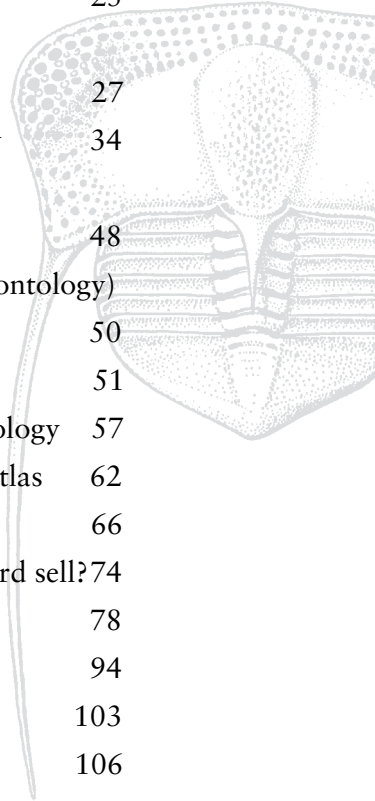


The Palaeontology Newsletter

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Reminder: The deadline for copy for Issue no 72 is 5th October 2009.

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

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Association Business

Annual Meeting

Notification is given of the 2009 Annual General Meeting and Annual Address

This will be held at the University of Birmingham on 14th December 2009, at the end of the first day of scientific sessions in the 53rd Annual Meeting. Please note that other items may be added to the agenda following the October Council meeting.

Agenda

Apologies for absence

Minutes of the 52nd AGM, University of Glasgow

Annual Report for 2008 (published in Newsletter 71)

Accounts and Balance Sheet for 2008 (published in Newsletter 71)

Election of Council and vote of thanks to retiring members

Palaeontological Association Awards

Annual address

H. A. Armstrong

Secretary

DRAFT AGM MINUTES 2008

Minutes of the Annual General Meeting held on Saturday, 20th December 2008 at the University of Glasgow.

Apologies for absence: None reported

- 1. Trustees Annual Report for 2008.** Agreed, proposed by Prof. I. Rolfe and seconded by Prof. J. Callomon.
- 2. Accounts and Balance Sheet for 2008.** Proposed by Prof. Sevastopoulo and seconded by Prof. Hallam, the accounts were agreed by unanimous vote of the meeting.
- 3. Increase in Subscriptions.** In view of the projected more difficult financial circumstances Prof. Cope recommended subscriptions from 2010 should be at the following levels: Student Membership £10; Ordinary Membership £36; Retired Membership £18. The recommendations were proposed by Prof. Sevastopoulo and seconded by Prof. Smith. The increase was agreed by unanimous vote of the meeting.
- 4. Election of Council and vote of thanks to retiring members.**
Prof. M. Bassett extended a vote of thanks to the retiring members of Council.



The following members of the Association were elected to serve on Council:

<i>President:</i>	Prof. R. J. Aldridge
<i>Vice Presidents:</i>	Prof. N. Macleod Dr Thomas Servais
<i>Treasurer:</i>	Prof. J. C. W. Cope
<i>Secretary:</i>	Dr H. A. Armstrong
<i>Chair of Publications Board:</i>	Prof. M. P. Smith
<i>Editor Trustees:</i>	Dr P. J. Orr Dr P. C. J. Donoghue
<i>Book Review Editor:</i>	Dr C. Jeffrey-Abt
<i>Publicity:</i>	Dr M. A. Purnell
<i>Newsletter Reporter:</i>	Dr A. McGowan
<i>Newsletter Editor:</i>	Dr R. J. Twitchett
<i>Web Officer:</i>	Dr M. Sutton
<i>Ordinary Members:</i>	Mr W. Fone Prof. S. Donovan Dr J. A. Rasmussen Dr C. Underhill Dr E. Rayfield Dr C. Buttler Dr D. Schmidt

Drs Harrington and Vandenbrouche were co-opted as Annual Meeting organisers for 2009 and 2010 respectively.

It was agreed Prof. Harper would be co-opted as the IPA representative, and would when necessary attend Council meetings to report on IPC3 2010 planning progress.

Prof. R. J. Aldridge extended a vote of thanks to Prof. M. Bassett, the retiring President.

5. Association Awards

The following awards were made:

- Lapworth Medal to Prof. C. H. Holland (Trinity College Dublin)
- President's Medal to Dr P. Upchurch (Natural History Museum)
- Hodson Award to Dr B. Wade (Texas A&M)
- Mary Anning award to Mr D. J. Ward
- Honorary Life membership was awarded to Sir Peter Crane.

The Annual Address entitled "The emergence of tetrapods: how far have we come in the last twenty years and where can we go in the next?" was given by Prof. J. Clack (University of Cambridge).

H. A. Armstrong
Secretary



Trustees Annual Report 2008 (Draft)

Nature of the Association. The Palaeontological Association is a Charity registered in England, Charity Number 276369. Its Governing Instrument is the Constitution adopted on 27th February 1957, amended on subsequent occasions as recorded in the Council Minutes. The aim of the Association is to promote research in Palaeontology and its allied sciences by (a) holding public meetings for the reading of original papers and the delivery of lectures, (b) demonstration and publication, and (c) by such other means as the Council may determine. Trustees (Council Members) are elected by vote of the Membership at the Annual General Meeting. The contact address of the Association is c/o The Executive Officer, Dr T. J. Palmer, Institute of Geography and Earth Sciences, University of Wales, Aberystwyth SY23 3DB, Wales, UK.

Trustees. The following members were elected to serve as trustees at the AGM on 17th December 2007: President: Prof. M. G. Bassett; Vice-Presidents: Prof. N. Macleod, Dr C. H. Wellman; Treasurer: Prof. J. C. W. Cope; Secretary: Dr H. A. Armstrong; Chairman of the Publications Board: Prof. D. A. T. Harper; Newsletter Editor: Dr R. J. Twitchett; Book Review Editor: Dr P. J. Orr; Newsletter Reporter: Dr A. McGowan; Internet Officer: Dr M. D. Sutton; Publicity Officer: Dr M. A. Purnell; Editor Trustees: Dr P. C. J. Donoghue, Prof. M. P. Smith (Secretary of the Publications Board); Other Members: Dr G. Budd, Prof. S. K. Donovan, Mr W. Fone, Dr C. Jeffery, Dr J. A. Rasmussen, Dr E. Rayfield, Dr T. Servais. Prof. M. Cusack organized the Annual meeting in Glasgow, 2008 and was co-opted to serve on Council for two years. The Executive Officer: Dr T. J. Palmer and Editor-in-Chief: Prof. D. J. Batten will continue to serve Council but are not trustees. Prof. R. J. Aldridge attended Council meetings as the President Elect.

Membership. Individual membership totalled 1,224 on 31st December 2008, an overall decrease of 45 over the 2007 figure. There were 742 Ordinary Members, a decrease of 11; 169 Retired and Honorary Members, an increase of 1; 313 Student Members, a decrease of 35. There were 108 Institutional Members in 2008, and 94 institutional subscribers to *Special Papers in Palaeontology*.

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

Reserves. The Association holds reserves of £554,989 in General Funds. These reserves enable the Association to generate additional revenue through investments, and thus to keep subscriptions to individuals at a low level, whilst still permitting a full programme of meetings to be held, publications produced and the award of research grants and grants-in-aid. They also act as a buffer to enable the normal programme to be followed in years in which expenditure exceeds income, and new initiatives to be pursued. The Association holds £46,111 in Designated Funds which contribute interest towards the funding of grants-in-aid, the Sylvester-Bradley, Hodson Fund and Mary Anning awards. Funds carried forward to 2009 totalled £601,100. Following the recommendation of Citi Quilter it was agreed that the Association investment portfolio should contain up to 5% in hedge funds.

Finance. Total charitable expenditure for 2008 was £213,394. Total resources expended were £246,480. The Association continues its membership of the International Palaeontological Association and remains a Tier 1 sponsor of *Palaeontologica Electronica*. In view of the increasingly



difficult international financial situation it was agreed at the AGM that the new subscriptions commencing 2010 should be: Ordinary Membership £36; Student Membership £10; Retired Membership £18.

Risk. The recent falls in capital values have not adversely affected the ability of the Association to continue with its current and future charitable activities. The transition to the new Editor in Chief had been relatively smooth and was made possible by a period of overlap with Prof. Batten. It is recognised that this might not always be the case in the future and succession planning for executive officers should be reviewed.

Charitable Activities.

The Association continues to increase its range and investment in charitable activities, whilst continuing to keep individual membership subscriptions low.

Grants. Ten applications had been received for the Palaeontological Association Research Grant and funds were awarded to Dr Porter (University of California, Santa Barbara) and to Dr Upchurch (University College London). 'Grants-in-aid' included financial support for postgraduate attendance at the IPC/IOBC meeting in Bonn; a symposium at the GSA annual meeting in Houston; travel for Prof. Peterson who has been invited to attend the EED meeting in Ghent and for a symposium on fossilized ontogenies at the same meeting. An award was made from the Jones Fenleigh Fund and from Association General Funds to support an Association symposium at the SVP meeting. In addition it was agreed £6,000 should be made available to support up to 20 members from outside North America to attend NACP 2009. We have continued to provide funds to support student and speaker attendance at our own and international meetings.

Online activities. The online activities of the Association continue to expand. Electronic versions of *Special Papers in Palaeontology* were produced and abstracts from *Palaeontology* were scanned to allow online searching of back issues. New links have been made to national guidelines on fossil collecting and geo-diversity. The Association now hosts mirror sites for the PalaeoDatabase, *Palaeontologica Electronica* and the EDNA fossil insect database. The Association continues to support the "Ask a Biologist" website.

Public meetings. Three public meetings were held in 2008, and the Association extends its thanks to the organisers and host institutions of these meetings.

2008 Annual Meeting was held on 18–21 December at University of Glasgow, Scotland. Prof Cusack, Dr Owen and Dr Clark organised the meeting with much local support. This meeting included a symposium on "Biominerals – the hard part of palaeontology" and comprised a programme of internationally recognised speakers. There were 250 attendees. The Annual Address entitled "The emergence of tetrapods: how far have we come in the last twenty years and where can we go in the next?" was given by Prof. J. Clack (University of Cambridge) and was attended by 250 people. The President's Award was made to Robert Sansom (University of Leicester). The Council Poster Prize was presented to Heather Birch (Cardiff University). The pre-conference field trip was to sites in the local Carboniferous.

British Science Festival, Palaeontological Association Symposium: the annual forum for presentations to the public and general scientists was "Climate Change in the past: the latest evidence from fossil plants and animals," organised by Dr Charlotte Jeffery-Abt and Prof. Jim Marshall (University of Liverpool). *Progressive Palaeontology* was held at the University of Manchester on 29–31 May. The annual open meeting for presentations by research students was organised by Karl Bateson.



IPC3 2010. During the year the Association agreed to host this prestigious international meeting. The proposal included a consortium of Imperial College, the Natural History Museum, the TMS and Palaeontographical Society.

Publications. During the year Prof. Batten tendered his resignation and was replaced by Dr Stouge. Prof. Batten is duly thanked for all his hard work whilst in the post, in particular moving our journals to online publication. Publication of *Palaeontology* and *Special Papers in Palaeontology* is managed by Wiley Blackwell, who also make sales and manage distribution on behalf of the Association. Volume 51 of *Palaeontology*, comprising six issues, was published. *Special Papers in Palaeontology* 79, "Nautiloids before and during the origin of ammonoids in a Siluro–Devonian section in Tafilalet, Anti-Atlas, Morocco" by B. Kroeger, and *Special Papers in Palaeontology* 80, "Early Jurassic pterosaur *Dorygnathus banthensis* (Theodori, 1830) and The early Jurassic pterosaur *Campylognathoides* Strand, 1928" by K. Padian, were published during the year.

The Association is grateful to the National Museum of Wales and the Lapworth Museum (University of Birmingham) for providing storage facilities for publication back-stock and archives. Council is indebted to Meg and Nick Stroud for assistance with the publication and distribution of *Palaeontology Newsletter*.

Publicity. The Association continues to promote palaeontology and its allied sciences through its website and press releases to the national press, radio and television.

Awards. The Lapworth Medal, awarded to people who have made a significant contribution to the science by means of a substantial body of research, was presented to Prof. C. H. Holland (Trinity College Dublin). The President's Medal (new) for a palaeontologist in recognition of outstanding contributions in his/her earlier career – coupled with an expectation that they will continue to contribute significantly to the subject in their further work – was awarded to Dr P. Upchurch (Natural History Museum). The Hodson Award, for a palaeontologist under the age of 35 who has made an outstanding achievement in contributing to the science through a portfolio of original published research, was awarded to Dr B. Wade (Texas A & M). The Mary Anning award, for an outstanding contribution by an amateur palaeontologist, was made to Mr D. J. Ward. Council also awards an undergraduate prize to each university department in which palaeontology is taught beyond Level 1. Honorary Life membership was awarded to Sir Peter Crane.

Governance. The Association continues to improve its administration with further improvements to the *Newsletter* and website. Trustees were members of the Joint Committee for Palaeontology: Prof. Bassett (Chair) and Dr Donoghue represented the Association. Dr Armstrong acted as the Association representative on the International Palaeontological Association. Sir Peter Crane gave, on behalf of the Association, a lecture on the Life of Hooker at Kew Gardens as part of the "Local Heroes" series, as part of the Geological Society of London bicentennial celebrations.

Increasingly the Association is a respondent in national consultation exercises. During the year the Association responded to requests for information from the HEFCE consultation on the Research Excellence Framework, the proposed closure of the MSc. Micropalaeontology course at University College, London and the future of the *Treatise on Invertebrate Paleontology*.

Forthcoming plans. Council will continue to make substantial donations, from both General and Designated funds, to permit individuals to promote the charitable aims of the Association. In 2009, a similar programme of public meetings and publications will be carried out. The 53rd Annual Meeting and Progressive Palaeontology will be held at the University of Birmingham. The Association will again sponsor a symposium at the British Science Festival.



Resources will be made available from General Funds to support the Association Research Grant, Grants-in-Aid, provided to carry out research into palaeontological subjects, to disseminate findings in print and at conferences, and to support the provision of palaeontological workshops. The Association will continue to recognise the contribution individuals have made to palaeontology and associated sciences through its awards.

Funds will be made available to develop the website further, aimed at encouraging outreach and improving the Governance of the Association. It is intended that one new *Field Guide to Fossils* will be published within the year.

It is recognised that the Association is now one of the premier international learned societies. During the forthcoming year mechanisms will be developed by which the Association can have a greater presence at international geological meetings. Hosting IPC3 2010 will be a significant undertaking for the Association and Trustees during 2009 and 2010.

Howard A. Armstrong

Secretary

Nominations For Council

At the AGM in December 2009, the following vacancies will occur on Council:

- President Elect
- Vice president
- Treasurer
- Newsletter Reporter

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

All potential Council Members are asked to consider that:

"Each Council Member needs to be aware that, since the Palaeontological Association is a Registered Charity, in the eyes of the law he/she becomes a Trustee of that Charity. Under the terms of the Charities Act 1992, legal responsibility for the proper management of the Palaeontological Association lies with each Member of Council."

Responsibilities of Trustees can be obtained from <secretary@palass.org>.

The closing date for nominations is **1st October 2009**. They should be sent to the Secretary: Dr Howard A. Armstrong, Department of Earth Sciences, Durham University, Durham DH1 3LE; email: <h.a.armstrong@durham.ac.uk> or via <secretary@palass.org>.

The following nominations have already been received:

- President elect: Prof. Jane Francis (Nominated by Council)
- Vice President- Dr Paddy Orr (Nominated by Council)



53rd Annual Meeting of the Palaeontological Association

The 53rd Annual Meeting of the Palaeontological Association will be held at the University of Birmingham, on 13–15 December 2009, organized by Dr G. Harrington. Details and online registration are now available on the Association website.

Annual Address 2009

Digital dinosaurs: Unlocking the riddles of the past using advanced 3D imaging

Speaker: Lawrence M. Witmer, PhD

Professor of Anatomy and Chang Professor of Paleontology

Department of Biomedical Sciences

Ohio University College of Osteopathic Medicine

Athens, Ohio 45701 USA

email:<witmerL@ohio.edu>

Abstract:

The fossil remains of ancient organisms exist in the physical realm. In the past couple of decades, however, palaeontology has made the jump into the digital or virtual realm. Using techniques such as CT scanning, laser scanning, and other imaging modalities, the morphological structure of fossils can now be mapped into 3D coordinate space for analysis in a computer environment. This 3D revolution, still in its infancy, is transforming the discipline of palaeontology. Early on, the goal was simply to peer through the encasing rock matrix. Today, that goal has been expanded to include the digital extraction and 3D visualization of not just the hard parts, but also of reconstructed soft-tissue structures of extinct animals. Research in our lab has been directed toward the evolution of anatomical systems in the heads of archosaurs, the clade that includes birds and crocodylians today and such marquee extinct taxa as nonavian dinosaurs and pterosaurs. Although fossil specimens, of course, remain a central focus, biological interpretation of extinct organisms requires direct reference to their extant relatives for information on such unpreserved attributes as soft-tissue anatomy, physiology and behaviour. Evaluated in a phylogenetic context, these data allow biological hypotheses about extinct taxa to be adequately tested. Recently, our team has been using CT scanning, 3D modelling, and, in the extant realm, anatomical dissection to track the evolution of the brain, inner ear, blood vessels, muscles, air spaces, and other structures in the heads of dinosaurs and their kin to test hypotheses on sensory biology and behaviour. Although the brain's neurons have long since degraded, the contours of the brain reflect different levels of cognitive and sensory abilities and emphases (*e.g.*, the relative importance of vision or smell) in different dinosaur groups. Likewise, the structure of the delicate inner ear provides key information on not only the relative importance of hearing, but also the sense of balance; perhaps surprisingly, the inner ear also sheds light on the visual system and the 'alert' posture of the head, which may relate to the evolution of feeding behaviours in different clades of dinosaurs. Reconstruction of the air spaces provides new information on physiological functions and behaviours, potentially relating to metabolic physiology and communication, respectively. Again, this kind of research is still in its early stages, but clearly the future is bright for the generation of testable and informative 3D models of the anatomical and functional organization of extinct organisms.



Grants and awards

Grants in Aid

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

Grants-in-Aid: Workshops and short courses

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

Sylvester-Bradley Award

Awards are made to assist palaeontological research (travel, visits to museums, fieldwork *etc.*), with each award having a maximum value of £1,000. Preference is given to applications for a single purpose (rather than top-ups of other grant applications) and no definite age limit is applied. The award is open to both amateur and professional palaeontologists, but preference will normally be given to members of the Association and to candidates who have not previously won an award. The awards are announced at the AGM.

Council will also consider awards in excess of £1,000. Typically these would aid pilot projects with an aim of supporting future applications to national research funding bodies.

Electronic submission of applications, through the website, is preferred and will comprise a CV, an account of research aims and objectives (5,000 characters maximum), and a breakdown of the proposed expenditure. Each application should be accompanied by the names of a personal and a scientific referee. Successful candidates must produce a report for *Palaeontology Newsletter* and are asked to consider the Association's meetings and publications as media for conveying the research results. **Deadline: 1st November, 2009.**

Travel grants for student presenters at Annual Meeting

The Palaeontological Association runs a programme of travel grants to assist student members presenting talks and posters at the Annual Meeting. For the Birmingham meeting, grants of **up to £100** (or the Euro equivalent) will be available to student presenters who are travelling from outside the UK. The amount payable is dependent on the number of applicants and the distance travelled. Payment of these awards is given as a disbursement at the meeting, not as an advance payment. Students interested in applying for a PalAss travel grant should contact the Executive Officer, Dr Tim Palmer, by e-mail to <palass@palass.org>, once the organisers have confirmed that their presentation is accepted, and before **4th December 2009**. Entitle the e-mail 'Travel Grant Request'. No awards will be made to those who have not followed this procedure.



THE PALAEOLOGICAL ASSOCIATION Registered Charity No. 276369
STATEMENT OF FINANCIAL ACTIVITIES FOR THE YEAR ENDED 31st DECEMBER 2008

		General Funds	Designated Funds	TOTAL 2008	TOTAL 2007
Incoming Resources					
Incoming resources from generated funds					
Voluntary income	Subscriptions	66,376		66,376	61,688
	Donations	<u>6,410</u>	<u>1,418</u>	<u>7,828</u>	<u>1,377</u>
		72,786	1,418	74,204	63,065
Incoming resources from charitable activities					
Sales	<i>Palaeontology</i>	156,901			
	Special Papers	6,210			
	Offprints	1,123			
	Newsletters	300			
	Field Guides	2,813			
	Distribution	<u>643</u>			
		167,990	0	167,990	165,506
Investment income		<u>19,231</u>	<u>2,068</u>	<u>21,299</u>	<u>20,958</u>
TOTAL INCOMING RESOURCES		<u>260,007</u>	<u>3,486</u>	<u>263,493</u>	<u>249,529</u>
Resources expended					
Costs of generating funds					
... for voluntary income	Admin.	19,237			18,852
Investment management	Stockbroker	<u>1,891</u>			<u>2,220</u>
		21,128	0	21,128	<u>21,072</u>
Charitable activities					
Publications	<i>Palaeontology</i>	63,967			
	Special Papers	4,021			
	Offprints	1,164			
	Newsletters	15,033			
	Field Guides	0			
	Distribution	120			
	Marketing	2,530			
	Management	<u>47,081</u>			
	Total	133,916		133,916	154,632
Scientific Meetings & Costs		21,042		21,042	14,752
Grants and Awards		9,451	9,939	19,390	19,614
Research Grants		15,000		15,000	0
Admin. of charitable activities		<u>24,046</u>		<u>24,046</u>	<u>23,550</u>
		203,455	9,939	213,394	<u>212,548</u>
Governance costs					
	Examiner's fee	400			
	Trustee expenses	6,749			
	Administration	<u>4,809</u>			
		<u>11,958</u>	<u>0</u>	<u>11,958</u>	<u>10,523</u>
TOTAL RESOURCES EXPENDED		<u>236,541</u>	<u>9,939</u>	<u>246,480</u>	<u>244,143</u>
NET INCOMING RESOURCES		23,466	-6,453	17,013	5,386
INVESTMENT GAINS/LOSSES					
	Realised loss	-1,488			
	Unrealised loss	<u>-75,075</u>			
		-76,563		-76,563	4,337
NET MOVEMENT IN FUNDS		-53,097	-6,453	-59,550	9,723
FUNDS BROUGHT FORWARD		<u>608,086</u>	<u>52,564</u>	<u>660,650</u>	<u>650,927</u>
FUNDS CARRIED FORWARD		<u>554,989</u>	<u>46,111</u>	<u>601,100</u>	<u>660,650</u>



THE PALAEOLOGICAL ASSOCIATION Registered Charity No. 276369
BALANCE SHEET as at 31st DECEMBER 2008

2007 £		2008 £
	INVESTMENTS	
477,438	At market value	383,587
	CURRENT ASSETS	
162,995	Cash at Banks	216,682
<u>62,842</u>	Sundry Debtors	<u>77,959</u>
225,837	Total Current Assets	294,641
	CURRENT LIABILITIES	
23,036	Subscriptions in Advance	26,732
<u>19,589</u>	Sundry Creditors	<u>50,396</u>
42,625	Total Current Liabilities	77,128
<u>183,212</u>	NET CURRENT ASSETS	<u>217,513</u>
<u>660,650</u>	TOTAL ASSETS	<u>601,100</u>
	Represented by:	
608,086	GENERAL FUNDS	554,989
	DESIGNATED FUNDS	
14,421	Sylvester Bradley Fund	8,526
21,649	Jones-Fenleigh Fund	22,175
<u>16,494</u>	Hodson Fund	<u>15,410</u>
<u>52,564</u>		<u>46,111</u>
<u>660,650</u>		<u>601,100</u>

Agreed and signed 11th March 2009
R.J. Aldridge, President
J.C.W. Cope, Hon. Treasurer
H.A. Armstrong, Hon. Secretary



Notes to the Financial Statements for the year ended 31st December 2008

1. Accounting Policies

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

1.1 Basis of preparation of financial statements

The financial statements have been prepared in accordance with the revised Statement of Recommended Practice applicable from 2005 and include the results of all the charity's operations, all of which are continuing. The incoming resources and resources expended have been analysed under the headings laid down in the new SORP and the comparative figures from 2005 have also been analysed on the new basis.

The effect of events relating to the year ended 31st December 2007 which occurred before the date of approval of the statements by Council have been included to the extent required to show a true and fair state of affairs at 31st December 2007 and the results for the year ended on that date.

1.2 Fund Accounting

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

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

Sylvester-Bradley Fund: Grants made to permit palaeontological research.

Jones Fenleigh Fund: Grants to permit one or more students annually to attend the meeting of the Society of Vertebrate Palaeontology and Comparative Anatomy (SVPCA).

Hodson Fund: Awards made in recognition of the palaeontological achievements of a worker under the age of 35.

1.3 Incoming Resources

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

1.4 Resources Expended

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

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

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

1.5 Investments

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



2. Analysis of Financial Resources Expended

	Staff costs	Other costs	Total 2008	Total 2007
Generating Funds	13,860	7,268	21,128	21,072
Charitable activities	28,107	185,287	213,394	212,548
Governance	<u>3,465</u>	<u>8,493</u>	<u>11,958</u>	<u>10,523</u>
	<u>45,432</u>	<u>201,048</u>	<u>246,480</u>	<u>244,143</u>

3. Staff Costs

	Salary	National Insurance	Pension Contributions	Total 2008	Total 2007
Publications - 1 employee (2007 - 1)	8,888	913	982	10,783	32,048
Administration - 1 employee (2007 - 1)	<u>27,660</u>	<u>2,852</u>	<u>4,137</u>	<u>34,649</u>	<u>32,064</u>
	<u>36,548</u>	<u>3,765</u>	<u>5,119</u>	<u>45,432</u>	<u>64,112</u>

4. Trustees Remuneration and Expenses

Members of Council neither received nor waived any emoluments during the year (2007 – nil)

The total travelling expenses reimbursed to 20 Members of Council was £6,749 (2007 – £5,600)

5. Costs of Independent Examiner

	2008	2007
Examination of the accounts	400	350
Accountancy and payroll services	<u>1,150</u>	<u>1,100</u>
	<u>1,550</u>	<u>1,450</u>

6. Debtors

	2008	2007
Accrued income - receivable within one year	77,959	62,842

7. Creditors - falling due within one year

	2008	2007
Social Services costs	3,679	1,790
Accrued expenditure	<u>46,717</u>	<u>17,799</u>
	<u>50,396</u>	<u>19,589</u>



THE PALAEOLOGICAL ASSOCIATION Registered Charity No 276369
DESIGNATED FUNDS
STATEMENT OF FINANCIAL ACTIVITIES FOR THE YEAR ENDED 31st DECEMBER 2008

	Sylvester Bradley	Jones- Fenleigh	Hodson	TOTAL 2008	TOTAL 2007
Donations	744	674	0	1,418	1,377
Interest Received	<u>567</u>	<u>852</u>	<u>649</u>	<u>2,068</u>	<u>2,341</u>
TOTAL INCOMING RESOURCES	1,311	1,526	649	3,486	3,718
Grants made	<u>7,206</u>	<u>1,000</u>	<u>1,733</u>	<u>9,939</u>	<u>11,381</u>
NET SURPLUS / (DEFICIT)	-5,895	526	-1,084	-6,453	-7,663
FUNDS BROUGHT FORWARD	<u>14,421</u>	<u>21,649</u>	<u>16,494</u>	<u>52,564</u>	<u>60,227</u>
FUNDS CARRIED FORWARD	<u>8,526</u>	<u>22,175</u>	<u>15,410</u>	<u>46,111</u>	<u>52,564</u>



**Independent Examiner's Report
on the Accounts of The Palaeontological Association
for the year ended 31st December 2008**

Respective responsibilities of trustees and examiner

The charity's trustees consider that an audit is not required for this year (under section 43(2) of the Charities Act 1993 (the Act), as amended by s.28 of the Charities Act 2006) and that an independent examination is needed.

It is my responsibility to:

- examine the accounts (under section 43 of the Act as amended)
- follow the procedures laid down in the General Directions given by the Charity Commissioners (under section 43(7) of the Act as amended), and
- to state whether particular matters have come to my attention

Basis of independent examiner's statement

My examination was carried out in accordance with the General Directions given by the Charity Commissioners. An examination includes a review of the accounting records kept by the charity and a comparison of the accounts presented with those records. It also includes consideration of any unusual items or disclosures in the accounts and seeking explanations from the trustees concerning such matters. The procedures undertaken do not provide all the evidence that would be required in an audit and consequently I do not express an audit opinion on the accounts.

Independent examiner's statement

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

- (1) which gives me reasonable cause to believe that in any material respect the trustees have not met the requirements to ensure that:
 - proper accounting records are kept (in accordance with section 41 of the Act) and
 - accounts are prepared which agree with the accounting records and comply with the accounting requirements of the Act
- (2) to which, in my opinion, attention should be drawn in order to enable a proper understanding of the accounts to be reached.

Dated: 13 May 2009

G R Powell F.C.A.
Nether House, Great Bowden,
Market Harborough
Leicestershire LE16 7HF



Nominal	Holding pre 2008)	Cost (bought end 2007)	Value (sold in 2008)
£19,000	6 1/4% Treasury 2010	£17,580.14	£20,092.00
£4,700	Treasury 2.5% I/L Stock 2013	£10,145.15	£11,361.00
£13,000	Treasury 2.5% I/L Stock 2011	£32,947.71	£37,196.00
£32,250	UK 1.25% I/L Stock 22/11/17 GBP		
£25,000	UK 4.75% Stock 07/03/20 GBP 100		
£20,000	UK 4.5% Gilt 07/03/19 GBP 0.01		
£64,176.46	COIF Charities Fixed Interest Fund	£85,000.00	£81,196.06
804	Royal Dutch Shell B shares	£12,432.00	£16,802.00
00	BHP Billiton \$0.5 shares	£4,341.48	£9,276.00
500	BG Group Ordinary 10p shares	£3,977.95	£5,750.00
925	HSBC Holdings Ordinary 0.5 US Dollar shares	£8,138.45	£7,789.00
1750	Lloyds TSB Ordinary 25p shares	£10,169.91	£8,260.00
450	Natl Express Group Ord GBP 0.25		
3,000	Rentokil Initial Ord GBP 0.01		
550	Cadbury Schweppes Ordinary 12.5p shares	£3,971.34	£3,416.00
1,055	Glaxo Smithkline Ordinary 25p shares	£16,608.00	£13,493.00
25	IMI Ord GBP 0.25		
2,499	Bluecrest Allblue Ord Npv GBP shares		
1,100	Wood Group (John) Ordinary 3.33p shares	£2,975.36	£4,763.00
7,000	Ing Global Real Estate Securities Ordinary NVP shares	£7,084.00	£5,810.00
2150	BT Group Ordinary 5p shares	£7,787.53	£5,864.00
1,400	Inmarsat Ordinary 0.0005 shares	£4,958.80	£7,602.00
300	Unilever PLC Ord GBP 0.031111		
950	Biffa Ordinary 10p shares	£2,989.95	£3,135.00
460	Pearson Ordinary 25p shares	£8,069.00	£3,367.00
1350	Prudential Ordinary 5P shares	£7,063.25	£9,612.00
650	RIT Capital Partners Ordinary £1 shares	£4,903.90	£6,721.00
20	Schroder Alt Solut Agriculture C GBP Dis Hdg		
1500	British Empire Sec & Gen Trust Ordinary 10p shares	£5,005.61	£6,525.00
425	Findlay Park Partners US Smaller Companies	£6,158.47	£9,065.00
4450	New Star European Growth Instl Acc Nav	£6,079.59	£9,625.00
3900	Edinburgh Dragon Trust Ordinary £0.20 shares	£4,478.10	£6,367.00
3100	Capita Morant Wright Japan B Inc Nav	£5,170.11	£4,793.00
55	Fauchier Ptnrs Paragon Cap App Instl Stlg		
1283.8	COIF Charities Investment Fund Acc Units	£75,000.00	£102,967.31
5,720	M & G Charifund Units	£4,073.00	£76,591.00
	Total	£357,108.80	£477,438.37
	Total Investment Income		



Proceeds in 2008	Cost (bought during 2008)	Gain realised end 2008	Value during 2008	Gain unrealised in 2008	Income
£20,131.93		£39.93			£1,126.19
£11,499.44		£138.44			£275.43
£37,786.54		£590.54			£—
£35,280.40	£35,239.95	£40.45			£220.45
	£25,202.60		£28,390.00	£3,187.40	£—
	£20,092.99		£22,381.00	£2,288.01	£—
			£84,058.33	£2,862.27	£—
			£13,877.00	-£2,925.00	£666.59
			£7,764.00	-£1,512.00	£219.47
			£4,785.00	-£965.00	£52.20
			£6,124.00	-£1,665.00	£437.14
			£2,205.00	-£6,055.00	£631.75
			£2,226.00	-£1,847.57	£57.24
£1,990.85	£4,073.57				£19.50
£3,053.91	£3,036.00	-£1,045.15			£—
		-£362.09			£—
			£13,551.00	£58.00	£580.25
	£4,053.31		£2,514.00	-£1,539.31	£191.48
	£3,020.28		£2,593.00	-£427.28	£—
			£2,071.00	-£2,692.00	£44.93
			£2,223.00	-£3,587.00	£315.00
			£2,907.00	-£2,957.00	£339.70
£5,913.87		-£1,688.13			£—
	£4,326.21		£4,737.00	£410.79	£—
£3,325.00		£190.00			£21.85
			£2,949.00	-£418.00	£148.58
			£5,603.00	-£4,009.00	£246.92
			£5,746.00	-£975.00	£26.00
	£2,987.22		£2,002.00	-£985.22	£23.25
			£4,973.00	-£1,552.00	£87.75
			£8,540.00	-£525.00	£—
£6,392.66		-£3,232.34			£—
			£4,856.00	-£1,511.00	£62.40
			£5,878.00	£1,085.00	£26.05
	£9,894.52		£8,860.00	-£1,034.52	£—
			£79,879.58	-£23,087.73	£4,620.72
			£51,894.00	-£24,697.00	£3,934.07
£125,374.60	£111,926.65	-£5,328.35	£383,586.91	-£75,075.16	£14,374.91
					£14,374.91



ASSOCIATION MEETINGS



Palaeontological Association Symposium: Innovations in evolution – how life created the Earth as we know it

University of Surrey, Guildford 7 September 2009

How living things adapt to their environment is common knowledge, but you may not realise how life actually created many aspects of the World we know. Join us as we highlight some of the surprising ways in which life unalterably changed the Earth, including the invention of sex, how life created our atmosphere, and how nothing was ever the same again once living things started eating each other.

After opening remarks from Prof Ken Hsu, speakers are:

Dr Simon Poulton: *A short history of Earth's early biosphere: the rise of oxygen and animal life.*

Professor Lynn Margulis: *Sex or Reproduction: forbidden fertilization on the pre-Phanerozoic Earth.*

Dr Nick Butterfield: *How animals changed the world.*

Dr Charles Wellman: *The first plants on the land and how they changed the Earth.*

The PalAss at the British Science Festival

This year's British Science Festival (formerly known as the British Association Festival of Science) promises to be a good one for palaeontology. Not only does the Palaeontological Association symposium on "Innovations in evolution – how life created the Earth as we know it" include some excellent speakers and big names in science (see above), but one of the five prestigious 'Award Lectures' that take place during the Festival is on a palaeontological subject. In addition, Daniele Schreve will deliver the Halstead Lecture, on Pleistocene mammals.

The British Science Association Award Lectures are given by talented communicators with an interesting story to tell about their research. This year's Lyell Award Lecture will be given by Dr Maria McNamara (twice winner of the President's Prize at our Annual meeting). Her talk is entitled: *What rots? How dead animals decompose and its importance for decoding the history of life*, and will be based on her exciting experimental and fossil-based approaches to investigation of the taphonomy of exceptionally preserved organisms.

Details of the Festival programme, and how to book tickets, can be found on the web at <http://www.britishecienceassociation.org/>. The Palaeontological Association has a small number of tickets for the symposium, and a few weekly passes, available to members at no charge. If you would like one, please contact the Executive Officer, Tim Palmer.



53rd Annual Meeting of the Palaeontological Association
Birmingham, England 13 – 16 December 2009

The 53rd Annual Meeting of the Palaeontological Association will be held at the University of Birmingham (<<http://www.birmingham.ac.uk/>>), organised by members of the School of Geography, Earth and Environmental Sciences.

Registration and Call for Abstracts

Registration and abstract submission is now open on the Palaeontological Association website (<<http://www.palass.org/>>). A circular containing more information on the venue and city is also available for download. Abstracts must be received by **Friday 4th September**.

The main conference lecture theatre has a capacity of 380 and the number of registrants will have to be capped at this figure, even within the registration deadlines if necessary, on a 'first come first served' basis.

Accommodation

Please note that accommodation is not included in the online registration form and must be booked separately. Unfortunately we cannot use student accommodation on the main campus so we recommend that delegates stay in the city centre. The University is approximately three miles from the centre but connected to the centre by a very frequent direct train service. Accommodation is also available in Edgbaston (Hagley Road area), although this is less convenient for travel to the University unless you have private transport. Rooms at a variety of prices can be reserved through the this website, set up specifically for the Annual Meeting: <www.visitbirmingham.com/paam>.

We have also placed many accommodation options under the accommodation tab on the Annual Meeting website. These cover a broad range of prices from backpacker-type hostels to high-end hotels. In the run-up to Christmas the city will be busy at the weekends so we suggest you arrange accommodation early. In addition Birmingham is a major conference venue and if there are big events in the city this will place more pressure on accommodation options.

Meeting Format

The meeting will begin with a symposium on Sunday 13th December entitled "Macroecology in Deep-Time", followed by a drinks reception in the Round Room and Industrial Gallery of the Birmingham Museums and Art Gallery in the city centre (<<http://www.bmag.org.uk/birmingham-museum>>). The conference proper will commence on Monday 14th December with a full day of talks and posters and the AGM of the Association. This year the Association Annual Address will be given by Prof. Larry Witmer (Ohio University). In the evening there will be a drinks reception followed by the Annual Dinner in the Great Hall of the University. Tuesday 15th will be a full day of talks and poster sessions. The meeting will conclude on Wednesday 16th December with a field excursion to the Cotswolds to view some of the renowned Jurassic sections.

The time allocated to each talk will be 15 minutes including questions; if there are a large number of high-quality suitable abstract submissions, we may run parallel sessions for some part of the meeting. Oral presentations should be prepared in PowerPoint and posters should be prepared at A0 portrait size (*i.e.* 84 cm wide, 119cm tall).



The President's Prize will be awarded for the best talk at the Annual Meeting by someone under the age of 30 who is a member of the Association. This is a cash prize of £100. The Council Poster Prize will be awarded for the best poster at the Annual Meeting by someone under the age of 30 who is a member of the Association. This too is a cash prize of £100.

Symposium

The start time will be communicated shortly on the Annual Meeting website, but the provisional list of speakers and their general topics at the opening symposium "Macroecology in deep-time" on Sunday 13th December will be as follows:

Prof. Jim Valentine (University of California, Berkeley): *Macroecology and relationship to macroevolution – The Cambrian explosion.*

Dr John Alroy (University of California, Santa Barbara): *Phanerozoic diversity and species richness.*

Prof. Mikael Fortelius (University of Helsinki): *Geographic range dynamics and taxon assemblages.*

Prof. Steve Holland (University of Georgia): *Alpha-beta diversity.*

Dr Gene Hunt (Smithsonian Institution): *Body size evolution and distribution.*

Dr Tom Olszewski (Texas A & M): *Relative abundance and ecological communities.*

Prof. Andy Purvis (Imperial College London): *Macroecology and links with palaeontology.*

Registration and costs

The cost for early registration is £40 (ordinary & retired members) and £30 for students; non-members pay £50. Early registration ends on **Friday 4th September** after which date all registration fees will increase by £15. Final registration is **Friday 20th November**. No refunds will be considered after that date.

The field excursion costs £15. Information on lunch options will be communicated later to those expressing interest in the trip but will probably involve a pub lunch (which is not included in the excursion fee). The cost of the Annual Dinner is £42. Lunches will be available on Monday 14th and Tuesday 15th December at a cost of £10 each day. We encourage participants to take the meal option because there will be limited options on campus for purchasing food.

Travel grants to help student members (doctoral and earlier) to attend the Birmingham meeting in order to present a talk or poster

The Palaeontological Association runs a programme of travel grants to assist student members presenting talks and posters at the Annual Meeting. For the Glasgow meeting, grants of up to £100 (or the Euro equivalent) will be available to student presenters who are travelling from outside the UK. The amount payable will depend on the number of applicants and the distance travelled. Payment of these awards is given as a disbursement at the meeting, not as an advance payment. Students interested in applying for a PalAss travel grant should contact the Executive Officer, Dr Tim Palmer (e-mail <palass@palass.org>) once the organisers have confirmed that their presentation is accepted, and before 4th December 2009. Entitle the e-mail 'Travel Grant Request'. No awards will be made to those who have not followed this procedure.




Summary of dates and deadlines

- 4 September 2009 **Abstract submission & early registration deadline**
- 20 November 2009 **Late registration deadline**
- 13 December 2009 Symposium “Macroecology in deep-time”
Opening Reception – Birmingham Museums and Art Gallery
- 14 December 2009 Technical sessions
AGM & Annual Address
Reception and Annual Dinner, Great Hall
- 15 December 2009 Technical sessions
- 16 December 2009 Field excursion to the Cotswolds

Contact

The main meeting organiser is Dr Guy Harrington, University of Birmingham. The organising team includes Prof. Paul Smith, and Drs Ian Boomer, Jason Hilton, Ivan Sansom, and James Wheeley. We can be contacted by e-mail to <Birmingham2009@palass.org>.

We look forward to seeing you in Birmingham!



INTERNATIONAL
PALAEONTOLOGICAL
CONGRESS



LONDON

2010

June 28 - July 3

WWW.IPC3.ORG

INTERNATIONAL PALAEOONTOLOGICAL CONGRESS IPC3, LONDON, 2010

— venue —

**Imperial College & The Natural History Museum
London, UK**

— hosted by —

**The Palaeontological Association & partner
organizations (Natural History Museum, Palaeontographical
Society, The Micropalaeontological Society)**

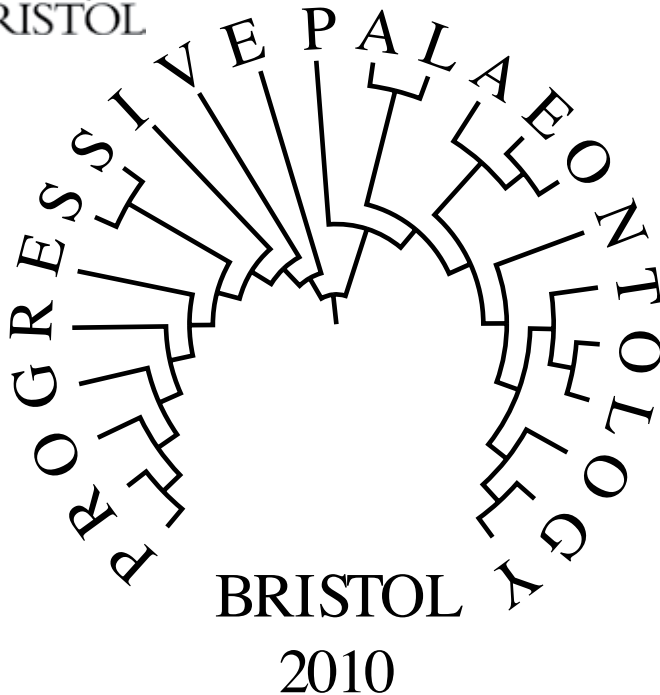
The programme will comprise field trips, plenary lectures, workshops, contributed talks & posters, and thematic symposia including:
Comparing the geological and fossil records, and the implications for biodiversity studies — Macroevolution and the Modern Synthesis — The micropalaeontological record of global change— The Great Ordovician Biodiversification Event — Geomicrobiology at critical periods of Earth history — Palynology and the Palaeozoic Earth system — Biotic recovery after mass extinctions — Microfossil contributions to understanding the tree of life — Modelling the climate of Palaeozoic Earth — Rates of morphological evolution in fossil lineages — Molecular palaeobiology, and many more

**The conference dinner will be held in the Central
Hall of the Natural History Museum**

**Registration fee: to be finalised, but less than £200
for full registration (student rate even less)**

**For a full listing of symposia & workshops, online
abstract submission & registration (from November
2009) and regular updates, please bookmark**

— **WWW.IPC3.ORG** —



PROGRESSIVE PALAEOLOGY
BRISTOL
2010

26th - 28th May 2010

Department of Earth Sciences, University of Bristol

Progressive Palaeontology is an annual conference for postgraduate students who wish to present their results at any stage of their research. Presentations on all aspects of palaeontology are welcome.

The itinerary will include an evening icebreaker reception, a day of oral and poster presentations, the annual dinner and a field trip to a local fossiliferous sequence.

Further information can be found at <<http://www.palass.org/>>

For any individual enquiries please contact <progpal@palass.org>

The Bristol 2010 organising committee are:

Jen Bright, Aude Caromel, Jenny Greenwood and Duncan Murdock



news



Lyell Meeting 2011

It will be the Association's turn to organise the Lyell Meeting for 2011. This is an opportunity for Association members to propose a one- or (exceptionally) two-day programme for the meeting to be held in the Geological Society, London. The meeting is traditionally held in February but other dates may be possible by arrangement with the Geological Society. The Lyell meeting is considered by the Geological Society as one of its flagship meetings, and proposals for the meeting should preferably be interdisciplinary and have a broad palaeontological theme so as to attract a good audience. Both the Geological Society and the Association will contribute substantial funding for the meeting, enabling international speakers to be financed. The Geological Society is keen to publish papers from the meeting.

The subject of the meeting will be considered at the meeting of the Joint Committee for Palaeontology in December. In the meantime, any proposals should be sent to the Secretary of the Joint Committee, Dr Paul Barrett (e-mail <p.barrett@nhm.ac.uk>).

PalAss at the British Science Festival

The Palaeontological Association has a small number of tickets for the Symposium *Innovations in evolution – how life created the Earth as we know it*, to be held at the University of Surrey, Guildford on 7th September, commencing at 13.30 (see page 18). These tickets are available to PalAss members at no charge. If you would like one, please contact the Executive Officer, Tim Palmer (e-mail <palass@palass.org>).

Alexander von Humboldt commemoration

Without a doubt, 2009 is Darwin's year, combining the bicentenary of his birth and the 150th anniversary of the first publication of *On the Origin of Species*. A host of commemorative events have been held around the world, celebrating the contributions that Darwin made during his long scientific career to zoology, botany, geology, biogeography and, of course, evolution.

By coincidence it is also the 150th anniversary of the death of Alexander von Humboldt. Von Humboldt does not have quite the global recognition of Darwin, but he is certainly a favoured son of Germany. On 6th May, memorial events were held across Germany, including one that I was able to attend in the Senatssaal of Humboldt-Universität. The programme was an appropriate mixture of musical performance at the open and close of the ceremony, talks about the contribution Von Humboldt made to culture and science in Europe during the 18th and 19th centuries, and the reading of some of his original letters.

Several parallels are apparent in the younger life of the pair. Natural history and geology figured prominently in their early scientific work, and neither man entered the conventional career path



that had been planned for them. Von Humboldt and Darwin both crossed the Atlantic to work on the continent of South America, although Darwin's voyage on the *Beagle* then took him onwards. Von Humboldt's voyage was pioneering in its own respects. As well as collecting scientific specimens, he calculated the correct geographic coordinates of Havana, then the main Spanish naval base on Cuba, earning him a fine dinner with a Spanish admiral.

Both men were interdisciplinary in their approaches, passionate about all aspects of natural history, and both had a grand question they attempted to answer by collating many different observations on diverse topics. For Darwin it was how species originated, and led to his theory of evolution by Natural Selection. Von Humboldt was driven to understand what controlled the geographic distribution of plants and animals, now the field of biogeography. In pursuit of this goal he made major discoveries in meteorology and physical geography, as well as collecting ethnological observations.

Upon returning from their voyages of discovery, that continue to inspire geologists and biologists to this day, the two men followed rather different lives. The story of Darwin's long residence at Down House as a Victorian Country Gentleman, husband, father, Justice of the Peace (a local magistrate), his work in his study and thinking walks around The Sandwalk are all common elements of Darwiniana. Von Humboldt was also a man of his time and culture, and published on a vast range of topics. The scientific milieu he returned to was that of the German Romantic movement that focused on what we would now think of as a holistic, or systems, approach to science inspired by Schiller and Goethe. His major work, *Kosmos*, was published in five volumes and presented the latest scientific data for an educated lay audience, an achievement Darwin also managed with *On the Origin of Species*. Von Humboldt did not live to see the publication of *On the Origin of Species*, which came out on 24th November, but he certainly influenced Darwin, who regularly mentioned his works. A fitting way to end this article is with a warmly approving quote from Darwin:

"He was the greatest travelling scientist who ever lived."

Al McGowan



Plaque on 22–23 Jäger Strasse, in central Berlin beside the Gendarmenmarkt, indicating that this is where Alexander von Humboldt was born. The building is now part of the Berlin-Brandenburg Academy of Sciences complex.



From our Correspondents

The mineral zoo

It's a distinct memory from quite the better part of half a century back, from those comic-book adventures that reached those parts that the worthy and more improving style of fiction didn't. A memory that plumbed the depths, quite literally. Now what was there? A hero and heroine, certainly, glass spheres around their heads, exploring Atlantis, encountering the Atlantean mer-people (mostly the bad guys, I seem to recall), and undergoing the standard (but oh so absorbing) comic-strip rollercoaster of perilous adventure. Did they have a plucky dog, as was customary, to warn them of lurking mer-villains, barks emerging in bubbles from its own canine diver's helmet? No matter – among all the near scrapes and nick-of-time escapes, one of the plotline McGuffins bit deep, and lodged in the memory after most else faded. Orichalcum.

Now here was a comic-book writer who had done some homework. Orichalcum was certainly part of the Atlantis legend. It was the fabled lost metal, written about by Plato, some 9,000 years (so he said) after Atlantis – if it ever existed – sank in to the ocean. Almost as prized as gold, it supposedly clad the inner walls of Poseidon's temple on Atlantis. What was it? It apparently shone with a 'red light', and so has been variously interpreted as amber, or as a copper-gold alloy (the Romans termed it 'aurichalcum'), or – by more sceptical commentators – as simply something invented by Plato's fertile imagination. And as for Atlanteans being the bad hats... well, according to Plato, Atlantis was the antithesis, the polar opposite, of the 'perfect society' of ancient Athens. This society, as outlined in Plato's *Republic*, though, has itself had its critics: Karl Popper, for instance, thought it essentially totalitarian. Now there's a moral dilemma to ponder on while following the breathless adventures of our heroes (and their dog) amid the drowned temples.

Orichalcum was part of a menagerie of mythical metals and minerals that seem to capture the imagination more effectively than do copper and iron and feldspar, in the same way that rocs and griffons and the mighty kraken, not to forget *Nessiteras rhombopteryx*¹, will always fascinate more than can elephant and giraffe and gnu. There was the philosopher's stone, for instance, that tempted otherwise sane men into alchemy from the time of the Greeks to ... well, almost to the time that Henri Becquerel and his uranium-fogged photographic plate pointed the way towards the real transmutation of the elements.

The philosopher's stone was unusual for the calibre of the seekers after it. Isaac Newton, for example – though the search was not always for the base motive of turning ordinary metal into gold, but because finding it would bring enlightenment, and perhaps also immortality. And there was Mozart too, with his dabbling in Freemasonry (then a society with strong alchemical leanings) – and with his opera of the same name. Well, not quite his, to be honest – or not, directly, much more than five minute's worth. *Der Stein der Weisen* is one of the few things he did in committee, with five local composers who may not have been up among the immortals, but who could for sure turn out a good tune. Long overlooked, then revived with fanfare in 1996 (when

¹ n.b. type specimen still missing.



Mozart's role in it was confirmed), this opera – or perhaps musical entertainment – foreshadows the *Magic Flute*, with Lubano and Lubanara directly ancestral to Papageno and Papagena, and the wonderfully named Nadir as forerunner of Tamino. It's charming and fleet-footedly good-humoured stuff, with Mozart's contribution fitting in nicely, rather than towering above the rest. The Stone itself, by the way, exits early in the libretto, carried off by an eagle, and re-appears, eagle-borne again, at the end (a carrier pigeon might have done the job just as well, but with rocks of such aristocracy, one has to maintain standards, don't y'know).

Orichalcum and the philosopher's stone aside, the Earth is a good place to hunt for new, diverse and exotic mineral species – the best in the Solar System, indeed. For the living planet is also the increasingly mineral-rich planet – and the two phenomena go hand in hand. This is the thesis advanced recently by the mineralogist Robert Hazen and his colleagues. Thus, the inorganic world has followed (rather than led) the ever more complex, evolving biosphere, and an ever-greater range and diversity of mineral species has been generated throughout Earth history. Moreover, Hazen and company quite explicitly discuss aspects of Darwin's dangerous idea in this context. Even given the universality of Darwinian evolution to whatever and wherever life might have arisen in the cosmos, might it really apply, in any sense, to quartz and feldspar, to sapphire and emerald?

Let's set out their case. They start at the beginning of any kind of mineral existence, in the dust of interstellar clouds, where elements, originally forged in supernova explosions, have condensed into the earliest minerals. Rare relict grains of such stardust have been found, after painstaking searches, in meteorites (and are identified by isotope patterns that are quite outrageously not of the Earth, or for that matter of anywhere in the Solar System). As regards diversity, they're a pretty dull lot – just enough to populate a very, very small collector's cabinet: about a dozen mineral species all told. Mind, there is diamond in there, and a few other familiar forms: graphite, magnesian olivine, rutile and corundum, plus some less familiar, such as moissanite, a silicon carbide, and hibonite, a calcium aluminium oxide.

Take these as a starting point, and cook them up in nebula of a sun that is just beginning to fire up. More minerals appear in those flash-melted droplets known as chondrules. They include augite and magnetite and calcium feldspar, which any undergraduate student should recognise, and quite a few that would surely stump them: the iron/nickel phases kamacite, taenite, troilite, for instance. At this point, there are about 60 recognisable minerals.

Then clump these into meteorites and then planetesimals, and mix in the effects of the water/ice that is also whirling around the newborn Sun. It is the beginning of what one might call weathering, or more precisely aqueous alteration. Hydroxides are formed, and sulphates, and carbonates, and chlorite and talc and other phyllosilicates (this is the start of the long story of Mud). As the planetesimals collide, and grow bigger, new phases appear. Some are related to impact shock, and some to differentiation as the planetesimals begin to melt, and separate out into 'core' and 'mantle/crust', each with their own minerals. There are now some 250 minerals all told.

The biggest planetesimals grow into planets, albeit still with violent histories of bombardment and collision. Such history has wiped out direct memories-in-rock, at least on Earth, where the first half-billion years of the Hadean is to all intents and purposes *tempora incognita*.



Nevertheless, one can surmise the mineralogical fallout as plate tectonics started, as continents were seeded and grew, as magma bodies slowly crystallized and separated out. If the planetary body is essentially devoid of water (like our Moon), the number of minerals can rise to perhaps some 350.

Add water, though (not least to allow, by hydrous lubrication, the kick-starting of the plate tectonics engine, and hence the seeding and growth of terrestrial continents), and yet more minerals can be conjured out of a promising new planet. There are those associated with granite bodies, say, when those last water-enriched dregs of magma create networks of pegmatite veins. In this particular type of mineralogical Aladdin's Cave, about 550 minerals alone have been recognised, some found nowhere else, as complex compounds of lithium and boron and caesium and tantalum crystallized out. These magma bodies then, as heat engines, drive water along fractures through the crust, leaving trails of further minerals, of ores of copper and zinc and lead, of molybdenum and uranium.

So far, so good. Here we have an increasingly complex physico-chemical system. It is evolution in one of the several senses of the word (that is, change through time), but nothing, really, to further philosophize about, *especially* in the pages of a pamphlet dedicated to those of the fossilish persuasion. But then life turned up, and the world changed, and so did its minerals.

Life, of course, had been primed by those minerals, and by some of them in particular. It is much easier to string amino-acids together, for instance, when clay minerals are around as a handy scaffolding. But once a fully functioning microbe had appeared, and multiplied, it, or rather a countless *they*, then began to take the world around it, and to transform it.

Not immediately, according to Hazen & co., and at least not by so very much (speaking purely in terms of new mineral production), in the first billion years or so of their existence. The early microbes lived in an anoxic world, and their products were not for the most part novelties *per se*, being cherts and various iron minerals, and – once their own remains had been metamorphosed – graphite (which had drifted in interstellar dust for billions of years before the Earth was formed at all). Increases in mineral complexity likely did come about, though, if often by roundabout means – the carbonate minerals associated with stromatolites, say, being altered by an intruding magma to produce dozens of new skarn minerals.

But it was the neat trick that some of the microbes eventually invented, the production *en masse* (and eventual taming) of that chemical dynamite, free oxygen, via photosynthesis that, Hazen *et al.* argue, drove perhaps the greatest revolution in new mineral production on Earth.

About two and a half billion years ago, the world split into two. There was the world without free oxygen, which was (and remains) most of it, of course – pretty well all of its interior – and (in those times) most of the ocean depths. And then there appeared the oxygenated – and hence highly oxidising – world of the land surface and of the shallow seas. In this chemically schizoid world, the numbers of new minerals climbed dramatically. In the seas and the marine strata that formed in them, in Banded Iron Formations and in carbonates and mudstones, there appeared pyrolusite and rhodochrosite, minnesotaite and ferri-annite, turquoise and malachite, and dozens – indeed many hundreds – more. In that transition, the numbers of mineral types probably roughly doubled, from the 1,500 or so likely present some 2.5 billion years ago in what



were hydrous, but essentially anoxic times. Today, for comparison, some 4,300 minerals are recognised, of which some half are oxidised and hydrated mineral species that mostly have their roots in the phenomenon of photosynthesis. Most minerals, hence, can be said to be a product of biology: not directly as in being a component of a shell or bone, but indirectly, in reflecting and reacting to a world transformed by the action of living organisms.

Nothing much happened, after that, for a further billion years. The Proterozoic was pretty dull mineralogically, with not much in the way of innovation: much as it was (and perhaps *because* it was) a time when life also found it tough to develop and diversify. That in turn may have been because those oceans, still largely anoxic at depth, scavenged and buried (into sulphides) many of the elements essential for life, such as iron and phosphorus and molybdenum, as Anbar and Knoll proposed in 2002.

The next step came with those impossibly Hollywoodesque events, of Snowball Earth and the Cambrian explosion (still too far-fetched, both, for any sensible scriptwriter to entertain). By whatever cascade of environmental feedbacks these were triggered (and one might fill a good-sized library with models and scenarios and hypotheses on these topics) they brought in the time when animals and plants, having learnt the difficult trick of being multicellular, made minerals on a planetary scale.

Biomineralization, then, became commonplace, and brought in some further novelties, albeit not on the scale of the Great Photosynthesis Event. There's quite an emporium of mineral stuff secreted in living tissues, some a little surprising, such as the copper mineral atacamite in the jaws of one species of bloodworm. And each one of us human animals – to take one familiar and domestic example anatomized, as it were, by Yoder (2002) – secretes no fewer than 26 minerals, including (as well as the hydroxyapatite and whitlockite of bones and teeth) calcite and aragonite, quartz and gypsum, anatase and magnetite and periclase and (if the company is not excessively polite) urea. The biomineralization brought with it, of course, not just new minerals, but – even, say, in a humble whelk shell – wonderfully new and intricate ways of growing crystals and interleaving them with organic matter, micro-engineering that is the envy – and perplexity – of human materials scientists (Rubner, 2003).

It's quite a story, this, of the ever-increasing mineral diversity of a planet that has incubated life. There are sundry practical considerations as a consequence. Don't, for instance, put the family savings and your shirt on shares in Interplanetary Prospecting Enterprises Inc. You'd lose it all, shirt included, because the place where minerals have been segregated and concentrated and emplaced, time and time again, is not in some outpost of the asteroid belt: it is here, at home, under our feet.

And here, at home, there are implications as regards the co-evolution of the living and non-living, which Hazen *et al.* discuss. Living organisms, as they note, at one level, provide environments, both surrounding them and within their tissues, that are geochemically distinctive and different from the wider surroundings. Thus, they amplify and accentuate a wider (and effectively unidirectional and irreversible) trend that they recognise in the mineral kingdom through time, one of ever-increasing complexity and diversity.

This doesn't mean that the mineral species (unlike the living ones) are subject to change through natural selection. They don't show heritable mutations as such, for example, or behave



competitively. But their evolution (in the sense of change through time) has, on Earth, been driven in large measure by the evolution (through natural selection) of living organisms. And Hazen and colleagues even suggest that, in this, they show a kind of large-scale punctuated equilibrium – for instance the jump in mineral diversity after the Great Oxygenation Event.

Though, unlike living species, mineral species do not, for the most part, become extinct (in the sense of ceasing to form), even though one might imagine that the Earth has changed so much that some mineral-forming environments might have disappeared. To this, the response was that, although one can think of cosmic environments no longer replicated on Earth (those that formed some highly chemically-reduced meteorite minerals, say), any major type of Earthly surface environment still tends to have persisted as a mineral-forming domain somewhere. Thus, despite the spread of oxygen, anoxic environments still remain, in abundance (just below our feet, for example). The Earth (as well as its minerals) has simply become – and then stayed – more *various*.

Venus, though, is quoted as being different. That planet is now searingly hot and very, very dry, while early in its history it might well have been simply warm and humid and (perhaps!) beginning to incubate life. In that runaway greenhouse transition, it lost its water, and any life that may have emerged, and a host of minerals also disappeared: those that had been hydrated. They would have reverted to anhydrous forms, so a wave of mineral extinctions would have taken place on that unfortunate planet.

Not all planets undergo such fates, and hence there are further implications, for instance for those patient and optimistic scientists who search for other life beyond our own solar system. Far-off planets, if they have life, will also have a mineral spectral signature that is not so much characteristic of such-and-such a mineral (for who knows what a paratrilobite from around Alpha Centauri might make its paracarapace of), as distinctive through the exobiologically enhanced variety of its minerals, whatever those minerals might be.

By this token, Isaac Asimov's splendid concept of the silicony is, alas, impossible. Appearing in one of his *Asimov's Mysteries* short stories, siliconies were small life-forms that were not carbon- but silicon-based (silicon being quadrivalent, like carbon, and the only other element able to form truly long-chain compounds). The siliconies lived on asteroids, absorbed energy from uranium ores, were intelligent (as 'talking stones') and could technically be described as cute. It's a lovely idea, but asteroids with their modest total of some 250 minerals are just not places to grow complex life-forms – nor ones to generate concentrated uranium ores.

Exceptions might be found under some highly specific conditions, of course. Aficionados of the Superman saga will know that Krypton, the home planet of the super-powered protagonist, was reduced, on its destruction, to fragments of kryptonite. This suggests that it might have been, uniquely, a life-sustaining but still low-mineral-diversity planet. It was perhaps not *entirely* monomineralic, as real devotees will know, for in addition to the standard green variety, there has been red kryptonite (the ur-variety), gold kryptonite, blue kryptonite, x-kryptonite and anti-kryptonite, and yet others besides.

It's all sheer tripe, of course, among the purest and most gloriously unadulterated nonsense (accept no imitations!) to have been created to feed the adolescent mind. Not, though, that that



has stopped speculation on its mineral affinities in some quite unexpected quarters. One new mineral discovered by a Natural History Museum mineralogist was hailed as 'the real kryptonite' because its composition – sodium lithium boron silicate hydroxide, no less – was spookily close to the composition of kryptonite as outlined in the film *Superman Returns* (though the new mineral was in reality, alas, snow-white and as benign as you please). An alternative interpretation that was, by contrast, satisfyingly green, luminous *and* dangerous was concocted by University of Leicester chemists for the 60th birthday of the Superman fable: radioactive krypton difluoride, a nasty enough oxidant to sap anyone's powers, let alone Superman's. Is it the real M'Coy? Perhaps not. Yet other authorities have suggested kryptonite to be a mixture of plutonium, tantalum, xenon, promethium, dialium², mercury and 'unknown'. Tsk! – it's as confusing a taxonomic mess as orichalcum.

And yet, reluctantly casting all hokum aside, the ever-diversifying catalogue of Earthly minerals, as bound up with the evolution and diversification of organic life, gives considerable pause for thought. Not least, because now a further stage seems to be upon us, a new punctuation event in terrestrial mineral evolution. It's something that Hazen & colleagues refer to only in passing, in noting the artificial production of completely new types of garnet (one with yttrium and aluminium, manufactured as a faux-diamond).

This represents just one of many possible examples of what must, surely, be the greatest mineral diversification event since oxygen flooded the Earth's surface two and a half billion years ago. How many synthetic minerals – those not found in any natural surroundings on Earth – have humans produced? There seem to be dozens of new garnet types alone (for gems, and for lasers too). There is synroc and other synthetic zeolites, made to try to hold radioactive waste. There is borazon, a compound of carbon, boron and nitrogen that is famously harder than diamond. And somewhere in the flash-heated concoctions that form bricks and tiles, there are surely novel minerals too. Then, there are hundreds – or thousands? – of mineral chemists in hundreds of laboratories worldwide, putting together countless combinations of elements in different conditions of temperature and pressure and ambient chemical environment, to see what emerges, for all manner of uses, actual and potential. In this they are simply creating novel chemical micro-environments, much as that copper-secreting bloodworm does within its tissues – but doing so extra-corporeally (and with creative intent). I'm not aware of any catalogue of the entirely novel additions to Earthly mineralogy that have arisen in this way (the electronic web has proved highly opaque in this respect), but the total must run into thousands, if not many thousands – and likely is being added to daily.

One might plead that minerals so produced are not natural. Well, *we* are natural, a product of natural selection within a primate lineage. So our products must also be natural, in the same way that a nest relates to a bird, or a web to a spider, rather than being 'artificial'³. There again, one might protest that some of the new minerals are present in tiny amounts. Well, some of the natural (that is, non-humanly produced) minerals are utter rarities, while some of the human-manufactured ones – like borazon, say, as an abrasive – are now produced by the ton.

² n.b. *Dialium* is a genus of legume in the Fabaceae family.

³ One might argue that the very word 'artificial' is in itself ... artificial.



Tons only? Well, in total, humans have now exceeded that by some way. In fact we have now collectively more or less doubled the amount of metals being cycled at the Earth's surface (Rauch & Paczyna 2009), with some popular species – copper, for instance – substantially exceeding that. A lot of this is naturally⁴ in novel mineral combinations that in turn have their own specific effect on the biosphere. Take those fine mineral dusts falling from the atmosphere, that fertilize the surface waters of the open oceans, particularly with iron. There is, though, iron and iron. Desert dust has lots of iron, but almost all as highly insoluble iron oxides and hydroxides – and hence of not much use to the poor iron-starved plankton. Glacially-ground rock flour has about ten times as much of its iron in available form as a nutrient – but that's still only a couple of percent. Industrial fly ash, now, has a staggering 70% of its iron in easily available form, mainly as sulphates (Schroth *et al.* 2009). Those serious people in certain multinational board rooms would, I'm sure, be intrigued as to just how influential they are amongst the marine plankton that now form a large part of their clientele.

Natural phenomenon or not, human creativity with the inorganic world likely represents a purely temporary – indeed, fleeting – upsurge of mineral diversity, rather than the kind of effectively irreversible thresholds of the geological past highlighted by Hazen and his colleagues. For these synthetic minerals will only be made as long as humans make them. This not only means that if (or rather *when*, as some of my colleagues would insist) our own species becomes extinct, the new minerals will become extinct with us. Only a few fossil minerals might be left behind us in a thin Human Stratum, as distinctive and exotic as the shocked quartz and buckminsterfullerenes left by meteorite impacts. Even within our sojourn, as technology advances at its dizzying and now quite unEarthly speed, we make and then discard different minerals, from generation to generation. It's just another example of just how singular our own species is, and how distinctive an effect we are having on the world.

Alternative futures might be imagined, though. The imminent demise of the human species is not, quite, a foregone conclusion, although there may be future ambiguity in the meaning of the word 'human'. Give it – give *us* – a few more generations, of sufficient stability to allow Moore's Law to unfold, of that doubling in computer power every two years (holding steady, still, after four decades, with no sign of slowing). Who knows, then, in what form silicon intelligence might then fuse with human flesh – or which of these elements will gain the upper hand? From there, mineral evolution just may become mineral revolution, as sentient mineral comes to beget further mineral (selectively, naturally): the stone, then, may truly become the philosopher.

Now there's a dystopia (a concept that is something else, apparently, to thank Plato's *Republic* for) to wax dismal about. Heigh-ho. Perhaps the evolving polymineraleic future will have its compensations, though. Our great-great-great-great-grandchildren – or perhaps *grandbeings* – can relax in their condominiums lined with the latest shades of orichalcum (re-invention becoming all the rage), and contentedly muse upon the dreadful untidiness of the primitive, carbon-based past. So long as they remember, just before powering down, to let the silicony out for the night.

Jan Zalasiewicz

⁴ Or unnaturally, if you wish.



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PalaeoMath 101

Shape Theory

Now that we've come to grips with *Procrustes* superposition we're in a position to understand what shapes really are and how they are distributed in a geometric space. From there, the problems associated with analyzing shapes with traditional, distance-based variables will be obvious, as will the manner in which shapes should be analyzed. This material all falls under the general heading of 'shape theory' which is part of the mathematical field of topology. Even mathematicians find topology an arcane, complex and difficult subject. So, you'll be relieved to learn we're not going to discuss it in detail. But I will need to introduce you to some basic topological concepts in the context of the discussion.

Let's begin the discussion with a simple example of the standard approach to the description of shape. Consider the set of triangles shown in Figure 1.

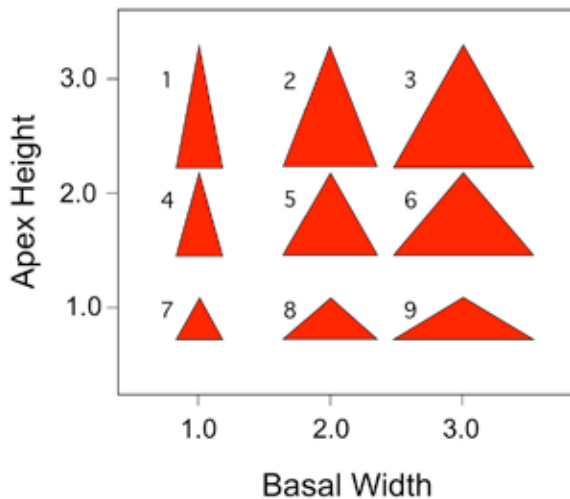


Figure 1. Nine triangles with positions plotted in a distance-based morphometric space.

The standard distance-based variables used to describe triangles are basal width and apex height.¹ Note these distances make a clear distinction between the apex landmark and basal landmarks, with the latter able to be further subdivided into right and left locations. Accordingly, these variables could be calculated for any set of three landmarks used to portray the relative positions of structures on a fossil body. Indeed, this triangle measurement system assumes that each landmark can be defined uniquely within its set.

Once the landmarks have been located it is a trivial task to place each shape in its correct position relative to others in the space formed by these two variable axes. This is precisely the sort of shape space we used in our discussions of regression and multivariate data analysis. But is a space so defined fully adequate to express similarities and differences among these objects?

The first hint that this might not be the case comes through inspection of the diagonal of triangle shapes from lower left to upper right. These are all equilateral triangles (= all sides of equal length) and so have the same shape. The difference between the triangles located along this diagonal is one of size, not shape. Now consider the other diagonal of shapes, from upper left to lower right. All three triangles along this diagonal differ in shape. But whereas the upper left and lower right forms are identical in size, both are smaller than the middle triangle. Thus, size and shape are complexly confounded within this distance-based form space. The final complication, however, comes with the realization that this space is unable to describe triangles uniquely.

For the example shown in Figure 1 I chose to draw isosceles triangles in the space. I could have chosen any type of triangle. Figure 2 shows the same plot for right-angled triangles that verge either to the left or to the right. Of course, right-angled triangles still have a basal width and an apex height. We can use the same variables to describe them. But note that when we do, both sets of right-angled triangles plot in *exactly the same positions* as the set of isosceles triangles in Figure 1.

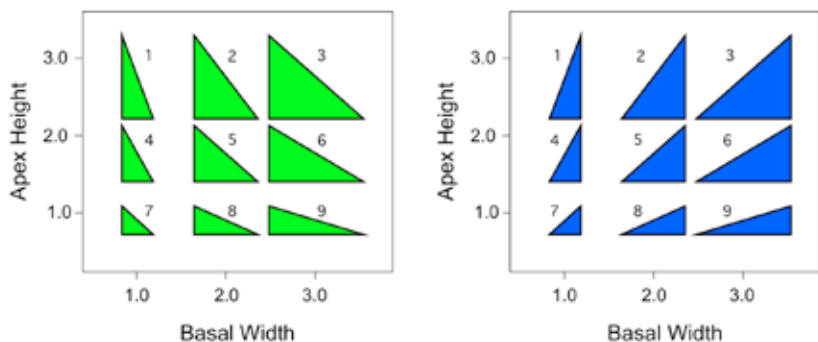


Figure 2. Plot of right-angled triangles with basal width and apex height dimensions equal to those of the isosceles triangles shown in Fig. 1. Note that these triangles, which are clearly different from each other and from the previous set of isosceles triangles, plot in exactly the same positions within the ordination space formed by these two distance variables.

¹ McGhee (1999) has described this space as a theoretical morphospace of hypothetical triangular forms.



This simple experiment suggests the geometric space formed by these two distance variables is anything but simple and straightforward to interpret for morphological data. Size and shape are confounded in complex ways, and individual positions within the space represent large (effectively infinite) families of possible shapes (in this case triangles), each of which differs from the others in shape, size, or both. Such variables may be able to be used to test simple hypotheses involving shapes whose range of variation is limited (e.g., our example trilobite data). Even in these cases though, the inherent geometric ambiguity of the space formed by such variables should always be kept in mind.

If all this complexity applies to the analysis of two distance variables, imagine the problems associated with both assessing and keeping track of the additional complexities that result from the description of shapes using more than two distance variables! As we have already seen, patterns of variation in such data can be assessed using powerful techniques such as PCA and PCoord. But use of these methods does not improve the power of distance variables themselves to describe shapes adequately. If anything, the correct geometric interpretation of multivariate ordination spaces based on inherently ambiguous distance variables is even more complex than this simple two-variable example for any but the most well-behaved datasets.

What to do? Triangles are simple, two-dimensional figures. There must be a geometric space in which the shape of any triangle can be located uniquely. What we need to do is find this space, develop some insight into what this space looks like, and develop tools that will allow us to use this space to make accurate comparisons between shapes. Let's try to use the *Procrustes* tool we developed last time on these triangle data to get our heads around what's going on.

Recall that, under the *Procrustes* approach, shape is that aspect of geometry left over after the factors of form attributable to (1) position, (2) scaling, and (3) rotation have all been removed from data consisting of the coordinate locations of comparable landmarks. If we take the set of x,y coordinates for the 27 triangles shown in figures 1 and 2 and calculate their *Procrustes* superposition on the sample mean shape, the resultant plot of superposed coordinate values looks like Figure 3.

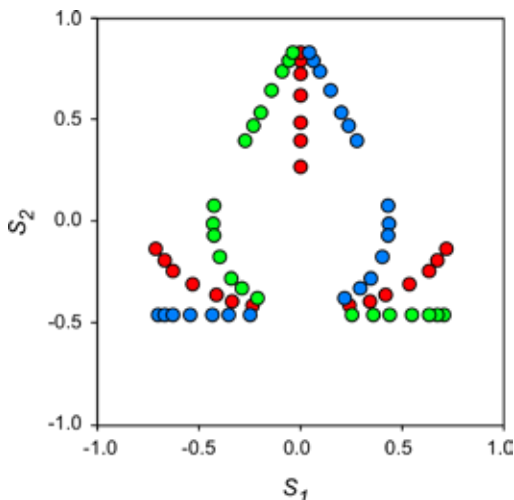


Figure 3. Procrustes superposed shape coordinates for the triangle datasets shown in figs 1 and 2. Colour codes as in those figures.

The symmetry of this shape-coordinate plot may come as a surprise. Remember, generalized *Procrustes* superposition tries to minimise the deviation between a target and a reference form (= the mean shape) at all corresponding landmark locations across the entire form. Sometimes this results in odd-looking rotations of the datasets. But *Procrustes* superposition has the distinct advantage of minimising shape differences globally.

Table 1. Eigenvalue results of triangle shape analysis.

Component	Eigenvalue	Shape Variance (%)	Cum. Shape Variance (%)
1	0.058	49.88	49.88
2	0.057	48.64	98.52
3	0.002	1.48	100.00

Once these data have been matched for shape variation we can obtain a sense of their linear ordination by performing a standard PCA analysis of the superposed coordinate values. Table 1 provides information about the amount of shape variation that exists in this superposed shape-coordinate dataset. Despite the fact that six variables were used in the analysis, there are only three non-zero eigenvalues. This happens because the *Procrustes* standardization for position, size and rotation removes three components of shape variation from a dataset of landmark points described by two Euclidean dimensions. With respect to the remaining axes, PC-1 and PC-2 subsume subequal amounts of shape variation with a small remainder being represented on PC-3. Here it is important to emphasize that the three-dimensional representation of the triangle shape space is not a mere by-product of this dataset. Three non-zero eigenvectors would be returned no matter how many triangles were included in the dataset or what their shapes were, so long as they are represented by two-dimensional (x,y) coordinate data matched using the *Procrustes* method.

Since we have defined shape as that subset of the observed variation left over after standardization for position, size and rotation, this means that the characteristic shape space for any form represented by three landmarks is three-dimensional. By using appropriate software we can graphically represent the complete mathematical shape space of triangles. Of course, our small dataset of 27 isosceles and right-triangles is but a small subset of all possible triangles. Nevertheless, inspection of this small region of the overall triangle shape space (Fig. 4) yields important insights.

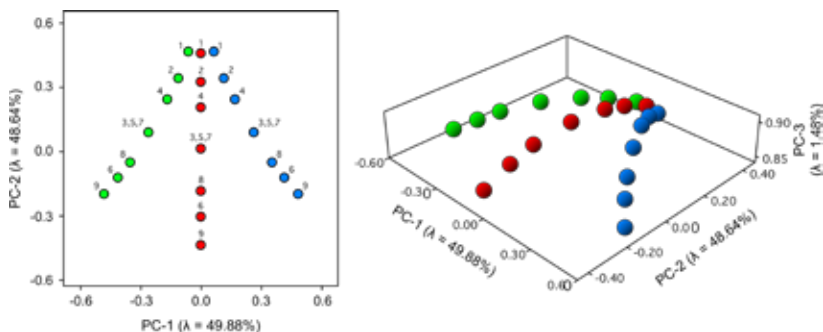


Figure 4. Portion of the overall triangle shape space subsumed by the triangles shown in figs 1 and 2. The plane through the first two principal components of shape variation (left). Perspective diagram of variation along all three shape variation axes (right). Colour codes and shape numbers as in previous figures. See text for discussion.



There's much to discuss with relation to this graph. First, notice that, unlike the distance-based PC space shown in figures 1 and 2, the *Procrustes* shape space has a unique coordinate location for all three sets of triangles. This means the *Procrustes*-referenced representation of shape relations is complete. In fact, it's more complete than it probably appears at first glance. Count the number of points in each colour-coded triangle set. That's odd! There are only seven points in each set. Yet, in figures 1 and 2 there are nine triangles. What happened to the extra two per set?

Recall that in each set the upward-trending diagonal (lower left – upper right) contained forms that differed in size, but not in shape. These forms plotted in different places in the distance-based space because that (traditional) space confounds size and shape relations. Not so the *Procrustes* space. The fourth point in each series is a coordinate location where three shapes plot. This represents an internal check on the fidelity of the *Procrustes* shape space. In the distance-based PCA space, shapes that were identical plotted in different locations. In the *Procrustes* PCA space, these same shapes plot at the same location.

But does the overall picture of shape similarity relations shown in Figure 4 make sense? The triangles in figures 1 and 2 can be subdivided by the upward-trending diagonal of identical shapes into two groups. Triangles that plot below the diagonal are wide and low. Those plotting above the diagonal are tall and narrow. Within these subsets the shapes occupying the upper left and lower right corners are more extreme than the two closer to the diagonal. Therefore, we should expect these extreme shapes to represent the ends of each sequence in Figure 4, the identical shapes along the diagonal to represent the middle of each sequence, and the intermediate tall-narrow and short-wide shapes to be located in between, on either side of the group-specific mean shapes. This is precisely the ordering of shapes seen in Figure 4.

In terms of inter-group relations, the tall, narrow end-member shapes in each sequence are grouped close together at the top of the diagram because it is possible to bring their landmark locations into close alignment. This correspondence is impossible to achieve with the shorter, broader forms. Therefore, not only is the *Procrustes*-based shape space portraying shape similarities accurately, it's also portraying shape differences in a manner that agrees with what would be a taxonomist's geometric intuition.

The advantages of using the *Procrustes* alignment as a basis for shape comparison should be clear by now. But there's more. Perhaps the most intriguing aspect of the *Procrustes* shape space is the curvature in the shape sequences that's plainly visible when all three PCA axes are plotted together (Fig. 4, right). It's almost as though the shapes are lying on the surface of some invisible, underlying structure. As it turns out, that's exactly the case.

We can better assess the shape of this invisible structure by increasing the sample size and diversity of triangular shapes and repeating the analysis. Figure 5 shows a selection of a dataset of 500 random triangles that were subjected to *Procrustes* alignment and PCA analysis. Figure 6 details the distribution of these 500 triangles in the space formed by the three PCA axes.

Because *Procrustes* shape data are expressed as deviations from a mean shape, the *Procrustes* PCA space is centred on the mean shape. Also, because the dataset is composed of random triangle shapes, the distribution of shapes is roughly circular about the mean shape. However, as you can see from the three-dimensional plot in Figure 6, all the triangle shapes are distributed on

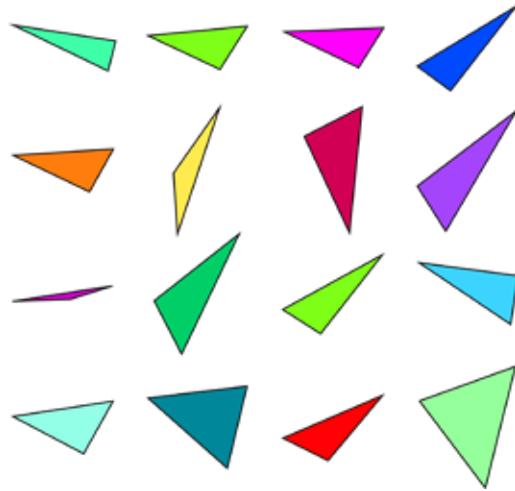


Figure 5. A selection of random triangles used in the exploration of the triangle shape space.

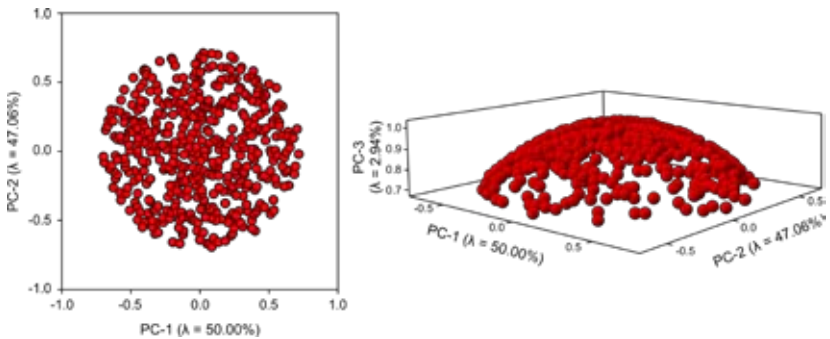


Figure 6. Procrustes PCA ordination of 500 random triangles. See text for discussion.

the surface of what appears to be a hemispherical form. Regardless of the final geometry of this surface, it would appear *Procrustes* shape distributions exist in a curved mathematical space.

As it turns out, the full form space for triangles is a perfect sphere. Figure 7 is the canonical representation of this space which, for reasons that will become clear momentarily, morphometricians call the **pre-shape space**.

Figure 7 is a two-dimensional map of the three-dimensional triangle pre-shape sphere. Like all spheres, the orientation of the grid system is arbitrary. In this diagram, an equilateral triangle, apex up, has been chosen as one pole and the same triangle, apex down, as the other pole. The green circle is the sphere's equator and the lower hemisphere has been folded up to form a ring around the upper hemisphere. Triangles whose apices are located above the baseline are located in the upper hemisphere, those whose apices are located below the baseline in the lower

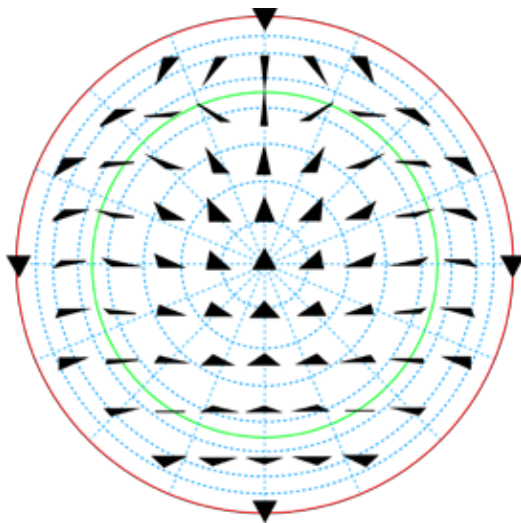


Figure 7. The pre-shape space of triangular forms.
Redrawn from Rohlf (<<http://life.bio.sunysb.edu/morph>>).

hemisphere. In this orientation the equator represents the set of colinear triangles in which all three vertices lie on the same line.

There are several important things to note about the pre-shape sphere. First, all possible triangles can be mapped to a unique coordinate location on the surface of the sphere. Another way of saying this is that each coordinate location on the pre-shape sphere represents a unique configuration of the three landmarks that make up a triangle. Thus, this sphere's surface represents a complete representation of the geometry of triangular shape.

What about size? In this representation size is denoted by the radius of the pre-shape sphere. Physically large triangles plot on the surfaces of spheres with large radii, small triangles on spheres with small radii. Recall that, by convention, *Procrustes* alignment rigidly expands or shrinks all shapes until they have unit centroid size. This operation projects the original shapes—that exist on pre-shape spheres of varying sizes—to their corresponding positions on the unit-sized sphere, thus facilitating direct shape comparison.

What about rotation? Recall that our definition of shape specifically excludes configurations of points that are identical to each other, except for the fact that one has been rotated rigidly relative to the other about their mutual centroid. The pre-shape space is considered 'pre-shape' because it places some forms that differ only by rotation at different coordinate locations on the sphere's surface. This can be appreciated most easily by noting that the equilateral triangles occupying the two polar positions in Figure 7 are identical except for a 180° rotational difference. In fact, the symmetry between the lower and upper hemispheres of the pre-shape sphere arises because of 180° rotational differences (= reflection). However, by correcting for such rotational differences between shapes, the lower hemisphere of the pre-shape space can be mapped onto or merged with the upper hemisphere (or *vice versa*), thereby achieving a fully realized shape



space in which the effects of position, scale and reflection-rotation have all been removed. Geometrically this transforms the pre-shape sphere into a shape hemisphere. It is this shape hemisphere (also termed the shape half-space) that is being depicted in Figure 6.

Actual shapes that can be characterized by any set of three landmarks represent a realized subset of all possible shapes that map to a particular region on the triangle shape half-space. This region may be large or small depending on the amount of shape variation present in the sample. Shapes may be distributed uniformly through the region or arranged in density clusters, again depending on the character of shape variation present in the sample. All the intuitive conceptual conventions we've grown accustomed to when thinking about shapes and shape analysis, along with the concepts we use to describe shape variation (e.g., shapes that are similar are 'close to' one another, those that are different are 'distant from' one another) still apply. But now we understand why in a precise mathematical sense. As a result, this knowledge of what size and shape really are can be used to inform our choice of data-analysis methods and our interpretations of the results of various mathematical operations.

Best of all, these conventions don't just apply to shapes represented by three landmarks. It's convenient to work with the triangle shape space because all triangular shapes can be represented in three uncorrelated dimensions we can easily 'see' in our mind's eye and represent on a flat piece of paper or on a computer screen using various graphic conventions. But all shapes that can be described by sets of landmarks have their own shape spaces that behave in precisely the same way.

Morphometricians and topologists call the mathematical surfaces on which shapes reside **manifolds**, which are mathematical spaces that—on a small enough scale—resemble a Euclidean space of a certain dimension. The triangle pre-shape space and the shape hemisphere are both examples of two-dimensional manifolds. The problem with the more complicated manifolds on which shapes defined by more than three landmarks reside is that most of us find it difficult to think in more than three dimensions, and our graphic tools for depicting higher dimensional spaces are very primitive. Nevertheless, we can use the triangle shape manifold to gain insight into the practicalities and complications of truly geometric shape analysis.

At this point I need to make a point about why shape data are different from other sets of data so as not to give you the impression that you can use *Procrustes* PCA to analyse anything and everything. Recall that PCA (and PCoord, and FA, and MDS) is a generalized data-analysis procedure. It (and they) can be used to analyse data of any sort. The reason why standard distance-based data are not ideally suited for shape analysis is that, in addition to relations among variables (e.g., covariance, correlation), shape data have an inherent geometry that needs to be respected at the design and computational levels of the analysis. Distance data are simply magnitudes. By themselves they preserve no aspect of the fundamental geometry of the shape. This places constraints on the analysis and interpretation of shape data that simply doesn't exist for other variable types.

In a sense, standardizing generalized data corrects for the same sorts of factors as the *Procrustes* standardization for position and size. In some cases it makes sense to standardize such data. In others it doesn't make sense to do so. It almost always makes sense to undertake such standardizations for shape data. But there is no routinely invoked equivalent for rotation to a



common reference in non-shape data. The bottom line is, the inherent geometry of shape data means they are different in ways that are not handled well by distance-based variables, but that can be handled by the same sorts of data-analysis procedures we have used throughout our discussion of linear regression and multivariate analysis provided these shapes are represented by landmarks whose positions relative to one another have been rigidly matched using generalized *Procrustes* superposition (or an equivalent matching technique).

Let's end this first exploration of shape theory by discussing a few of the complications that follow from shapes existing mathematically on a curved manifold. If the shape space is curved this means that, strictly speaking, it is inappropriate to use tools of linear algebra (e.g., covariances, eigenanalysis) to explore and summarize relations among shapes. The basic problem is illustrated in Figure 8.

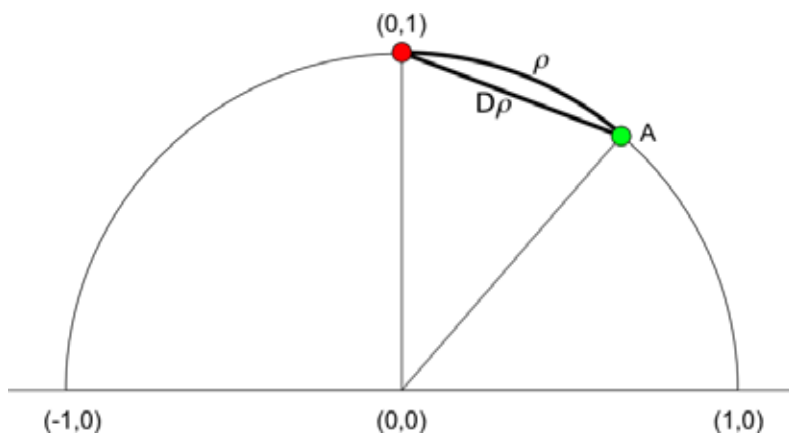


Figure 8. Cross-section through the triangle shape space with the positions of two shapes indicated. See text for discussion.

Since hypotheses about shapes typically turn on the issue of shape similarity, and since shape similarity is quantified by the distance between two shapes or between a shape and the reference shape in the context of the shape space, it is important to calculate the distances between shapes accurately. In this context the distances we're interested in are the distances of the shortest curve between two configurations' coordinate positions *along the shape manifold*. However, the easiest distances to calculate are the linear distances between points on the manifold. The full, curved distance is termed the *Procrustes* distance (ρ in Fig. 8) and the linear distance the partial *Procrustes* distance ($D\rho$ in Fig. 8). As you might imagine, the equations used for calculating the *Procrustes* distance are formidable, especially when the shape space is high-dimensional. However, we've all seen this problem before and are aware of a readily available solution.

An important hint at the solution is provided in Figure 7. This is a map of the three-dimensional triangle pre-shape space that's been flattened out to occupy two dimensions. Note that the method employed to flatten the three-dimensional space has left the points in the lower hemisphere wildly distorted, but points in the upper hemisphere at positions close to their true three-dimensional positions.



I've accentuated the difference between p and Dp in Figure 8 by placing the green point (A) a good distance from the reference shape (red point). If, in your mind's eye, you move the green point along the curve toward the red point a difference between p and Dp remains, but becomes far less marked. Therefore, if our sample of shapes are more-or-less similar to start with, substituting Dp for p should not introduce a large error into estimates, plots, and summaries of shape similarity.

Here it is appropriate to note that landmark datasets are often biased toward overall shape similarity insofar as it is comparatively rare to find sets of organisms with radically different morphologies that can be represented adequately by a set of landmarks. The simple fact that the same set of landmarks must be able to be found on all specimens in the sample goes a long way toward ensuring that the range of shape differences included in any landmark-based analysis is relatively small. For those who like to check assumptions, tests are available to determine how much distortion is likely to be present in *Procrustes*-based shape analysis. So, we can simplify our problem by taking advantage of linear approaches to data analysis, providing our sample doesn't encompass too much shape variation.

This having been said, from a practical point of view the problem of distortion due to inappropriate selection of tangent-plane orientation is usually far more important than distortion due to the range of shape variation present in a sample. In previous discussions you may have wondered why it's standard for *Procrustes* superposition to express shape variation as deviation from the mean shape. After all, we don't usually express distance-based data as a deviation from the mean distance. Moreover, there are other reference forms that could conceivably be used as a reference for a set of shape data (*e.g.*, either the juvenile or mature adult forms in an ontogenetic study, a putative ancestral form in an evolutionary study, a holotypic form in a taxonomic study). What, if anything, is so darn special about the sample mean shape?

The answer to this question has to do not with some stylistic chauvinism among geometric morphometricians, but with the fundamental geometry of the *Procrustes* shape space. If shape variation in a sample is moderate, it is possible to project shape configuration locations from their positions on the surface of the shape manifold to a linear plane where the well-developed, traditional, and familiar tools of linear algebra can be used to quantify, summarize, represent, and test shape distributions. But there are an infinite number of possible planes that could be used for this purpose. Which, from among this infinite set of tangent planes, is the best choice?

Figure 9 shows two possible tangent plane choices for a dataset composed of two groups, green and blue. In this hypothetical example the shapes exhibited by the green and blue groups are quite distinct. The orientations of the two tangent planes are given by locating tangent points on the *Procrustes* shape hemisphere. Since each point on that surface corresponds to a configuration of landmark points, this is tantamount to specifying a reference shape. The red dot represents the position of the mean shape for the pooled sample. The yellow dot represents an alternative and arbitrary choice of reference shape. There are several ways of performing the projection, which we'll discuss in a moment. For now however, let's assume we're going to perform a simple, orthogonal or major axis projection to the tangent plane.

Once we've got a clear picture of what the choice of tangent planes entails for the analysis, the correct choice is equally clear. Selecting a point at the periphery of a shape distribution (the

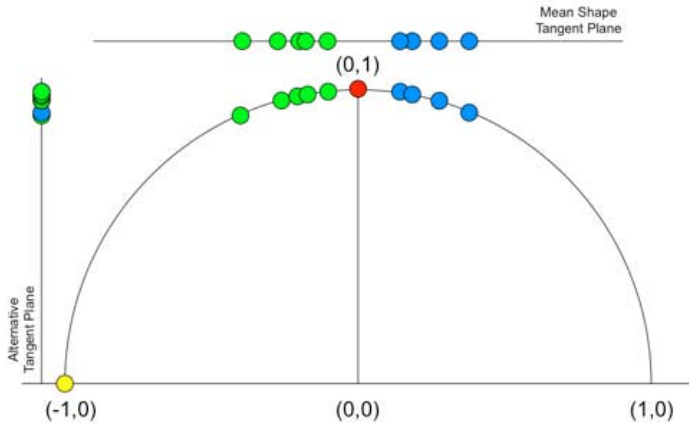


Figure 9. Cross-section through the triangle shape space with the positions of two alternative tangent planes indicated. See text for discussion.

yellow point in Fig. 9) guarantees a relatively high level of distortion in the resultant shape ordination due to the curvature of the *Procrustes* shape space. The effect has been exaggerated in Figure 9 by placing the yellow dot well outside the limits of the observed sample's shape variation. Nevertheless, and as I hope you can see from the diagram, the distortion will be present for any reference shape choice drawn from the periphery (or beyond) of the shape distribution.

Contrast this with the situation that results from selecting the mean shape (= red dot) as the basis for tangent-plane orientation. This is a position that is guaranteed to orient the tangent plane in a position that minimizes curved-space distortion for the sample. Distortion is present in projections to a tangent plane defined by the mean shape, and will be greater for those points at the periphery (as opposed to the centre) of the shape distribution. Some degree of distortion is inevitable whenever a distribution that exists in a high-dimensional space is represented in spaces of lower dimensionality. But as you can see from Figure 9, the amount of distortion is much reduced. For this hypothetical dataset, the difference is that of being able to recognize and interpret the shape difference that characterizes these groups or not.

The last shape-space issue we'll discuss is the strategies available for making projections of points on the surface of the shape hemisphere to the tangent plane. Alternative approaches are summarized in Figure 10.

For completeness I've added a second potential shape manifold to this diagram, shown in Figure 10 as the dashed circle inscribed between the origin and reference shape in the *Procrustes* shape hemisphere. This is the Kendall shape space (or shape manifold), which is formed by relaxing the constraint that all shapes should be adjusted to unit centroid size. As you can see on the diagram, whereas the *Procrustes* distance (p) can be estimated by partial *Procrustes* distance (Dp), this is not the shortest distance between the reference shape and a configuration whose form is identical to that of the comparison shape. This shortest distance is represented by Df in Figure 10, which is termed the full *Procrustes* distance. The difference here is that the blue point

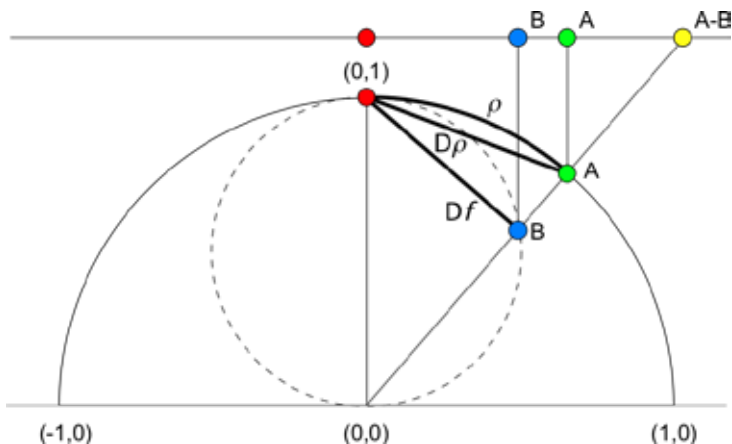


Figure 10. Cross-section through the triangle shape space with the geometry of three alternative tangent plane projection schemes indicated. See text for discussion.

(B) does not lie on the unit *Procrustes* shape manifold. Instead it resides at a position along the same trajectory from the shape manifold's origin, but internal to its surface. This is a position in which the configuration's shape is the same, but the size is slightly smaller.

Application of this 'relaxed size' convention produces an alternative shape space that provides a better overall fit of configurations to the reference, but does so at the cost of continually varying the configuration's size factor in a highly nonlinear manner. Once again, and as I hope you can appreciate from the diagram, for distributions of shapes that are all fairly similar—the typical case in systematics in general— ρ , $D\rho$, and Df all converge on similar values. Accordingly, in such situations it's usually acceptable to employ the more easily calculated partial *Procrustes* distance in representing shape ordinations.

Regardless of this complication over which space is most appropriate to use as a basis for shape comparison, there are two primary ways of projecting points from the shape space(s) to a tangent plane. The stereographic method projects shape configurations from the origin of the *Procrustes* shape hemisphere (and/or the polar position of the Kendall shape space) through the positions of the geometrically homologous configurations on the surfaces of these two shape spaces to the tangent plane. In Figure 10 this projection is used to place point A-B.

Note that the stereographic method makes no distinction between the *Procrustes* shape manifold and Kendall shape manifold. Both ways of representing shape project to identical positions on a tangent plane. This is a distinct advantage. The disadvantage of this approach is that the apparent distance between the reference and the projected point is always an overestimate of the true *Procrustes* distance (ρ), especially for configurations lying at some distance from the reference shape. Indeed, for forms that lie along the equator of the *Procrustes* shape manifold (= at the pole of the Kendall shape space) no projection is possible as the distance is infinite. However, this is a rarely encountered situation. In the overwhelming majority of cases involving biological shape analysis the estimate is accurate, though the systematic bias to overestimation is always present.



Alternatively, projection to the tangent plane may be undertaken in an orthogonal (= major axis) mode using the orientation of the tangent plane as the basis for projection. In Figure 10, orthogonal projections are used to place points A and B on the tangent plane. For this projection strategy the advantages and disadvantages are reversed from those of the stereographic mode. Here, it makes a difference as to whether you choose to match shapes using the *Procrustes* or Kendall shape spaces. But in either case the projection underestimates the partial *Procrustes* distance (D_p) or the full *Procrustes* distance (D_f) respectively, both of which also underestimate the *Procrustes* distance. As with the stereographic projection, the magnitude of the distortion increases for those configurations that differ markedly from the reference shape. But in no case does the projection lead to an infinite result. Overall, orthogonal projections from the *Procrustes* shape manifold produce more accurate estimates of the *Procrustes* and partial *Procrustes* distances. Unsurprisingly, orthogonal projections from the Kendall shape manifold produce less accurate estimates of the *Procrustes* and partial *Procrustes* distances, but better estimates of the full *Procrustes* distance.

If you've made it this far, congratulations (and thank you). It might have seemed like a long, hard slog that had little to do with palaeontology *per se*. Please be assured that my purpose in this essay—and in this column—is not to turn you into mathematicians. Rather, it's to explain how the tools of mathematics can make us all better palaeontologists and, if truth be told, to lower the level of intimidation most palaeontologists feel toward mathematics. You don't have to understand the intricacies of non-linear algebra to be able to design and execute a *Procrustes* shape analysis intelligently, provided you have a firm grasp of the fundamentals. Most importantly though, as *Procrustes* analysis is arguably the most powerful tool in the quantitative form-analysis kit, and since the basic data of all palaeontology constitutes form, the ability to conduct such analyses should, in my view, be part of every palaeontologist's training. Besides, once you've got a proper guide it's not really all that hard to understand.

As for software, I really haven't covered anything in this column that is new in terms of procedures that requires access to new software. Most of the algorithms and calculations have been described in previous columns. The triangle examples are included as part of the *PalaeoMath* 101-2 spreadsheet so you can see exactly how the figures I've used to illustrate this column were obtained. A full analysis of the raw data can also be performed using Jim Rohlf's tpsRelw program, which is downloadable from his SUNY morphometrics website (<<http://life.bio.sunysb.edu/morph>>). I've written several *Mathematica* routines that were used to perform all the analyses presented herein. These are available free on request. The only procedures that haven't been covered in algorithmic detail are the routines used for stereoscopic and orthogonal projection to a tangent plane. I need to develop a few additional concepts before I explain how these projections can be accomplished. Accordingly, they will be the subject of a future column.



Finally, references. There really aren't that many descriptions of this material that have been written to date for non-mathematical audiences. A full mathematical treatment is provided by Mardia and Dryden (1989) and Dryden and Mardia (1998). The canonical conceptual treatment of the concepts involved is covered by Bookstein (1991). A useful, though somewhat overly complex, introductory version of this material can be found Zelditch *et al.* (2004). Finally, a short, but useful discussion is included in the help section of Rohlf's *tpsRelw* program.

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Don't forget the *PalaeoMath 101-2* web page, at:

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



Meeting REPORT



“Spectacular, spectacular”:

The First International Congress on North African Vertebrate Palaeontology

Marrakech, Morocco 25 – 27 May 2009

The First International Congress on North African Vertebrate Palaeontology was held in Marrakech, Morocco, from 25th to 27th May, bracketed by pre- and post-congress field excursions. From humble beginnings, I know that the organisers would agree that this congress ended up being much larger than anticipated: a gathering of more than a hundred vertebrate palaeontologists and geologists with presentations covering a large range of North African topics: Palaeozoic proto-amphibians through to archaeological remains.

For me, the NAVP1 spectacular spectacular started with the preconference field excursion to the Permian–Triassic of the Argana Basin – leaving Marrakech in the morning of 23rd May, and heading in a convoy of two minibuses in the direction of Agadir (southwest of Marrakech). In reverse stratigraphic order (because of logistical constraints), Triassic sediments were the focus for the morning of our first day ‘in the field’ (with stops, as appropriate, for coffee, tea, cigarettes and the most amazing ‘conference provided’ bagged-lunch I have ever encountered). The weather was extremely hot in Morocco at this time of year, for me and most other northern Europeans, but there was some wonderful geology, plant life and local colour – and surprisingly few birds and not that many fossils to be found. My previous Moroccan field experience prospecting in the southerly Cretaceous sediments of the Kem Kem had perhaps led me to expect more – I don’t know.

Our overnight stop on this excursion was spent in Morocco’s answer to Atlantic City: the beach-side resort city of Agadir. Lots of Irish people come here to get lobster-fried on the beach, said one hotel porter, sporting a shamrock lapel pin.

Examining Permian rocks, including an excellently well-preserved and extensive Permo–Triassic section, I learned about Cretaceous bird tracks found in the vicinity of Agadir, and a new geological term – ventifact. These are abundant in the coarse conglomeratic sand that caps the Permian in the Argana area: rocks that have been rolled in the wind, becoming triangular in shape and indicative of arid climate. I received a crash course in Brazilian politics on the bus back to Marrakech.

Back in the city, on campus at Cadi Ayyad University, the NAVP1 conference started in earnest on Monday morning (the 25th). Broadly organised by age, and with a liberal display of posters outside our large circular (and cool) auditorium, we learned about Palaeozoic marine vertebrates and their biogeography, continental ones (Monday), and then taxa from the ‘Age of Dinosaurs’ (all day Tuesday). (That’s the Mesozoic for you ... everybody in the shadow of the dinosaurs, even though the Tuesday morning session was mostly devoted to temnospondyls and fish). Then on Wednesday afternoon the conference shifted to analyses of Mesozoic faunas, the K–T boundary, and finally into the Cenozoic – the emergence of African mammals and humans. Accustomed to North American meetings where I’m constantly in-and-out of talks, up-and-down, unusually I sat through most of



the NAVP1 offerings, but fear not: there is no blow-by-blow account here (see <<http://www2.mnhn.fr/hdt203/info/navep1.php?catid=29&blogid=4>> for abstracts and the conference programme), rather two immediate impressions: lots of people are working on the fauna of the Cretaceous Kem Kem, and all the mosasaur palaeontologists (at least those at this meeting) get along really well. The lunch breaks at this conference were also amazing.

NAVP1 presentations didn't just deal with Morocco (although admittedly, most talks did), but also covered research done in Algeria, Egypt, Mali, Niger and Yemen. North African in its most liberal interpretation also encompassed talks on Argentine and Scottish fossils (biogeographic stories there) – the preponderance of Moroccan-based research reflecting the accessibility and openness of this country and its palaeontologists.

I sat on the plane back to London and contemplated the scale of this meeting: I don't know what I expected but really many more people – disparate researchers – have professional interests in North Africa (especially Morocco) than I thought. Americans, Brazilians, Canadians, French (of course), Germans, Italians, Spanish, Swiss, Japanese and a large North African (even one South African, although he had to fly first to Europe to get to Marrakech) contingent attended NAVP1. A truly international meeting.

We took a coach ride out of Marrakech for the last night of the congress – 'spectacular, spectacular' said the Berbers on the way in and the Canadians for the rest of the night. Inside the walls of a faux Moroccan castle, complete with Aladdin's Cave, a snake-mouth waterfall, belly dancers and Berber musicians, in groups of 8–10 we ate tagine, sides of lamb and couscous before watching displays of fireworks and horseback acrobatics. Tourists in Morocco for a night – they even burned a giant NAVP1 sign at the end of the evening. A 'spectacular, spectacular' conference indeed: well done again, congratulations, and thank you, to Nour-Eddine Jalil, his research team, and his organising committee for a great time. I learned that lots of important vertebrate palaeontology will be done in Morocco and for many years to come: watch this space though because there are some talented students working with Nour-Eddine, on the way through. NAVP2 promises to be just as good – and there are plans to formalise a society around these meetings and to extend them to encompass all African vertebrate palaeontology; expect more and more emphasis on North African work actually done in North Africa. Morocco in general, and Cadi Ayyad University in particular, is shaping up to become a major player in our field. After all, they have some of the best fossils, and certainly the best weather!

What was the highlight of NAVP1 for me? Easy: when our minibus stopped by the side of the frenetic Marrakech–Agadir highway and we all piled out to see a huge vertical roadcut containing massive parallel sauropod dinosaur tracks. Amazing. I heard that the post-conference fieldtrip to the Paleogene phosphates of the Ganntour Basin was just as good, although I didn't attend.

Gareth Dyke



MYSTERY FOSSIL 17

The latest Mystery Fossil was sent in by **Beatriz Aguirre-Urreta**, of the Departamento de Ciencias Geologicas, Universidad de Buenos Aires. It is apparently found in abundance in the uppermost Cretaceous rocks of the Neuquen Basin of western Argentina, in a sequence equivalent to the Malargue Group (Late Campanian–Palaeocene). The depositional setting is described as being very marginal marine. Beatriz notes that the fossils have branches and are covered by microbial mats, which (she suggests) have probably assisted in preserving these fossils.



Mystery Fossil 16 – update

No flurry of responses this time around, but we did have a possible identification for Mystery Fossil 16, described by **Sam Ciuca** in the last issue from the Upper Silurian Bertie Group of New York:

Scott McKenzie, palaeontology curator at Mercyhurst College, USA, suggests that MF16 (see figure above) is “most likely an early and undescribed octaradial charophyte”. Scott goes on to write, “The thick stem is most unusual, I have seen thinner stems and one in a museum collection that is thicker and with more whorls. I think that the illustrated example is the best of the 25 or so recovered specimens in existence. **Sam Ciuca** is to be congratulated as a keen observer and dedicated collector!”

R.J. Twitchett



‘*Nihon e nano kenkyo ni kimashita ka?* Life in Japan for the JSPS Postdoctoral Fellow

It's Golden Week, the entire country is on holiday, all the *Shinkansen* bullet trains are booked and hotel rooms/tent pitches are like gold dust. You find yourself in a crowded river valley in the hot and humid, almost subtropical, sun with hundreds of Japanese amateur fossil collectors looking for that very elusive shark's tooth. It is at this moment that you start a casual but ever so slightly formal conversation with a local, in a language that only 18 months ago was total mystery to you. Nevertheless, this is a conversation that you would have had many times and tends to start with the question “*O-kuni wa dochira desu ka*” – where are you from? – and will always finish, in my case, with *sega-takai desu ne!* – gosh you are tall!

Anyway at the end of a hard day in the sweltering sun you can look forward to Japanese *bangohan* – ‘evening rice’ – followed by a nice relaxing hydrothermal *onsen* bath with your fellow fossil hunters and most of the local population “oh natural” of course! All this, with the full support of your post-doctoral host, in the guise of cultural exchange, while being funded by a generous fellowship from the Japanese government.

One of these fossil hunters was my fellow ‘resident’ alien and ultra-*gaijin* Simon Darroch who in the last issue of this *Newsletter* gave an account of his experiences as a graduate student in Japan. Partly on his suggestion, I thought it would be fitting to write this follow-up article on how to get a post-doc position in Japan and how our experiences, although similar, are quite different to those of a graduate student. The hope is to assist those who are considering heading to the Far East for a truly unique placement.



Fossil hunting in Mizunami, Central Japan: Simon and I pointing to something very interesting ... honest!

Applying to the JSPS

For those who are willing to work in Japan there are several options in applying for a fellowship, which depends if you want short-term (maximum of six months) or long-term (up to two years). I have found that those applicants in the early stages of their career find that six months or even a year is not nearly long enough to appreciate fully all that Japan has to offer. These fellowships are provided by the Japan Society for the Promotion of Science (JSPS) in open competition across all sciences. The key task is to identify a host who is willing to look after you and take responsibility for all aspects of your application and tenure. This host should be in your area of speciality although in some cases they are willing to diversify, as it is often considered a great honour for them to receive an international guest even if they are staying for two years! It certainly helps if your host is



Japanese amateur collectors hard at work in Mizunami, Central Japan.

international in outlook and can speak good English, as even some high-ranking academics may be able to write excellent English, but be unable to speak a word.

Luckily, in my case, I had Dr Tatsuo Oji as my host who not only spoke excellent English and was very friendly and wonderfully helpful, but also had lots of experience working abroad and had successfully hosted at least two previous international post-doctoral fellows (including the *Newsletter* Editor!). Dr Oji is an established authority on post-Palaeozoic and recent crinoids and is a faculty member at Japan's most elite institution, the University of Tokyo. As someone who had only previously worked on fossil crinoids from the Jurassic and Cretaceous, going to Tokyo was an excellent opportunity to work on the only living captive population of sea lilies in the world.

Although the Japanese often claim that their country is small, Japan is actually astonishingly diverse – from the rainforests and mangroves of Okinawa and the

Yaeyama-Shoto Islands in the south to the thick forests of Hokkaido in the north, rich in Cretaceous ammonites. For this reason there is a huge range of universities, and potential hosts with whom you can collaborate. In addition, the Japanese are still investing heavily in impressive local museums and institutes with a strong bias towards local geology, which means you often come across people with vast reserves of palaeontological knowledge in the remotest locations.

In starting your application it is a good idea to subscribe to the free JSPS newsletter through its website – <<http://www.jsps.go.jp/>>. This has all the further particulars of each programme available with deadlines throughout the year.

Once you have found your host, either they can apply directly to the JSPS, or like myself you can apply for a 24-month fellowship through the Royal Society (<<http://royalsociety.org/funding.asp?id=7068>>) who will then nominate you to the JSPS. The first route has to be done through the university or institute, as typically their admin have their own submission dates which can be weeks before the real deadline. If successful, the JSPS will pay your return flight from your city of residence to your host's closest airport. There is money provided for settling in to your life in Japan and you will be provided with health insurance and cover for other research-related activities. Before you leave the UK, you will need to get a visa for cultural activities either as a 'researcher' or 'professor' and a 'certificate of eligibility' prepared by your host.



Looking for that elusive shark's tooth.



Looking for ammonites in Hokkaido bear country – hence the bear protection suit and bells!

Both can be obtained from the Japanese embassy in Piccadilly (<<http://www.uk.emb-japan.go.jp/en/visa/visa-certif.html>>). You do not need a work permit for a JSPS fellowship as your salary is actually a tax-free allowance and you will not be able to seek other employment during your tenure.

Apart from the standard reports and presentations, the only main limitation of a JSPS fellowship is restrictions on foreign travel. The total amount of time you are permitted to spend outside Japan is 30 days per year, and there are no exceptions (even for conferences or field work). If this limit is exceeded, you will have to take a rather large pay-cut or risk losing the fellowship altogether. Although this could deter people from going to Japan, in my experience most fellows enjoy living in East Asia so much that they do not want to leave, let alone be away for over a month – though it does make going to nearby China or South Korea for long periods a bit tricky.

Arriving in Japan, finding accommodation, and everyday cost of living

When you arrive in Japan, the first thing you will have to do is obtain your ‘certificate of alien registration’ from the city office. This will be your first experience of Japanese bureaucracy: city hall is full of hundreds of secretaries and admin staff, each one in charge of one very specific task ... you just need to find the right one ... and the right coloured form to fill in (there are over 30, colour-coded in racks like newspaper stands) ... it’s not that easy! As a consequence, it is essential that you have someone with a decent command of Japanese with you. Once you have received your *gaijin* card you then pick up more paperwork to open your bank account and obtain a mobile phone.

As Simon mentioned in his article, it is true that Tokyo is one of the most expensive cities in the world. However you can eat like a king in Tokyo very cheaply, especially if you love Japanese food. Things become a lot simpler if, like me, you are addicted to ramen, a very fatty noodle soup draped with slices of roast pork which is about as healthy and easy to find as a hamburger and has enormous regional variety, and many weeks can be spent happily finding your favourite



one. As you would imagine in a tightly packed city the big expense in Japan is accommodation: the options are to go into very cheap university accommodation (which is like going back into halls), or a shared 'guest' house, or try to get your own apartment. For university accommodation you will need to contact your host well in advance so that he can apply. Although communal 'guest' houses are an option, as a JSPS fellow your budget does allow for you to have



Japanese lunch box in the field with our students and the sensei.

your own apartment. I was extremely lucky to have a very nice apartment in a very traditional neighbourhood inside the *Yamanote* line (the green circle line of Tokyo). My *apparto* was small by UK standards, and the kitchen was like a ship's galley, but nevertheless it was not far from the university, and as luck would have it was sandwiched between a very lovely formal garden and a woman's university tennis court, making my flat very quiet indeed.

Finding an apartment in Japan can be complicated and expensive, with archaic traditions like 'key money', which is best described as a non-returnable gift deposit. This, plus the agent's fee, the cleaning fee and the normal deposit could mean that you pay out over one million yen (approx. £6,000) just to move in. Luckily there are a few letting agents who specialise in finding apartments for foreigners and can help you through the paper work (see <<http://www.kimiwillbe.com/>>). It's a good idea to recruit some graduate students from your office to help with your search, and they will gladly help, happy in the knowledge that you will be proof-reading their papers for the next two years! I must add that most apartments are unfurnished, so it is good to get furniture and appliances second hand.



Student looking for Cretaceous ammonites during palaeontology practical: Gifu Prefectural high school Gizan, Central Japan.

Working and teaching at a Japanese University

As you would expect Japanese labs are enormously friendly and welcoming to all newcomers to their scientific community. Some elements of lab culture do take a bit of getting used to, such as students sleeping in their offices, reading hundreds of *manga* comics, or working 12-hour days. It is rather easier to get used to the frequent beer parties that take place in your office. Many labs prefer that their post-docs share an office with the graduate students, which has considerable advantages for both integration and language skills, not to mention that it is the best way for you to gain experience in helping graduate students who need to prepare their papers and presentations in English.



Like Simon, I found the Japanese graduate students very helpful and independent. Students are encouraged to work on their own as their supervisors are often extremely busy. Despite this, rank and seniority are deeply rooted in Japanese culture and are never far from the surface. Foreign researchers are for the most part exempt from the incredibly formal rules and customs that govern exchanges between faculty, students and native post-docs. You are not always exempt from the formality between you and your host (although your host will address you informally). You may find that your Japanese *sensei* has formed an opinion over many years of research and experience, and may find it difficult to accept your new ideas or methods if these go against their own accepted wisdom. However, the whole point of a JSPS fellowship is to foster a productive relationship with your host regardless of these different opinions.

The lab tends to be organised into seminar groups which are headed by the professor. The labs have fantastic equipment that is freely available if it belongs to your seminar group – but collaboration outside this unit is fraught with difficulties and politics. Of paramount importance is the student seminar meeting where attendance is mandatory (yes, they do take a register). For the post-doc this should not pose a problem, however each student will repeat *ad infinitum* the same presentation at bimonthly intervals, making only small and incremental amendments until the final defence, when it is deemed to be perfect. Although more than a little repetitive, this is the way in which the *sensei* can keep track of all his graduate students. In Tokyo, the presentations were totally in Japanese and the slides were more like a Chinese character lesson than a scientific talk! The MSc and PhD students can be stopped at almost any moment with a question or comment from the audience, and protocol dictates that the students refrain from defending the material, and instead receive remarks very politely and incorporate the feedback into the next presentation. Such a seminar can go on for a very long time; my record at the University of Tokyo was nearly four hours!



The famous Kinkaku-ji-Golden Pavilion temple Kyoto.

Language and culture

Unlike graduate students, it is not essential for post-docs to learn Japanese to near fluency, especially if you work in the big cities. Most post-docs are simply too busy to find the time to learn Japanese. However if you really want to enjoy life in Japan to the full then it is best to dive into lessons as soon as possible, especially if you intend to stay more than a year. A good level in Japanese is especially valuable if you travel or intend to live outside the major cities, and for those outside Tokyo, Osaka and Kyoto the JSPS does provide paid one-to-one tuition. The big universities have an extensive network of Japanese classes at all levels that are of a very high quality and moreover are free! These will ease you into learning the logical grammar system and introduce you to other researchers and students with the help of extremely friendly, professional, almost mother-like, teachers.



Funding and other opportunities

JSPS fellows have so many other opportunities open to them in Japan. Not only is there an enormous range of cultural and travel opportunities open to you, and the almost compulsory all night *karaoke* evenings, but JSPS fellows are provided with generous research grants that you and your host may use for fieldwork (and lab equipment). For micropalaeontologists, or those working on living animals, there is the opportunity to work for JAMSTEC (Japan Agency for Marine-Earth Science and Technology (<<http://www.jamstec.go.jp/e/>>)) and join a research cruise. While in Japan, you could also join the Paleontological Society of Japan (<http://wwwsoc.nii.ac.jp/psj5/E_index.html>) and go to their very well attended meetings, at which I can guarantee that you will be the only non-Japanese person there. Fellows are especially encouraged to join the science dialogue programme (<<http://www.jps.go.jp/english/e-plaza/e-sdialogue/index.html>>)) which allows JSPS fellows to give a lecture and practical to high school students and is a truly unforgettable experience.

In Summary

Like Simon, I believe being given the opportunity to carry out research and supervision at the University of Tokyo was a real privilege. Japan is a place apart, almost a crime-free utopia with clean streets and very courteous people. I could easily write a lot more about the temples, shrines, castles and many festivals that are to be experienced, but I will let you discover those for yourself. Post-doctoral studies in Japan are an invaluable experience and really open your mind to a completely different way of thinking. JSPS funding is extremely difficult to obtain for Japanese graduates with six students going for just one fellowship in my seminar group last year. Thus, foreign researchers are extremely lucky that such fellowships are available to them, and I encourage possible applicants to take advantage of this opportunity to foster links with Japanese research groups.

Aaron Hunter

(Formerly JSPS Fellow, University of Tokyo)

<afossilhunter@gmail.com>



Friends visiting the Kiyomizu temple Gion, Kyoto.

Graduate Opportunities in Palaeontology!

Students: Do you want to study for a postgraduate qualification (MSc, MRes, PhD etc.) in palaeontology or a related discipline in the UK or abroad?

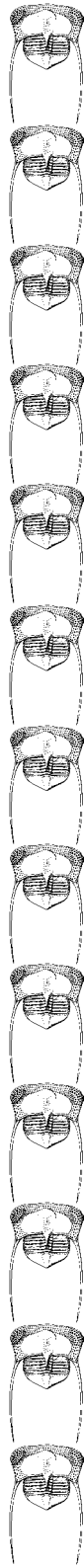
If the answer is YES then please check out the home page of the Palaeontological Association (<<http://www.palass.org/>>) and follow the link to “Careers & Postgrad Research”.

These pages will be updated regularly over the coming months, so don't forget to check back at regular intervals!

Researchers: Do you want to advertise your palaeo-related MSc course or PhD to as many students as possible?

If the answer is YES then please send details of your courses/projects to the Newsletter Editor. These details will then be posted on the Association website and will be published in a forthcoming edition of the *Newsletter*.

For available PhD titles please include the title, the names of all academic advisors and a contact email address. For MSc and other graduate courses please include a brief descriptive paragraph, a link giving details of admission procedures and a contact email address or telephone number.





Current MSc opportunities in palaeo-related subjects

MSc in Palaeobiology: University of Bristol, Department of Earth Sciences

The MSc in Palaeobiology offers a broad-based overview of modern approaches in palaeobiology. Students study nine out of 14 possible options, and topics range from taphonomy and palaeoecology to dinosaur and mammalian palaeobiology, to trace fossils and arthropod palaeobiology, and systematic methods. Then there is a six-month independent project, and students are offered a wide range of topics. The programme is designed for students with a BSc in either a biological or an earth sciences subject, and conversion courses in evolutionary biology and sedimentology are offered. Students also receive training in writing scientific papers, creating websites, applying for Ph.D.s and jobs (both in Britain and overseas). So far, 160 students have graduated, and many have gone on to rewarding careers in palaeontology and related scientific areas.

The project is a major component of the degree, and we encourage students to carry out cutting-edge work and to present it in publishable form. So far, some thirty MSc projects have been published, and we aim to help and encourage students to publish as many as possible.

Full details of the programme, of former students, and of how to apply are available on the course website at <http://palaeo.gly.bris.ac.uk/MSc/index.htm>.

Application forms may be downloaded from the website, or can be provided by contacting earth-msc@bris.ac.uk.

MSc in Geobiology at Cardiff University

Cardiff University School of Earth and Ocean Sciences introduced a new taught one-year MSc degree course in Geobiology in September 2007.

Geobiology is a rapidly developing interdisciplinary and holistic approach to Earth and Life sciences. It explores the inter-relationships of life and environment on Earth and their consequences for both.

The course reflects Cardiff's research strengths in areas such as climate change, geomicrobiology, and palaeobiology. The Geobiology MSc consists of Taught Courses (late September to April) followed by a Research Project (May to mid-September). The taught courses include: Biogeochemical Cycles, Climate Change, Geobiology Frontiers, Geobiology Residential Field Course, Geomicrobiology, Marine and Terrestrial Biospheres Past and Present, and Transferable Skills.

Cardiff is a friendly and vibrant capital city, and the School of Earth and Ocean Sciences is a leading centre for research and teaching. We welcome applications from students with backgrounds in Earth Science, Environmental Science, or BioScience.

For further information see our website at <http://www.earth.cardiff.ac.uk/>, or contact Emma Paris by sending email to parisec1@cardiff.ac.uk.



MSc in Advanced methods in taxonomy and biodiversity: Imperial College London

Imperial College London College of Science, Technology and Medicine and The Natural History Museum are jointly offering a Masters degree course in Advanced Methods in Taxonomy and Biodiversity.

The one-year full-time MSc course provides essential skills for all concerned with taxonomy and biodiversity. The course is composed of ten taught modules followed by a four-month research project. The series of modules seeks to provide as wide as possible an overview of the theory and practice of modern taxonomy and systematics, with associated biodiversity studies. During their four-month research project, students can specialise in their chosen area.

The course is based at The Natural History Museum, London, one of the world's premier institutions for research on the diversity of the natural world. The collections include over 68 million specimens, 800,000 of which are type specimens, and the Museum houses a world class library covering all areas of taxonomy and systematics. The Museum is situated next to the main South Kensington campus of Imperial College, and there are close research and teaching links between the two establishments. Students will therefore be situated in the heart of London, and able to make full use of the facilities at both institutions.

Students are trained to a high level of competence in systematics and a detailed understanding of the various uses and problems involved. The course provides methodological background, including quantitative skills, computer applications and practical skills in morphological and molecular techniques of taxonomy and systematics. The most up-to-date ideas and research in taxonomy and biodiversity are taught, to a large extent from primary literature. Hands-on training in conducting research in this area will be provided by project supervisors, with specialisation in the student's field of choice.

After completing the course, students will be able to:

- apply a wide range of techniques to the study of systematics, including collections management, identification, key construction, taxonomic revision, phylogeny reconstruction and comparative methodologies;
- understand the diversity of living organisms in space and time, and be familiar with methods for measuring this diversity and monitoring changes due to both anthropogenic and natural factors, and in Earth history;
- select appropriate methods to solve taxonomic and biodiversity problems, and be able to acquire and analyze taxonomic data, including both traditional and molecular data;
- understand fully the conceptual basis of taxonomy and phylogenetics, and in particular, cladistics, and to understand "biodiversity" within this framework;
- apply these concepts to issues of biodiversity and conservation management and research, to set priorities for sustainable development, environmental assessment and inventories;
- apply these concepts to other areas of biology such as parasitology and epidemiology.



Who is this course aimed at?

The course is aimed at anyone concerned with taxonomy and biodiversity. It is relevant to those involved with biodiversity assessments, conservation and sustainable development, from biomedical sciences to agriculture and fisheries, as well as to those intending to pursue academic careers in systematics and related fields.

Entry requirements:

Applicants should normally either have or expect to gain at least a lower second class honours degree (or equivalent) in a biological or environmental subject (*e.g.* zoology, botany, microbiology, agriculture, veterinary science). Exceptionally, students with different backgrounds or with related work experience will be considered.

Further details:

Please contact Ms Amoret Brandt, Department of Entomology, Natural History Museum, London SW7 5BD, UK (tel +44 (0)20 7942 5036, fax+44 (0)20 7942 5229, e-mail <a.brandt@nhm.ac.uk>).

MSc/MRes in Global Environmental Change: University of Plymouth, School of Earth, Ocean and Environmental Sciences

The MSc/MRes in Global Environmental Change is a one-year, full-time course which aims to provide opportunities within a multi-disciplinary environment to gain both theoretical knowledge and practical experience in understanding the scientific basis of past, present and projected future environmental change. Quantitative, multi-disciplinary training is provided for Earth, Marine and Environmental scientists together with graduates from biological or other scientific disciplines.

The course emphasises applying scientific knowledge largely through practical application to real environmental problems. The key objectives of the course are to provide:

- an understanding of the operation of the climate system, and its interactions with other elements of the Earth System (oceans, biosphere, *etc*);
- an understanding of variability in the global environment, now and in the past, and the methods by which long-term temporal variations can be reconstructed and explained;
- experience of the fundamentals of key data-gathering processes and methods (*e.g.* electron microscopy, remote sensing, marine and non-marine palaeoenvironments, isotopic and geochemical techniques);
- insights into aspects of biological diversity;
- an assessment of the basis of future climate prediction, primarily through numerical modelling experiments.

The Global Environmental Change course provides an interdisciplinary approach designed to evaluate the potential impacts of global change; a critical assessment of the political responses to scientific advice on 'global warming'; and aims to develop and promote a sense of independent enquiry and the development of investigative and research skills, addressing particular aspects of environmental change.



Further details and application forms:

Please contact the Postgraduate Admissions Team, Faculty of Science, University of Plymouth, Drake Circus, Plymouth PL4 8AA, United Kingdom (tel +44 (0)1752 233093, e-mail <science@plymouth.ac.uk>). University bursaries may be available.

MSc/MRes in Micropalaeontology: University of Plymouth, School of Earth, Ocean & Environmental Sciences

This programme in Micropalaeontology operates within a scheme involving a range of M-level subjects in the Earth, Marine, Environmental and Biological Sciences. In the first term a range of taught courses are offered, including both subject-based topics and skills training. After this is completed satisfactorily, students pursue a major research project from January to mid-September (for the award of MRes). This may be based on field samples collected by the student, samples provided by an industrial sponsor, samples requested from the Ocean Drilling Programme, or other samples in the collections of staff. Projects undertaken by students in the last few years include foraminifera from Plymouth Sound, sea level change in S. E. Italy, foraminifera from the Cretaceous/Palaeogene boundary in Texas, foraminifera from the Callovian “Squid Bed” in Wiltshire, and the use of foraminifera and stable isotope stratigraphy in dating volcanic activity on Montserrat, Caribbean Sea. During this period of research, students have to generate assessed reports and give a full seminar presentation on their research. The MSc students are involved in three further modules during the Spring Term, after which they embark on a research project (May to September).

Further details and application forms:

Please contact the Postgraduate Admissions Team, Faculty of Science, University of Plymouth, Drake Circus, Plymouth PL4 8AA, United Kingdom (tel +44 (0)1752 233093, e-mail <science@plymouth.ac.uk>). University bursaries may be available.

MSc in Geology by Research: Royal Holloway University of London, Department of Geology

This programme is offered to prospective students who wish to pursue research in a selected field of the Geological Sciences for a period of one calendar year full-time or two calendar years part-time and be awarded a Masters degree. Students will receive training in research skills, including data collection, data handling and analytical techniques as well as transferable and presentation skills. Students will take a course in a subject area closely related to the chosen field of research, selected from a menu of masters level courses offered by the department. The main outcome of the programme is a piece of independent research presented in the form of a dissertation. Upon completion of the programme students will have gained experience of research and presentation of material in the geological sciences which equips them to publish work in international scientific journals.

Prospective students should contact individual members of staff in the department to discuss potential research projects. The research interests of staff are available on the department website at <<http://www.gl.rhul.ac.uk/staff/acad.html>>.



Research on Carboniferous ammonoids from the Anti-Atlas of Morocco

Dieter Korn, Volker Ebbighausen

Few regions have, within a few decades, experienced such a rapid increase in palaeontological interest as the Anti-Atlas of Morocco. Fossils from this region are described and illustrated in countless scientific articles, sold in bazaars and flea markets, and they are deposited in most of many geoscience collections. Polished limestone slabs containing various fossils decorate hotels and private apartments. Numerous geological and palaeontological research projects have been successfully completed, others are continuing or planned. The local people in the Anti-Atlas are intensely involved with the mining and preparation of fossils, so that dealing and exporting of fossils has been developed into an important economic sector. Occasionally, the beauty of the fossils is 'improved' by the use of plaster, glue, and artistic skills.

Knowing all these facts, one may ask if it is rewarding at all to plan further excursions in this region. Is it possible, apart from minute details, to gain new insights from the study of the fossiliferous strata? Is it possible, with so many fossil species already known from Morocco, to discover new species, genera, or even higher taxa? 'Yes' for a number of reasons.

First, the initial area of interest for palaeontologists was the Devonian succession and its fossil content, whereas the Carboniferous played only a subordinate role. Secondly, the Carboniferous fossil-bearing strata are predominantly exposed in distant areas, which are not as easily accessible as the Devonian outcrops; they are often restricted because of military reasons, *i.e.* blank spots in the scientific landscape. These blank spots were the target of our expeditions – the Carboniferous



Margin of the Sahara Desert with the Gara el Itima in the background.



sedimentary rocks in the military-controlled areas near the frontier with Algeria. At these places, research is only possible with the permission of the local and regional authorities, e.g. the police, the gendarmerie, and even the military in the province capital. Needless to say, permission is only provided for well-reasoned projects.

The area we studied in Autumn 2004 is about 50 kilometres south-east of the towns of Erfoud and Rissani, some distance from the, nowadays, well-accessible Erg Chebbi, which is the largest sand dune of the Anti-Atlas. In this area, an erosional window of approximately 40 km² within Cretaceous sediments exposes hundreds of metres thickness of older rock, mainly of Early Carboniferous age. At first glance, the succession is a monotonous sequence of shales with occasional interbeds of thin-bedded sandstone. Only some fossil coral and sponge reefs and a number of cone-shaped mudmounds provide some entertainment.



Early Carboniferous Mudmounds, perfectly exhumed.

The distance of the fossil-bearing sites from the nearest towns requires some effort for the expeditions. Water and food have to be transported, and lack of space may not allow one to carry a tent. Therefore, one sleeps usually in a sleeping bag on the ground. However, the lack of comfort is rewarded by absolute silence, a black starry sky at night and new discoveries.

It is puzzling that occurrences of well-preserved ammonoids from the late Viséan (Early Carboniferous) were not discovered by the mapping geologists. The oversight is even more remarkable, as the fossils are not small at all; they reach diameters of up to 12 cm and are often completely eroded out of the surrounding matrix and lying on the surface, if only in a very few places. Their discovery was made by Christian Klug (Zürich), who in the course of measuring a geological section almost coincidentally found the first three specimens. Interestingly, these three specimens are among the best-preserved of the some hundreds of individuals now known.



Ammonoid specimens (mostly Platygoniatites) as collected in the field.

Intensive investigation of these largely barren strata during extensive searches on foot was rewarded by the discovery of six successive faunal bands. These contained a rich fauna, including many ammonoids, gastropods, and rugose corals, but also nautiloids and brachiopods. On the basis of these findings, an enormous gap in knowledge could be filled: rich ammonoid faunas of latest Viséan age have not been described from the Anti-Atlas.

The Early Carboniferous is a particularly intriguing time interval because its ecosystems were affected by the collision of the two supercontinents Laurussia (in the North, consisting of North America, the northern part of Europe, and large areas of Russia) and Gondwana (the gigantic southern continent, consisting of modern South America, most of Africa, India, Australia, and Antarctica). During the phase of collision, which produced the Variscan Mountain Chain, extensive shelf regions existed at the margins of the continental plates. The various communities of ammonoids in these shelves are promising subjects for the study of palaeobiogeographic relationships between the occurrences.

In the earliest Carboniferous, relatively similar ammonoids had a nearly global distribution, at least in the palaeotropics. The uplift of the Variscan Orogen, as the continents coalesced, caused a barrier to be formed separating the northern Variscan shelf (including Central Europe, the British Isles, South Portugal, and surprisingly North Africa north of the High Atlas) from the southern Variscan shelf (with southern France, northern Spain, south-western Algeria, and the Anti-Atlas of Morocco). Consequently, increasing provincialism of ammonoid faunas caused divergent developments of the two realms toward the end of the Early Carboniferous.



The late Early Carboniferous was a time in which the ammonoids experienced a significant increase in taxonomic diversity and morphological disparity. The new finds in Morocco contribute much to the knowledge; while previous research projects often dealt with extinction events, new projects with the focus on biogeography or the faunas and adaptive radiations come in the centre of interest.



Specimen of Dombarites granofalcatus



>>**Future** Meetings of Other Bodies



An International Conference on the Cambrian Explosion

Banff, Alberta *August 3 – 7 2009*

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

For further details visit the meeting website at

<<http://www.geology.utoronto.ca/facultycaron/Walcott2009.htm>>.

International Scientific and Organizing Committee (as of April 2007)

Co-Chairs:

Dr Jean Bernard Caron (Royal Ontario Museum, Toronto), <jcaron@rom.on.ca>

Dr Doug Erwin (Smithsonian Institution, Washington), <ERWIND@si.edu>

David Rudkin (Royal Ontario Museum, Toronto), <davidru@rom.on.ca>

Members:

Matthew Devereux (The University of Western Ontario), <mdevereu@uwo.ca>

Dr Stephen Dornbos (University of Wisconsin-Milwaukee), <sdornbos@uwm.edu>

Dr Sarah Gabbott (University of Leicester), <sg21@le.ac.uk>

Dr Robert Gaines (Pomona College), <robert.gaines@pomona.edu>

Dr Charles Henderson (University of Calgary), <cmhender@ucalgary.ca>

Dr Paul Johnston (Mount Royal College, Calgary), <pajohnston@mtroyal.ca>

Kimberley Johnston (Palaeontographica Canadiana), <kimberley@paleos.ca>

Dr George Pemberton (University of Alberta), <george.pemberton@ualberta.ca>

Dr Jean Vannier (Université Claude Bernard Lyon 1), <jean.vannier@univ-lyon1.fr>

Dr Xingliang Zhang (Department of Geology, Northwest University, Xian),

<xlzhang@pub.xaonline.com>

Dr Maoyan Zhu (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences),

<myzhu@nigpas.ac.cn>



5th International Symposium on Lithographic Limestone and Plattenkalk

Basel, Switzerland *17 – 22 August 2009*

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



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

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

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

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



**ICGP 572: Recovery of ecosystems after the Permian-Triassic mass extinction:
Field workshop in Turkey**
Antalya, Turkey 3 – 6 September 2009

The field workshop aims to investigate the recovery of ecosystems following the end-Permian mass extinction through analyses of the rock and fossil records, via studies of biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry.

A one-day meeting is organized at the Engineering Faculty of Akdeniz University in Antalya. The field trip will be introduced by Aymon Baud. We propose to have open discussions to address various topics, such as: recovery patterns of various fossil groups; reconstruction of global Permian–Early Triassic oceanic and climatic conditions; P/Tr ecosystem types; and correlations of these types of data within a global stratigraphic framework. Different topics will be introduced by a short talk and will be followed by a group discussion. Propositions for further discussion topics are welcome!

The two-day field trip will offer participants the opportunity to visit the magnificent outcrops of the Taurus Mountains that provide unparalleled access to Permian to Triassic Tethyan platform carbonate. This fieldwork will be dedicated to the memory of Jean Marcoux, who studied and



mapped in great detail the geology of the area and promoted Permian and Triassic studies.

The number of participants is limited to 20, for safety reasons. Acceptance will be in order of registration and payment.

There is more information at <<http://sgfr.free.fr/seance/marcoux/fieldtripIGCP.php>> or contact <sylvie.crasquin@upmc.fr> or <aymon.baud@unil.ch>.



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

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

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

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



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

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

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



69th meeting of the Society of Vertebrate Paleontology and 57th meeting of the Society of Vertebrate Palaeontology and Comparative Anatomy
Bristol 23 – 26 September 2009

The Palaeobiology and Biodiversity Research Group at the University of Bristol is proud to host the 69th Annual Meeting of the Society of Vertebrate Paleontology. This will be a momentous occasion for the Society, the first time it has held its annual meeting in Europe, and only the second time



outside North America.

We will offer a number of special events to reflect the rich palaeontological heritage of the United Kingdom and mainland Europe. There will be the opportunity to participate in pre- and post-meeting field trips to the Isle of Wight, the Dorset Coast, Scottish Highlands and Islands, the Natural History Museum conservation unit and the famous fossil Lagerstätten of Germany, amongst others. Furthermore, there will be special events in honour of the centenary of the University of Bristol, the early study of Mesozoic reptiles (Anning, Buckland, Mantell, Owen), and of course Darwin. The year 2009 is Darwin year (the 200th anniversary of his birth, and 150th anniversary of the publication of *On the origin of species*) and there will be the opportunity to join a Charles Darwin Heritage tour, visiting Cambridge and Down House. Finally, as Bristol is home to the BBC Natural History Unit, we will offer an extensive programme on education and engagement in vertebrate palaeontology, including a special evening lecture by Sir David Attenborough.

We send a special invitation to all European vertebrate palaeontologists to consider attending the meeting. Membership of SVP is not required to attend. Further details, including booking details, may be found at <<http://www.vertpaleo.org/meetings/index.cfm>>.



**IGCP 572: Ecosystem evolution over the Permian–Triassic transition,
10th Paleontological Society of China Congress & 25th CPC**
Nanjing, China 14 – 17 October 2009

This symposium aims to update the studies on ecosystem collapse and re-building over the Permian–Triassic transition based on sedimentary and fossil records from South China. There is a growing number of new P/Tr boundary and Lower–Middle Triassic sections studied in South China in recent years. The IGCP 572 symposium hopes to offer opportunities for various Chinese working groups to communicate their new discoveries obtained from the newly found P/Tr boundary and Triassic sections. The IGCP 572 session also provides a unique opportunity for non-Chinese working groups to communicate directly with various Chinese researchers, and thus bridge their collaborations in the near future. Small funds are available to help students and presenters from countries outside China. More information can be found at <<http://www.china-psc.org.cn/>> and <<http://www.igcp572.org/>>.

If you have any questions, please contact organizers Jinnan Tong (e-mail <jntong@cug.edu.cn>) or Zhong Qiang Chen (e-mail <zqchen@cyllene.uwa.edu.au>).



**IGCP 572: Recovery of ecosystems after the Permian–Triassic mass extinction:
Field workshop in Oman**
Muscat, Oman 20 – 26 February 2010

This field workshop aims to investigate the recovery of ecosystems following the end-Permian mass extinction through analyses of the rock and fossil records, via studies of biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry.



The topics of the one-and-a-half day conference at the Gutech, Muscat, on 21 & 22 February 2010 will address recovery patterns of various fossil groups; reconstruct global Permian–Early Triassic oceanic and climatic conditions; outline P/Tr ecosystem types; and correlate these types of data with a global stratigraphic framework. New data on the Permian–Triassic transition in Oman will be presented.

The four-and-a-half days' field workshop excursion will offer to the participants the opportunity to visit the magnificent outcrops of the Oman Mountains, that provide unparalleled access to the Permian–Triassic transition units along the Gondwana margin of the Tethys, from shallow carbonate platform, Tilted block margin, continental slope and abyssal plain deposits.

More information can be found at the IGCP 572 website at <<http://www.igcp572.segs.uwa.edu.au/>>.

Pre-registration will start in late August, at the GUTech website at <<http://www.gutech.edu.om/>>.

For further information, e-mail Michaela Bernecker at <michaela.bernecker@gutech.edu.om>.



Special Meeting of the French Geological Society: Jurassic environments and faunas
Lyon, France 22 – 24 April 2010

This multidisciplinary meeting will consist of two days of indoor sessions and a one-day field-trip, and is planned to address various aspects in sedimentary geology, palaeoecology, biostratigraphy and palaeobiogeography. Scientific sessions will consist of keynote lectures, oral presentations and posters. The proceedings of the meeting will be published in the peer-reviewed journal Bulletin of the French Geological Society.

The post-meeting excursion will include a visit to the well-known Jurassic localities around Lyon (southern Beaujolais and Mont d'Or lyonnais).

For further information please visit <<http://SGF-elmi.univ-lyon1.fr>>.



IGCP 572: 2010 Meeting and Field Workshop in South China, International Conference of Geobiology (ICG)
Wuhan, China 4 – 6 June 2010

IGCP 572 is one of the major sponsors of the ICG and will organize three sessions at the ICG, China University of Geosciences, Wuhan, in Summer 2010: Permian/Triassic (P/Tr) mass extinction; Triassic restoration of marine ecosystems; and Global distribution of Early Triassic microbialites.

The symposium aims to update the studies on the P/Tr mass extinction and possible causes, investigate the mechanisms and processes of marine ecosystem restoration following the P/Tr mass extinction through studies of biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry, and elucidate the growth mechanisms and environmental significance of the Early Triassic microbialites. Three potential field excursions will be organized before and after the symposium: 1) Meishan-Chaohu: examining the P/Tr mass extinction and its



aftermath from platform ramp to basin setting; 2) Guizhou: assessing recovery pattern and processes of palaeo-communities in various facies settings; 3) Southern Tibet: collapse and re-building of marine ecosystems at the margins of Gondwana. Funds are available to help students and presenters to participate in the meeting and field excursions. More information can be found at <<http://geobiology.org.cn/2010meeting>> and <<http://www.igcp572.org/>>.

If you have any questions, please contact organizers Jinnan Tong (<e-mail jntong@cug.edu.cn>) or Zhong Qiang Chen (e-mail <zqchen@cyllene.uwa.edu.au>).



The 5th International Conference on Fossil Insects, Arthropods and Amber
Beijing, China 20 – 25 August 2010

The 5th International Conference on Fossil Insects, Arthropods and Amber will be held at Capital Normal University in Beijing, China from 20th to 25th August 2010. A series of scientific sessions – including plenary and special sessions, and special group meetings, in addition to mid-conference and post-conference field excursions – will be organized. Social events and programmes will also be arranged.

Preliminary schedule:

20 August: Registration and welcome reception

21 August: Opening Ceremony and group photo, Conference symposia and general sessions

22 August: Conference symposia and general sessions; Congress Banquet

23 August: Mid-conference social programme and conference excursion

24 August: Conference symposia and general sessions

25 August: Conference symposia and general sessions, workshops, Closing Ceremony

26–28 August: Post-conference field excursions

Abstracts for the meeting are due by 31st March 2010. A request for abstracts will be announced in the Second Circular, which will also have instructions for their electronic submission.

The mid-Conference social programme will be a visit to the Great Wall and Ming Tombs.

The post-Conference excursion will visit the Jurassic–Cretaceous Biota of Northern China: Insects, Feathered Dinosaurs, Basal Birds, Mammals, and Angiosperms. In recent years, the study of the Jurassic–Cretaceous Biota has been progressing rapidly in Western Liaoning of China. A lot of very significant fossils have been found in this area. Up to now, about 23 kinds of fossils in the Jehol and Yanliao Biota have been reported from Western Liaoning, including insects, dinosaurs, lizards, choristoderes, pterosaurs, birds, mammals, turtles, amphibians (anurans and salamanders), fishes, conchostracans, ostracods, bivalves, gastropods, shrimps, limuloids, spiders, ferns, gymnosperm, angiosperm, algae, pores and pollens. Western Liaoning of China is really a rare treasury of Mesozoic fossils and a magnificent place to study the origin and evolution of insects, birds, eutherian mammals and angiosperms. This trip begins and ends in Beijing, including two localities in Beipiao City, one locality in Chaoyang City and one locality in Lingyuan City of Western Liaoning.

The registration fee is US\$350 (students US\$200, accompanying person US\$200), which will cover the expenses of the meeting resources and support, congress publication (congress special



issues, abstract volume and programme, not provided for accompanying members), conference bag, T-shirt, tea and coffee breaks, all meals from 20th to 26th August, Mid-Conference social programme to Great Wall and Ming Tombs on 23rd August, icebreaker reception, and conference lunch and dinner. The Congress Banquet on the evening of 22nd August will be available for regular registrants without additional charge.

Note:

1. Registration fees are subject to modification depending on the exchange rate between the Chinese Yuan RMB and US\$. The rate of exchange on 23rd January was US\$100 = 680.37RMB Yuan.)
2. Payment: A down-payment for the meeting and field trips will be requested in the Second Circular. The balance will be due at the time of the meeting, payable in US\$.
3. Outstanding students and distinguished retired palaeontologists may apply for limited financial support (free of charge for Registration Fees and Accommodation from 20th to 26th August). All applicants should give an oral presentation and contribute an original manuscript to the Proceedings for evaluation by the Organizing Committee.

If you would like to receive the Second Circular with the programme outline, registration and abstract forms and the application for accommodation, please contact the Conference Organizing Committee before 31st December 2009 at the address below:

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Cell: 0086-13661048193

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



SPECIAL MEETING of the French Geological Society (S.G.F.) LYON: 22-23-24 April 2010

Jurassic Environments and Faunas

Under the auspices of the Comité Français de Stratigraphie,
the Groupe Français d'Etude du Jurassique and the Association Paléontologique Française



A tribute to Serge ELMI

The meeting will consist in two days of indoor sessions (22-23 April 2010), and one day of field excursion (24 April 2010). This multidisciplinary meeting on **Jurassic Environments and Faunas** is planned to address various aspects in sedimentary geology, palaeoecology, biostratigraphy and palaeobiogeography. Scientific sessions will consist in keynote lectures, oral presentations and posters. The proceedings of the meeting will be published in the peer-reviewed journal *Bulletin of the French Geological Society*.

The post-meeting excursion will include the visit of the well-known Jurassic localities around Lyon (southern Beaujolais and Mont d'Or lyonnais).

Informations: SGF-elmi.univ-lyon1.fr

Organizing committee : D. Barbe, A-M. Bodergat, Ph. Fortin, C. Gaillard, F. Giraud, P. Hantzpergue, B. Lefèbvre, E. Mattioli, S. Passot, S. Reboulet.

Scientific committee : Y. Almérás, K. Benshili, M. Boutakiout, G. Dromard, L. Duarte, R. Enay, C. Lécuyer, N. Morton, G. Pavia, R. da Rocha, L. Rulleau.





Palaeontology courses: a hard sell for hard times?

The past year has seen major turmoil in the economy, and there are indications of a major rise in applications to UK universities, with reports of around an eight percent rise in applications compared to 2008. An unusual part of the overall rise is the higher proportion of people over the age of 24 who have applied (see for example <<http://www.timesonline.co.uk/tol/news/uk/education/article5741496.ece>>).

As these economic shifts are being felt globally, similar trends are likely to emerge in other countries. Whatever your political views are on the matter, it is timely to consider how palaeontological courses, and the broader earth and biological sciences degrees in which they are embedded, can be made attractive to students who are being asked to shoulder, on average, significantly larger debts than people who completed their first degrees even as recently as the mid-1990s. In an ever more market-driven system we should think of the problems faced by students on courses with high numbers of contact hours and the accompanying potential for loss of supplementary earnings involved in the field component. Finally, it is worth considering what the employment prospects are for palaeontologists, and how these prospects may be changing.

Overcoming debt-aversion

Charging for higher education has been a point of contention almost since people first had the opportunity to seek such education in ancient Greece. The current situation in most countries is that most students will make some financial contribution to their fees and living costs at university. Since student loans were introduced in the UK, concerns have been voiced that they have deterred people from less well-off backgrounds from entering university. Some research has been done on the topic, and definite evidence has emerged that a combination of negative attitudes towards getting into debt and being from a less well-off background do deter some people, even when other factors are controlled for (Callander & Jackson 2005). More worrying is the fact that this effect extends to people who have equivalent education qualifications to those who do enter university and have thus clearly demonstrated that they can benefit from university education (Davis *et al.* 2008).

Debt aversion, and the wider issue of encouraging people into university, has two facets: perceived costs and perceived benefits. The perceived costs influence the choice to enter university at all and I will focus on this aspect. By focusing on reducing the perceived costs, it is easier for the benefits to outweigh them. As noted above, there is a need for universities, schools and colleges to target their efforts on those for whom perceived costs are highest, and who may have other concerns about the value of Higher Education (HE) (<<http://www.UniversitiesUK.ac.uk/studentdebt>>). Research indicates that once debts have been taken on, people will adjust their thinking to accommodate the fact as a positive choice, and the focus should be on getting students into HE in the first place (Davis & Lea 1995). So it is important that we have admissions tutors who are as comfortable with explaining the financial aspects of HE entry as with helping people pick the right subjects and courses.

Most societies seem willing to intervene in the environment that people grow up in, and economic systems are one means of doing so. We should couple this willingness to manipulate economics (which not everyone is) with a principle such as Rawls' 'veil of ignorance' – the



argument that the choices we make about how our society works should be taken from the standpoint of someone who did not know the family or environmental circumstances they were going to be born into (Rawls 1971). Rawls also espoused the principle that inequalities in society should work to benefit the least advantaged, which corresponds to the debt-averse but academically-able students discussed by Davies *et al.* (2008).

A particular aspect of the 'veil of ignorance', in relation to parents, is that they do not know what their children are going to be like. While many parents make sacrifices to enable their children to pursue careers, it seems unfair to ask parents who may be baffled by what their child does, to make enormous sacrifices relative to other parents around them. A good example of trying to bridge the gap was one exercise Fred Ziegler ran on his Historical Geology course that was aimed at allowing the students to go home and tell their parents about the geology near where they grew up. Obviously, there is not universal agreement on Rawls' principles and theory. However, so much discussion and criticism has centred upon these influential ideas, that I think they make a good starting point for thinking about these issues, and remind us that apparently isolated problems always have a wider political and societal context.

The work–work balance

Once students have entered university there is another major dilemma; how much paid employment should they undertake during their course of study? The expansion of HE in the UK has been accompanied by a significant increase in the number of students who work during term-time through the week in order to support themselves (NUS/HSBC survey 2008). The survey shows that this is partly down to the expansion in the range of things that students spend money on, but for many students it is a matter of financial necessity. Many science and engineering courses can easily have 30 hours of classes a week and during project sessions students can be introduced to the reality of academic research; that it does not run nine-to-five for five days a week. This diminishes their ability to fit into flexible shift patterns that many part-time employers prefer. In a more market-driven world, student interest may be more reluctant to pursue such courses due to the limitations on the opportunity to make money during the course. Competition for part-time work has also increased with the recent changes in the economy (<http://news.bbc.co.uk/2/hi/uk_news/education/7956274.stm>).

For students on field-based courses the earnings issue problem can become even more acute. A Summer spent mapping is a Summer without income, but this is usually a requirement of an earth sciences degree. To their credit, many university departments with a field component have chosen to subsidise fieldwork or make it free, but this cannot fully compensate for loss of earnings for a Summer. Some of the more unusual transferable skills gained in palaeontology are learned during fieldwork, and some people who may be attracted to working outdoors may be put off by worries about their loss of income. To have students choosing courses they are less passionate about for economic reasons runs the real risk of such students achieving less than they might have at university.

A positive move would be to make students aware of their skills as early as possible, and encourage them to try for better-paid Summer work that will both contribute to their professional development and help to bridge the income gap during term-time. Another option, although perhaps a controversial one, would be to encourage students to come to university when they are slightly older, after building up some savings. This could have other benefits, such as allowing prospective students to learn how to live and work independently before starting at



university. It is often easy to forget that many undergraduates have to make multiple transitions when they start university, and not having to make all the transitions simultaneously might be beneficial to some.

Palaeontology: what's it good for?

To be blunt, palaeontology is rarely studied as the sole topic of an undergraduate degree but as a component of a geology, earth or biological sciences degree. Earth scientists lie in the middle ranks of science and engineering starting salaries for recent graduates in both the UK and Ireland (Forfás 2006). When it comes to careers that require palaeontological knowledge and training, one of the traditional employers of choice has been the petroleum industry, particularly for micropalaeontologists. While it is true that there are still good positions to be had in the extractive industries, students need to be aware that being an excellent geoscientist alone may not be enough. Although geological and palaeontological skills are critical in finding the raw resources that the energy, mining and minerals sectors exploit, such companies must emphasize the production and marketing aspects of their operations in order to satisfy shareholders and the market.

The energy and mining sectors are sensitive to the commodities and stock markets, which have fluctuated considerably over the past few years. Last Summer the press was filled with reports of new earth sciences graduates being snapped up by these sectors with excellent offers. The interviewees were understandably elated, but I am not confident that these people will have been retained with the downturn in demand for oil and metals. We owe it to students to make them understand how companies work and make them realize that the task they are trained in, the finding and evaluation of deposits, is only one aspect of the business of such companies. Students who express an interest in working in these industries should be encouraged to consider some courses in production engineering, law or resource economics, as this will allow them to advance within these industries.

On a more positive note, what are the emerging areas where specialist palaeontological skills might be of benefit? Previously, I have written in the *Newsletter* about geodiversity (McGowan 2006), and this area has some potential as a source of future employment for geoscientists. As many geodiversity plans or surveys will have a palaeontological dimension, this is somewhere that students with palaeontological training will have a particular advantage. As Earth heritage is beginning to influence broad areas of the economy, including tourism, land use and planning applications, it is possible to have a diversified portfolio of activities that could be combined with other activities. Earth sciences and palaeontology also have a broader contribution to make in national parks, ranger services and conservation bodies. Such work may not be as well-paid, but it can make up one aspect of a broader career in consulting.

Another area where palaeontologists may have particular advantages is in adult and museum education. Earth sciences courses are often popular choices for adult education, whether run in a museum or a university, and can be viewed as an extension of the general enthusiasm for natural history topics. Such courses straddle the boundary between education and leisure, but this does not mean they are not a good potential source of jobs for palaeontologists who often have both field and museum experience. Shifts in the economy mean that more people are being employed in such areas of the economy, and getting students who are interested in such careers involved in local natural history museums and science centres would help them to understand that their palaeontological knowledge is a real advantage when engaging with passionate amateur scientists.



The cost of running field courses also makes me wonder whether some universities might move towards having specialist, shared field centres with dedicated field-teaching and training staff. Other universities, with smaller budgets or only a few geology students, might opt to send students to 'field camp' as happens in the USA. The Field Studies Council already has some centres that run on this model; such field centres could have genuine potential for a range of teaching, and also interdisciplinary research. Field centres could also make a real difference to local economies in rural areas, and provide another route to economic diversification in the countryside.

Conclusion

The tough economic decisions facing current university applicants can provide a stimulus for us to think about the perceived value of palaeontology and its allied disciplines. By working through some of the economic arguments, I have endeavoured to highlight how prospective students might be evaluating the attractions of various courses in ways that are not always obvious to those who have 'come out the other side'. Evidence-based studies make worthwhile reading, as they can help us to arrive at balanced judgements about the outcome of policy decisions, and are particularly useful for highlighting when policies we may agree with for ideological reasons, or because they have been successful in other countries, are failing in the particular country or region we work and live in.

After a doggedly 'market' examination of the perceived costs and benefits of a palaeontological degree, I'd like to end on some of the 'non-market' aspects. Becoming an earth scientist has profoundly changed my perception of the world, as it has made me aware of the vast range of spatio-temporal scales that have shaped our planet and our universe. The interaction between my formal scientific training and my broader interests in natural history and habitat conservation has enhanced my experiences as both a 'professional' and a 'citizen' scientist. It is also a great pleasure to be able to explain landscapes, rocks and fossils to people who ask, particularly being able to explain the underlying processes.

I conclude with a moment of pure pleasure that I could not have experienced without my training in geology and palaeontology. In Iain Banks' *The Crow Road* the father of the central character, Prentice, writes stories based on the geology and landscape of the Highlands. Prentice recalls that his dad's longest, and best, story is about the formation of Scotland and the geological processes that accompanied it. I know I can tell my daughter that story too. With added fossils.

Al McGowan

Newsletter Reporter

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Sylvester-Bradley REPORTS

Re-evaluating the early evolutionary history of Crocodylomorpha

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Modern crocodylians all occupy a well-defined semi-aquatic carnivore niche and represent only the tip of the iceberg in terms of historical crocodylomorph diversity. For instance, metriorhynchid crocodyliforms lived in marine waters while sphenosuchian crocodylomorphs lived exclusively in terrestrial settings. In 1986, Clark produced the first comprehensive cladistic treatment of crocodylomorph systematics, using morphological data. To the credit of this work, the relationships inferred from the resultant phylogenetic trees are upheld still. That analysis forms the foundation for many of the more recent analyses, and today there are numerous competing systematic analyses. However there are many points on which there is general agreement. It is widely accepted that within Crocodylomorpha, sphenosuchians are most basal in position, outside of a larger grouping named Crocodyliformes. Within Crocodyliformes, protosuchians are considered most basal, with all other crocodyliforms placed in Mesoeucrocodylia, which may be further subdivided into more refined groupings. However the regions of the cladogram that require more attention are the boundaries between the well-defined groupings. Analyses that focus on crocodyliforms rarely include more than a few sphenosuchians, which are usually forced to be outgroups.

The primary aim of this project was to supplement my existing character-taxon matrix with new information about a number of key species from South America that were poorly represented in the matrix. In particular, sphenosuchians like *Pseudhesperosuchus jachaleri* and *Barberenasuchus brasiliensis* were of great interest. Other species including some aetosaurs (e.g. *Aetosauroides scagliai*) and protosuchians (e.g. *Hemiprotosuchus leali*) were also studied to allow comparisons. The Sylvester-Bradley Award made it possible for me to visit collections in Buenos Aires and Tucuman in Argentina, and Porto Alegre in Brazil. The data collected from these visits has been included within the supermatrix that forms part of the basis of my PhD. Analysis of this dataset is ongoing, but has benefited from a number of character revisions, thanks in part to these collection visits.

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CLARK, J. M. 1986. Phylogenetic relationships of the crocodylomorph archosaurs.
Ph.D. dissertation, University of Chicago, 556 pp.



Libycosuchus and the ancestry of mesoeucrocodylian hypercarnivory

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Crocodylians (= Crocodylia Gmelin 1789; = Crocodyliformes Benton & Clark, 1988) include a wide variety of forms, from terrestrial to fully marine, or from carnivorous to omnivorous (and possibly herbivorous), from small (~1 m) to large (15 m) species, ranging from the Upper Triassic to the present day. Only the eusuchian crocodylians survive today, a poor restricted sample of the original diversity of forms (see Buffetaut, 1979; Clark, 1994). My project focuses on the origin and diversity of the highly predaceous terrestrial species, which include a variety of forms often termed Sebecosuchia (e.g. Gasparini, 1972; Steel, 1973; Buffetaut, 1982; Ortega *et al.*, 2000), contained within the former Mesosuchia (= non-eusuchian Mesoeucrocodylia).

Sebecosuchians were high-walking forms from South America, possessing long, narrow snouts and serrated teeth (= ziphodont dentition; Prasad & Broin, 2002; Andrade & Bertini, 2008). Also, all sebecosuchians had a complete secondary bony palate and nasopharyngeal duct, 'mesosuchian' choanae (= bounded by pterygoids and palatines) and non-procoelous vertebrae. More primitive groups (e.g. Protosuchidae, Sphenosuchidae) had no bony palate, while the living crocodylians (Eusuchia) have procelous vertebrae and the choanae enclosed by the pterygoids. Despite their common features, the validity of Sebecosuchia has been criticised (e.g. Clark, 1994; Andrade *et al.*, 2006; Larsson & Sues, 2007). This is one of the key phylogenetic problems in the heavily debated evolutionary history of crocodylians, particularly on the poorly supported interrelationships of the Mesoeucrocodylia (e.g. Clark, 1994; Ortega *et al.*, 2000; Sereno *et al.*, 2001; Turner & Calvo, 2005; Andrade *et al.*, 2006; Gasparini *et al.*, 2006; Larsson & Sues, 2007). Following the phylogenetic approach by Sereno *et al.* (2001), Mesoeucrocodylia is divided into two main branches: Notosuchia (mostly South American terrestrial forms) and Neosuchia (mostly Laurasian semi-aquatic forms). The last group includes the Eusuchia and all living forms. This phylogenetic arrangement, though widely used, is far from being consensual, as a number of clades "jump" from one branch to the other with great ease, according to the phylogenetic hypothesis taken.

Many poorly known sebecosuchian taxa are represented by incomplete material, in limited and outdated descriptions, most of them published before the 'cladistic revolution', meaning that the data available are often inaccurate. The Sylvester-Bradley Award allowed me to examine a few of the most enigmatic Sebecosuchians housed in Germany, most notably *Libycosuchus breviostris* Stromer and *Bergisuchus dietrichbergi* Kuhn (Figure 1, overleaf), as well as other highly predaceous forms belonging to different crocodylian branches (see below). Additional to its palaeobiological relevance, the skull of *Libycosuchus* (BSPG-1912-VIII-574; see Stromer, 1914) was one of the few pieces of Stromer's collection to 'survive' the Second World War. Also, examination of the German collections allowed me to expand my phylogenetic matrix widely (particularly on basal neosuchians).



Figure 1. Key fossil crocodilians examined during this project. A) Libycosuchus brevisrostris type, in its resting place at BSPG, Munich. Bergisuchus cf. dietrichbergi, right mandibular ramus, housed by Geiseltalmuseum, Halle (Saale). Bar = 20mm.

Methods followed standard procedures for fossil study, photography and measurement. The specimens were sketched in detail, with notes on their morphology and preservation. The binocular microscope was used to examine details of dentition, particularly serrations. Species were added to the phylogenetic matrix, directly coded during the examination. Photographic equipment comprised of a Nikon D40 with standard lens/macrolens, tripod and remote control. These produced high-quality images, enabling illustration of fine anatomical details, such as tooth serrations and delicate sutures (Figure 2). A small number of teeth were borrowed from Munich and Stuttgart for scanning electron microscopy (SEM) study at the University of Bristol. The material was returned prior to the end of 2008.



Figure 2. Macrophoto with detail of a maxillary tooth of *Pristichampsus* GM-XXII-415-1961. Note the small features of teeth crowns, such as the absence of enamel ornamentation and the presence of serrated carinae, formed by true denticles.

Four days were spent in the Museum für Naturkunde der Humboldt-Universität zu Berlin (MB), examining material mostly of thalattosuchians and pholidosaurids, allowing the enhancement of the phylogenetic matrix, notably the neosuchian branch. An entire day was taken to visit the astonishing collection of the Geiseltalmuseum, at the Institut für Geowissenschaften, in Halle (Saale). This collection houses amazing specimens of post-Cretaceous crocodylians preserved within layers of carbon, including: *Diplocynodon*, *Allognatosuchus*, *Bergisuchus*, *Pristichampsus* and *Asiatosuchus*. The *Pristichampsus* material preserves *in situ* gastroliths and hoof-like unguals. *Pristichampsus* and *Asiatosuchus* are also important fossil species in this study because they were hyperpredaceous post-Cretaceous eusuchians, the former being highly convergent upon sebecids.

Five days were spent in the Bayerische Staatssammlung für Paläontologie und Geologie (BSPG) in Munich, where many historical types are housed. There, I examined the sole skulls of *Libycosuchus* and *Geosaurus grandis*, *Cricosaurus* and *Pelagosaurus*. *Geosaurus grandis*, a fully marine Jurassic metriorhynchid, also had a theropodomorph dentition and was of particular interest. The curator, O. Rauhut, graciously granted me additional access to an undescribed specimen of cf. *Hamadasuchus*.

This was followed by five days of work in the Staatliches Museum für Naturkunde Stuttgart (SMNS), where the neosuchian *Vectisuchus* and the thalattosuchians *Dakosaurus*, *Geosaurus suevicus*, *Steneosaurus*, *Pelagosaurus* and *Platysuchus* were examined in detail, most of which are beautifully preserved with articulated skull and postcrania. The curator, R. Schoch, kindly offered an unreported mandible of *Araripesuchus* from Brazil for examination and description. In fact, the specimen turned out to be from a much rarer taxon, possibly a trematochampsid, which will be the subject of a separate manuscript. Unfortunately, no contact could be established to



examine the *Bergisuchus* specimens from Darmstadt; therefore a visit to Frankfurt, originally included as the last part of the project, was not possible. Nevertheless, a cast of the specimen was kindly made available for study by L. Loeffler (DES-UBris).

The most important results – after more than 15 days of detailed study, observation, phylogenetic coding and data collection – include the direct examination of no fewer than 80 specimens of more than 30 fossil taxa, a vast collection of photographs, and an improved phylogenetic data matrix.

As regards *Libycosuchus*, close examination of the specimen reveals that the material demands a new interpretation, opposing the original conception by Stromer (1914) in several aspects. Poor techniques of preparation (common at the beginning of the 20th century) seem to be largely responsible for several misleading features attributed to the taxon: the intense use of plaster to reconstruct structures (e.g. infratemporal bar) also covered important structures that would be visible otherwise (e.g. antorbital fossa). Furthermore, the mandible was completely reconstructed, artificially resembling that present in alligators. The element doesn't even articulate with the skull! *Libycosuchus*' dentition is incompletely preserved and most teeth are missing; therefore, no statement on its dentition as a ziphodont can be supported. Specific phylogenetic assignment was obtained, but it is not as basal a crocodylian as previously conceived.

The dentition, ornamentation and symphyseal morphology of *Bergisuchus* resembles that found in sebecids, although tooth crowns are unserrated (the tooth crowns bear only a distinct keel).

The comparison of German-housed terrestrial hyperpredators (*Libycosuchus* and *Bergisuchus*) with South American forms (Baurusuchidae) does not support the Sebecosuchia as a natural group. Sebecosuchian-like forms represent at least three different groups in crocodylian evolution. Moreover, highly predaceous forms with serrated teeth (either true or false; see Prasad & Broin, 2002; Andrade & Bertini, 2008) evolved at least three other times within Mesoeucrocodylia: at least once in Thalattosuchia (*Geosaurus* + *Dakosaurus*); twice in Eusuchia (*Pristichampsus*, *Asiatosuchus*). A full manuscript on the issue will be produced as part of my PhD thesis, and submitted in the following months.

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Polar gigantism in Ordovician trilobites from Portugal

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During their 300 million year history, trilobites evolved to occupy a wide geographical, ecological and morphological range, adapting to many distinct environmental settings (Fortey and Owens 1997). Concurrently, the group developed a large range in adult 'holaspid' body size. Although modern arthropod (especially terrestrial) groups display a more restricted size range, this was not true of Palaeozoic arthropods (Briggs 1985), and trilobites were no exception. Holaspids are currently known to vary from around 2mm (*i.e. Acanthopleurella* Rushton and Fortey 1988) to over 700 millimetres long (*Isotelus rex* Rudkin *et al.* 2003).

The understanding of macroevolutionary patterns of size change is an important area of palaeontological research; several trends have been observed in many disparate animal groups and throughout the Phanerozoic. Usually, these patterns are placed into popular 'rules', *e.g.* Cope's Rule (for 'driven' trends over time) or Bergmann's rule (for latitudinal gradients of size). Bergmann's rule is defined as a within-species trend towards larger size at increasing latitude. It is usually restricted to ectotherms such as birds but has been suggested to apply to other invertebrate groups. Chapelle and Peck (1999) suggested that increasing size in amphipods is positively correlated with increased oxygen availability in higher latitudes. Both 'rules' have been subjected to severe criticism, with no real agreement on whether they are applicable or not.

The Sylvester-Bradley award supported a visit to a newly discovered site. Located near the town of Arouca (south of Porto), western Portugal, this slate quarry is important as a scientific locality as well as a local monument. Fossil arthropods, graptolites, brachiopods, echinoderms, molluscs, hyoliths and conularians are mainly found in two horizons within the slates of the Valongo Formation (Middle Ordovician) (Sá and Guitierrez-Marco 2006). The trilobites in the fauna show high diversity, containing members of the Asaphida, Phacopida, Illaenidae and Lichida. The aim of the visit was to photograph and record the dimensions of the specimens that have so far been collected in the site. Armed with a camera, callipers and a large notebook I set about measuring as many specimens as possible. The site is an active slate quarry, so it was not possible to examine the section or specimens *in situ*, however the level of dedication for the preservation of these specimens is such that should a new specimen appear, the quarry is shut down until it is retrieved from the rock.

There appears to be little pattern in the distribution of trilobite gigantism, with large individuals and populations described from the Cambrian to the Devonian and from high and low palaeo-latitudes. Rudkin *et al.* (2003) suggested that only *Uralichas hispanicus* conforms to Bergmann's rule and therefore, polar gigantism. To a certain degree this is true: *Isotelus rex* and *Teretaspis grandis* are known from equatorial palaeolatitudes (*i.e.* Laurentia). However, localities placed near to the palaeo-pole also provide populations of large individuals (~300 mm). Such examples include *Paradoxides davidis* (Middle Cambrian of Avalonia) (Bergstrom and Levi-Setti 1978), *Dikelocephalina sp.* and *Asaphellus sp.* (Tremadoc of Morocco) (Levi-Setti 1999).



Other contemporaneous polar sites contain specimens with a notable positive size bias; individuals from the Lower Fezouata Formation in Morocco (Tremadoc) are typically larger than 250 mm (Van Roy 2006). However, trilobites from the Valongo Formation show a much wider size range, with holaspids varying from 40 mm (*Bathychelius castilianus* and *Placoparia (Placoparia) cambriensis*) to 300 mm (*Hungiodes bohemicus* and *Ogyginus fortleyi*). Large specimens are abundant in the collection, and the largest is a specimen of *Ogyginus fortleyi*, consisting of a cephalon and four thoracic segments (Figure 1).



Euan Clarkson (left) and Peter Budil (right) standing with some of the larger specimens of Ogyginus fortleyi. The specimens in the top middle are the part and counter part of the largest specimen in the collections. For scale, Euan stands 5 ft 11 inches (180cm).

From existing data on this family it is possible to predict the size of the complete specimen with a high degree of accuracy. Using the dimensions of the cephalon it is possible that *Ogyginus* may rival the current record holder (*Isotelus rex*). Unfortunately, due to tectonic stresses, many of the specimens have been deformed, some more than others. Nevertheless, those that show less deformation (Figure 2) suggest that the increased body size seen in this region is not an artefact.

During this visit the Canales site was also the setting for the pre-conference field trip for the Fourth International Trilobite conference. This provided the quarry owner Manuel Valerio and the other organisers an opportunity to show off their specimens to some of the world's trilobite researchers. As part of the trip the quarry, designated the Centro de Interpretacao Geologica Canales (CIGC), was inaugurated into the International Geopark network (<<http://www.geoparquearouca.com/>>). This culminated in the unveiling of a monument in the centre of Arouca of several large slabs of the site's slate complete with bronze trilobites. Manuel, who is so dedicated to the preservation and scientific study of his specimens, has also supervised the construction of a trilobite-themed museum (again from local slate) consisting of three smaller buildings (or sclerites I suppose), a shop, a museum and a small lecture theatre. The latter includes a large model of *Neseuretus avus*, an important component of the fauna (measuring 2 metres in length, unfortunately it's just a model) (Figure 3).

The several hundred trilobites measured during this trip have been added to the database of trilobite size built during my PhD. This will allow for the comparison of size between high



A specimen of Ogyginus forteyi, showing less evidence of deformation. Callipers (30 cm) for scale.

and low latitude terranes across the Palaeozoic to determine whether polar gigantism occurs in trilobites. Initial results suggest that this is the case, with equatorial trilobites displaying consistently smaller size (e.g. China, Siberia and Australia) than polar trilobites (Morocco, Newfoundland and England).

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A model of Neseuretus avus from the museums lecture theatre, anterior (left) and left lateral (right) views.



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Nitrogen and organic carbon isotopes in Cretaceous fossils from Argentina

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'O Patagonia!' he cried. 'You do not yield your secrets to fools. Experts come from Buenos Aires, North America even. What do they know? One can but marvel at their incompetence. Not one palaeontologist has yet unearthed the bones of the unicorn.'

From *In Patagonia*, by Bruce Chatwin

In modern ecosystems, the trophic level of organisms can be distinguished on the basis of their nitrogen and organic carbon isotopic signatures. The stable isotopes of nitrogen (^{14}N and ^{15}N) and organic carbon (^{12}C and ^{13}C) are fractionated by all animals during the assimilation of food and the creation of new body tissues (DeNiro & Epstein 1978 and 1981). ^{15}N and ^{13}C content increases with trophic level in consumers and the resulting ratio of heavy to light isotopes ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) in tissues can define the trophic level occupied by an organism. This increase results from preferential excretion of the lighter ^{14}N and ^{12}C as a by-product of protein synthesis, leaving the animal enriched in ^{15}N and ^{13}C when compared with its diet (Kling *et al.* 1992). In top predators the concentrations of ^{15}N and ^{13}C are therefore at a maximum (Cabana & Rasmussen 1994). Using $\delta^{15}\text{N}$ data, trophic level can be calculated directly for an entire ecosystem by using one species from a known trophic level as a reference (see Pinnegar *et al.* 2002). An example of the stepwise relationship between $\delta^{15}\text{N}$ and trophic level in an ecosystem is shown in Figure 1. Because consumers generally have carbon isotope compositions similar to their foods, $\delta^{13}\text{C}$ measurements



place constraints on the influence of different potential food sources (Kling *et al.* 1992; Hecky & Hesslein 1995; Vander Zanden & Rasmussen 1999). These stable isotopes have been utilised to distinguish many modern food webs, particularly those where trophic interactions cannot easily be observed and where gut content analysis can be misleading, such as with sperm whales and giant squid in the deep ocean (*e.g.* Ruiz-Cooley *et al.* 2004; Chérel & Hobson 2005). Using this chemical technique has also proven to be a powerful tool for understanding the interactions and feeding habits of prehistoric animals, particularly in the interpretation of diet in early humans from archaeological sites (*e.g.* Drucker & Bocherens 2004; Hedges & Reynard 2007).

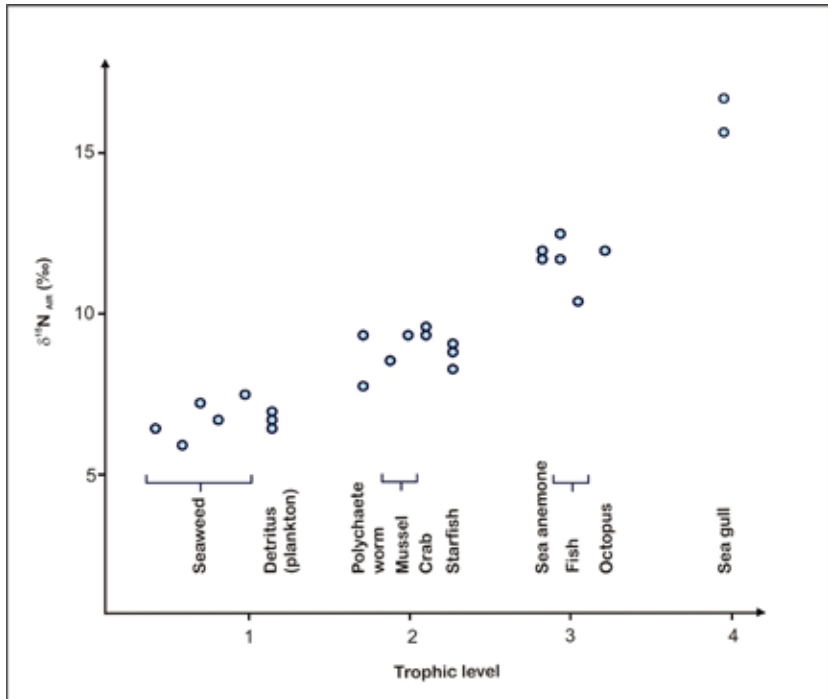


Figure 1. Stepwise enrichment of $\delta^{15}\text{N}$ between species feeding at different trophic levels in an intertidal community in Usujuri, Japan (from Minagawa & Wada 1984).

In many isotopic studies of prehistoric animals, collagen has been extracted from bone and tooth dentine for nitrogen and organic carbon isotopic analysis in order to interpret human diet source (*e.g.* Wright & Schwarcz 1999; Drucker & Bocherens 2004; Fischer *et al.* 2007; Hedges & Reynard 2007). However, in much older fossils the collagen is typically thought to have degraded within the first 10–30 k.y. post-mortem, although remnants of organic matter can persist (Briggs *et al.* 2000). Subsequent to the inception of my PhD project, two studies utilising $\delta^{15}\text{N}$ and $\delta^{13}\text{C}_{\text{org}}$ values to interpret ancient food webs that contain primary producers and the preserved soft tissues of vertebrate organisms have been reported (Schweizer *et al.* 2006 and 2007). Both focus on fossil lagerstätten from Tertiary lacustrine ecosystems and conclude that the $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values are valid and can be used to reconstruct trophic structure. My PhD study focuses primarily on the Eocene fish from the Green River Formation of southwest Wyoming, USA, in an attempt to



differentiate the trophic structure of a well-studied ancient aquatic community using $\delta^{15}\text{N}$ and $\delta^{13}\text{C}_{\text{org}}$ data from the fossilised hard parts of these extinct organisms. Much work has been done and the results are promising, indicating that the isotopic composition of fish scales is reliable. An excellent opportunity to apply this method of isotope investigation to an additional extinct aquatic community arose in March 2008 at the kind invitation of Dr Daniel Poiré of the Centro De Investigaciones Geológicas, Universidad Nacional de La Plata, Argentina. The Mata Amarilla Formation in the Austral Basin of southern Patagonia (Figure 2) contains countless fragments of bones, teeth and scales from vertebrates of the upper Cretaceous, thus presenting an exceptional opportunity to attempt to use N and C isotopes to gain valuable insight into an older and little known fossil community. The Sylvester-Bradley Award enabled me to travel to Patagonia and collect material for analysis.



Figure 2: Map showing location of the field area of interest in the Santa Cruz Province, Argentina (redrawn after Iglesias et al. 2007). The extent of the Austral Basin is shown in pale blue.

Biomineralized tissues such as scales and teeth of fish and sharks, turtle carapace fragments and dinosaur bones were collected for analysis (Figure 3, overleaf). Despite many possible causes of variation in the $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ isotopic composition of animals during both life and diagenesis, the resulting data appears to be robust. This conclusion is based on expected isotopic differences between these ecologically distinct taxa as predicted from their extant equivalents. These data also exhibit the expected trend of isotopic enrichment with increasing trophic level. This palaeocommunity confirms the potential of using N and C stable isotope ratios from hard tissues of animals of geological age to determine trophic levels and palaeoecology within an extinct ecosystem. This data will be presented in future conference presentations and publications. Retrieval of original isotopic data from the organic matrix within biomineralized tissues of fossils opens up new possibilities for similar ecological assessment of other ancient communities.



Figure 3: Collecting fossils in Patagonia with Dr Daniel Poiré.

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The homology of biomineralization in the Lophotrochozoa: implications for the Cambrian biomineralization event

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The Precambrian–Cambrian boundary is easily identified in the field in large part because the Phanerozoic is characterized by the abundant skeletal fossils of animals, algae and protists. Polyphyletic radiations are intriguing because they provide evidence for broad ecological changes operating at a particular point in time. In the Cambrian biomineralization event, the advent of skeletons was likely due to increased predation pressure leading to 'arms races' between predators and prey or oceanic geochemical change such as an increase in the availability of ions used to 'make' biominerals. However, to date there have been few studies investigating whether



biomineralization in animals is homologous or convergent, which is important for understanding whether this was indeed a polyphyletic radiation as opposed to an invention of the genetic machinery necessary to make skeletons. Biomineralization is a cellular process, and as such, homology can be usefully tested using modern organisms. Regardless of their mineralogical composition, biominerals have an organic phase occluded within the mineral. These proteins reduce the brittleness of a pure mineral and are actively involved in providing nucleation surfaces and directing the shape and properties of the biomineral. It has long been suggested by palaeontologists (Runnegar, 1986) that the phylogenetic distribution of these shell-matrix proteins may hold clues to the homology of biomineralization.

Based on a study of Cambrian taxa such as *Halkieria* and *Wiwaxia*, Conway Morris and Peel (1995) proposed that sclerites characterized the last common ancestor of molluscs, brachiopods and annelids. Thus palaeontological data suggest that biomineralization may perhaps be homologous for at least a subset of the Lophotrochozoa. In the course of my research I have been testing this hypothesis both by working towards constructing a molecular phylogenetic framework for the Lophotrochozoa, and investigating the shell-matrix proteins used by molluscs and brachiopods. The phylogenetic work has proceeded along two lines; the first using a concatenated set of seven nuclear housekeeping genes, for which I now have data from over 60 lophotrochozoans. The second line of inquiry involves microRNAs, which are small non-coding RNA genes that appear to have high value for phylogenetics as they are continually added to metazoan genomes and once added, rarely lost, making them an essentially homoplasy-free dataset. I have constructed and sequenced microRNA libraries from thirteen lophotrochozoan taxa, and am currently in the process of analyzing this data. These approaches should provide a solid phylogenetic framework to understand the evolution of biomineralization within the Lophotrochozoa.


This Summer I travelled to the Friday Harbor Labs in the San Juan Islands of Washington State, USA, and collected specimens of *Terebratalia transversa*, and dissected out their mantle tissue. I have extracted the messenger RNA from the mantle, which encodes the shell matrix proteins, and am currently building the cDNA library for sequencing. The highly expressed messenger RNAs will likely be either nuclear housekeeping genes or shell matrix proteins. After removing the housekeeping genes using BLAST searches, the remaining putative shell matrix proteins can be compared to known mollusc proteins to see if the two phyla hold any in common.

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Soapbox

Idolatry

Certainly no reader of this newsletter will be unaware that there is a new kid on the block in the Pantheon of famous fossils: Ida. She was revealed to the world on 19th May 2009 through two distinct channels. Her formal description appeared in a scientific paper in the peer-reviewed journal *PloS ONE*, but the vast majority of people will have first met Ida in the popular media, where she was presented as a rather more glamorous girl than what the sober facts would seem to suggest. Hence, immediately after this double debut, scientists, science writers and everyone else with an opinion took on the media

hype in the communal inbox of the blogosphere. Yet, it wasn't any of the basic facts about Ida that elicited this global typing tirade. After all, she represents the most completely preserved fossil primate ever found, and as such fully deserves the media attention so liberally foisted upon her. She is so stunningly fossilized that the furry outline of her body can be traced on the rock, and even the remains of her last meal of leaves and fruit are still detectable in her digestive tract.

I saw a cast of Ida last week at the Natural History Museum in London. She is on display in the middle of a large room that she has all to herself on the mezzanine level of the Central Hall, just a few metres away from a large statue of the man in whose honour she received her formal name *Darwinius masillae*. As I stared at her cast in silence before the hordes of visitors arrived at the Museum, I contemplated what all the fuss was about. Bizarrely, I wish that somehow Ida could have known that 47 million years after her death she would become an overnight pop culture celebrity, that she would come to adorn the logo of Google, if even for just one day, that she would be introduced as the special guest on Charles Darwin's 200th birthday party, and that she would be hailed as the "missing link" and "ancestor" to another group of primates, who would value her little skeleton to be worth almost \$13,000 per centimetre.

Yet, even though we are living through a global economic crisis, it is not the almost \$750,000 price tag that is controversial about Ida. Instead, the controversy focuses on both the phylogenetic interpretation of Ida as reported in her scientific birth certificate in *PloS*, and especially on the evolutionary hyperbole with which she is surrounded in the popular media. The reason why I decided to write this essay, rather than simply refer you to the many pages on the Web that discuss the Ida case at length (I especially recommend the Ida pages on the blog of science writer Carl Zimmer: <<http://blogs.discovermagazine.com/loom/category/darwinius/>>), is the response of Dr Jørn Hurum, who is one of the authors of the Ida paper, to a question posed by Lucas Laursen in a *Nature News* interview (Laursen, 2009) on 27th May 2009. Laursen asked Hurum "[w]hat response do you have for critics who argue that your approach [in the coordinated media circus] distorts the scientific process?" Part of Hurum's answer was that "[y]ou need to simplify it down to more understandable words. Of course in that you lose a little bit of the scientific terms, but really I think the message is very, very much the same in what we are doing popularly and scientifically." Since Hurum is the global spokesperson for Ida (he convinced the Natural History Museum of the University of Oslo to buy her from a collector, and then orchestrated the scientific research and



the worldwide media presentation) it becomes very interesting to investigate in some detail this palaeontologist's strategy of translating his science into language understandable to lay people, or in his words "more understandable words," without distorting the scientific conclusions. I think this little exercise provides an important lesson to all of us who are concerned with disseminating our research to a broader audience. And lastly, while Hurum has been roundly condemned for the spin he has given *Ida* in the media, we must not fail to realize that his strategy is nothing more than a very visible example of what regularly goes on in our own professional journals. Unless we want to be hypocrites, we should at least have the courage to probe our communal sins before publicly crucifying one individual.

Phylogenetic party poopers

The entire controversy about *Ida* is phylogenetic. The paper that describes *Ida*'s morphology and palaeobiology (Franzen *et al.*, 2009) concludes with a brief phylogenetic discussion. Except 'discussion' is really the wrong word, and I wouldn't dare call it a phylogenetic analysis either (the authors also don't). It offers its main conclusion in just a single sentence: "All of the determinate synapomorphies in Table 3 link *Darwinius masillae*, and by implication other Adapoidea [a clade of strictly fossil primates of uncertain phylogenetic position], to Haplorhini [dry-nosed primates] rather than Strepsirrhini [wet-nosed primates] (see also Fig. S7)." Since humans are haplorhines this phylogenetic position means that *Ida* could potentially illuminate early steps in the evolution of humans from their primate ancestors. In what must be a rare exception to the rule that pictures are worth a thousand words, the authors apparently felt compelled to graphically bolster this concise conclusion with a superfluous three-taxon cladogram in the supplementary material (their Fig. S7). But never mind, so far so good you might think. But, it is here that the trouble starts.

Experts were quick to point out that the phylogenetic conclusion was wholly unconvincing. For example, in a commentary in *Science* on 19th May 2009 (Gibbons, 2009a), Dr Chris Beard from the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania claims that *Ida*'s describers have "ignored 15 years of literature," including important work by himself. Dr Richard Kay from Duke University said "the data is cherry-picked". The conclusion is that other crucial taxa and many more characters need to be considered before we can pinpoint *Ida*'s address in the primate tree. Any definite phylogenetic statements in the Franzen *et al.* (2009) paper are premature. Jørn Hurum seemed unconcerned about this. At the unveiling event of *Ida*'s cast at the NHM in London, Rowan Hooper, online news editor for *New Scientist*, asked Hurum whether the team should perhaps have waited until they had done a more rigorous analysis before making the media splash they did. Hurum responded that the phylogenetic conclusion "is really not an important part of the paper" (Hooper, 2009). This is a very surprising answer, because the terms in which the great importance of *Ida* is described all over the media are entirely phylogenetic.

Now that wireless Internet connections have become our adult umbilical cords, science bloggers play the useful role of digital antibodies in helping us to fend off media-mutated scientific factoids that leak incessantly from the hulking placenta of the Web. Recall the recent media flurry surrounding the Dunn *et al.* (2008) paper on metazoan phylogeny in *Nature* last year. The paper showed that ctenophores were the sister group to the rest of the Metazoa, which would have remarkable consequences for envisioning the evolution of animal body plans. The popular media took this to mean that comb jellies are/were our 'first ancestor,' a misinterpretation quickly



corrected in the blogosphere. In Ida's case, the blogosphere's phylophiles went ballistic, mostly justified in my view, because the media widely labelled Ida as "the missing link" and an "ancestor" in the evolutionary lineage leading to humans. The commentaries rightly focused on the difficulties of recognizing ancestors and the arbitrariness of calling a particular fossil taxon "the" missing link. However, in contrast to the case of the comb jellies, the spin doctoring in the case of Ida was started and encouraged by the scientists.

Shades of inconsistency and conflicts of interest

Ida is Jørn Hurum's baby. He can't help but be overpoweringly enthusiastic. I would be as well if I had described the most complete fossil primate ever. And Hurum has more than pure science to be excited about because the biggest splash was made in the public arena. However, could it be that the boundless enthusiasm masks signs of inconsistency and conflicts of interest between the science and media aspects of Ida's discovery? Surely it would be rash to suggest that the media project could have affected the science, right? No competing interests were declared in the Franzen *et al.* paper. Well, not initially anyway.

The plot thickened a little bit when the science writer Carl Zimmer (<<http://blogs.discovermagazine.com/loom/>>) questioned this. This led to a formal correction of the paper (in the comment section) disclosing that "a production company (Atlantic Productions), several television channels (History Channel, BBC1, ZDF, NRK) and a book publisher (Little Brown and co) were involved in discussions regarding this paper in advance of publication". Of course, there really was no competition between any of the parties involved, because everything was well organized so that Ida took the public and scientific spotlight on the same day. Hurum simply labels this coincidence "just luck, really" (Laursen, 2009).

Luck? Perhaps, in a way. Just luck? Definitely not, in the sense of being mere coincidence. As revealed by Managing Editor of *PLoS ONE* Peter Binfield (<<http://blogs.discovermagazine.com/loom/category/darwinius/>>) the journal managed to race the paper through the production process weeks faster than is customary in order to try to have it published on the day of Ida's global unveiling on 19th May. In fact, Binfield reveals that the journal respected the authors' wish not to issue a press release or any other information relating to the paper before 19th May. This is a great strategy to pack maximum punch with the media presentation of Ida, which of course is exactly what the scientists attempted to achieve: "The scientific publication of Ida has been carefully timed so that the film, book and website can be launched at the same time" (<www.revealingthelink.com>). This is hardly just luck.

Here we need to touch briefly on the choice of the journal in which Ida was formally described. Given the extreme effort and money involved in the research, and in view of the exceptional scientific importance that is loudly claimed for Ida on her official website (<www.revealingthelink.com>), the choice may seem puzzling. First, Hurum convinced the museum where he works to pay almost \$750,000 for Ida. An armed escort delivered Ida to Oslo in September 2007. Then he assembled an international "dream team" of researchers to work on her in secrecy. The team agrees that what we have here is a "Rosetta stone", an "8th wonder of the world," "the scientific equivalent of the Holy Grail", new insights that will be "like an asteroid hitting the earth" (all quotes from Ida's official website). And then they decide to publish in *PLoS ONE*. A journal without an impact factor. When the author of the above *Nature* interview (Laursen, 2009) asked Hurum whether they



had offered the paper to any other journals, he simply said no. Hurum stated that second author Phil Gingerich had had a good experience with *PloS ONE* for a previous paper, “so he was the one suggesting *PloS*.”

I find this rather amazing, even though other papers may follow of course. I am certain that most of us would be strongly advised, to say the least, to seek an outlet with at least an impact factor. Moreover, although Gingerich may indeed have suggested *PloS ONE*, a statement he made in the *Wall Street Journal* (Naik, 2009) at least suggests that that choice was not just informed by scientific reasons. Asked whether the study would not have deserved publication in *Science* or *Nature*, Gingerich answered “There was a TV company involved and time pressure. We’ve been pushed to finish the study; it’s not how I like to do science.” That sounds suspiciously like a potential conflict of interest between science and media exposure. Yet, Hurum explains: “I’m paid by the tax payers of Norway to do this research. I’m not paid by *Nature* or *Science* and still they charge money for other people to read my scientific results.” I have no reason to think Hurum is disingenuous here, even though he doesn’t acknowledge any funds in the *PloS* paper, which may of course just indicate that the work wasn’t done on a formal government grant. It is true, of course, that *Science* or *Nature* would likely have offered less space than *PloS ONE* for the important descriptive details about Ida. However, some inconsistency arose when answering a question by *New Scientist*’s Rowan Hooper at the NHM. Anticipating a more comprehensive phylogenetic analysis in the future, Hurum without hesitation stated “This will be a *Nature* paper” (Hooper, 2009).

Life in a mediocracy: from jargon to “more understandable words”

The most concise phylogenetic conclusion of the Franzen *et al.* paper is that Ida is more closely related to haplorhine primates than to strepsirrhine primates. An even more concise summary in terms of sister group relationships is impossible because the authors know that Ida is part of a larger clade of exclusively fossil primates (Adapoidea), but none is included in their cladogram. For the present purpose, ignoring the criticisms that primate experts have levelled against the paper’s phylogenetic conclusions, one could ‘translate’ this finding as follows. Living primates can be subdivided into two groups, the strepsirrhines (wet nose primates), and the haplorhines (dry nose primates). Ida is more closely related to the dry nose than to the wet nose primates. Because humans are dry nose primates, Ida may have the potential to help us infer the evolution of some traits acquired by certain early primate ancestors of humans. This is one of several possible concise and clear translations, with minimal use of evocative but vaguely defined words such as ‘early.’ Now consider the way in which Ida’s describers and the associated book and documentary present her to the general public.

1. “She’s on our ancestral line” (Hurum in Devlin, 2009)
2. “It is a member of the ancestors” (Jens Franzen, in Herbert, 2009)
3. “It is a representative of an ancestral group giving rise to all kinds of higher primates” (Hurum in Waugh and Susman, 2009)
4. “This is the first link to all humans” (Hurum in Gibbons, 2009a)
5. *The Link. Uncovering our earliest ancestor* (book by Tudge, 2009)
6. *Uncovering our earliest ancestor: the link* (title of the BBC1 documentary)



Where do these statements leave Hurum's claim that "the message is very, very much the same in what we are doing popularly and scientifically"? An anonymous editorial in *Nature* (Anon, 2009) strongly condemned the research team's media pronouncements as a "drastic misrepresentation of their research." The above statements suffer from the ill effects of the use of evocative but deceptive language. Statements 1 and 2 are richly suggestive, yet very vague. Statement 3 seems to conflict directly with a conclusion in the *PLoS* paper. The paper notes that *Ida* is an adapoid, and that adapoids "could represent a stem group from which later anthropoid primates evolved, but we are not advocating this here, nor do we consider either *Darwinius* or adapoids to be anthropoids [monkeys, apes and us]." Statement 4 and the titles of the book and documentary that accompanied *Ida*'s unveiling are deeply anthropocentric in their use of the definite article. It is ironic that even though Hurum states on *Ida*'s website that "Humans are not special – we're related deep in time to more primitive mammals", the apparent strategy is to make *Ida* more special by explicitly attempting to cast her as our long lost primate cousin. Of course the whole concept of missing links has always referred to the seemingly enormous chasm between us and the rest of the animals, but in this case there was nothing really missing. For those for whom our current understanding of the primate tree of life is not sufficiently compelling to accept our primate ancestry, poor *Ida* is not going to do the trick. Not surprisingly, creationists dismiss *Ida* as just a dead lemur. Also, the misleadingly unequivocal "the" gives non-professionals a wholly distorted view of the scientific process. *Ida* is a special fossil, but not that special. A simple rewording may have avoided much criticism: *Ida* may be a missing link.

These are hardly the "more understandable words" that Hurum hoped to achieve in the popular presentation of *Ida*. In overhyping *Ida*'s evolutionary significance in the media, her describers behaved a bit like over-enthusiastic salesmen trying to convince us that their inordinately beautiful and expensive gem is also a wickedly efficient crystal ball that affords an unobscured view into the deep past. Although one should never underestimate the media's own ability to spin scientific findings, should we be surprised in this case that other media sound very similar or worse? Just consider these gems from a SKY News TV report that aired on 19th May 2009 (<<http://news.sky.com/skynews/Home/World-News/Missing-Link-Scientists-In-New-York-Unveil-Fossil-Of-Lemur-Monkey-Hailed-As-Mans-Earliest-Ancestor/Article/200905315284582>>). "You're looking at one of our ancestors." "She is according to scientists a direct relative." "Ida and her descendants evolved into humans." "Since Darwin mankind has been looking for the missing link, the primate that is at the root of our creation. And this is she." The report goes on: "Ida is a transitional species that developed into a fully fledged primate and eventually into humans." "The link with our past. Perhaps the beginning of the story of our development." "She could rewrite science. She could confirm Darwinian theory and debunk creationism. She could also question religion itself." In a video report on *Ida*'s website Sir David Attenborough said: "This little creature is going to show us our connection with the rest of all the mammals," "It is not a question of deduction, not a question of imagination, not a question of suggestions. It's fact. There it is." "Now people can say, 'Ok, we're primates like monkeys and apes and that we came from very simple and generalized mammals. Show us the link.' The link they would have said until now is missing. Well, it is no longer missing" (<www.revealingthelink.com/the-implications/>). Given that Sir David emerged as Britain's "most trusted person" in a *Reader's Digest* poll several years ago, 12 places ahead of even the Queen, his pronouncements carry a heavy weight in our mediocracy.



It is not easy to communicate notions about evolutionary ancestry in an accurate way to lay people, but a brief online search revealed that many reports about Ida were not even accompanied by the basic concepts that can provide context to the news. On 12th June 2009, I Googled the following in Google News: “Ida missing link,” which yielded 1,040 hits (464,000 in Google). This reduced to 366 when I added “between” to the query (457,000 in Google), which suggests that in many cases it is implicit between which organisms Ida is a missing link. Even more extreme reductions resulted when I added “tree” (78), “phylogeny” (3), or “phylogenetic” (7) to the query. Similar reductions in the number of hits resulted when including “stem” or “sister.”

I will not insult the phylogenetic know-how of the average reader of the *Newsletter* by listing all the problems with the above statements. Worryingly, news reports such as these do claim that “scientists claimed...,” which suggests that we scientists may have played more than just a passive role in the media distortion of research in this case, and perhaps in others. Even in this case we can hardly blame the scientists for not having been able to fully control the media’s demagogic dribble. Yet, when Hurum was asked whether the phrase ‘missing link’ was appropriate for Ida, he answered: “Why not? I think we could use that phrase for this kind of specimen.” “[People] have a feeling that if something is important it is a missing link” (Randerson, 2009). Okay... and as for trying to avoid unnecessarily anthropocentric and imprecisely evocative language in the press, Hurum states: “It’s hard to discuss haplorhines and strepsirrhines in a press release. You need to link it to us” (Gibbons, 2009b). I really would have hoped that in this Darwin year we would no longer feel that ancient and quaint need to see ourselves as the measure of all things. Hurum continues: “Yes, I am shaking things up. If you want kids to be interested in science, we need to start packaging it in many ways” (Gibbons, 2009b). I’m all for trying to package science more as entertainment (see my essay in issue 63 of this *Newsletter*) to reach a larger audience, but I strongly feel that too much of a *Jurassic Park* ploy only leads to the intellectual equivalent of the showy but shallow beauty of cosmetic breast implants, detracting from the ‘real thing.’ But given today’s glamour-obsessed, ADHD society, the real thing may be of secondary importance.

But, of course, such media attention may well pay off financially, as in Ida’s case it apparently did. In a video link on the website of Norway’s Ministry of Education and Research, minister of Higher Education and Research Tora Aasland proudly pledged \$350,000 to further research on Ida, claiming that Ida “gives us new insights about the ancestors of human beings” and that “this project will give the world new knowledge of our ancestors” (<<http://www.regjeringen.no/en/dep/kd.html?id=586>>).

Innocent victims

Ida’s website <www.revealingthelink.com> optimistically claims that “Ida has already inspired millions of people to take an interest in our evolution, and in how our world developed over millions of years.” Quite apart from how they know how efficient their campaign has been (and I genuinely hope it was successful) I fear that for many people their fascination will not last very long, and perhaps their lasting memory will be an impression of the intensity of the wave of corrective commentary that was necessary to reign in the excessive media hype.

I just hope that the backlash on the Internet has not completely blinded the public to the potential evolutionary significance of Ida. Although the web swells with razor sharp verdicts that dismiss her worth as a missing link and a human ancestor, the fact remains that she still has potential. The phylogenetic position of Ida needs further research, and may yet turn out to illuminate aspects of



our ancestry. Willi Hennig embodied the potential homology of character states, until disproved by phylogenetic analysis, in his 'auxiliary principle.' I propose we adopt a similar principle for the ability of entire taxa, fossil and living, to affect character state optimizations along a cladogram's internodes. When the placement of a taxon can influence character state optimization along internodes, that taxon could legitimately be called a missing link, even if it was only missing from its proper place in the tree. Let's call this Ida's principle, which she may or may not come to illustrate.

Let us hope that the flurry of critical commentary has not bred a more cynical public. Let us hope that the public doesn't think we are simply after a free ride on that already crowded roller coaster called 'Celebrities without Talent.' Many talented scientists and science writers continue to do an admirable job communicating science to us all, and in this particular case they have played an important role in correcting and clarifying the less than transparent media claims made by the scientists themselves. However, I want to end this essay by pointing out that *Idal*atry is simply a highly visible example of a more widespread phenomenon that usually stays hidden from view between the dusty covers of our professional literature. This does not exculpate Ida's describers from being guilty of hyperbole, but it does show that they are not uniquely guilty.

Judge not lest ye be judged

In 1873, 23-year-old Nicolaas Dirk Doedes, a Dutch natural history student, wrote Charles Darwin a letter from my alma mater in Utrecht in the Netherlands to ask him about his thoughts about religion and the existence of God. Darwin kindly replied, and with respect to the origins of things wrote "I am aware that if we admit a first cause, the mind still craves to know whence it came and how it arose" (see <www.darwinproject.ac.uk>) (Doedes later incurred the wrath of Darwin's son Francis when he decided to publish the letter in a Dutch freethinking journal shortly after Darwin's death. Francis was angry that the public came to know Darwin's religious thoughts in this way: Van der Heide, 2006). This reply could well be the motto of modern evolutionary biology. A preoccupation with the origins of things is one of our distinctively human characteristics.

Ancestritis is particularly common among phylogeneticists, and has been ever since the origin of the discipline. Mayr & Bock (2002: 175) defined phylogenetics as "so to speak, a backward looking endeavour, the search for and study of common ancestors." Things are of course different now. Attempts to expunge our fascination with ancestors and ancestor-descendant relationships have been a conspicuous component of the cladistic revolution in systematics. Yet, despite this cleansing exercise many of us still try to glimpse ancestral outlines through the dense phylogenetic foliage of sister group relationships. And I think that is only natural. Origins are just too damn interesting!

Ida's describers simply tried to convey their fascination with reconstructing evolutionary origins to the general public. Unfortunately they did this by coming very close to reifying Ida as a human ancestor, and by using evocative language. As a result "Dr Hurum has caused a self-inflicted wound to his own reputation," according to P. Z. Myers on his *Pharyngula* blog. Maybe so, but this 'crime' is almost routinely perpetrated by our best and brightest in the most prominent journals.

The smoking gun is the use of evocative, but ill-defined language that labels the organisms under study as early, archaic, ancient, primitive, basal, prototypical, classic, *etc.* Often these labels are restricted to the title and/or abstract of the paper, without any explicit justification in the text. To give just two examples from my bulging file, a recent paper in *Evolution and Development*



that was highlighted in the *Faculty of 1000 Biology* was titled “Functional analysis of Pitx during asexual regeneration in a basal chordate” (Tiozzo & De Tomaso, 2009). The chordate in question is a colonial ascidian. Quite apart from their position within tunicates, current consensus places Tunicata as the sister group to Vertebrata, and Cephalochordata as the sister to this clade. Is that basal? All that this term does is create the false impression that the tunicates under study may be more likely to possess primitive character states, or represent a set of ancestral characteristics, than other chordate taxa. That is highly misleading. Not straying far into the tree, Garcia-Fernández & Benito-Gutiérrez (2009) claim “amphioxus (lancelet) is now recognised as the closest extant relative to the stem chordate.” No it is not. All extant chordates are equally closely related to any taxa in their stem lineage. And amphioxus is also not “the earliest chordate” as is claimed.

As for labelling particular fossil taxa as ancestors, remember the vetulicolians? In a *New Scientist* piece from 2001 titled “The giant tadpole that spawned us all” written by Joanna Marchant, Professor Simon Conway Morris is quoted as saying “We’re confident they are the ancestors of the group that includes vertebrates.” This is pictorially summarized in another *New Scientist* piece from 2003 that was authored by Conway Morris and titled “Once we were worms.” The figure shows a chordate cladogram sprouting from a vetulicolian.

Maybe these are errors, but for better or worse, we are fascinated with origins and ancestors. We also want to publish our work in good journals, we have to compete for grant proposals (the white papers of genome sequencing projects in particular are a veritable treasure trove for examples of pimped up language), and we want the general public to know that we are doing important and cool research. It is then not too surprising that we sometimes succumb to pimpin’ our organisms. But it would be hypocritical to publicly condemn one research team for doing this in public, while ignoring our own sins.

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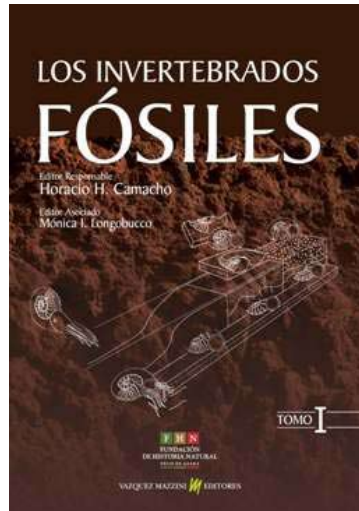
Los Invertebrados Fósiles

Horacio H. Camacho (editor), Monica I. Longobucco (associate editor). 2008. Volume I, p 1–440 pp, Volume II, 441–785, each volume plus glossary and indexes. Fundación de Historia Natural Félix de Azara, Vasquez Mazzini Editores. ISBN 978-987-22121-7-9.

Argentina has always been a great country for fossils, ever since the day of Charles Darwin. The magnificent collections of glyptodonts and other vertebrates in the Museo de Ciencias Naturales, in La Plata, are enough to stir even the most specialised of invertebrate palaeontologists. But that vast country remains a strong force in palaeontology, over the whole range from vertebrates, invertebrates, palaeobotany, to trace fossils and microfossils. The Argentine Palaeontological Association publishes the admirable journal *Ameghiniana*, and in 2003 there appeared *Ordovician Fossils of Argentina*, edited by Juan Benedetto, a masterpiece if ever there was one. And now we have this new, two-volume textbook, and it really is extremely good. And very comprehensive.

This book is a multi-author work; the writing team consists of no less than 39 experts, all from Argentina, and there are 27 chapters altogether. In the first volume, Chapter 1 consists of an introduction to the whole field of palaeontology, an interesting history of the development of the subject in South America, and a discussion of Precambrian biotas. Chapter 2 concerns the processes of fossilisation, while Chapter 3 surveys the animal kingdom, the evolution of life and the Cambrian explosion. There follow individual chapters on foraminiferid, radiolarians, other protists, sponges, cnidarians, bryozoans, brachiopods, a general account of molluscs, then gastropods, rostroconchs, and bivalves are considered separately. The second volume continues the taxonomic survey with cephalopods, problematic molluscs, annelids, a general account of arthropods, followed by trilobites, crustaceans, ostracods, chelicerates, hexapods (with a section on South American insects), echinoderms, graptolites, chordates and trace fossils. Each chapter has a bibliography (usually about two pages), and at the end there is a glossary, an index of terminology and a systematic index. The chapters are illustrated mainly by line drawings, but there are also a good number of photographs. The authors, naturally, figure many South American fossils, and it is good to see them.

This book seems to be intended for advanced undergraduates, their teachers, and professional and amateur palaeontologists generally. Although first-year students could certainly gain something from it, it is really pitched above that level. The coverage of each of the fossil groups is very





thorough, and each chapter is an erudite and highly satisfactory study on its own. Moreover, many more fossil groups are discussed than in most textbooks (including my own *Invertebrate Palaeontology and Evolution*), and this is a really useful, and indeed indispensable work, if you want to find out about tintinnids, tentaculitids or hexapods.

Standards of production are, on the whole, high; there are very many line drawings and some photographs for each chapter, and quite a number of sea-floor reconstructions. The computer-drawn line illustrations, and their labels, have reproduced less well than those drawn by hand, but they still convey the necessary information clearly.

I used to advise my students, when I was still teaching, that good science is not confined to English language publications, and that at least some understanding of other tongues is eminently desirable for any scientist. Of course Spanish is one of the most widely spoken languages globally, and this book will be used, surely, all over the Spanish speaking world. But let us hope it has a wider audience too.

Euan Clarkson
Edinburgh, Scotland



Books available to review

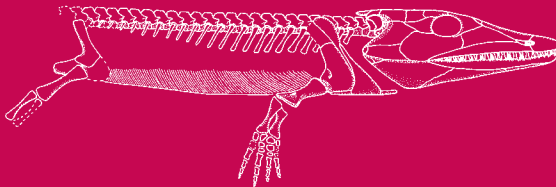
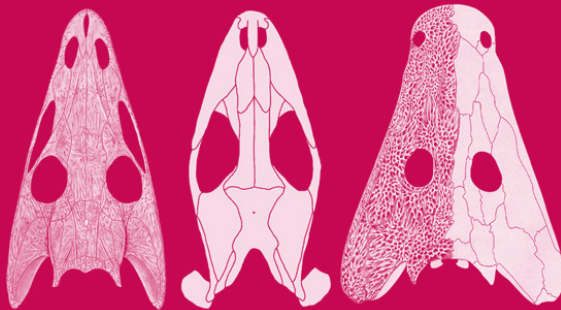
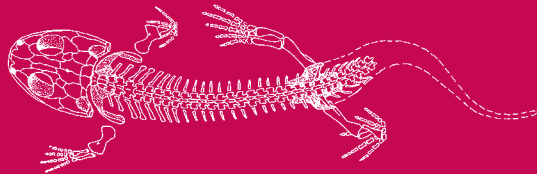
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- *Holocene Extinctions*, edited by Samuel T. Turvey (ISBN 0199535095)
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Patterns and Processes in Early Vertebrate Evolution

Edited by MARCELLO RUTA, JENNIFER A. CLACK *and* ANGELA C. MILNER



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