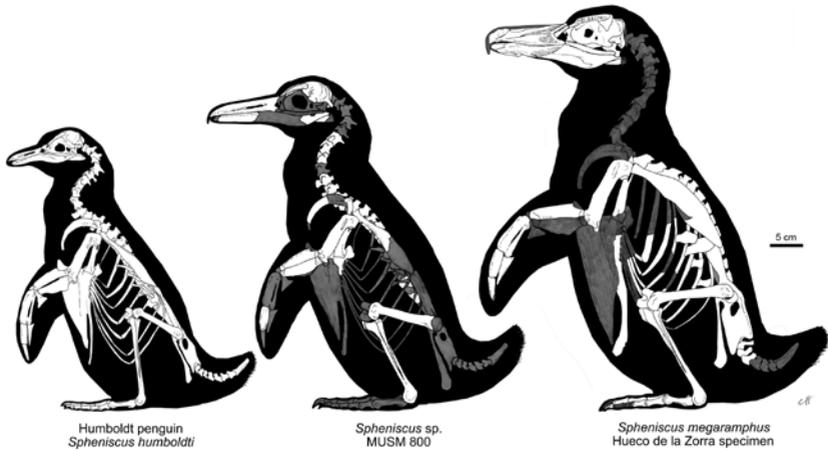


Fig. 3. The “megaramphus-type” penguins compared with the living Humboldt penguin (*Spheniscus humboldti*). Note the difference in size and robustness between *Spheniscus* sp. MUSM 800 and *S. megaramphus*.

Originally the metric difference observed in the paratypes was attributed to sexual dimorphism (Stucchi *et al.* 2003), but the consistency in the size of both sets and the extreme difference in the robustness of the postcranium suggest the possible existence of two species. Testing both hypotheses will be an essential part of this developing research.

Additionally, the extraordinary preservation of the keratin covers in the Hueco La Zorra specimen permits some comparisons of soft tissue characters (Fig. 2). During the revision, it was also possible to identify the presence of fragments of rhamphotheca in the holotype of *S. urbinai* (MUSM 401) (Fig. 2A). The rhamphotheca of *S. megaramphus* is highly similar to that in living species of the genus. The surface of the rhamphotheca is deeply furrowed in both species, something distinctive of the living species of *Spheniscus*. The nasolabial grooves and culminolabial grooves are present in *S. megaramphus*, and the posterior shape of the rhamphotheca resembles that in *Spheniscus magellanicus* and *Eudyptula*.

Acknowledgments

I wish to thank to Rodolfo Salas, Rafael Varas, Ali Altamirano, Julia Tejada and all the rest of the vertebrate palaeontology team of the Museo de Historia Natural de la Universidad de San Marcos, Lima, Peru, for their reception and help during my stay in Peru. Special thanks are given to the family Varas for their hospitality and to The Palaeontological Association for funding this project.

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Everybody's Appy Nowadays

Many years ago, the then editor of this esteemed organ asked me to put together the good, the bad and the ugly of fossils on the web. I was a fresh-faced postgrad, and he probably thought I knew about such things. Glad to finally have an authorized excuse to type strange things into Internet search engines, I did as I was asked, and found some interesting creations. My favourite was this one – <http://mjt.org/> – and I still have no idea what it's really about.

Like most of my research, though, I never wrote it up. I made a few notes, got distracted, and things moved on. The Association soon started handing out Golden Trilobite awards to the best palaeontological websites, so my non-submission of the report paled into insignificance.

Digital palaeontology has *really* moved on now, though, and it was only recently that I realized just how far. I've never been very good at keeping up with technological developments, but I feel like a fraud. I'm online a lot of the time, I use Facebook, Twitter and all the usual gubbins; I've even employed sophisticated software to reconstruct trace fossils in 3D. Older colleagues assume I know a lot about computing and websites and apps, and how to take palaeontology into the 21st Century.

I don't, though. I'm really not up to speed with very much. I'm of that limbo generation, young enough to have pretty much always had a home computer, but old enough to recall a time before mobiles. I use technology, but not very well.

If my embracement of the digital age is patchy, though, so is the Association's. We've recently added RSS feeds to the news section of the website, we provide financial support for various online projects (about which more shortly) and we still hand out Golden Trilobites (four last year, in case you were wondering). However, we're well aware that our website needs a major overhaul; that we should be providing more digital resources: most PalAss Council meetings include at least some discussion of these topics. The key problem is time: who on Council can devote sufficient energies to this sort of thing?

"Well what about you, Herringshaw?" I hear a voice spluttering in my ear. "You're the sort of slacker who finds endless opportunity to go Facebooking or twittering (@fossiliam, in case you were wondering) or blogging and never gets any proper work done! And you're the Newsletter Reporter – why don't you report on some new things?"

I can't deny those charges. So, rather than fight to clear my name, I have decided to self-besmirch instead, and FOR THE BENEFIT OF THE ASSOCIATION'S MEMBERS (sorry, Caps Lock issue there. I told you I wasn't very good on computers), investigate the best online palaeontological or fossil-related resources out there on the interweb. Of course I recognize the irony in doing this in analogue, printed, non-online form, but what the heck.

So, where do I start? How about with those projects that the Association has provided monies for?

The longest-running is *Palaeontologia Electronica* (<www.palaeo-electronica.org/>), which has been a tremendous success. Now in its 15th year it has set a benchmark for online-only journals. The content is excellent, the research topics diverse, the images high-quality, and everything is open-access. What seemed a leap into the unknown in 1997 is now an unquestionable success:



the site has received more than 37 million visits, and now attracts more than half-a-million hits each month.

It may be entirely electronic, but *PE* is, after all, a scientific journal. Rather newer and aiming to appeal to a somewhat different audience are ventures such as *Palaeontology [online]* (<<http://www.palaeontologyonline.com/>>). Run by Russell Garwood, Peter Falkingham, Alan Spencer and Imran Rahman, the site launched at the beginning of 2011 and is supported financially by the Association. It publishes articles on all aspects of palaeontology, written by experts in their field, but aimed at non-specialists. At present, these fall into three broad topics: Fossil Focus, Patterns in Palaeontology, and Life as a Palaeontologist. Recent contributions have examined marsupial evolution (<<http://www.palaeontologyonline.com/articles/2012/fossil-focus-marsupials/>>), the Cambrian explosion (<<http://www.palaeontologyonline.com/articles/2012/the-cambrian-explosion-paradoxes-and-possible-worlds/>>) and palaeobotany (<<http://www.palaeontologyonline.com/articles/2012/fossil-focus-plant-fossils/>>).

Recognizing that the Web is a predominantly visual medium, lavish illustration of *Palaeontology [online]* articles is encouraged. One or two articles are a bit lacking in pictorial content, but most embrace the approach, and it works well. Dave Hone's piece on pterosaurs is especially good, including images of exceptional fossils, trackways, head shield reconstructions and an imagination of how the largest flying reptile would look standing next to a giraffe. I don't know how much traffic the site has attracted, but it deserves to be a success. My only issue is the choice of font for the site logo – it makes *Palaeontology [online]* look very similar to our own journal, and could cause confusion.

Even newer to the scene, and having received approval for PalAss financial support only at the most recent Council meeting, is *Palaeocast* (<www.palaeocast.com>). It was officially launched on 1st September and aims to be the home of palaeontological podcasts. If you've never embraced them, podcasts are digital media that use any combination of audio, video, text, and still-image content to produce a file you can listen to or watch on a mobile device or computer. BBC Radio has been a particularly avid user of the approach.

Palaeocast episodes are 30–60 minutes long and focus on particular topics of interest by interviewing a scientist conducting research in the area. The first two podcasts examined exobiology and the hunt for extraterrestrial life, and *Isotelus rex*, the biggest trilobite ever found. Subsequent episodes have looked at parasitism preserved in amber, and the Devonian fossil forests of New York State. The site is run by Dave Marshall, Joe Keating and Jon Tennant, who carry out the interviews, and compile and present the podcasts.

"Palaeontology is a field full of interesting characters with amazing stories to tell," says Marshall. "One of the main ideas behind the project was to present these stories to the public and make the scientists, as well as the science, the star of the show." They are also looking to use *Palaeocast* as an educational tool, and are working with Peg Yacobucci of the Paleontological Society to make it an online resource for teachers and students.

It's early days, but signs look promising for the project. If you're in need of further online audio presentations of palaeontology, though, you should check out the Progressive Palaeontology 2012 website: <<http://progpal2012.tumblr.com/>>. The meeting was held in Cambridge at the end of



May, and a report is included in this Newsletter. You can jump the gun, however, as many of the participants agreed to have their talks recorded. Without the accompanying images, some of the content is inevitably lost, but at the very least you should listen to Simon Conway Morris give the health and safety drill. I'm not sure if they'll take a similar approach, but the 2013 meeting will be held in Leeds: follow @ProgPal2013 on Twitter for regular updates.

Everything I've mentioned so far has been supported by the Association, but there are many other fossiliferous digital projects out there. *GB/3D* is the new JISC-funded project run by the British Geological Survey, which aims to provide online images of all the type fossil specimens in UK collections. Most will be digital photos, some will be stereographic images, and a lucky few fossils will be rendered into full 3D glory. At the moment, project progress is recorded at <http://www.gb3dtypefossils.blogspot.co.uk/>, but the full web portal is due to be launched in 2013, from which you will be able to download the various image files.

With its Open Geoscience (<http://www.bgs.ac.uk/opengeoscience/>) and Citizen Science (<http://www.bgs.ac.uk/citizenScience/home.html>) projects, it seems the BGS is investing a lot of time and money into freely accessible online resources. Particularly popular is the *iGeology* application for smart phones; a similar app for fossils would be undoubtedly successful. In North America, a commercial app called *Terraphone* tells you about the geology of your location, including the fossils, whilst there are numerous dinosaur-based apps out there too. Comprehensive, reliable, electronic fossil guides seem to be in short supply though.

Inevitably, many people go to Wikipedia to find out fossil facts, but whilst coverage of vertebrates (especially dinosaurs) there is fairly good, lots of invertebrate groups are poorly represented. There is a site called *FossilWiki* (www.fossilwiki.org), which advertises itself as "the palaeontology wiki that anyone can edit", but it suffers from similar problems to its bigger brother. As nobly democratic as it is, freely editable content does mean the opinions of an expert are equalized with those of a lunatic. If you need reliable information on a palaeontological topic outside your own area of expertise, you might still be best sending a message to the PaleoNet mailing list (<http://www.nhm.ac.uk/paleonet/Index.html>), or going onto Ask A Biologist (<http://www.askabiologist.org.uk>).

As an Association committed to the promotion of palaeontology and its allied sciences, we should be helping to address this issue. One possibility is to take existing Wiki content and transpose it to our own website, where we can modify, amend and expand the data accordingly, whilst retaining editorial control. This is pretty much the path the BBC has taken for its Fossils pages (<http://www.bbc.co.uk/nature/fossils>), but again, the issue of time rears its ugly head. Who in our community is willing or able to devote sufficient energies to such a project?

Mercenary as it might sound, money is probably the solution. The Association has a mandate to become an authoritative location for online information on fossils, and significant reserves in its coffers to get behind it. In the meantime, if you know of excellent palaeontological websites, apps or other digital projects I've failed to mention here, I'd be very happy to hear from you.

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Book Reviews

Palaeoenvironmental Habitat Reconstructions: A palaeoentomological perspective

Bizley, R. 2011–2012. <<http://www.bizleyart.com/>> (a series of seven artistic prints 26x39cm with cream-coloured mountboard, backing and wrapped in cellophane £200 (plus p+p); single prints at £38 (plus p+p). Available via the artist's website. Smaller prints also available.

This is not a book review in the strict sense, but as the old adage goes, *a picture paints a thousand words*. Reviewed here are seven paintings (one from each major geological period from the Devonian onwards) that were commissioned as a learning and teaching resource and will presumably be of interest to readers of this Newsletter. They depict palaeoenvironmental reconstructions from a primarily palaeoentomological perspective. Together they form a rather unique resource, especially given that little else along these lines has been produced before (other than the ubiquitous giant meganeurid griffenflies that appear in most Carboniferous reconstructions), even in books that concentrate on the insect faunas of specific deposits (e.g. Crato – Martill *et al.*, 2007; China – Dong *et al.*, 2010; Purbeck – Coram & Jepson, 2012). The images were painted using acrylics by the well-known palaeoartist Richard Bizley in conjunction with palaeoentomological expert advice, with important consideration paid to diagnostic taxonomic features. The painting illustrated in this review is that of the Cretaceous Crato palaeoenvironment. Despite the well-known nature of fossils from this deposit, including a recent comprehensive synthesis by Martill *et al.* (2007), this represents the first artistic reconstruction of this fossil locality, and the same is true for several of the other paintings.



Descriptions of the palaeoenvironmental reconstructions are as follows (the numbers refer to those of the artist's online catalogue where each of the images can be viewed):

Devonian of Scotland (1118). A reconstruction of the Rhynie Chert palaeohabitat from Aberdeenshire, Scotland, representing one of the earliest terrestrial ecosystems. It depicts some of the oldest hexapods (Collembola: *Rhyniella praecursor*), one of which is about to fall prey to *Palaeocharinus rhyniensis*, a member of the extinct arachnid order Trigonotarbia. The plant illustrated is *Horneophyton lignieri* (Horneophytosida), which was an early colonizer of the hot spring sediments or sinter. The chert was formed when silica-rich water from hot springs (also illustrated) rose rapidly, flooding the surrounding areas and permeating into the soil. Whilst various reconstructions of this palaeohabitat already exist, none of them includes *Rhyniella*, the oldest known hexapod.



Carboniferous of Europe (1119). The European Coal Measures swamp forest palaeohabitat with vegetation consisting of *Lepidodendron* trees and *Calamites* horsetails. The flying insects illustrated are griffenflies *Meganeura* sp. (Meganoisoptera: Meganeuridae) that resembled giant dragonflies, and also a member of the family Homiopteridae (Palaeodictyoptera), which were characterized by long tails, a long beak, and flap-like pronotal paranota. A primitive roachoid *Manoblatta* sp. (Archimylacrididae) with a long ovipositor (absent in extant cockroaches) for laying eggs is resting on a *Calamites* stem. In the foreground is a primitive mesothele spider (Araneae: Mesothelae) at the entrance of its burrow, and in the background an amphibian has just emerged from the water.

Permian of Russia (1202). There is a flying insect *Sylvohymen sibericus* (Megasecoptera: Bardohymenidae). An insect resting on an *Equisetum* horsetail is *Paleothygramma tenuicornis* (Caloneurodea: Paleothygrammatidae). On a rock in the foreground is the predatory arachnid *Permarachne novokshonovi* (Uraraneida: Permarachnidae), the new arachnid order described recently by Selden *et al.* (2008). Also illustrated are two predatory synapsids with their characteristic sail-fin backs. All the orders illustrated here are now extinct. The setting reflects the arid climate with red, iron-rich soil typical of this period.

Triassic of Australia (1203). The insects in flight and in the bottom left foreground are *Clatrotitan andersoni* (Orthoptera: Clathrotitanidae). This was a large (30cm wingspan) insect that stridulated by rubbing its wings together. Perched above to the right is a female scorpionfly *Choristopanorpa bifasciata* (Mecoptera: Orthophlebiidae), which was very similar to extant forms. Hanging from the vegetation top left is *Tillyardiptera prima* from the extinct tipulomorph-like fly family Tillyardipteridae, which is unique to the Triassic of Australia. There is also a large dicynodont herbivore in the foreground.

Jurassic of China (1120). The picture depicts the giant orb-web spider *Nephila jurassica* (Nephilidae) catching a giant cicada *Palaeontinodes reshuitangensis* (Auchenorrhyncha: Palaeontinidae) in its web. In the background is a pair of sauropods *Omeisaurus tianfuensis*. Drinking at the water's edge is the earliest placental mammal *Juramaia sinensis*, whilst mayflies of the genus *Epicharmeropsis* (Ephemeroptera: Hexagenitidae) flit around above the surface (although these are too far in the distance to illustrate any diagnostic features). The large insect in the foreground is a large butterfly-like neuropteran *Limnogramma hani* of the extinct family Kalligrammatidae. The reconstruction shows the delicate wing venation with the characteristic eye-spot. A smouldering volcano in the background reflects the volcanic nature of these fossil insect deposits.

Cretaceous of Brazil (1201). The insects include a mayfly *Mickoleitia longimanus* (Coxopteroptera: Mickoleitiidae), from the extinct order newly described by Staniczek *et al.* (2011). There is a pollinating wasp *Cretosphex parvus* (Hymenoptera: Sphecidae) visiting a magnolia-type flower, illustrating the presence of angiosperms at this time. Two antlions *Baisopardus cryptohymen* (Neuroptera: Myrmeleontidae) show the distinctive wing patterning described by Heads *et al.* (2005). There are also water striders *Chresmoda* sp. of the extinct order Chresmododea, although these are too far in the distance to exhibit any detailed characters, and a grasshopper *Cratolocustopsis* sp. (Orthoptera: Locustopsidae) about to be eaten by a sun spider *Cratosolpuga wunderlichi* (Solifugae: Ceromidae). Behind, a *Santanaraptor* looks out across the lagoon while two pterosaurs *Lacusovagus magnifens* fly overhead. This is the first reconstruction of this highly fossiliferous deposit that is thought to represent a lagoon/arid hinterland setting.



Tertiary of Europe (1117). The Baltic amber forest, with insects including a praying mantis (Mantodea) trapped in the fresh resin oozing from the tree, two damselflies (Odonata: Coenagrionoidea) and a rock crawler (Notoptera: Mantophasmatodea), described as a new insect order by Klaas *et al.* (2002) and identified first as an inclusion in Baltic amber before being found in the extant fauna of Africa. Mayflies (Ephemeroptera) are flitting around over the water to the right and a swarm of midges (Diptera: Chironomidae) are close to the base of the tree on the left, although no diagnostic features are visible due to their small size. Also on the trunk of this tree are a butterfly (Lepidoptera) and a true bug (Hemiptera). The larger animals are *Europolemur*, two *Propalaeotheriums* and a flightless bird, *Diatryma*. The dense, subtropical nature of the forest is well depicted.

As a researcher specializing in amber the last is of greatest interest to me and probably my favourite, although as with the other images there are many groups known to occur in the deposits that are absent from the images. Clearly this kind of painting could never depict the entire range of biota present, and overcrowding the illustration would no doubt present an unrealistic representation. On reflection however, the artist has done a very good job of depicting 'key' taxa that are either representative of each period, unique to the deposit, or have some other special significance and hence would form a good discussion point in palaeontological teaching classes. Great attention has been paid to making important diagnostic characters such as wing venation and banding patterns as accurate as possible, although these are only particularly clear in insects situated in the foreground. This series of paintings would fit comfortably in any palaeontology teaching laboratory, but especially one that has an emphasis on palaeoarthropodology. I also have it on good account that the artist would be happy to add to this series for those with a research or teaching focus on other fossil localities.

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Eurypterids Illustrated: the Search for Prehistoric Sea Scorpions

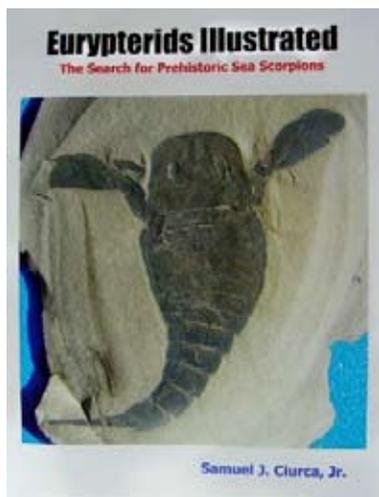
Samuel J. Cieurca, Jr. 2010, PaleoResearch, Rochester, New York, USA. 30pp. \$12.00. ISBN 978-1-450-73656-6.

Eurypterids Illustrated is an informative contribution to the literature of what is perhaps the most iconic and well-known extinct arthropod group (aside from trilobites). The 30 page volume consists predominantly of high-quality images of eurypterids (or sea scorpions) that Samuel Cieurca Jr. has collected over 40 years of exploring and excavating the quarries and outcrops of the Silurian Bertie Group that outcrops in New York and Canada. Each image is accompanied by information about the species, anecdotes, and observations about the animal's morphology, distribution and life habit.

For the most part the book looks at particular species of the Bertie Group, where Cieurca has done most of his collecting, but there are also some specimens figured from Scotland and the Ukraine that he has managed to procure over the years. The final pages are taken up with work Cieurca has done on the stratigraphy of the Bertie Group, with the back cover showing various images of the author in the field. Whilst it is principally aimed at fossil enthusiasts, *Eurypterids Illustrated* is useful for anyone interested in or doing research on eurypterids of the Silurian–Devonian localities covered in the book, largely due to the high-quality photos, some of which detail species that have otherwise had only cursory treatment in the literature. Furthermore some very unique specimens are figured, such as the 3D *Eurypterus*, which are rare, of extreme interest, and worthy of more in-depth study.

The overall layout of the book is clear and easy to follow, with the primary focus being on the fossils. The second page bears a drawing of the eurypterid *Hughmilleria*, with some important morphological terms labelled, however a further glossary may be useful for those who aren't familiar with eurypterids and are not familiar with terms such as chelicerae and operculum. The author also slips into abbreviations such as 'C&R 1912', which to those familiar with eurypterid literature can only refer to Clarke and Ruedemann's 1912 monograph but might not mean much to those new or unfamiliar with the topic. In addition, placing the important section on stratigraphy closer to the start of the volume would have given the reader a firm grounding on the Bertie Group's geology and made it easier to place each of the figured species within the stratigraphical succession.

The science is up to date, with Cieurca being at the forefront of research into the stratigraphy of the region and possibly knowing more about the eurypterids from the area than anyone else. Recent and relevant scientific papers are cited throughout, however occasionally there are a few minor taxonomic errors – for example, the Ukrainian eurypterid species are still referred to as *Baltoeurypterus*, while they were synonymized with *Eurypterus* in 2002. The text associated with the images is very readable, full of anecdotes that hold the reader's interest and give you a feeling





of what it's like to find these amazing fossils. However, the main focus of the publication is the images. These are of high quality, in focus, and with good lighting, although all the photographs other than those on the front and back covers are in black and white. Nevertheless, the lack of colour is no real problem as the published specimens are by necessity in black and white due to journal constraints. A few images could have better contrast, but this is only a minor point.

At \$12 when ordered from Ciorca directly (from <<http://eurypterids.net/EurypteridMonth23.html>>) the book is great value for money, especially as some of the species covered have previously only been poorly figured in the literature. Overall it is a valuable volume, benefiting from the author's 40 years of collecting experience and the detailed nature and quality of the fossils. Ciorca's urging that private collectors consider making provisions for their collections eventually to be donated to public repositories is vital and relevant, as it is local collectors who find the majority of fossil specimens. It is through collaboration between collectors and researchers that some of the most important scientific discoveries have been made, and it is heartening to see a collector encouraging such collaboration.

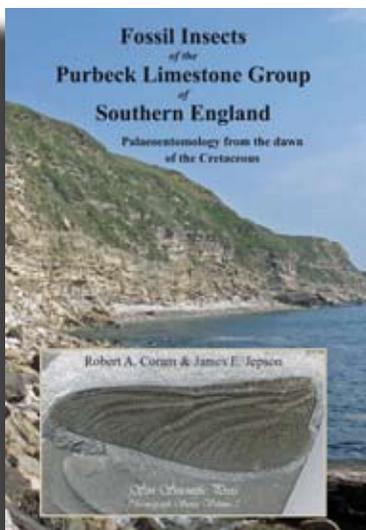
The book is highly recommended, both for its appeal as a public showcase of some of the brilliant Bertie fossils and for its scientific content, and is a must-read for anyone interested in eurypterids or the Silurian of New York.

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Fossil Insects of the Purbeck Limestone Group of Southern England: Palaeoentomology from the dawn of the Cretaceous

Coram, R.A. & Jepson, J.E. 2012. SIRI Scientific Press, Manchester, UK.
143pp. £50.00. ISBN 978-0-9567795-3-3.



Our image of the end of the Jurassic and the beginning of the Cretaceous is typically based on the Purbeck Limestone Group (Purbeck beds of old) outcropping at the eastern end of Dorset's Heritage Coast. 'Must-sees' are the stromatolitic limestones enclosing coniferous stumps and mud-cracked carbonates with tetrapod footprints. Purbeck Stone was once a desirable commodity, and associated evaporates are still mined as far away as north-east Sussex.

On a smaller scale, Victorian naturalists and pioneer geologists realised that the micritic limestones enclosed more than halite pseudomorphs. The 'Wealden' entomofauna in the Rev. P. B. Brodie's landmark 'History of the fossil insects in the Secondary Rocks of England...' is actually from the Purbecks of Wiltshire. Oxford professors (especially J. O. Westwood) soon became interested because these insects resembled



modern ones. The ‘bugs’ thus gave us an insight into the environment of the alien, ‘saurian’-dominated, middle ages of Earth history.

In the twentieth century, palaeontological interest shifted from the UK to the continental palaeolakes of Asia; but by the millennium, a revival of Purbeck studies was well under way, buoyed up by new palaeobiological ideas and geological techniques. The hexapod renaissance is encapsulated in this comparatively short, easy-to-read, and well-illustrated research monograph. The up-to-date commentaries cover insects from mayflies and dragonflies to crickets, cockroaches, true bugs and flies, beetles, wasps and many more besides, including scorpionflies, lacewings, snakeflies and even ice crawlers. The associated biota (plants, crustaceans, molluscs, vertebrates, *etc*) is included, not just for good measure, but for holistic overview. The basis of a future Palaeontological Association Field Guide, perhaps?

What emerges are the palaeoecology and food webs of the variable-salinity water bodies and their inflammable hinterland that covered southern England circa 144 million years ago. The importance of fresh water and risks of fly-borne disease in Purbeck times have a resonance in our time. Yet sustainability was to be found in a globally warm southern England despite the ‘killer’ salt (actually beloved by some midges). Drs Rob Coram and James Jepson provide a unique perspective, as viewed through compound eyes, based on two decades of study and revealing an inordinate fondness for insects. Not for lack of searching, the Purbeck landscape lacked ants, bees and butterflies, as well as birds and ‘true’ flowers. But considering the number of new species that remain to be formally described, the Purbeck insects must compare with the European calcareous lagerstätte (Solnhofen, Montsech, Cuenca) at least in taxonomic biodiversity.

This mini-monograph is an essential palaeontological guide to the semi-arid Jurassic–Cretaceous transition and its immediate aftermath on a basinal and regional scale. Annoying, like midges, are a few upside-down insect wings, and welcome as nits is the mis-spelling of Josiah Westwood’s name. But read or peruse it, and you will be itching to peer at the Jurassic Coast through a hand lens as well as a camera lens. It will surely give you a buzz.

Ed Jarzembowski

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Carnivoran Evolution. New Views on Phylogeny, Form and Function

Anjali Goswami and Anthony Friscia, eds. 2010. Cambridge University Press, UK. 492pp. £35.00 (Kindle edition £24.94). ISBN 978-0-521-73586-5.

This banana-yellow fistful is the first volume in Cambridge University Press’ new ‘Studies in Morphology and Molecules: New Paradigms in Evolutionary Biology’ series, which promises to “address the interface between morphological and molecular studies in living and extinct organisms”. But rather than presenting an historical perspective on this shift (as in Sepkoski and Ruse’s extensive *The Palaeobiology Revolution*) *Carnivoran Evolution*’s structure here offers a collection of new science (following a symposium at SVP 2007 in Austin, Texas) representing current zeitgeist – be that in methodology, understanding or academic popularity – constrained within a taxonomic group.



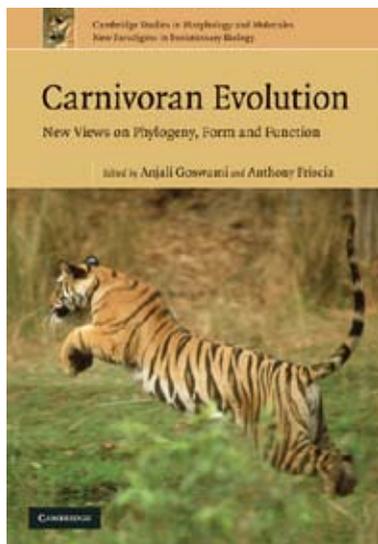
Due to the specialism-led academic model that pervades within our community, and the fact that zoologists – like children – still have favourite species and families (I don't mean to throw stones within a glasshouse here: in my opinion, you can't beat the lowland streaked tenrec), CUP have guaranteed that these brilliant overviews of contemporary techniques will be bought – or at least borrowed – by any researchers working on the family concerned (if for no other reason than to have a fairly accurate who's who on their shelf). So why not start with one of the most iconic mammalian families?

Carnivora, as the editors' synopsis and preface are quick to point out, have invaded niches as disparate as 'bamboo-eating pandas, clam-eating walruses and ... flesh-eating sabre-toothed cats,' and have left an excellent fossil record (there are three times as many extinct carnivoran genera as there are extant). Goswami puts this diversity into startling context: "the deepest diving carnivoran, the northern elephant seal, can reach depths of over a kilometre, while its distant relative, the cheetah, can cross that distance on land in less than a minute". They are ideal for studying convergence, ecomorphology, macroevolutionary patterns and life history evolution. So where to begin?

All contemporary zoological investigations depend on our understanding of the evolutionary relatedness of species. Flynn, Finarelli and Spaulding write in the second chapter that "phylogenetic reconstruction within a clade forms the fundamental evolutionary frame of reference for further analysis into the evolution of character transformation and correlations within that group". Convergence has dogged the reconstruction of Carnivora phylogenies for the past 100 years, as is summarised by a detailed historical sketch. Large hypercarnivorous forms have evolved several times, large, cat-like forms have evolved in at least six families, wolf-like forms at least five times, and bone-cracking at least twice.

As well as naming and proposing a phylogenetic definition and diagnosis for a newly recovered major clade within Carnivoramorpha: the Carnivoraforms, Flynn *et al.* provide the backbone of the book with their phylogeny cited throughout the text. The chapter highlights both the importance of fossil data (in order to break up long branches and to "provide temporal context for the evolution of living clades"), and the total evidence method of analyses, on methodological and philosophical grounds.

The text moves on through the state of Carnivora phylogeny, into a suite of chapters concerned with more specific questions: beginning with the recent revision of the viverrids (Veron) which presents the difficulties encountered due to convergent osteological traits, a theme that is continued into the next chapter. Morlo and Peigné's work on the Ailuridae proves to be especially fascinating (if for nothing more than the general loveliness of the only remaining extant member of the family, the red panda) and includes a very detailed historical review of all the molecular and morphological data and a natural history of the family including the systematic palaeontology of all known extinct forms.





One of the strengths of the collection becomes extremely apparent over the course of the next few chapters, in that the reader is exposed to fresh methodologies, technology and techniques. Goswami and Polly investigate the correlated evolution of characters within carnivorans in order to assess the influence of character correlation on phylogenetic analyses. The authors present a morphometric analysis of 44% of extant genera and 15% of extant species. The resulting methodology (including PC space, character distance matrices, 3D landmark data and Monte Carlo Simulations) goes almost as far as to be a protocol, and the authors report that character correlations may well have affected morphological phylogenetic analyses of Carnivora.

Holliday uses the carnivoran fossil record to investigate the macroevolutionary question of whether hypercarnivory can lead to a dead end, a theme Goswami has spread at conferences far and wide in terms of the constraints of developmental and functional limitations. As well as defining the concept of *modules* and the *evolutionary stable system*, Holliday attempts to better isolate the cause of disparity through the comparative methodology, concluding that the macroevolutionary ratcheting (a literal phrase, brilliantly capturing the physicality of the concept) means hypercarnivores are strongly limited in their ability to respond to environmental change and that “the lack of reversals to a more generalized condition has a greater effect on the evolution of hypercarnivory than does directional selection towards specialization” (a theme that is revisited in Friscia and Van Valkenburgh’s ecomorphology chapter on creodonts).

Werdelin *et al.*’s and Wesley-Hunt *et al.*’s work brings biogeography into the mix, and the following chapters consider disparity across carnivorans (an excellent choice of study group within which to study morphological diversity: the Carnivora has the greatest range of body mass of any mammalian order). Returning to a more conservatively palaeobiological thread, Morlo *et al.* present an analysis of ecospace and guild structure in Laurasia from the Eocene through to the Miocene.

The morphology theme continues into Jones and Goswami’s work on the secondarily aquatic carnivores, the pinnipeds. This elegant morphometric study presents the apparent convergence in adaptations related to diet and mating displays. Their use of independent contrasts as a method of removing phylogenetic inertia seemed a little stale, but the otherwise excellent method and natural history is a worthy addition to the literature on these oddly understudied mammals.

In the final chapters of the book the focus becomes fixed first on the postcranial skeleton and locomotion through time, and then on the most iconic members of the Carnivora: the sabre-toothed Machairodontidae cats. Wroe’s final FEA-heavy chapter benefits from (and indeed would have been incomprehensible without) the 19 colour plates bisecting Morlo *et al.*’s work.

Following the chapters the reader is offered an index but no glossary. This omission is an important one: CUP are attempting to present encapsulations not just of current knowledge but also of current techniques. However, a book arranged by order rather than specialization limits the ability of the reader to understand *all* the concepts covered and, to pick one example, those not up to scratch on their statistics (Akaike Information Criteria abound) would benefit greatly from a glossary – although the generation of a glossary from a collection of papers from multiple authors would not be easy. My only other irritation with the collection was the occasional heavy-handed ladling-on of loosely based ‘conservation’ concerns. Issues were discussed as in Veron’s chapter: “current distribution and genetic diversity of population of the red panda are the result of habitat fragmentation...”, but the idea that palaeontologists studying the macroevolutionary ratchet of dental specialization had any



salient conclusions for conservation biologists was, as is always the case when palaeontologists feel some odd need to over-justify themselves, unnecessary and embarrassing.

No volume for ten years has collected papers containing state-of-the-art phylogenetic, macroevolutionary analyses for Carnivora, and this volume certainly plugs the gap admirably. The *Studies in Morphology and Molecules* series is set to continue this year with the publication of similar volumes on bat and house mouse evolution. This condensation of evo-devo, molecular systematics, new approaches and techniques in vertebrate palaeobiology and evolutionary functional morphology within one text would have been extraordinary ten years ago, with readers firmly rooting for either “molecules” or “morphology”, whilst only a few individuals on either side were bothering to read the technical literature of the other. But we have all moved on. I found this encapsulated in Goswami’s chapter wherein the discussion of modularity and integration in the mammalian cranium illustrates the beautiful level of understanding that can be reached when morphologists, evolutionary developmentalists and geneticists visit each other’s seminars.

Carnivoran Evolution stands as a celebration of effective communication and the successes evolutionary biologists, be they palaeobiologists or not, have had in the last decade as a result of profitable interactions with each other in order to listen, understand and, ultimately, discover the answers to their questions by whatever technical means possible, rather than hiding behind their academic specialisms. This book, as a few have before it, made me wonder. Are the words ‘palaeontologist’ and ‘neontologist’ really going to stick around for much longer?

Nick Crumpton

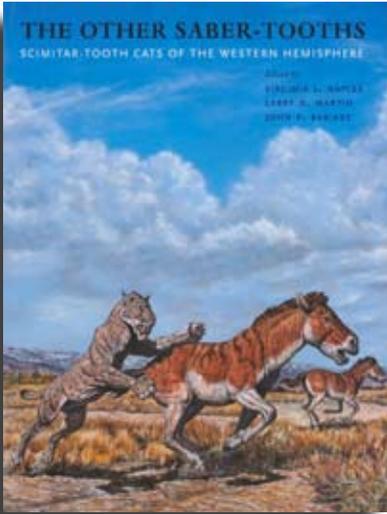
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The Other Saber-Tooths: Scimitar-Tooth Cats of the Western Hemisphere

V.L. Naples, L.D. Martin and J.P. Babiarez, eds. 2011. The Johns Hopkins University Press, Baltimore, USA. 236pp. \$110. ISBN 978-0-801-89664-4.

Sabre-toothed cats have caught the imagination of the public for more than one and a half centuries, since the first discovery of these impressive creatures of the past. The elongated canines of these carnivores have puzzled scientists and commoners alike, for how did these predators wield their fragile-looking canines without breaking them, and how did they hunt? These questions are among several that this book attempts to address. As the title indicates, this volume is mainly focused on the sabre-tooth cats of the tribe Homotheriini; a tribe containing the scimitar-toothed *Machairodus*, *Homotherium* and *Xenosmilus*, but omitting the much better known dirk-toothed *Smilodon* which belongs to the tribe Smilodontini. It was the Finnish naturalist Björn Kurtén who divided the sabre-tooth lineage into two ecomorphs; the dirk-toothed and the scimitar-toothed. *Smilodon* is probably among the best-known extinct mammals, popularized in illustrations by Charles R. Knight and by the numerous skulls collected from the Rancho La Brea Tar Seeps in Los Angeles. Since the majority of the attention has been given to *Smilodon*, the cats belonging to Homotheriini have largely been ignored. This book has been written to remedy that and to introduce the reader to a couple of different kinds of sabre-tooth.

The book starts well, giving the reader a short introduction to sabre-toothed carnivorans, including details of when they lived, how they may have hunted and what their prey may have been. It



further introduces the reader to mammal chronology of North America, and suggests a relationship between environmental changes and the extinction of sabre-tooth cats. There is also a short introduction to dating methods and taxonomy.

The second chapter is dedicated to experimental palaeontology, investigating how *Smilodon* may have used its elongated canines. By mounting both steel and plastic teeth on steel jaws on a hydraulic excavator, and experimenting on bison and moose carcasses, different theories on how *Smilodon* may have bitten are tested. In the third chapter, pathologic cases of sabre-tooths are discussed and used to infer the killing behaviour of the extinct cats. Chapter four is a very detailed review of the osteology of *Xenosmilus hodsonae* and is very carefully illustrated. The fifth chapter is

dedicated to the myology in *Xenosmilus*. Chapter six deals with both the osteology and myology of *Homotherium ischyryus* and is again well illustrated. In chapter seven, the authors attempt a revision of the Homotheriini in the new world. This is followed by a short chapter eight which contains a description of a *Homotherium* skull from Tajikistan, and a discussion of the relationship between Homotheres of Eurasia and North America. In chapter nine, the authors present their opinion on both the relationships within the Homotheriini and their migrational history, and further try to sum up their conclusions from the earlier chapters.

Every rose has its thorns: the dramatic cover illustrations may give the impression of a book targeting the popular science audience, but it is not. This is a book primarily for the specialist and for those with a special interest in felid evolution or the Pliocene–Pleistocene fauna of North America. Had the reader hoped for a lengthy discussion on the phylogeny, distribution and behaviour of the Homotheriini, they would be disappointed. The chapters on the osteology and myology of *X. hodsonae* and *H. ischyryus* take up two-thirds of the book, whereas the discussion of phylogeny and behaviour amounts to only a few pages.

The book is endowed with beautiful drawings of bones and live reconstructions of both *Xenosmilus* and *Homotherium*, but the lack of illustrations for the many comparisons to other taxa is somewhat perplexing. The authors repeatedly compare the Homotheres with *Smilodon* in the text, but do not include any detailed illustrations of *Smilodon*'s skull or dentition. This is slightly odd, as it would have made the comparison between the different sabre-tooths much easier for the reader to understand. Furthermore, an entire splendidly-illustrated chapter is dedicated to how *Smilodon* used its canines, whereas very little is spent on illustrating how the main subject, the Homotheres, dispatched their prey. The authors also base a new ecomorph, the “cookie-cutter” cat, on *Xenosmilus*, but again did not find it necessary to back up their finding with any illustrations, which could have supported their arguments for erecting this new ecomorph. The lack of illustrations is also obvious in the last chapter, in which the authors argue against the general envisioning of *Homotherium* as a derivation of *Machairodus*. A few good pictures or drawings of the differences



in morphology between the two genera would have been beneficial. Likewise when discussing migrational routes, a map is often a good place to start.

Despite the above-mentioned criticisms, the book fills a big gap in the literature and makes a good contribution to our understanding of the morphology of the Homotheriini. The book is unfortunately difficult to obtain in Europe and the price is a bit steep, with a suggested price of \$110, but specialized literature is often rather costly.

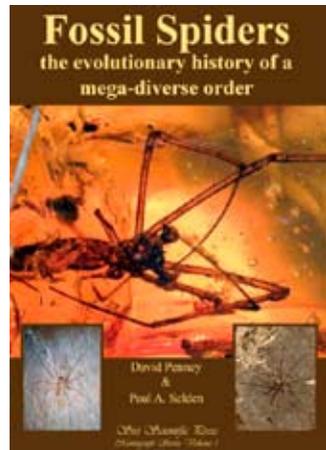
Jan Adolfssen

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Fossil Spiders. The evolutionary history of a mega-diverse order

David Penny & Paul A. Selden. 2011. Siri Scientific Press, Manchester, UK. 128pp. £32.00 RRP. ISBN 978-0-9558636-5-3.

Immediately after reading this book I had a few realizations. Firstly, it is curious that palaeoarachnology is a relatively small field, in terms of active workers, given that the fossil record of spiders easily falls within the size category of “pretty big”. Secondly, if I woke up tomorrow and decided to become an arachnologist, offering to do this review would have unknowingly earned me one of the most citeable publications on my bookshelf. Finally, the title “Fossil Spiders: a full account of the taxonomic and systematic history of a mega-diverse order” would have been more appropriate for this book. These thoughts essentially encapsulate my overall feeling of the work by Penney and Selden, who manage to weave a sense of how little is known about the fossil record of spiders with an excellent account of their classification and nomenclature, even if the latter somewhat overshadows the former at times.



The preface and back cover provide a brief explanation of the relevance and objectives of this publication, and promote it as interesting reading material aimed at amateur and professional arachnologists, as well as palaeontologists in general. Not being an arachnologist myself, but having some palaeontological training and a profound interest in arthropods, I imagined that this would put me in a comfortable middle-tier position from which to assess some of the virtues of the content, and provide a balanced opinion for both ends of the intended audience. With this in mind, let us review the content from these two complementary approaches.

From the scholarly point of view, this work most certainly deserves a handy spot on the bookshelf of any arachnologist. The volume essentially represents a thorough review of the systematics and taxonomy of true spiders (Order Aranea), but also includes sections that focus on some biological aspects of these organisms such as their palaeoecology, evolutionary history and biogeography. Probably the biggest asset of the book is the great deal of attention given to the classification of numerous groups of fossil spiders through the whole text, as well as the notes that aim to clarify



several systematic inconsistencies that have accumulated over many years of description and nomenclatural over-splitting in the palaeoarachnological literature. One chapter features a list of extinct spider families, including useful information such as their stratigraphic ranges and several notes on the taxonomy of its members. Furthermore, the text also contains numerous tables that condense important data on the occurrence of fossil spiders, their localities and the original bibliography. These components ensure that this will likely become a valuable resource for junior and seasoned arachnologists alike.

The text is accompanied by numerous high-quality photographs of type specimens that highlight the different styles of preservation, the biodiversity captured in the fossil record, and occasionally serve for establishing comparisons with living species; these often illustrate effectively the generalized morphology of the particular fossil or extant araneid taxa being discussed. However, with the exception of the front cover, all the images in the book are printed in black and white. At times this works in favour of the figure by focusing the attention of the reader on the pictured specimen, as in the case of several amber-hosted fossils, but often results in somewhat dull looking images of fossils preserved in rock which may be difficult to interpret for the amateur arachnologist, such as myself.

Despite its heavy emphasis on systematics, the book also delves into the biological importance of spiders through time, some interesting aspects of their evolutionary history, and even covers some notes on their taphonomy and preservation potential. Furthermore, most of these subjects are addressed in the context of the phylogenetic relationships within Aranea, and thus puts emphasis on the benefits of utilizing both palaeontological and neontological approaches to understand the evolution of the group. One of the sections describes araneids as successful and diverse predators with a generalist diet, the latter probably a crucial asset in their favour during the several mass extinctions that spiders have survived across their 319 million year history. A particularly engaging theme covered is the preservation of fossil spiders in amber, a taphonomic window that yields exceptional information about their morphology and sometimes even physiology. The latter can be exemplified with several instances of fossilized spider silk threads found in amber over 100 Ma, which also carries exciting palaeoecological implications, and the recognition of autotomy (*i.e.* “voluntary” detachment of a limb) in individuals that apparently tried to flee their resinous entrapment while still alive, albeit unsuccessfully. The sections that tackle the diversification of spiders, the effect of mass extinctions on Aranea as a clade, and the evolutionary interaction with hexapods overlap considerably. However, the authors provide a clear picture of the complexity of this group, and utilize the opportunity to dismiss some of the more traditional ideas regarding their evolutionary history. For instance, the interpretation of a co-radiation between spiders and insects is favoured over the older co-evolutionary view.

Ironically, several of the strengths of this book will probably deter the amateur reader from benefiting completely from its contents. The main reasons for this lie in the overall writing style and presentation, as the text reads like a technical paper rather than a ‘story’ about the origin and evolution of spiders. Although some sections (*e.g.* introduction, curatorial and imaging techniques) are fairly accessible and even entertaining, these are too few and are abruptly interrupted by the occasional taxonomic note and a string of obscure Latinised binomial names. In most of the other parts where the taxonomy represents a more central issue, the prose becomes arid, and the associated use of technical jargon is alienating at best. Most photographs have only a short



descriptive caption that includes a species name and the author(s) who described it, providing little context for understanding the purpose of the figure apart from its mere identity. Often there is very little differentiation between each of the chapters in terms of construction and content, and more than once I found myself starting a new section without noticing a clear closure of the previous one. This problem partly stems from an awkward choice of formatting for the headlines, in which each chapter title is presented in a similar font size and style to the rest of the text, making them easy to miss while attempting to focus on the content. This is not to say that the book was written without the amateur reader in mind, as there are sections (e.g. curatorial and imaging techniques) that provide detail in great simplicity; oddly enough, these few sections may be superfluous at times for the scholarly audience.

In conclusion, Penney and Selden have produced a prime piece of work that will prove of great utility when dealing with the complications that commonly arise from descriptive palaeoarachnology. The sheer amount of time and effort saved from tracking down arcane references in the old arachnological literature are more than worth the price of £30.40 (at the time of writing, source [amazon.co.uk](https://www.amazon.co.uk)). Although I would be hard pressed to describe this as a fun read, unlike its more popular but much less scientifically accurate competitor, *The Amazing Spider-Man*, this definitely represents a robust publication and a superb starting point for any query related to the taxonomy, phylogeny and palaeoecology of fossil spiders.

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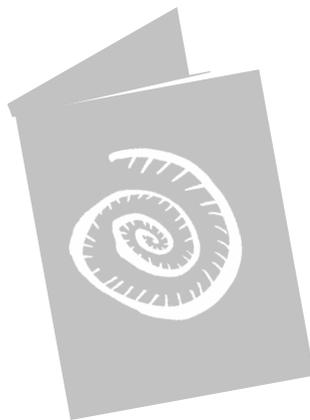
Books available to review

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

- *Evolution & Belief: Confessions of a Religious Paleontologist* by Robert J. Asher.
- *Fossil Arachnids* by Jason A. Dunlop & David Penney.
- *Living Dinosaurs: The Evolutionary History of Modern Birds* by Gareth Dyke & Gary Kaiser.
- *Geology of the Jurassic Coast: The Isle of Purbeck to Studland* by Paul Ensom & Malcolm Turnbull.
- *Frasnian (Upper Devonian) Colonial Disphyllid Corals from Western Canada: Taxonomy and Biostratigraphic Significance* by Ross A. McLean.
- *Late Ordovician and Early Silurian Stromatoporoid Sponges from Anticosti Island, Eastern Canada: Crossing the O/S Extinction Boundary* by Heldur Nestor, Paul Copper & Carl W. Stock.
- *Embryos in Deep Time* by Marcelo R. Sánchez.
- *Evolution of Island Mammals: Adaptation and Extinction of Placental Mammals on Islands* by Alexandra van der Geer, George Lyras, John de Vos & Michael Dermitzakis.
- *Structural Biomaterials* (3rd edition) by Julian Vincent.
- *Tabulate Corals from the Givetian and Frasnian of the southern region of the Holy Cross Mountains (Poland)* by Mikołaj Zapalski.
- *Models in Palaeontology* Biology Letters Special Feature vol 8. no. 1.
- *Evolution* app for iPad from The Natural History Museum.

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Palaeontology

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Special Papers in Palaeontology No. 88

Smithian (Early Triassic) ammonoids from the Salt Range, Pakistan

Thomas Brüwiler, Hugo Bucher, David Ware, Elke Herman, Peter Hochuli, Ghazala Roohi, Khalil Rehman and Aamir Yaseen.

Abstract: Intensive sampling of the Lower Triassic successions at the Chiddru, Nammal and Zaluch localities in the Salt Range (Pakistan) has yielded abundant and well-preserved Smithian (Early Triassic) ammonoid faunas that are of prime importance for ammonoid taxonomy and biostratigraphy. The Salt Range is the type area of many Smithian taxa, and it has played a central role in Lower Triassic ammonoid zonation since the pioneer works of Waagen and Mojsisovics *et al.* in the late 19th century. Our data allow the construction of a highly resolved ammonoid succession spanning the entire Smithian. Boundary faunas with the older Dienerian and the younger Spathian are also well documented. ...

Key words: Ammonoidea, Early Triassic, Smithian, Salt Range, Pakistan, biostratigraphy.

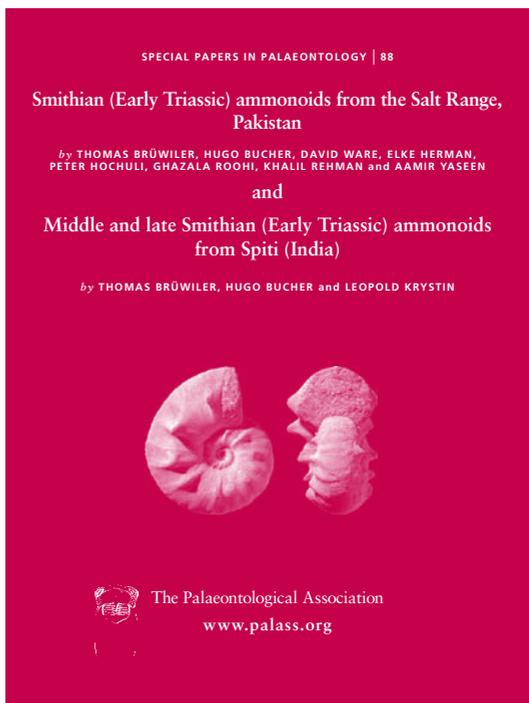
and

Middle and late Smithian (Early Triassic) ammonoids from Spiti (India)

Thomas Brüwiler, Hugo Bucher and Leopold Krystin.

Abstract: The 'Parahedenstroemia' beds in the Mikin Formation at the Mud, Guling, Lalung and Losar localities in the Spiti area (Himachal Pradesh, northern India) yield abundant and well-preserved Smithian (Early Triassic) ammonoid faunas. Our data allow the construction of a high-resolution ammonoid succession spanning the middle to latest Smithian time interval. ...

Key words: Ammonoidea, Early Triassic, northern India, Mikin Formation, biostratigraphy.



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