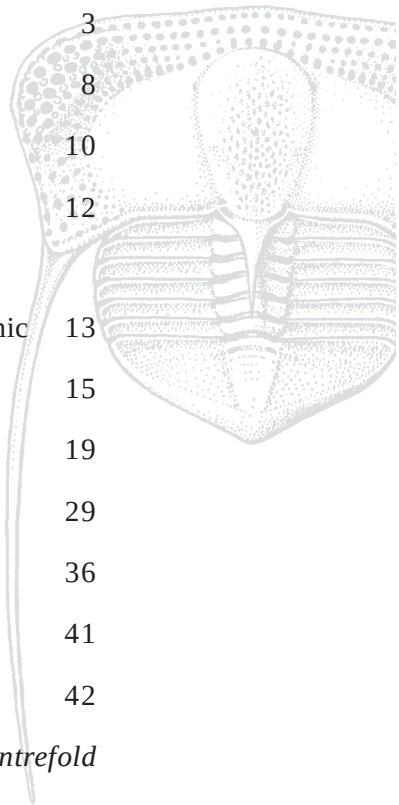
The Palaeontology Newsletter

44

Contents



Reminder: The deadline for copy for Issue no 45 is 13th September 2000

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

Editorial

It is with more than a little trepidation that I take over as newsletter editor from Sue Rigby. We owe a vote of thanks to Sue, not only for maintaining the Association's newsletter, but for completely revolutionising its layout and content. Mercifully, I also inherit the Edinburgh team in the form of Meg and Nick Stroud, who format the newsletter, and Edinburgh University Press, who print and arrange distribution of the newsletter; and Tim Palmer, the Association's executive officer who arranges everything else. I am left somewhat bemused, therefore, to find that all I have to do is actually *edit* the newsletter!

From past experience of both reading and editing newsletters, I am more than aware that their weakness often lies with the concept of 'news'. I will work as hard as possible to solicit copy for the newsletter, and I'm particularly interested in assembling a team of regular columnists (volunteer yourself before I 'volunteer' you!), but I must also rely on you, the members, to help shape the newsletter, and to maintain its success. So, for example, next time you jet off to some place hot and sticky for the latest conference on the commercial and social applications of dinoflagellate flagella (or whatever), please spare a thought for those left behind: write a report and take a few pictures for the newsletter! Or better still, nobble someone else to do it….

Phil Donoghue
University of Birmingham
<p.c.j.donoghue@bham.ac.uk>

Association Business

Council 2000-2001

President

Prof. C. R. C. Paul (University of Liverpool)

Vice-Presidents

Dr M. J. Barker (University of Portsmouth)
Dr J. E. Francis (University of Leeds)

Treasurer

Prof. J. Hancock (Shaftesbury, East Dorset)

Secretary

Dr M. P. Smith (University of Birmingham)

Newsletter Editor

Dr P. C. J. Donoghue (University of Birmingham)

Newsletter Reporter

Dr P. Pearson (University of Bristol)

Publicity Officer

Dr M. A. Purnell (University of Leicester)

Editors

Dr R. Wood (University of Cambridge)
Dr J. A. Clack (University of Cambridge)
Dr S. Evans (University College London)
Prof. D. A. T. Harper (Geological Museum, Copenhagen)
Dr A. L. A. Johnson (University of Derby)
Dr C. Wellman (University of Sheffield)

Other Members of Council

Dr S. K. Donovan (Natural History Museum)
Dr S. Gabbott (University of Leicester)
Dr E. Harper (University of Cambridge)
Dr D. K. Loydell (University of Portsmouth)
Dr I. J. Sansom (University of Birmingham)

Salaried Officers of the Association

Executive Officer – Dr T. J. Palmer (University of Wales, Aberystwyth)
Technical Editor – Prof. D. J. Batten (University of Wales, Aberystwyth)

Sylvester-Bradley Awards 2001

In light of the recent financial success of the Association, Council has decided to increase the number of awards and their maximum value from 2001. Applications are now invited for the Sylvester-Bradley Awards, to assist palaeontological research (travel, visits to museums, fieldwork *etc.*), with each award having a maximum value of £1,000. No definite age limit is applied, although some preference may be given to younger applicants or those at the start of their careers. The award is open to both amateur and professional palaeontologists, but preference will be given to members of the Association.

The closing date for the 2001 award round is Thursday 30th November 2000. Applicants will be informed of the outcome of their applications in March. Application forms and further information may be obtained from the Association's Web site or from the Secretary: Dr Paul Smith, School of Earth Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT. Please send completed forms to the Secretary.

Grant Aid to attend the Annual Meeting

It has been decided to introduce a programme of grant aid to assist overseas palaeontologists attending the Association's Annual Meeting. A total sum of up to £1,500 will be available annually for distribution to those travelling from outside the country hosting the Annual Meeting. (England, Scotland, Wales and Northern Ireland will be considered as constituent members of the UK for this purpose). Awards will be limited to those applicants making an oral or poster presentation. Applications for grant aid to attend this year's meeting (no form necessary) should be made to the Executive Officer: Dr Tim Palmer, Institute of Geography & Earth Sciences, University of Wales Aberystwyth, Aberystwyth, Ceredigion SY23 3BD.

Mary Anning Award 2000

Members are reminded that nominations for this year's award for amateur palaeontologists will close on Thursday 30th November 2000. The award is made annually to candidates who, in the opinion of Council, have made an outstanding contribution to the study of palaeontology from a non-professional perspective. Such contributions may range from the compilation of fossil collections to their study, care and conservation, and/or collaboration with professional palaeontologists.

The award will comprise a cash prize plus a framed scroll. It will be presented to the winner at the AGM in May 2001. Nominations should comprise a short statement (up to one page of A4) outlining the candidate's principal achievements. Members putting forward candidates should also be prepared, if requested, to write a profile in support of their nominee. Please send your nominations to the Secretary (address above).

Paul Smith
Secretary
<m.p.smith@bham.ac.uk>

Costs and subsidies: help us to help you

Every year the Association publishes detailed accounts of its income and the costs of carrying out its activities. We are required to do this by Charity Law, of course, but we also want to give members as much information as possible, even though I suspect that only a handful of people read them – mainly ex-Treasurers and Treasurers of other societies in all likelihood!

But by application of a little simple arithmetic these figures can be made to tell an interesting story. Last year it cost us £170,626 to run the Association for the year, excluding the grants made from the Sylvester-Bradley and Jones-Fenleigh funds. At the end of the year, there were 1,201 members who had paid their subscriptions, so you might think that each member should pay a subscription of just over £142 per year. Do not worry, gentle reader! This is not the start of an announcement that the subscription rate is about to go up. And when it eventually does, we won't make it hurt quite that much.

Clearly this means that the Association offers very considerable subsidies to all its members. This is how we carry out our charitable purpose and serve the interests of the subject, by making our publications available to as wide an audience as possible, adjusting the cost towards that which we think a maximum number of people will be able to afford. The subsidy is modest for Institutional Members (less than £50), generous to Ordinary Members like you and me (£114) and gobsmackingly beneficent to Students (£132).

This is exactly how we want it to be, but we can afford to do this only because of the number of publications – *Palaeontology*, *Special Papers*, and *Field Guides* – that we sell to libraries and individuals. These sales accounted for two thirds of our total income last year; subscriptions and income from investments (the results of modest annual surpluses over most of our 42-year history) made up the remainder.

You as a member may be in a position to help maintain or improve this situation. One way is to persuade your institution's library to subscribe to *Special Papers in Palaeontology* if it doesn't already do so (if it doesn't get *Palaeontology* either and you can persuade it to, even better). Furthermore, many libraries don't have copies of the *Field Guides to Fossils*. University libraries often buy readily on the suggestion of a staff member, especially at low prices like ours. If you are in a university or a research institution, please ask your library to stock one or more Field Guides. Most of them are very useful for teaching, and have excellent up-to-date introductions on stratigraphy, diagenesis, palaeoecology, etc. Maybe you could recommend other booksellers to hold stock as well. We would also like to sell copies of these publications direct to members. There is a catalogue included with this *Newsletter* of the latest Members' prices for *Special Papers*, most of which are still in print. Prices have never been so low. Roll up! Roll up!

There is also a simple and direct way by which people can help: that is by paying when the first subscription notice comes round with the final Newsletter of the year. Many people do. This year was a bit of a problem because the notices were tucked inside the Newsletters and not at all obvious, so we had to sent out 400+ reminders in April. Not only is this expensive and time consuming, but until we know how many people genuinely don't wish to renew, we

have to print unnecessary extra copies of *Palaeontology* to be on the safe side. So you can help by being prompt with your payment and avoiding reminders. We get a bit of extra interest on your subscription as well.

Finally, a very small number of people are subscribing as Ordinary Members in order to supply an institutional library. This is an unfair practice because it inflates the costs of our other activities, and it is contrary to the Rules of the Association. We ask any institutions that are subscribing to our publications in this way to take out Institutional Membership. We do not propose to charge them earlier years' costs retrospectively, but we reserve the right not to supply any individual whom we have reason to believe holds Membership of the Association principally in order to avoid the additional costs of Institutional Membership.

Tim Palmer
Executive Officer
<palass@palass.org>

The Palaeontological Association and the Data Protection Act 1998

On 1st March the Data Protection Act 1998 Act came into force, replacing the previous act of 1984.

We are affected by legislation in this field because we hold and use ('process') retrievable information about members. In our case, all such information is held in a large Microsoft Access file which is currently only used by the Executive Officer (the 'Data Processor' in the meaning of the Act). This file is held only on the Hard Drive of the Association's PC and on back-up floppies. We hold only personal data that relate to supply of publications (*e.g.* name, delivery address, etc) and payment of subscriptions (date of most recent payment, membership category, e-mail, etc). No 'sensitive personal data' (*e.g.* ethnic origin, political opinion, religious belief, health, sex-life, criminal conviction, trade union membership) is held. We do not keep a record of the sex or academic qualifications of members, nor do we keep any record of Credit Card details for those individuals who pay their subscription or purchase our publications in this way.

Decisions as to how our information is used are made from time to time by Council, the 'Data Controller' within the meaning of the Act. Currently, the information that we hold is used only for matters relating to the smooth administration of Membership. We have a rule that no information is made available to any outside organisation for any business other than the mailing of our own publications. We routinely, for example, refuse requests to make our list available to publishers for advertising purposes. Instead, we may mail flyers on their behalf with the *Newsletter*. We have no expectation that Council will alter its position in this respect; were it minded to do so, the matter would be brought to the membership at an AGM, due notice having been given to members in the *Newsletter*.

Because the Palaeontological Association is a U.K. Registered Charity that uses its limited data as outlined above, Council is not required to notify the Commissioner for Data Protection that it wishes to be included on the Register of those intending to process personal data. Any member is welcome to contact me (by e-mail to palass@palass.org) about the details of the information that we hold on him or her. I shall update data promptly when requested by the individual concerned.

Tim Palmer
Executive Officer
<palass@palass.org>

Award of the Lapworth Medal to Professor Emeritus Harry Blackmore Whittington

10 May 2000

The Lapworth Medal was instituted by Council of the Palaeontological Association, to be presented to a geologist who has over the years made outstanding contributions to palaeontology and related disciplines. The first ever Lapworth Medal, marking the Millennium, was presented to Professor Emeritus Harry B. Whittington at Leicester on the occasion of the 43rd Annual General Meeting of the Palaeontological Association on 10th May 2000.

Harry Whittington received his first degree and Ph.D. in the 1930s from the University of Birmingham, in the Department of which Charles Lapworth was the first Head. Harry's Ph.D. studies were on the Lower Palaeozoic rocks of Wales, including the structure and stratigraphy of the district of Llansantffraid ym Mechain. His early papers on the structure, stratigraphy and faunas of the area and other regions of Wales were published in 1938. He went to the USA, and in the early 1940s taught and researched in China, with his wife Dorothy.

Thereafter he returned to America and from 1949 to 1966 was Professor in the Agassiz Museum of Comparative Zoology, Harvard University. During these years he became known as a foremost student of trilobites, having published many large, and now classic, taxonomic monographs chiefly on North American and British faunas. I remember writing to him when I

was a research student in the early 1960s over some points of detail in trilobite morphology, and I still have the courteous and helpful letter I received from him. He masterminded not only Volume O of the 1959 *Treatise on Invertebrate Palaeontology* (Trilobites and related forms), but also the first volume of the second, revised edition (1998). His immense knowledge of trilobites and their distribution resulted in his masterly synthesis in 1966 on the global distribution of Ordovician trilobite faunas in terms of former positions of continents and oceans, which had very far-reaching influences and led to many new developments.

Around this time he returned to Britain to take up the position of Professor of Geology, University of Cambridge, and began a programme with younger geologists on re-collection and re-evaluation of the Burgess Shale of British Columbia, which generates great public interest, as well as a steady flow of monographs, papers, and articles, and entirely new concepts. Many of his former research students, who co-operated on the Burgess Shale fauna and on other projects, are now prominent palaeontologists in various universities; three, like Harry himself, are Fellows of the Royal Society of London.

Harry Whittington's papers on trilobites have spanned taxonomy, stratigraphic uses and distribution, limb structure, silicified faunas, ontogeny, hypostomes, functional morphology and evolution, to name but some of his areas of special interest. Harry has contributed immeasurably to our understanding of these long-extinct marine invertebrates, as well as other fossils. His book, *Trilobites* (1992), is a visual delight as well as a mine of information.

Harry Whittington has managed, despite singular administrative responsibilities, which include long-standing commitments to the Palaeontological Association, to keep up a high research profile. Many honours have been bestowed upon him, Fellowship of the Royal Society of London being one, but we hope he will especially treasure the Lapworth Medal. Now over 80, he is still producing first-rate papers. May he long continue to do so!

Euan N. K. Clarkson
(Past-President)

Association Meetings Programme

Annual Meeting 2000: Announcement and Call for Abstracts

University of Edinburgh / National Museums of Scotland / British Geological Survey
17-20 December 2000

The 2000 Annual Meeting will be held at the Edinburgh Conference Centre, Heriot-Watt University, Riccarton Campus, Edinburgh, from Sunday 17th December to Wednesday 20th December 2000.

Talks and posters on any area of palaeontology or related subjects are invited. Abstracts, not exceeding 200 words, should be sent to Vicen Carrió-Lluesma at the address below by Friday 22nd September 2000. State whether the abstract is for an oral or poster presentation. Abstracts should preferably be submitted as an e-mail message or attachment. They may also be submitted on disk in ASCII format or clearly printed on white paper. Abstracts received after 22nd September cannot be guaranteed inclusion in the meeting's programme.

Talks will take place on Monday 18th and Tuesday 19th December, and each will last 20 minutes (15 if demand is high) to avoid parallel sessions. Speakers and poster presenters who are members of the Association and under the age of 30 at the time of the meeting, and who wish to be considered for the President's Award and/or Council Poster Prize, should indicate this when submitting their abstract.

The Edinburgh Conference Centre is situated at the Riccarton Campus, Heriot-Watt University, some five miles west of Edinburgh City centre. Accommodation will be in single-bedded rooms, some with en-suite facilities. All lectures and poster presentations will be given in the Conference Centre where there are excellent display and presentation facilities (including PowerPoint). Catering standards are renowned. The Annual Dinner will be held at the National Museums of Scotland, preceded by a wine reception. Delegates will be taken there and back again by coach.

A field trip has been arranged for Wednesday 20th to the classic Upper Devonian to Lower Carboniferous sections at Siccar Point, Pease Bay to Cove and Barns Ness (Catcraig), along the East Lothian shore. In view of the uncertainty of the Scottish mid-December climate, this has been chosen so that the field party will never be more than a short distance from the coach. Alternative half-day trips in the city will be arranged: (1) Building Stones of Edinburgh (morning); (2) Dynamic Earth Centre (afternoon).

Booking

The booking form is inserted in the centre of this *Newsletter*. Please return it with your payment no later than 15th November.

Organisers

Professor Euan Clarkson, Department of Geology and Geophysics, University of Edinburgh, West Mains Road, Edinburgh, Scotland EH9 3JW, e-mail euan.clarkson@ed.ac.uk, tel +44 (0)131 650 8514, fax +44 (0)131 668 3184.

Vicen Carrió-Lluesma, National Museums of Scotland, Chambers Street, Edinburgh EH1 1JF, e-mail: vc@nms.ac.uk, tel +44 (0)131 247 4254, fax +44 (0)131 247 4819.

Mark Dean (field excursions), British Geological Survey, Murchison House, West Mains Road, Edinburgh, e-mail m.dean@bgs.ac.uk, tel +44 (0)131 650 0354, fax +44 (0)131 668 2683.

Lyell Meeting 2001

London, UK, February 2001

The Lyell meeting, at the Geological Society of London in February 2001, will be on the theme of:

Palaeobiogeography and Biodiversity Change

First call for contributions.

Particular emphasis will be placed on the links between palaeobiogeography and biodiversity change during the Ordovician and Cretaceous-Tertiary as periods of marked provincialism, major continental break-up, sustained biodiversification and episodes of mass extinction. Presentations on faunas (marine or terrestrial) and floras from other periods, or on widely applicable techniques, will also be included.

If you are interested in contributing to the meeting, please let either of us know as soon as possible, giving a provisional title and letting us know whether you would like to give a talk or present a poster. If there is sufficient interest from the contributors, a volume of papers from the meeting will be published, so please let us know this as well.

Alistair Crame
British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK
e-mail: A.Crame@bas.ac.uk

Alan Owen
Division of Earth Sciences, University of Glasgow, Gregory Building, Lilybank Gardens, Glasgow G12 8QQ, UK
e-mail: a.owen@earthsci.gla.ac.uk
Web: http://www.earthsci.gla.ac.uk/

news

IPA Directory of Palaeontologists of the World

The International Palaeontological Association is pleased to announce the publication in electronic form of the 6th edition of the Directory of Palaeontologists of the World. Palaeontologists are urged to open the IPA's web site

http://ipa.geo.ukans.edu/index.htm

where they will find links to the directory. Once they have opened the directory pages, they will be able to enter their personal information or search the directory in a number of ways for information that has already been submitted by others.

The IPA directory will be a success only if palaeontologists the world over participate wholeheartedly in the effort. At the end of June 2000, the directory had only about 500 entries. To make the directory truly useful, our goal is to have at least 15 times that number. This can happen, but only if every palaeontologist is sure to enter information.

Roger L. Kaesler
Paleontological Institute, The University of Kansas, 121 Lindley Hall, Lawrence, KS 66045-2911, U.S.A.
<kaesler@ukans.edu>

From our Correspondents

Evolution: Organic and Inorganic

By the spring of 1838, Charles Darwin (age 29) had been on dry land for eighteen months. As a "graduate" of HMS Beagle with first hand experience of natural phenomena to rival almost anyone in science, he was furiously writing up the results of his journey around the world. After years of observation and theorising, remote from debate and discussion, he needed to order his priorities. What had he seen that confirmed or refuted current questions of scientific debate? Which of his ideas were wrong, irrelevant or just old hat? What was really new?

Historians of biology place special emphasis on this period in Darwin's intellectual development. Having taken the possibility of organic evolution seriously for at least a year, Darwin was by then deep into a third notebook dedicated to thoughts, theories and odd facts pertaining to species. These scribbled comments show that he was focusing on the role of reproduction and breeding in shaping species. On the other hand he had yet to read Malthus's Essay on Population, which he later identified as a key moment in the development of his views (that came in September), and the full-blown theory of natural selection was some way off. Scholars have reconstructed Darwin's whereabouts for the period in painstaking detail, and minutely pored over the notebooks searching for clues that might shed light on the genesis of his theory.

The "species" notebooks were not the only ones open at the time, however. It tends to be forgotten that Darwin seems to have spent just as much time in this crucial period thinking about igneous rocks. My thesis is that this igneous work may have influenced Darwin's thinking on evolution, by 1) promoting an evolutionary view of nature, and 2) providing a direct analogy for the process of natural selection, namely crystal fractionation.

Having resolved very early in the Beagle voyage to write about the geology of volcanic islands, by Spring 1838 Darwin was struggling to bring his many facts and observations together into a coherent theory. In particular, far from accepting that the disparate types of igneous rock (from silica-poor basalt to silica-rich trachyte, for example) reflect different modes of origin, as others had done before him, he was convinced from his observations that they must be related. As a modern textbook on igneous geology puts it (but not with intended reference to Darwin): "One of the most obvious facts about igneous rocks is that they are extremely variable both in mineralogy and chemical composition. This leads petrologists to think automatically in evolutionary terms, like zoologists and botanists. Yet it is not immediately obvious that inanimate materials have the capacity to evolve, until one contemplates the variety of igneous rocks and asks how the individual types may have come to be created. One is obliged to postulate either that they were all created different, or that some processes exist which have the capacity to generate variety". (Cox, K.G., Bell, J.D., and Pankhurst, R.J., 1979, *The Interpretation of Igneous Rocks.*)

Darwin proposed that the various types of igneous rocks were derived from an initial composition of "trap" or basalt, which was generated at great depth, and he suggested a

specific mechanism by which this segregation could occur. He proposed that during cooling, but while still at an intense heat, crystals begin to form while the rest of the matter remains fluid. These crystals are likely to become separated from the fluid on account of their different specific gravities, which he listed, from feldspar (light) to olivine and iron oxides (heavy). Sinking would form rocks in which the crystals were disproportionately concentrated, as in fact he had observed in the Galapagos islands. More importantly, the process would cause permanent chemical segregation of the melt, and was "worthy of further consideration, as throwing light on the separation of the trachytic and basaltic series of lavas".

Aside from the astonishing prescience of this theory, which remains central to igneous petrology, I cannot help proposing that it is, in a way, a form of natural selection. Just as the removal of crystals causes an inevitable change in the composition of a magma, so the death of an organism causes a change in the composition of a gene pool. Despite the great differences between the two theories, it may be more than a coincidence that they were buzzing about in Darwin's head at precisely the same time.

Historians should take heed of a jocular letter that Darwin wrote to a friend in May 1838. This was written at a time in which he is generally supposed to have been thoroughly obsessed with developing his ideas on organic evolution: The possibility of getting married, he wrote, "always drives granite and trap out of my head in the most unphilosophical manner".

For a longer account of Darwin's igneous geology, see my paper in *Earth Sciences History* Vol. 15:49-67 (1996).

Paul Pearson
University of Bristol
<Paul.Pearson@bristol.ac.uk>

Nature, Nurture – and Fossils

When the Editor asked me to write something for the *Newsletter*, my initial reluctance was soon overcome by my natural desire to pontificate – the triumph of pope over experience, one might say. And so I have picked a notorious subject that, although generally loathed and distrusted, is having a little renaissance – the topic of how environment relates to evolution.

Here, then, is a text-book picture of 'how evolution works'. Genes make morphology, and a particular gene's frequency can vary for four different reasons: selection; drift (both of which tend to reduce genetic variation); mutation; and migration (both of which tend to increase genetic variation). The environment acts as a blind Natural Selector in choosing between different morphologies and the genes responsible for them. In this case, the environment is the customer for the wares of the genome – and the customer, as we all know, is always right. Sounds familiar? Here is one more component. It is hard to demonstrate evolution of this sort in fossil lineages, because the environment has its own effect on morphology too, an effect that (according to all of our anti-Lamarckian training) cannot also affect the genome, and thus cannot be inherited. We are all taller than the Romans were, simply because we eat more and better food. Some effort has gone into trying to devise tests for 'ecophenotypic' and 'genetic' morphological change, and the constant 'nature or nurture' argument about various human characteristics hinges on the balance between the two factors.

Now comes the distressing part. Why do *some* environmental changes produce ecophenotypic variation and others *do not*? And why do they produce the variation that they do? For example, why does the marsh plant *Sagittaria* produce arrow-shaped leaves when growing on land, and long thin leaves when submerged (fig. 1)? The answer can only be: 'because of the genes'. It was that clever geneticist C. H. Waddington (who, incidentally, started his scientific career collecting ammonites in Dorset with S. S. Buckman (Arkell 1933, p. 445)) who, together with the Russian theorist Schmalhausen, first seems to have really grasped that morphological response to the environment was under genetic control, and was thus i) inheritable, and ii) subject to selection and evolution. This seems simple enough, but the consequences are most unfortunate.

Fig. 1. The diagram of two ecophenotypic variants of the marsh plant Sagittaria reproduced by Schmalhausen (1986). On the left is the 'dry' variant, and on the right the 'wet' variant. How does the plant 'know' which morphology to produce, and how does it do it?

Let us suppose that one ecophenotypic effect could be called forth by extreme cold, but it turned out to be slightly selectively advantageous. What might happen next? First, there would be variation in the response, so the response that was most advantageous could be selected for. Secondly, the frequency of the response would also increase. Thirdly, and perhaps most oddly, offspring that more readily produced such a morphotype, under less extreme conditions, would also be selected for. The logical endpoint would seem to be that, eventually, a highly advantageous morphology would be just produced anyway, whether it was cold or not. Why not? But now we have the disturbing situation that a morphology that was originally 'ecophenotypic' is now an 'ordinary' genetically-based and heritable one: the organism has 'acquired' a character. Waddington, in a series of subtle experiments on the much-abused fruitfly, tried to show exactly this effect, and although his results were for a long time highly controversial, he seems to have been right. He called his effect 'genetic assimilation' (*e.g.* Waddington 1961). Incidentally, many of the notorious efforts in the past to

demonstrate Lamarckian evolution, and which claimed positive results, are explicable by this mechanism. The worst case is that of poor Paul Kammerer, who thought he had shown character acquisition in the midwife toad, but was subsequently attacked so vigorously that he committed suicide (see McLaren 1999 for discussion of this and possible molecular mechanisms).

Where do the fossils fit in here? Suppose one were looking at a fossil lineage, and was worried whether the observed changes were 'ecophenotypic' or 'genetic'. It may be that this is a false dichotomy. For Waddington's work seems to suggest that rather than being watertight compartments, there is in fact a highly complex and *evolutionary* relationship between the two, and one could evolve from one to the other – and back. Adrian Lister has suggested just this effect for the 'island dwarfing' seen in (say) red deer – lack of resources originally led to stunted individuals, but this size reduction became stabilised later genetically, so that the eventual offspring were small, well-fed or not (Lister 1995). Another example that comes to mind would be temperature-induced heterochronic shifts in Cambrian trilobites. Of course, one expects low temperatures, poor food supply and so on to have particular effects, so one might be able to predict the sorts of genetic assimilation that would go on in certain environments,

Next time you show Peter Sheldon's 'microevolution in trilobites' diagram to your students then, let the following niggling thoughts sit in the back of your mind. What if, in a particular lineage, the pygidial rib numbers are starting off as rather random 'ecophenotypic' effects, which first become progressively 'tuned' to environmental change, and then become genetically assimilated? How might one be able to see the difference? I have never seen a study of genetic assimilation being attempted in fossil lineages; could this be a good place to start? Or what about microfossil lineages?

Of course, one cannot simply take this sort of mechanism as a universal one for all sorts of evolutionary change. To be honest, it violently annoys students of conventional evolutionary theory (a recent book (Schlichting and Pigliucci 1998) pushing this sort of idea was dismissed in a review in *Science* as promoting a 'baroque hypothesis' (Orr 1999)). And it is certainly unlikely that a sudden temperature reduction led to the calling forth of perfectly winged mammals, for example. Nevertheless, why shouldn't such large scale novelties be composed of a myriad of tiny shufflings into the genome of many ecophenotypic effects? Even morphologies that are today under ruthless genetic control could have started their lives in this way (Budd 1999). Perhaps evolutionary rates are dependent on rates of environmental change for this reason.

The point behind all this speculation is that morphology can only be selected for if it is actually expressed, but only one morphology is normally made, even given a vast range of different potentials in the genome and environmental conditions. This 'canalisation' is greatly to our benefit of course – who wants to grow an extra head if you happen to be born in the Winter rather than the Spring? Nevertheless, the genome's resistance to change can be overcome with sufficient environmental pressure, and then its normally dark and placid surface is revealed to be merely the acceptable face of uncertain depths of noisome water. We all have within us the potential to make all sorts of morphologies, some of which might be really quite nice to have, and mutations are constantly replenishing this potential. If these

hidden depths could consistently be fitted into series of microevolutionary adaptive change, then the conventional view of 'genome proposes, nature disposes' might need some radical rearrangement.

Finally, let me offer a modest if perverse extension of the range of genetic assimilation. It is well known that viral infection induces morphological change – tobacco leaf curl, for example. Suppose that such a change was advantageous in some way, or even broadly neutral: then the host organism's genome might start taking over the task of generating that morphology. Rather than descendants resembling (say) juvenile ancestors, in this case they would resemble *diseased ancestors*. With some effort, one can even think up possible cases in vertebrate evolution. Horrifically, cross-infection of diseases between species could lead to very similar morphological features being convergently genetically assimilated in different lineages, leading to all sorts of problems for cladists.

I propose the term 'Heteropathy' for this no doubt critically important evolutionary mechanism.

You (as they say) heard it here first.

Graham Budd
Uppsala University
<graham.budd@pal.uu.se>

References and further reading

Arkell, W.J. (1933). *The Jurassic system in Great Britain*. Clarendon Press, Oxford.

Budd, G.E. (1999). *Does evolution in body-patterning genes drive morphological evolution – or vice versa?* Bioessays 21, 326-332.

Gibson, G. and Wagner, G. (2000). *Canalization in evolutionary genetics: a stabilizing theory?* BioEssays 22, 372-380.

Lister, A.M. (1995). Sea-levels and the evolution of island endemics: the dwarf red deer of Jersey. In Preece, R.C. (ed.) *Island Britain: a Quaternary perspective. Geological Society Special Publication* 96, 151-172.

McLaren, A. (1999). *Too late for the Midwife Toad: stress, variability and Hsp90*. Trends in Genetics 15, 169-171.

Orr, P.A. (1999). *An evolutionary dead end?* Science 285, 343-344.

Schlichting, C.D. and Pigliucci, M. (1998) *Phenotypic evolution, a reaction norm perspective*. Sinauer Associates, Sunderland, Mass.

Schmalhausen, I.I. (1986) *Factors of Evolution: the theory of stabilizing selection*. University of Chicago Press, Chicago. [reprint of original 1949 version]

Waddington, C.H. (1961). *Genetic assimilation*. Advances in Genetics 10, 257-290.

Meeting REPORT

Geoscience 2000
Manchester

Palaeontology was well represented at this meeting of the British geological societies. On the last morning Paul Smith told me I was the only person he knew who had attended all the relevant sessions, who was not either a contributor or convenor, and asked me to write a report. I did attend most talks in four symposia (Climate Change in the Mesozoic, Plankton Evolution and Climate Change, History of Biodiversity, and Palaeoclimate Reconstructions from Fossils) but can't pretend equal attention to all of them. Inevitably, there was overlap of topics, and the second session on biodiversity clashed with the first on palaeoclimate reconstruction: I chose the latter. *Plankton evolution* is reviewed in this issue by David Gelsthorpe, and *History of biodiversity* by Tim McCormick. So what follows is a partial and personal view, partly of topics and trends and partly of individual presentations.

Palaeoclimate Reconstructions from Fossils

Measuring palaeoenvironments

One can use fossils either directly as recorders of conditions or events, by means of their morphology, inferred behaviour and relationship to living taxa; or indirectly as generators of compounds of geochemical significance, not critically dependent on the identity of the precipitating organism: the best known instance of this being the inference of palaeotemperatures from the oxygen isotopic composition of calcite precipitated by marine organisms. In the latter case, it is important to understand, or at least be aware of, the physiology of formation of the compound of interest: the influence of "vital effects" on some foraminiferal isotopes, both oxygen and carbon, has been appreciated for many years. One of the most significant recent developments has been the separation, identification and isotopic analysis of individual organic molecules, which may serve both as biomarkers for the presence of particular classes of organisms which may not otherwise be preserved, and as isotopic recorders of environment. It is not so long since organic geochemists could be seen, by many geologists, as collectors and describers of complex molecules whose significance was only apparent to another chemist: a fancy probably about as fair as the contrary accusation that palaeontologists only collected species as others collect stamps. Not any more. Separated molecules have at least two advantages over bulk analyses of organic matter. They can be related to specific functions in the source organism, and the fact that they have been preserved at all indicates either lack of diagenetic alteration or an understood diagenetic pathway. Bulk analyses still have their place and may be all that is available, but they are likely to be more reliable as indicators of trends than of absolute values of temperature or CO_2 partial pressure.

When I reviewed palaeoatmospheres for a Geological Society symposium in 1989 I regretted that, although climate models were beginning to suggest elevated CO_2 levels, we lacked a CO_2 palaeo-barometer. The models developed rapidly, most notably in Berner's well-known curves. Now we have several empirical barometers too, and these were in evidence at the meeting. There were striking claims not only about CO_2 levels but their rapid perturbations; whether these were correct or mutually compatible is more than I can discuss here.

Mesozoic climates, atmospheres and oceans

Anybody who supposed the Mesozoic to have been a period of stability must have been quickly disabused. McElwain *et al*. (in a paper delivered in the climates-from-fossils session) determined, on the basis of stomatal densities in plant cuticles, that there was a super-greenhouse climate at the Triassic-Jurassic boundary, with a four-fold increase in CO_2 and a 3-4°C rise in temperature. They related this to the mass extinction recognised at this time, and postulated a volcanic source for the CO_2. Hesselbo *et al*. used carbon isotopes in wood to infer rapid negative changes in isotopic composition of the entire external carbon reservoir (atmosphere plus shallow ocean) during the Toarcian and the early Cretaceous anoxic events; the only sufficient source was methane from hydrates in the ocean, in their turn de-stabilized by volcanism and consequent oceanic circulation changes. These changes were held to be even more drastic than those surrounding the now well-known Late Paleocene Thermal Maximum. Weissert, Robinson *et al*., and Erba & Premoli-Silva, also documented major changes during the early Cretaceous (especially the Aptian) and inferred volcanic and palaeo-oceanographic links. Sinninghe Damste gave a particularly radical interpretation of the Cenomanian-Turonian Oceanic Anoxic Event. Using isotopic changes in biomarkers derived from phytoplankton, he inferred a rapid drop in CO_2 across the boundary, coincident with an increase in carbon burial; this was accompanied by a rise of anoxic water into the photic zone, as demonstrated by the occurrence of isorenieretane. (This molecule, exclusively derived from bacteria which are obligate anaerobes but photosynthetic, is rapidly revolutionising black shale studies in a wider context). Even more remarkably, molecules from waxes of higher plants show such a major shift as to indicate that C_4 metabolism was acquired by plants at this time, due to the CO_2 draw-down which favours this metabolic pathway; it is usually thought not to have arisen until the Miocene.

Direct estimation of temperature was not neglected; Bice *et al.* inferred a real greenhouse world for the Cenomanian tropics from oxygen isotopic analyses of exceptionally-preserved foraminifera: 32 ± 2°C at 5°N. However, not all the Cretaceous was necessarily warm everywhere: Hugh Jenkyns reminded us in his summary of the occurrence of high-latitude glendonites at various Lower Cretaceous horizons, as documented some years ago by Kemper, Frakes and Francis.

Milankovitch cyclicity continues to attract interest both for its relevance to environmental change and for its potential in improving stratigraphical correlation. There is a paradox here. Linkages of sedimentary and biotic changes to astronomical forcing are more and more rigorously demonstrated, but exactly what determines the signals observed remains obscure to this onlooker. It certainly varies from case to case, because the predicted effects of tilt oscillations differ from those of the precession-eccentricity interaction. On the other hand, a cynic might claim that proponents of methane bursts or volcanic forcing propose

mechanisms in *deus ex machina* style, without having clearly demonstrated a temporal link. However, according to Palfy *et al*., there is indeed a coincidence in time between the end Triassic and early Toarcian extinction peaks and major volcanic episodes.

Environment, evolution, diversity and extinction

So, the environment changed during the Mesozoic, and as other symposia reminded us, in the Cenozoic and the Palaeozoic too. The range was wide and the changes sometimes rapid. How did the biota respond, particularly in respect of biodiversity, and particularly among the plankton, where a fairly direct response to environmental perturbation might be expected? Here, I confess to some puzzlement. The speakers in the symposium on plankton all remarked on how much compilation of data remained to be done. Thoughtful papers by Pearson & Coxall and by Bown *et al.* on the evolution of planktonic forams and coccoliths respectively found that both groups were profoundly affected by the extreme K/T event. Other linkages to climate and sea level were indirect, but external forcing of some kind was suggested to Pearson by the markedly non-random incidence of radiations and extinctions that he observed. A general impression is that less lethal environmental impacts than the K/T changed the course of evolution rather little, perhaps surprisingly little. The same lesson has been drawn from the Quaternary, for instance by Coope at the meeting: large and rapid changes in climate and sea level lead to migrations, not extinctions. Yet some of the CO_2 changes claimed for the Mesozoic far exceed those of the Quaternary, and the end-Ordovician glaciation evidently did cause extinctions. A further difficulty of interpretation lies in distinguishing between a population crash, leading to a small and isolated population that later re-enters the fossil record as a Lazarus taxon, and a true extinction. (This was discussed by Smith and by Twitchett in the session I missed – see report by Tim McCormick.)

Do organisms drive, or moderate, environmental change?

Or do they only respond to whatever the physical environment does to them? As just mentioned, most contributions explored links of the second kind. Yet it seems clear that on the largest scale organic evolution is absolutely crucial: most believe that photosynthesis is responsible for the oxygen in our atmosphere, and Berner's modelling recognises a major role of the invasion of the land by plants in influencing CO_2 levels. It is not all down to plates, volcanoes and solar variation. Organisms must affect the carbon cycle collectively, if one believes that CO_2 drawdown in OAEs is due to deposition of organic carbon in sediments. This is also believed to be a main means of moderating oxygen levels in Gaia and many other models. It is more difficult to draw connections with the kind of evolution most palaeontologists study, which concerns descent and its reflection in diversity. The carbon cycle doesn't care whether there are 300 coccolith species or 30. Is the evolution and rapid radiation of the angiosperms discussed by Crane, an instance in which events within the genome ended up by affecting the global environment, and which of the environmental changes in the Cretaceous are the effects of this cause? More generally, one of the big questions facing palaeontology is the elucidation of cause and effect in both global environmental change and evolutionary radiations.

Polar forests, a (temporarily?) extinct ecosystem

All models, including those discussed at the meeting, predict that high latitude climates are

more sensitive to environmental change than tropical ones. If polar ice caps form, their effect feeds into the rest of the global ecosystem via the thermal structure and circulation of the oceans, as well as via sea level. Whatever the climate, polar regions experience polar night and months of daylight. Studies on polar forests therefore have much to attract both environmental and palaeo-physiologically minded palaeobotanists. Several papers in Jane Francis's symposium described these ecosystems. Because of *in-situ* preservation of stumps, biomass and productivity estimates become possible, as shown by Le Page *et al*.
A particularly intriguing suggestion was made by Creber & Francis, that months of light uninterrupted by nightfall may, at times when warmth was not a limiting factor near the poles, promote carbon fixation more effectively than low-latitude light distribution patterns do. Hence the flourishing polar forests of the Cretaceous and early Cenozoic, an ecosystem absent from the modern earth.

What happens next?

Looming over all discussion of global change and biodiversity are the questions of our species' impact on its own ecospace, and concern over the future of our planet's biodiversity. Sir Robert May was inclined to favour lower estimates of both current biodiversity and its rate of decline than some have proposed, but the message is still sober enough. A new message, as regards possible effects on human agriculture, came from David Beerling's data showing that plants experimentally grown under high CO_2 levels become more frost-sensitive. There is also evidence of this from historical records and herbarium specimens. This is a disturbing prospect that has not, so far as I know, reached the public yet. It may be bad for our food supplies (and incidentally complicate our attempts to use fossil plants as environmental indicators), but I doubt that it indicates doom for the world's vegetation in the long term. As remarked above, what seems surprising is how much environmental battering the world's biota has been able to survive, not how fragile it is. Gaia is a tough and adaptable lady. Whether our civilization is as tough, and whether it will prove capable of sufficient adaptation, is more doubtful.

John Hudson
University of Leicester
<JDH4@leicester.ac.uk>

Plankton Evolution and Climate Change

James Powell chaired the session, where a wide range of stimulating reviews of the relationship between plankton and climate change were presented. In the tradition of the meeting a good number of people from outside the field of palaeontology attended.

Most of the talks concentrated on the role of microplankton and climate change, but Andy Gale presented an interesting interpretation of vertical migration on some heteromorph ammonites.

Sue Rigby began the session by analysing graptolites related to climate. She outlined the main problems, but as with most speakers, concluded correlation to climate is problematic. Paul Pearson tackled plankton and climate by showing some results from computer generated evolutionary trees in forams. The diversity variations seem to suggest some

external forcing. He could see no single predominant influencing factor, but concluded the patterns were not purely random.

D. Lazarus then highlighted the potential of radiolaria as climate indicators. Their proximity to ocean currents should give a vital signal, but little research has been done. If the complex signal could be read, the data could give new insights into climate change from contoured extinction data.

Perhaps the most comprehensive analysis of climate change and plankton was presented by Alain Le Hérissé on acritarchs. He presented the extensive data set ranging from the Cambrian to the Carboniferous "blackout". Of particular interest was the Silurian cyclicity seen in extinctions and originations, which is closely related to the carbon and oxygen isotope record. The acritarch changes seem to precede those of the fauna. Considering its age, Alain presented the most detailed patterns related to climatic fluctuations.

The remaining lectures examined the dinoflagellate, calcareous nannoplankton and diatom evidence. Little work has been carried out in the dinoflagellate field, but Recent Atlantic work shows extreme sensitivity to climate. Cold, to intermediate, to warm assemblages were identified across the Callovian-Kimmerigian boundary. Paul Brown explored the interesting feedback mechanisms of calcareous nannoplankton and their relationship to gyres. Their role as a CO_2 sink and dimethyle sulphide production leading to possible cloud seeding were mentioned as complicating factors. He concluded that many concentrations are due to the expansion and contraction of gyres, influenced by regional variations.

The Cenozoic to Recent diatom evolution data shows a complex signal, but A. Mitlehner outlined the important factors. Their ability to trace circulation patterns, their carbon consumption and nutrient indication were suggested to be invaluable characters. Their enhanced production at glacial maxima and turnover into the glacial period were explored.

This stimulating session highlighted the rich record phytoplankton provides. At present we have an open book and we are just beginning to read.

David Gelsthorpe
University of Leicester
<DNG1@leicester.ac.uk>

History of Biodiversity

David Harper (University of Copenhagen) and Mike Benton (University of Bristol) jointly convened this one-day symposium as part of the Geoscience 2000 meeting, and it promised to provide an eclectic mix of perspectives on what is in many ways a controversial topic. The session was organised in four parts each introduced with a keynote lecture.

Part 1: Development of biodiversity, was opened by Sir Robert May FRS, Chief Scientific Advisor to the Government and Head of the Office of Science and Technology, who reviewed what we know about extant biodiversity on Earth (*i.e.* very little). In a statistic-laden talk he pointed out that not only do we have no idea how many species of eukaryotes exist today (Sir Robert favours a number somewhere between 5 and 15 million, but noted that estimates anywhere between 3 and 100 million are defensible), we cannot even say for sure

how many have been described and named by science (around 1.5 million, ±10% with a synonymy rate of about 20%). He discussed the relative effort spent on different groups, showing that it is far from evenly spread across the kingdoms of life. Finally he surveyed the different methods used to derive estimates of current and future rates of extinction.

Matthew Wills (Oxford University) and Mike Benton discussed the completeness of the fossil record as indicated by stratigraphical congruence of cladograms. Refreshingly, they noted that the degree of congruence between a cladogram and the order of appearance of the taxa in the fossil record has implications not only for the completeness of the record but also for the accuracy of the cladogram. Using a compilation of 1000 morphological and molecular cladograms for Phanerozoic groups, they showed that while some groups have better fossil records than others there appeared to be no overall temporal trend in quality through time; the fossil record does not get significantly worse the further back you go. However, some environments provide more complete records than others.

Mike Benton reviewed the broad patterns of diversification in terrestrial and marine environments. There was a logistic increase in the sea (the classic S-shaped curve consisting of slow initial increase, then a rapid rise, finally slowing to a plateau) but an exponential increase on land (more consistent with a branching model of diversification). Current terrestrial diversity is probably one or two orders of magnitude higher than marine diversity, possibly related to greater potential for ecological separation and/or greater endemism in the terrestrial setting. Significant biases in the preservation potential of different environments are likely greatly to affect what we can know about past diversity.

Minik Rosing (University of Copenhagen) took us almost all the way back to the beginning with a review of evidence for biological activity in the pre-3.7 Ga Isua supracrustals of western Greenland. Tiny carbon grains have delta ^{13}C values in the range indicative of biologically reduced carbon, and Minik argued that they were derived from planktonic photosynthetic organisms, and that life had reached a relatively high level of sophistication in the open oceans in a stable habitat. This was a crucial time in the Earth's history when biological processes were beginning to have a significant effect on the composition of the atmosphere and hydrosphere.

Peter Sheehan (Milwaukee Public Museum) opened *Part 2: Marine diversity*, taking an ecological approach in reviewing the evolution of marine diversity. Ecological Evolutionary Units (EEUs) represent long intervals of community stasis within Sepkoski's Evolutionary Faunas. Most EEUs ended with extinction events, followed by community reorganisation and radiation of taxa into new habitats. Incumbent groups appear to have dominated within EEUs, but following the disruption of a mass extinction event ecospace was cleared. In these newly cleared niches, survivors of the extinction event were able to adopt new lifestyles.

Paddy Orr (National University of Ireland, Galway) took a novel approach to studying biodiversity of deep-marine environments by showing how it is recorded in the Cambrian-Carboniferous ichnofossil record. Paddy showed a progressive decline in ichnotaxa normally considered characteristic of shallow water with a corresponding increase in deep-marine ichnotaxa, as well as increased partitioning of ichnotaxa into different niches. He attributed the post-Cambrian restructuring of the deep-marine trace fossil assemblages to

displacement of taxa offshore, possibly as a result of increased ecospace utilisation in onshore environments.

Alan Owen and Tim McCormick (University of Glasgow) used the British Isles as a 'natural laboratory' for studying the Ordovician radiation, the most sustained steep increase in marine diversity in the Phanerozoic. They are constructing a detailed database for the British Ordovician that captures the fundamental data of the fossil record: fossil species at localities. This allows the record to be interrogated for palaeogeographical, palaeoenvironmental and palaeoecological patterns in a much more sophisticated way than previous databases, and also allows assessment of biases that arise from the temporal, spatial and environmental distribution of the data. Taking trilobites as an example, they speculated that high species richness in the late Arenig – early Llanvirn may be related to the onset of provincial breakup in the Gondwanan palaeocontinent.

Alistair Crame (British Antarctic Survey) discussed the evolution of taxonomic diversity gradients in marine bivalves. He used a global compilation of extant bivalve faunas that revealed both latitudinal and longitudinal gradients. However, he found indications of significant north-south asymmetry. He also found that the steepest latitudinal gradients are associated with the youngest clades, suggesting that some important groups are of low-latitude origin and have not yet fully spread to higher latitude regions. Alistair argued that patterns of extant biodiversity may be strongly related to clade age.

Peter Crane (Royal Botanic Gardens) opened *Part 3: Diversity on land*, with a review of the history of land plant diversity. He illustrated the rise in importance of plants as a major component of terrestrial settings from the mid Ordovician onwards, noting the dramatic increase in size, complexity and diversity in the Devonian. He pointed out that the mass extinctions seen in marine invertebrates are in general not seen in land plants. Angiosperms first appeared in the early Cretaceous and rapidly increased in diversity and abundance throughout that period and the early Tertiary. Today they form the basis for most terrestrial ecosystems, and their species-level richness is greater than that of all other land plant groups put together.

Per Ahlberg (Natural History Museum) and Jenny Clack (University of Cambridge) presented the biodiversity of the fish-tetrapod transition as a double-act. Per discussed morphological characteristics of the late Givetian basal tetrapoda and followed subsequent developments up to the late Devonian mass extinction. Jenny reviewed the subsequent history of the group, which underwent a new radiation in the Tournaisian, when greater terrestriality was achieved. By the late Visean a fully terrestrial assemblage of tetrapods had arisen, including the roots of both amphibians and amniotes alongside other forms restricted to the late Palaeozoic.

In a presentation featuring, for my money, the most beautiful fossils of the session, Gareth Dyke (University of Bristol) discussed the discordance between estimates of the timing of the radiation of birds based on the fossil record (mostly in the early Tertiary) and estimates based on lineage divergence times calculated from molecular data (Mesozoic). Mesozoic bird fossils are extremely rare, but combining fossil evidence from the Palaeocene and Eocene with evidence from modern birds has helped in formulating phylogenetic hypotheses. The stratigraphical congruence of these hypotheses suggests that only a few of

the more basal clades of modern birds predate the K/T boundary, and that the major radiation of 'higher' land birds was indeed during the early Tertiary (chalk one up for the fossil record).

Two more database-based talks completed the session. Emmanuel Fara (University of Bristol) discussed the role of Lazarus taxa in a compilation of Cretaceous vertebrates. He found that the number of extinctions in Cretaceous tetrapod families is highly correlated with the number of Lazarus taxa, suggesting that the former statistic may be affected by artefact. It is possible that Lazarus taxa indicate poorly sampled stratigraphical intervals that exaggerate the apparent severity of extinction events. To assess the real meaning of the Lazarus effect, Emmanuel is compiling a huge genus-level database on Cretaceous vertebrates that will incorporate stratigraphical, ecological and phylogenetic information.

Paul Markwick (Robertson Research) introduced his (vast) database designed to explore the link between modern biodiversity and climate. The database, compiled over the last ten years, incorporates information on the distributions of modern and fossil vertebrates, invertebrates and megafloras, and includes over 30,000 taxa! It also stores lithological, stratigraphical and climate information, and is linked to a GIS. Paul showed how differences between the diversity distributions of ectotherms (reptiles and amphibians) and endotherms (mammals) relate to geographical climate variations. He hopes that demonstration of such links in the Recent fauna and flora will encourage the broader scientific community to accept palaeontological data in studying climate variations on geological timescales. It was interesting to see that the Owen & McCormick, Fara, and Markwick databases, though each storing different kinds of data, were all based on the same highly flexible relational structure.

Andrew Smith (Natural History Museum) gave the keynote presentation in *Part 4: Extinction and survival*. Beginning with the phrase "I am here to play Devil's advocate", he argued forcefully that the suggested magnitude and duration of mass extinction events may be grossly inaccurate because of such biases as: lack of preservation of some geographical regions, environments, and biotas; effects of variation in organic productivity; taxonomic practice. He used the relationship between eustatic sea-level change and the Mesozoic marine fossil record to highlight effects caused by lack of preservation of certain environments at certain times. These effects, he contended, conspire to generate great uncertainty even about the very reality of some mass extinction events. However, pressed by a questioner in the audience, Andrew confirmed that he does believe in extinction, and that he "probably" believes in mass extinction events.

David Harper and Rong Jia-yu (Chinese Academy of Sciences) reviewed extinction and survival in Palaeozoic brachiopods. Taking an unapologetically 'taxic' approach, they traced diversity throughout the group's Palaeozoic history, showing how it resulted from a series of radiations that were often associated with the origination of new specialisations to newly opening niches. They highlighted some of the specialised forms that originated during more regional phases of diversification, and that had restricted geographical and environmental distributions and thus suffered heavily during times of elevated extinction rates. The end-Permian extinction event eradicated a range of life strategies within the Brachiopoda.

Pat Brenchley and Jim Marshall (both University of Liverpool) used the late Ordovician to assess whether all mass extinctions necessarily represent ecological crises. The end-Ordovician event is unusual because although there were high rates of extinction, the ecological consequences were small. The event occurred in two phases. The first occurred when global cooling set in (evidenced in part by oxygen and carbon isotopes) lasting on the order of 0.5 to 1 myr, and was followed by the limited recovery represented by the *Hirnantia* fauna. The second phase of extinction occurred during the subsequent warming, and was followed by an interval (about 2 myr) with very low species diversity and low within-community diversity. However, the pre-extinction trophic structures were subsequently re-established and no major adaptive innovations appeared.

Richard Twitchett (University of Leeds) developed one of the effects mentioned by Andrew Smith, by looking at the effects of variation in nutrient production and preservation potential on the apparent magnitude of mass extinction events. Small populations are less likely to leave any trace in the fossil record, and smaller animals tend to have lower preservation potential than larger ones. Population sizes tend to be reduced, and animals tend to be smaller, during times of reduced primary production. The Lower Triassic appears to have been such a time of low productivity, and this may account to some degree for the depauperate nature of Lower Triassic marine faunas. A further effect causing inflated extinction estimates could be the real extinction of silica-producing organisms which in turn leads to an absence of silicified fossil assemblages and hence the apparent extinction of their constituents.

József Pálfy (Hungarian Natural History Museum), Paul Smith and James Mortensen (both University of British Columbia) closed the session, giving one of those computer-based presentations that will soon be *de rigeur*. They used high-resolution U-Pb dates to suggest that the peak of end-Triassic extinction in terrestrial plants and vertebrates (prior to 200.6 Ma) slightly predated the extinction in the sea (199.6 +/- 0.3 Ma). Dating of a lower-level extinction event in the early Jurassic (183 Ma) suggested that it was contemporaneous with the height of flood basalt volcanism in the Karoo and Ferrar provinces of southern Gondwana. József suggested that this volcanism may have caused environmental changes that played a role in both the end-Triassic and early Jurassic extinction events.

We spent a whole day hearing talks about a subject that usually gets just a couple of hours (if that) at other conferences, and this gave a feel for the breadth of the subject, its challenges, and the different approaches available for its study. The day highlighted, at least for me, several broad issues facing workers in this field, some of which were explicitly stated during the meeting, others not.

Should we even attempt to quantify past biodiversity? Notwithstanding the arguments of Smith and Twitchett, I think the answer is *yes*. Sir Robert May pointed out that if there is one value that defines our planet, it is the measure of its biodiversity. If we accept that past biodiversity is worth quantifying, the next issue is how? What should we count? The alternatives seem to be species, monophyletic 'higher' clades, or some ecological measure of diversity (number of niches or trophic complexity). How do we deal with the issue of 'taxonomic equivalency'? Needless to say this type of work can only be carried out in an ongoing environment of systematic research. How do we address the biases that degrade

the fossil record? The most we can probably hope for is to be able to recognise when the observed pattern is hopelessly wrong. Increasingly sophisticated methods will aid in this recognition.

I foresee a lot of debate in the coming years on the merits and methodology of palaeodiversity studies. I suspect the major themes of this debate will be the incorporation of phylogenetic systematics, statistical methods (particularly with respect to detecting biases) and improved technology for gathering and maintaining the data. The special edition of *Geological Journal*, edited by David Harper and Mike Benton, that will arise from this symposium will no doubt provide a valuable and timely contribution to that debate. Congratulations are due to them for organising what was a very interesting and thought-provoking session.

Finally it is worth noting that many of the speakers took the family- and genus-level Phanerozoic marine diversity curves calculated by the late J.J. Sepkoski as starting points for their presentations. It is likely that his pioneering work will continue to provide the background on which new and more detailed analyses are constructed for a long time to come.

Tim McCormick
University of Glasgow
<T.McCormick@earthsci.gla.ac.uk>

>>*Future* Meetings of Other Bodies

SVPCA 2000
Portsmouth, UK *28 August – 1 September 2000*

The 48th Symposium of Vertebrate Palaeontology and Comparative Anatomy, with The 8th Symposium of Palaeontological Preparation and Conservation, will take place in Portsmouth, UK, from 28th August to 1st September 2000.

SVPCA 2000, co-sponsored by the University of Portsmouth and the Museum of Isle of Wight Geology, is being held earlier than in previous years due to the early start of the teaching semester and the availability of accommodation prior to the start of the academic year.

As usual there will be three days of lectures and posters and a post-meeting field excursion. SPPC will take place before SVPCA.

Organisers

Dr David M. Martill (Portsmouth) SVPCA (e-mail: david.martill@port.ac.uk)
Dr Mike Barker (Portsmouth) SVPCA (e-mail: michael.barker@port.ac.uk)
Mr Steve Hutt (Isle of Wight) SPPC (e-mail: steve@miwg.freeserve.co.uk)

Dave Martill & Mike Barker
School of Earth, Environmental and Physical Sciences
University of Portsmouth
Portsmouth PO1 3QL UK

Steve Hutt
Museum of Isle of Wight Geology
High Street
Sandown
Isle of Wight PO36 8AF UK

Details are at http://www.svpca.org/

For further information regarding SVPCA please contact one of the organisers.

Dr D.M. Martill
Dept. of Geology, University of Portsmouth, Burnaby Road, Portsmouth PO1 3QL
<David.Martill@port.ac.uk>

IV Congreso del Terciario de España
IV Congress on the Tertiary of Spain
Tremp *19 – 21 September 2000*

The Unitat d´Estratigrafia (Departament de Geologia) of the Universitat Autònoma de Barcelona, the Ajuntament de Tremp, the Institut d´Estudis Il.lerdencs and the Consell Comarcal del Pallars Jussà are organizing the IV Congreso del Terciario in Tremp (Lleida province), from 19th to 21st September 2000, together with ceremonies in honour of Dr Joan Rosell Sanuy organized by the Ajuntament de Tremp.

The address for correspondence is Eudald Maestro Maideu or Eduard Remacha Grau, Secretaría

IV Congreso GET. U. d'Estratigrafia, Dep. Geologia. Fac. de Ciències, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain (tel 935 81 16 03 (E. Remacha) or 935 81 10 85 (E. Maestro) or 935 81 16 09 (Secretaría de Geología), fax 935 81 12 63, e-mail iget3@cc.uab.es or Eudald.Maestro@uab.es)

The Second Circular and other useful information are available in the Web page of the Congress, at http://www.catalunya.net/gettremp2000/

Precambrian-Cambrian International Seminar – Field Meeting
NW Himalayas *30 September – 9 October 2000*

This meeting is being arranged under the co-convenorship of Dr O. N. Bhargava and Prof S. B. Bhatia, by Dr Arun D. Ahluwalia, Principal Investigator, DST Project Terminal Proterozoic-Early Cambrian (Krol Belt-Spiti Himalaya), Geology Department, Panjab University, # 2114, Sector 15-C, Chandigarh 160014, India (tel 541740, fax 541409, e-mail ada%phys@puniv.chd.nic.in).

Funding is expected from a number of sources once response is known. Your suggestions and good wishes are solicited. If you are interested please indicate by e-mail and in writing, as a document signed by you would be most helpful for obtaining support. Your passport details *etc.* will be required to get clearance.

An earlier National Meeting on Mega Events from Blaini to Tal was held from 7th to 10th August, 1998. A brief review of this meeting is published in *Journal of Geological Society of India*, January 1999 (author Vibhuti Rai). Dr O.N. Bhargava gave a keynote address. Other participants were S.V. Srikantia (Secretary, Geological Society of India); B.S. Tewari (President of the Pal. Soc. India); S.S. Kanwar (Deputy Director General, Geological Survey of India); D.K. Bhatt (Director, Pal. Div, Geological Survey of India, Jaipur (India)); Arun Sharma and Jaitinder Sud Simla; Ravindra Kumar (GSI, Jaipur); Nawal Kishore Sharma; D. Ahluwalia (Convenor, RituRaj); Anjali Mehra (Chandigarh); K. Bassi, K.C. Prashra: Inder Singh (GSI, Chandigarh).

Abundant help came from the Mine Owners' Association, Sirmaur (H.P.) to all participants, and is also expected for this meeting.

Historical Patterns of Biodiversity
Memorial Symposium honouring the Work of J. John Sepkoski, Jr.
Field Museum of Natural History *7 October 2000*

Over the last quarter of a century, numerous palaeontological and neontological research programs have focused on long term patterns of origination, extinction and standing biodiversity. Whereas studies once used simple counts of species within particular genera and genera within particular families, historical biodiversity programmes have evolved into explicit hypothesis-testing programmes, examining (among other issues) alternative hypotheses about

modes of diversification, relative rates of speciation / extinction among related taxa, and relationships between environment, ecology and diversification.

This symposium represents a memorial for the late J. John Sepkoski Jr. Sepkoski's work is prominent among biodiversity research programs, expanding both the breadth of data used for inferring patterns, and the variety and rigour of analytical techniques used to test diversity-related hypotheses. Sepkoski's untimely death last year cost evolutionary biology one of its major contributors to historical diversity studies.

Speakers & Contributors:

Arnie Miller & Sean Connolly, Kaustuv Roy, David Jablonski & Jim Valentine, Mike Foote, Susana Magallon & Michael Sanderson, John Huelsenbeck, Sean Nee, Peter Wagner & Phillip Novack-Gottshall, Scott Lidgard, Paul Taylor & Frank McKinney, Roy Plotnick, Todd Grantham, John Alroy, Kay Behrensmeyer & Susan Kidwell.

For additional information, send e-mail to symposia@fmnh.org.

60th Annual Meeting of the Society of Vertebrate Paleontology
Mexico City, Mexico *25 – 28 October 2000*

For further details, visit http://alnus.uel.ac.uk/svp/meetings/

British Micropalaeontological Society 2000 – Annual General Meeting
15 November 2000 (Date To Be Confirmed)
Gustave Tuck Lecture Theatre, University College London.

The 2000 annual addresses are:

> *Listening to cysts – dinoflagellates of the late Cenozoic*, by Dr Martin Head (Godwin Institute for Quaternary Research, University of Cambridge).
>
> *Molecular view on origin, macroevolution and speciation of Foraminifera*, by Professor Jan Pawlowski (Station de Zoologie, Université de Genève).

Following the talks, a wine reception (sponsored by Robertson Research International Ltd) with poster presentations will be held in the South Cloisters at UCL. If you (students especially) wish to contribute a poster on any micropalaeontological topic, please contact Jamie Powell (see below).

Convenor: Dr James Powell, BMS Secretary, Dinosystems, 105 Albert Road, Richmond upon Thames, Surrey TW10 6DJ, England, UK, tel: +44 (0)181 948 6443, fax: +44 (0)181 940 5917, e-mail: ajp@dinosystems.co.uk, Web: http://www.bmsoc.org/

Society for Integrative and Comparative Biology: Chicago, Illinois
Chicago Hilton & Towers *3 – 7 January, 2001*

Further details are at http://www.sicb.org/

Third International Conference on Trilobites and their relatives
Oxford, UK *2 – 6 April 2001*

There will be a pre-conference field trip to Scotland and Northern England, and a post-conference trip in Wales and the Welsh Borders. Organiser-in-chief: Derek Siveter (Oxford).

Further details can be obtained from http://www.ashmol.ox.ac.uk/oum/wwwtrilo.html

North American Paleontological Convention 2001 (NAPC 7)
UC Museum of Paleontology, Berkeley, California *26 June – 1 July 2001*

NAPC 2001 continues a tradition begun in 1969 at Chicago and continued at five other sites since then. NAPC 2001 is the seventh meeting of North American paleontologists. In addition to our Mexican, Canadian, and American colleagues, we also welcome those from other countries. Sponsored by ANAPS, the Association of North American Paleontological Societies, and hosted by the Museum of Paleontology of the University of California at Berkeley, NAPC 2001 will be held in the beautiful San Francisco Bay area of northern California. The meeting will be organized into theme and volunteer sessions with workshops, field trips, special programmes for K-16 educators, tourist excursions, and programmes for the general public planned to complement the meeting.

As we enter a new millennium the Organizing Committee anticipates a lively discussion on the role of paleontology in the future as well as reflections on past accomplishments. We are especially interested in the importance of integrative approaches that use multiple lines of evidence to test hypotheses and solve complex problems in the history of life, that apply paleontological information to other fields, and that use methods and data from other fields to answer questions in paleontology.

Further details are at http://www.ucmp.berkeley.edu/napc/general.html

6th International Congress of Vertebrate Morphology
University of Jena, Germany *21 – 26 July 2001*

The congress will be hosted by the Institut für Spezielle Zoologie und Evolutionsbiologie in the new convention centre of the Friedrich-Schiller-Universität in Jena, Germany. The congress is designed to make the most current research available to the international community of

vertebrate morphologists, and to provide a basis for a synthesis between vertebrate morphology and other fields of biology. The scientific program of ICVM-6 includes ten half-day sessions with a variety of symposia and workshops, contributed oral and poster papers, and a plenary lecture by a distinguished scientist each day. In addition, the congress offers opportunities to present films, wet labs, imaging and computing facilities, and other demonstrations. A number of cultural events, excursions, and pre- and post-congress tours will be organised that introduce you to outstanding historical and cultural sites in the region, to the natural habitats around Jena, and to the internationally recognised centres of optical industry in Jena.

The second circular is available from http://icvm-6.zoo.uni-jena.de/

Third International Meeting on Mesozoic Fishes
Serpiano, Switzerland *August 2001*

Systematics, Palaeoenvironments and Biodiversity

We are pleased to host the third international meeting on Mesozoic Fishes in one of the most famous sites for these fossils, the Monte San Giorgio-Besano area. The organization of the meeting is supported by the Dipartimento di Scienze della Terra of the Milano University (Andrea Tintori), the Museo Cantonale di Storia Naturale in Lugano (Markus Felber), and the Palaeontologisches Institut und Museum der Universitaet Zuerich (Heinz Furrer).

Prof. Andrea Tintori, Dip. Scienze della Terra, Iniversità degli Studi di Milano, Via Mangiagalli, 34 I-20133 MILANO, tel: +39.02.23698202, fax: +39.02.70638261, e-mail: andrea.tintori@unimi.it, Web: http://www.soft.net.uk/richardforrest/svpca2000/otherconferences/mesozoicfishes.html

8th Congress of the European Society for Evolutionary Biology
Aarhus, Denmark *20 – 26 August 2001*

The eighth Congress of the European Society for Evolutionary Biology will be held in Aarhus, Denmark, from 20-26 August 2001. The structure of the congress will be similar to previous meetings, each day starting with a plenary keynote speaker, followed by parallel symposia. Besides, there will also be a few contributed paper sessions. The congress will cover the field of evolutionary biology in a wide sense but with emphasis on processes and mechanisms of evolutionary phenomena.

Details are at http://www.biology.au.dk/eseb/

Early Palaeozoic Palaeogeography and Palaeobiogeography of Western Europe and North Africa

Lille *22 – 29 September 2001*

After a very successful meeting on the topic *Palaeozoic Palaeogeography and Palaeobiogeography of western Europe*, held at Lille in 1992, the Laboratory of Palaeontology of Lille invites you to participate in and contribute to a conference on early Palaeozoic Palaeogeography which will take place at Lille in September 2001. A pre-conference field trip to visit the Lower Palaeozoic of Belgium and a post-conference field-trip to the southern Montagne Noire (Languedoc, southern France) will be organized.

The conference topics are designed to address various subjects related to the Lower Palaeozoic palaeogeography and palaeobiogeography of western Europe and north Africa, and include:

1- The geodynamic and tectonostratigraphic framework of western Europe and north Africa during early Palaeozoic times.

2- Relationships between the northwestern Gondwana margin and related terranes (Ossa-Morena, Armorica, Perunica, Avalonia, etc.).

3- Palaeomagnetic versus palaeobiogeographical data.

4- Biostratigraphic improvements of the Proterozoic-Cambrian transition and the Lower Palaeozoic (Cambrian to Silurian).

5- Lower Palaeozoic geochemical anomalies and palaeoclimatology.

6- Palaeogeographical controls on biodiversity patterns.

7- Volcanoclastic events and geochronological framework.

8- Evolutionary trends in early Palaeozoic ecosystems.

9- Event stratigraphy and radiation/extinction turnovers.

10- Sea-level changes, cyclicity and palaeoenvironments.

Dates:

Conference: (3 days) Université des Sciences et Technologies de Lille, Villeneuve d'Ascq, 24-26 September, 2001.

Pre-conference excursion: (2 days) Lower Palaeozoic of Belgium: 22-23 September, 2001.

Post-conference excursion: (3 days) Lower Palaeozoic of the southern Montagne Noire: 27-29 September, 2001.

Important Dates:

March 2000: first circular

October 2000: second circular – call for papers

May 2001: deadline for Abstracts and registration

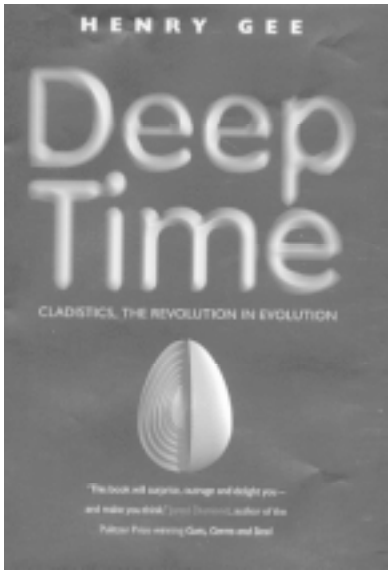
July 2001: third circular, programme and final arrangements

Please send correspondence to: *José Javier Alvaro* or *Thomas Servais*, USTL – Sciences de la Terre, UPRESA 8014 CNRS, Cité Scientifique SN5, F-59655 Villeneuve d'Ascq cedex (France), tel: (+33) (0)3 20 33 72 20, (+33) (0)3 20 33 63 92, fax: (+33) (0)3 20 43 69 00, e-mail: Jose-Javier.Alvaro@univ-lille1.fr, Thomas.Servais@univ-lille1.fr.

Book Reviews

Deep Time: Cladistics, the revolution in evolution

H. Gee. 2000. 262 pp. Fourth Estate. ISBN 1-85702-986-0. Hardback. £20.00.



One of the worst and most unfair criticisms made of palaeontologists is that they are just a bunch of 'stamp collectors' interested only in describing new fossils and arranging them according to their relationship to other known forms. I have never met such a palaeontologist, but I fear Henry Gee could be one.

Gee presents his forthright views on what is and what is not scientific in palaeontology in his new book 'Deep Time'. The central argument, which is relentlessly pursued, is that our innate tendency to form narrative histories linking one event with another is inappropriate when we are confronted with the enormity of geological time. Fossils are generally isolated and often fragmentary individuals 'lost in the fathomless sea of time', representing the minutest fraction of what once existed. Any attempt to build scenarios about what is descended from what, or what a particular structure in a given fossil was 'for', depends on unattainable knowledge. Our desire to determine cause and effect in the distant past and see patterns or trends in life's history are no more than post-hoc fantasies that reveal more about our deepest prejudices than reality.

I believe that Gee fundamentally misunderstands the nature of science. But before I make that case, it is necessary to consider the background to his views, gleaned from this book – which certainly lives up to the claim of being 'outrageous' as the cover promises.

'Deep Time' is about cladistics, how it has revolutionised our science, and the limitations to knowledge that in Gee's view become apparent when the implications of the method are fully digested. Cladistics is a method for inferring the most probable history of evolutionary branching for a group of related organisms given a list of their observable attributes or 'characters' (and no other information). Gee entertainingly describes how the rules of the game were first formulated by the entomologist Willi Hennig, and then picked up on in the 1970s and early 1980s by various palaeontologists around the world, including notably the

fossil fish group at the Natural History Museum in London. Now the method is firmly established across the life sciences as the best way to infer relationships among distantly related organisms or fossils given very incomplete data. Gee was around (albeit as a student) in those exciting times at the Natural History Museum, and describes how the fish group took long liquid lunches at an establishment called the Cranley and plotted the downfall of palaeontology as we know it.

Without doubt the advent of cladistics has been a real scientific advance because it has enabled palaeontologists to increase dramatically their degree of rigour inferring phylogenetic relationships. However it seems to me a touch fanatical to claim that 'cladistics represents a revolution in thought as profound as that of Darwinian evolution by natural selection' (p. 135) or 'without cladistics, palaeontology is no more of a science than the one which proclaimed that the Earth was 6,000 years old and flat' (p. 10). It is a useful method, but by no means beyond criticism itself and certainly not free from assumptions about the way life has evolved as Gee repeatedly claims. And there really is much more to palaeontology than phylogenetics.

The principal problem with cladistics, or rather its 'blind spot', is that a cladogram will not depict one fossil as being ancestral to another even if that was in fact the case. If one draws any branching diagram to represent a notional phylogeny, it is easy to see that half of the branches are internal (*i.e.* ancestral) and half are terminal. In other words, all things being equal, half of all fossil species are ancestral to others. But a cladogram will always represent these species as 'sisters' rather than lineal ancestors and descendants. Well, it's useful to know the limitations of one's method. But Gee gets very hung-up on the so-called 'untestability' of hypothesising that one organism is ancestral to another. In fact it is the book's principal theme.

Earlier I made the claim that Gee seems to misunderstand the nature of science itself. It is a serious allegation so it is my duty to substantiate it. Gee makes much of the fact that to be scientific, a hypothesis must be testable. Agreed. But, having read the book and thought deeply about the examples he uses, 'testable' to Gee seems to mean 'provable', whereas it should mean 'falsifiable'.

'Next time you see a fossil', says Gee, 'ask yourself whether it could have been your direct ancestor. Of course it could be your ancestor, but you will never be able to know this for certain. To hypothesise that it might be your ancestor, then, is futile, because your hypothesis would be untestable. So, to take a line of fossils and claim that they represent a lineage, is not a scientific hypothesis that can be tested, but an assertion that carries the same validity as a bedtime story' (p. 114). Well I did this. The next fossil I saw was a Jurassic ammonite. I could plot a cladogram (but I won't) showing that it cannot be my ancestor, at least with any degree of parsimony. So the hypothesis has been tested and rejected. What Gee seems to mean in the above quote is that the hypothesis is not "provable". But it is not necessary for a scientific hypothesis to be provable. Absolute truth is something that belongs to the priests and politicians, and they can keep it.

The above example is not a temporary aberration, but (and I have striven not to misrepresent the author) the fallacy is the book's principal foundation. The discussion of the extinction of the dinosaurs is just one example. Gee mentions that at least 50 causes have been proposed, of which an asteroid impact is currently the most popular. 'However, establishing whether the

impact really did extinguish the dinosaurs – making a link between cause and effect – is impossible, given what we know about Deep Time' (p. 111). But the hypothesis is falsifiable, to the extent that confirmation of the existence of Paleocene dinosaurs (thriving after the impact) is possible. If we all subscribed to Gee's defeatist philosophy, nobody would have bothered to research the issue. I for one have enough confidence in the amassed data of the last two decades to believe that a major impact occurred about 65 million years ago in what is now Mexico, and that the impact set in train a series of events which include the extinction of the dinosaurs. I am not sure of it, but then I am not "sure" of anything.

Next there is the important issue of adaptation and functionality as inferred from fossils. To Gee, functional hypotheses are second only to hypotheses of ancestry as unscientific and part of an old-time palaeontology that has been superseded by cladistics. For example, the idea that tetrapods evolved limbs to walk on land is 'scientifically unjustified, because we can never know that it is true' (p. 84). It's that fallacy again! More generally, 'to speculate about adaptation in extinct creatures is at best pointless, at worst recklessly misleading' (p. 86). Why? Because we cannot observe the behaviour of extinct organisms. We can never know for sure if we are right. We can never "prove" it.

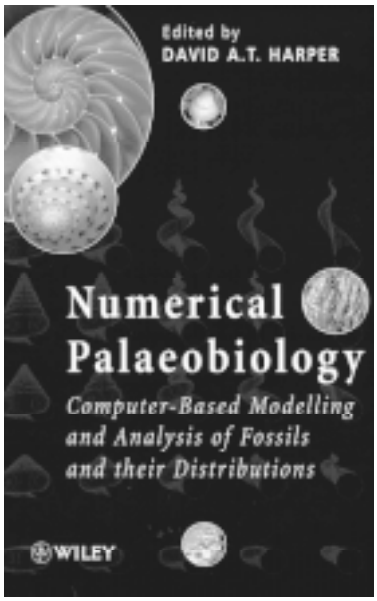
To illustrate his views on adaptive hypotheses, Gee concentrates on the question of avian flight, and how our views of its origin have changed (Chapter 6). He gives a reasonable account of the sort of adaptive scenarios that people (I hesitate to call them scientists!) once suggested of how birds might have evolved feathers for flight. 'This is the traditional picture of the origin of birds. It is sensible and plausible, violates no established rules and invokes no unusual mechanisms. For all that, the scenario that links birds with flight cannot be tested so your acceptance of it rather depends on whether or not you like it.' (p. 176). Curiously, however, he then goes on to show how the spectacular recent discoveries of feathered dinosaurs (that he seems to accept on biomechanical grounds could not fly) from China thoroughly undermine this old view. 'The traditional view of bird origins, as well as being theoretically indefensible, has been trounced by the fossil evidence' (p. 190). Gee takes evident delight in deriding those old-time palaeontologists and their adaptive ideas. But I put it to him that this tale shows how new scientific evidence has allowed us to test and reject a sensible hypothesis using adaptive reasoning!

There is no denying that Gee's book is an interesting read. He does a good job of expressing the enormity of time, and underscores how patchy the fossil record (generally) is. He explains well how to make a cladogram, and attacks the tiresome 'missing link' genre of journalism, and those outmoded ideas of the inevitable march of evolution toward human perfection. He signals many a welcome warning to all model builders to avoid foisting one's attitudes on the dead and necessarily mute remains of past life. But the book is much, much more than this. In essence, it is nothing short of a denial of the scientific basis of palaeobiology, based on a misunderstanding of what science is all about. If Gee is right, there is little left for us to do than describe our beloved fossils and determine their most likely relationship to other forms in the museum. Stamp collecting, in other words.

Paul Pearson
University of Bristol
<paul.pearson@bristol.ac.uk>

Numerical Palaeobiology: Computer-Based Modelling and Analysis of Fossils and their Distributions

David A. T. Harper (editor). 1999. 468pp. John Wiley & Sons. ISBN 0 471 97405 6 (hbk). £65.00



After more than 20 years of fairly regular attendance at Palaeontological Association meetings, I can recall a number of phases in the response of the culture of UK palaeontology to the burgeoning developments in computer applications. Initially, there were attempts at ridicule, then a phase of hiatus when young researchers seemed to avoid these methods, then a period characterised by some rather poor attempts! Now, however, there is a terrifically healthy acceptance and use of computer methods, and the UK community rivals the US in quality if not quantity of such work. This book will be immensely useful to both present and future palaeontologists, and will compensate for the rather poor coverage of these issues in certain other standard texts (which, I believe, was the stimulus that led to its conception). Harper and Owen, on quantitative and morphometric methods, have the first chapter, and, appropriately, include an interesting historical review that lists some key papers that were new to me. Their review of statistical applications is too concise to be useful to the beginner, but the chapter constitutes a remarkably intensive introduction to the appropriate literature, especially good for brachiopod or trilobite workers. The allometric equation is erroneously presented as $y = bxa$ rather than $y = bx^a$, but I know from harsh experience how difficult it is to proof-read mathematical material! There are very few other such errors in the book.

Carlson, on phylogenetic systematics, provides an excellent introduction to her subject and doesn't avoid a proper discussion of the difficulties involved. I have little experience of this subject but I found this to be possibly the best palaeontological overview I've seen. As a bonus, there is a long appendix-like technical section with advice on software use and case studies, culminating in some real appendices!

Computer-based serial section reconstruction is a big topic this year, and Herbert's chapter on this subject will, I think, be carefully studied. He provides a thorough guide to the methods, but this is one area where developments may outpace the time lost during publication. Also on imaging, Hughes writes on applications to deformed fossils, incorporating multivariate methods and use of photocopiers! This is one of many chapters in this book that have a definitive feel to them.

Armstrong's chapter on quantitative biostratigraphy commences with a review that functions as an introduction to biostratigraphy in a broad sense, and quantitative methods become involved in a way that seems, correctly, perfectly natural. There is an emphasis on graphical correlation and little on similarity coefficients, but not without some justification. There is a potentially useful conodont case study with data included.

Two important chapters on databases follow: Johnson and McCormick focus on applications on a local scale whilst Benton addresses the global scale. Benton's chapter, in particular, is essential reading: it has a refreshingly amusing and lively style, and concludes with a call-to-arms to the palaeontological community to attack the big, unsolved questions. The importance of pattern recognition in this area reminded me, though, of a syndrome that escapes mention here or elsewhere in the book: the Texas sharp-shooter effect. This is something of a statisticians' in-joke: the apocryphal Texas gunman claims retrospectively that everything he hits was his intended target. The warning here is not to test hypotheses on the same data set as that in which the pattern that prompts those hypotheses is initially observed! There are so many possible types of non-randomness that data resulting from a random process can be expected to show at least one.

Etter's chapter on community analysis, at 75 pages, is virtually a book in itself and covers the field comprehensively, though I thought his exemplar data from the Swiss Opalinum Clay a little uninspiring. Multivariate methods are encountered in a number of chapters, so there is some duplication of explanation of methods such as principal components, but that is probably exactly what the beginner needs. Jim Smith's introduction to these methods in palynofacies analysis is good, and his applications constitute a sound template for workers in that subject to follow.

Quantitative methods in ichnology are covered in a diverse and exciting chapter by Orr that is overflowing with ideas and originality. The book finishes with Ryan, Ryan and Harper on seriation, a method that has never really taken off despite being an ideal method for ordering data. They propose new Hill Climbing and Simulated Annealing approaches.

I have omitted mention of a chapter on computer modelling that I contributed; I can assure the reader that I have maintained complete objectivity in my opinions of the rest! This book is extraordinarily full: it has the content and usefulness of about four typical texts. It is perfect for new research students.

Andy Swan
Kingston University
<GL_S402@kingston.ac.uk>

Palaeontology

VOLUME 43 • PART 2

CONTENTS

Palaeontology

VOLUME 43 • PART 3

CONTENTS

Overseas Representatives

Argentina: Dr M.O. Manceñido, Division Paleozoologia invertebrados, Facultad de Ciencias Naturales y Museo, Paseo del Bosque, 1900 La Plata.

Australia: Dr K.J. McNamara, Western Australian Museum, Francis Street, Perth, Western Australia 6000.

Canada: Professor S.H. Williams, Department of Earth Sciences, Memorial University, St John's, Newfoundland A1B 3X5.

China: Dr Chang Mee-mann, Institute of Vertebrate Palaeontology and Palaeoanthropology, Academia Sinica, P.O. Box 643, Beijing. Dr Rong Jia-Yu, Nanjing Institute of Geology and Palaeontology, Chi-Ming-Ssu, Nanjing.

France: Dr J.-L. Henry, Institut de Géologie, Université de Rennes, Campus de Beaulieu, Avenue de Général Leclerc, 35042 Rennes Cédex.

Germany: Professor F.T. Fürsich, Institut für Paläontologie, Universität, D8700 Würzburg, Pliecherwall 1.

Iberia: Professor F. Alvarez, Departmento de Geologia, Universidad de Oviedo, C/Jésus Arias de Velasco, s/n. 33005 Oviedo, Spain.

Japan: Dr I. Hayami, University Museum, University of Tokyo, Hongo 7-3-1, Tokyo.

New Zealand: Dr R.A. Cooper, New Zealand Geological Survey, P.O. 30368, Lower Hutt.

Scandinavia: Dr R. Bromley, Fredskovvej 4, 2480 Holte, Denmark.

USA: Professor A.J. Rowell, Department of Geology, University of Kansas, Lawrence, Kansas 66044. Professor N.M. Savage, Department of Geology, University of Oregon, Eugene, Oregon 97403. Professor M.A. Wilson, Department of Geology, College of Wooster, Wooster, Ohio 44961.

TAXONOMIC/NOMENCLATURAL DISCLAIMER

This publication is not deemed to be valid for taxonomic/nomenclatural purposes [see Article 8.2 of the International Code of Zoological Nomenclature (4th Edition, 1999)].