PALAEONTOLOGY NEWSLETTER

The Newsletter for members of the Palaeontological Association
No. 36

(The Palaeontological Association is a Registered Charity)

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Reminder

The deadline for copy for Issue no 37 of the *Newsletter* is
30th January 1998

ASSOCIATION MEETINGS PROGRAMME

Palaeontological Association Annual Meeting

University of Wales College of Cardiff
Monday 15th – Thursday 18th December 1997

The meeting will be based at University Hall, University of Wales Cardiff, and registration will start in the late afternoon of Monday 15th December. Buses will leave the hall at 5:30pm for the National Museum of Wales where there will be a reception and the opportunity to see the spectacular 'Evolution of Wales' exhibition, one of the foremost palaeontological/earth-science exhibits in the UK. Supper will follow at 8pm in the University Hall.

Lecture sessions will be in the conference centre, University Hall, on Tuesday 16th and Wednesday 17th. The 40th Birthday Dinner will be held in the Main Gallery, National Museum of Wales, on Tuesday 16th, and will be preceded by a reception in Main College, University of Wales Cardiff. We hope to have a bar extension until 12:30 at University Hall.

Two field trips are organised for Thursday 18th December:

1) **Carboniferous-Triassic-Jurassic of the South Wales coast.** Leader: Prof. M.G. Bassett. The trip will leave University Hall at 9:30am and will finish at Cardiff railway station at 4pm (latest). The morning will include a) Dinantian (Tournaisian-Visean) carbonate ramp facies at Barry with silicified faunas and trace fossil assemblages; b) Carboniferous/Triassic unconformity and late Triassic (Norian) scree, alluvial fan and lacustrine facies; c) Dinosaur footprints. Lunch (not included in the cost) will be taken in a local hostelry. The afternoon will comprise Lavernock-Penarth coast, demonstrating a Triassic-Jurassic boundary succession, including Rhaetian bone bed facies and Hettangian ammonite-bivalve succession. There is no limit to numbers.

2) **Ordovician trilobites of the Builth-Llandrindod inlier and their evolution.** Leader Dr Peter Sheldon. Lunch will be at the Drovers Arms, Howey (payment on the day). We hope to return to Cardiff railway station in time for the 17:25 London train. The number of participants will be limited to c.15 due to the small extent of some exposures.

Please note that for this meeting we will make use of a convenient purpose-built conference centre close to University accommodation. If you have any queries, particularly regarding late registration, please get directly in touch with the organisers.

Further details are available from the Society's Web pages and:

Palaeontological Association Christmas Meeting,
Department of Earth Sciences,
University of Wales College of Cardiff,
PO Box 914,
Cardiff CF1 3YE
Wales, UK

Telephone 01222 874830
Fax 01222 874326.

Organisers: Dr Chris Berry (email `berrycm@cardiff.ac.uk`)
and Prof Dianne Edwards (email `earth@cardiff.ac.uk`)

Review Seminar: Molecular Phylogeny

Dept. of Earth Sciences, University of Cambridge
Wednesday 4th March 1998

A programme of lectures which will consider the role of molecular phylogenies in evolutionary studies. Speakers include Charles Marshall (UCLA), Mike Akam, Erika Hagelburg and Simon Conway Morris (Cambridge), and Andrew Smith (NHM). Organised by Rachel Wood.

For further details, contact Rachel at the Department of Earth Sciences, Downing Street, Cambridge CB2 3EQ (tel 01223 335420; fax 01223 333450; email `rw43@rock.esc.cam.ac.uk`).

Joint Europal/Palaeontological Association Workshop: Cretaceous Biodiversity

Department of Geology, University of Portsmouth, UK
10th-11th July 1998

For more information please contact Dr David M. Martill, Department of Geology, University of Portsmouth, Burnaby Building, Burnaby Road, Portsmouth PO1 3QL (tel 44 (0)1705 842256; fax 44 (0)1705 842256; email `david.martill@port.ac.uk`).

Further details will be published in the January *Newsletter*.

EXTRAORDINARY GENERAL MEETING
Conference Centre, University Hall
University of Wales Cardiff
9.15 pm, Monday 15th December 1997

To consider the creation of the salaried post of EXECUTIVE OFFICER

Papers outlining the proposed changes are included as an insert in this *Newsletter*. It is possible for members to amend their accommodation booking at the Annual Meeting in order to attend the EGM if they wish: please contact the organisers.

NOMINATIONS FOR COUNCIL 1998-1999

<u>President:</u> **Dr E. N. K. Clarkson** (University of Edinburgh)
Proposed – Prof. D. Edwards (University of Wales Cardiff)
Seconded – Dr R. M. Owens (National Museum of Wales)

<u>Vice-President:</u> **Dr R. M. Owens** (National Museum of Wales)
Proposed – Dr P. D. Lane (University of Keele)
Seconded – Dr D. M. Unwin (University of Bristol)

<u>Editor:</u> **Dr J. Clack** (University of Cambridge)
Proposed – Dr R. M. Owens (National Museum of Wales)
Seconded – Dr B. M. Cox (BGS)

Since nominations do not exceed vacancies, there will no ballot.

AMATEUR PALAEONTOLOGIST AWARD 1997

Members are reminded that the nominations for this year's Amateur Palaeontologist Award will close on Friday 28th November 1997. Details of the award were given in Palaeontology Newsletter 35.

SYLVESTER-BRADLEY AWARD 1998

The deadline for applications is Friday 28th November. Up to five awards will be made in 1998, each having a maximum value of £500; details regarding applications were given in the last *Newsletter*. Application forms are available on the Association's Web site or from the Secretary.

Dr Paul Smith (Secretary)
Lapworth Museum
School of Earth Sciences
University of Birmingham
Birmingham B15 2TT

email: m.p.smith@bham.ac.uk
telephone: 0121 414 4173
fax: 0121 414 4942

MEETING REPORTS

Biostratigraphy & Petroleum

Aberdeen

June

In late June the University of Aberdeen hosted a special meeting of the Petroleum Group of The Geological Society of London on “Biostratigraphy in Production and Development Geology”. The meeting was organized by Dr. Mike Simmons of the University and Dr. Bob Jones of BP Exploration, and was attended by 120 geoscientists from all around the world.

The meeting successfully illustrated the innovative role that biostratigraphy now plays in helping cost effectively maximize recovery from oil fields. About 30 oral and poster presentations were made which illustrated the utility of biostratigraphy in correlating at a reservoir scale and helping to define reservoir architecture and connectivity. The wellsite applications of biostratigraphy were also emphasized.

Conference proceedings will be published in a special publication of The Geological Society.

For more information contact Mike Simmons at Aberdeen University (`m.d.simmons@abdn.ac.uk`), or Bob Jones at BP (`jonesbob@bp.com`).

Mike Simmons

MAD DINOSAUR DISEASE

A friend of mine has been invited to talk to a youth group on "Why the Dinosaurs Went Extinct". To introduce the topic, she has compiled a list of 53 suggestions that have been put forward at one time or another to explain the mass extinction. These range from the amusingly implausible, such as "competition from caterpillars" and "Palaeoweltschmerz" (= depression and despair) to meteorite impact, which is probably the correct answer – in my opinion, I hasten to add. The last item on the list was BSE (mad cow disease), which on the face of it seemed to be one of the pottiest suggestion of all.

However, this started me thinking about the "infective agent" of BSE, which is not a bacterium or a virus, but a rogue protein called a "prion". Despite reading endless news reports over the last few years, I have to admit that I had not formed a clear idea of how a protein can be infectious. Surely for something to be infectious (rather than just poisonous) it has to multiply within the host. In other words, it must be able to make copies of itself. If prions have no DNA or RNA, how can they achieve this? As a newly appointed reporter to this *Newsletter*, I decided it was time to find out how prions "work" (OK, so many of you will know already…), and ask: are they potential causes of extinction?

I'm glad I picked this subject because, having done a little reading, I am now convinced that prions are one of the most fascinating things in all biology!

Basically, the current theory of prion infection is all to do with the folding of proteins. As we learn at school, proteins are chains of amino acids that are manufactured within cells. Whereas the DNA template that codes for the amino acid sequence is linear, proteins fold up spontaneously into dense 3D bundles. Unlike DNA, which is just an information store, proteins actually do things. The function that a protein performs in the cell depends on its shape. A protein may have a structural role, or it may catalyse a specific reaction, or it may be involved in information transfer.

Because proteins are so complex, it is currently impossible to model from first principles what configuration they will assume if all we know is their amino acid sequence. Nevertheless, these clever molecules are perpetually springing into shape, in exactly the same way, millions of times every second within our bodies. Or at least that is what they should be doing.

In various cells in our bodies we manufacture an obscure protein that has come to be called Prion Protein (PrP). In normal circumstances, PrP is completely harmless (it may also be useless: experimental mice lacking the gene for it seem to live quite happily). However, if a rogue version of this protein is already present in a cell, it can act like a nucleation "seed" and the newly manufactured PrP follows its example and folds up wrongly. The DNA gene is the same, the amino acid sequence is the same, but the 3D shape is different. This defective PrP is the prion, and it may go on to infect other cells just by being present in them.

Prion particles are far smaller than the smallest virus, so they may infiltrate tissues with ease. They easily survive various human-made insults, including roasting, freezing, disinfection by chemicals or ultra-violet light, and irradiation. They may remain dormant for an unknown, and possibly limitless period of time. If infected, animal immune systems do not know they are present. The defective protein aggregates into ugly crystals that do untold damage, especially to nerve cells. The disease spreads by one animal eating another and ingesting the prions, or even by an animal breathing in the infectious particles from the air (so be wary of putting bone meal on your roses).

Carleton Gajdusek, the Nobel Prize winner and originator of the “crystallisation” theory, pointed out an analogy with the strange history of a chemical called ethylene diamine tartrate (EDT). Before the second world war, EDT was widely used as an industrial purifying agent. One day, a factory that was producing it became “infected” with a nucleator that made all the EDT form abnormally. Suddenly, the molecules all adopted a useless configuration. It is now impossible to manufacture the original kind on an industrial scale, because it always gets contaminated. This is an uncomfortable analogy to ponder.

If Gajdusek’s theory turns out to be correct, it would appear that prions are a whole new category of “life form”, Jim. Apparently, there are various strains. In a limited way, they are capable of mutating, replicating and evolving, so as to increase their chances of survival and propagation. I am vaguely reminded of Graham Cairns Smith’s imaginative theory for the origin of life, which involved replicating clay crystals (see his excellent *Seven Clues to the Origin of Life*). In that theory, primitive “genetic information” was held within the structure of Archaean clays, in the arrangement of crystallographic twin planes, dislocations and so on.

Seemingly, PrP only occurs in mammals, so it makes an unlikely agent for the extinction of the dinosaurs. But hold on a minute! Our bodies – just like the dinosaurs’ once did – manufacture a huge variety of proteins, many of which are absolutely essential for survival. Surely every one of them is a potential source of mutant “prions”. Perhaps, over geological time, many diseases akin to BSE have cropped up, and even caused the wholesale extinction of species or related groups of species that use a particular kind of protein.

The notion that prions can cause extinction is admittedly far fetched, and difficult to test, to say the least. An argument in favour might be the widespread and puzzling aversion to cannibalism in the animal world. An argument against is that our bodies have evolved little defence against prion infection (although there are proteins called chaperones that somehow police the environment during protein formation). We will have to wait for the biogeochemistry of the next century before there is such a thing as “prion palaeontology”. All in all, I suspect (and hope, considering the current health scare) that prions are an interesting but minor side show in the history of life. In any case, it would be extremely problematic to explain that end-Cretaceous iridium anomaly using the prion hypothesis.

Paul Pearson
University of Bristol

NEWS

Giant ammonite goes on display

The new national Museum of New Zealand, due to open in Wellington next February, has opted for few, spectacular specimens for its natural history display. The Institute of Geological and Nuclear Sciences (which includes the former New Zealand Geological Survey) holds several spectacular specimens in its type collections and pressure from the Museum authorities to use these specimens has raised the thorny question – should type specimens be used in public displays? The Institute's staff palaeontologists were divided in their opinions on the matter, but in the end, the specimens have been taken for the display, and they include the giant ammonite *Lytoceras taharoaense*, weighing 8-900 kg, 1.4m in diameter. A fork-lift and several brawny workers were required to move it.

The issue is a difficult one for curators of type collections, who are resonsible for the security and preservation of the specimens in their care. We all know of examples of types disappearing from, or being damaged in, public displays. On the plus side, the public will be able to view and enjoy some of the more impressive examples of the country's natural heritage and, hopefully, better appreciate the need for their study.

Roger Cooper,
Institute of Geological and Nuclear Sciences,
New Zealand

Catalogue of Palaeontological Types in Austrian Collections

This database project (financed by the Austrian Academy of Science, the Austrian National Bank and the Natural History Museum Vienna) has been an ongoing endeavour for several years. Currently more than 26,000 palaeontological types (plants and animals, figured and unfigured specimens) from 10 Austrian institutions have already been included.

The information for every specimen includes the

1 generic (sub-) name

2 species (sub-) name

3 author(s) of the species (sub-)

4 information on the geographic and stratigraphic position

5 reference and illustration

6 status of the type

7 collection file no.

8 institute (where the material is kept)

A restricted version of this database is now accessible on the World Wide Web via the address:

`http://www.oeaw.ac.at/~oetyp/palhome.htm`

It contains the data on items 1 to 3 and 5 to 8 above and provides the opportunity to combine up to four criteria in one search run. Four different sorting possibilities are available for the output of the results. More detailed information on the objects is available from the collection curators at the respective institutes. An address list enables the user to contact the responsible persons there.

All the references for which types have already been included in the database are listed alphabetically (now more than 800).

As the data input is an ongoing process, regular updates will be provided.

Contributing Institutions:

Geologische Bundesanstalt Wien

Karl-Franzens Universitaet Graz:
Institut fuer Botanik
Institut fuer Geologie und Palaeontologie

Krahuletzmuseum Eggenburg

Landesmuseum Joanneum Graz

Naturhistorisches Museum Wien

Universitaet Innsbruck:
Institut fuer Geologie und Palaeontologie

Universitaet Wien:
Institut fuer Geologie
Institut fuer Palaeontologie

Vorarlberger Naturschau Dornbirn

Johanna Kovar-Eder
Natural History Museum Vienna, Geological-Palaeontological Department, Burgring 7, A-1014 Vienna, Austria.

MURRAY: ATLAS OF INVERTEBRATE MACROFOSSILS

Although the English edition of this popular and extensively illustrated book has been sold out for a couple of years, the German edition is still available from the publisher (*not* from the Association’s Marketing Manager or Blackwell’s).

Title: Wirbellose Makrofossilien
ISBN: 3 432 96601 6
Publisher: Ferdinand Enke Verlag, Rosensteinstrasse 24, D-70190 Stuttgart, Germany
Fax: 00 49 711 255 2030
Price: not known

Tim Palmer (`tjp@aber.ac.uk`)

Sylvester-Bradley Award 1997: Report

THE FOSSIL CONTENT OF THE UPPER SILURIAN CEPHALOPOD LIMESTONES FROM THE CAUCASUS (RUSSIA) AND THEIR PALAEOGEOGRAPHIC RELATIONSHIPS.

OLGA K. BOGOLEPOVA, Department of Historical Geology & Palaeontology, Institute of Earth Sciences, Norbyvagen 22, S-752 36 Uppsala, Sweden.

Northern Caucasus (Russia) is one of the regions within the Greater Caucasus where Silurian strata have been recorded. Rocks of this age are not particularly widespread, and are usually strongly metamorphosed. Only a few fossil localities are known in Kabardino-Balkaria, situated along the middle reaches of the Malka River, 25 km south of the town Kislovodsk, in the ravines of Ulu-Lakhran and Cheget-Lakhran.

Three units may be distinguished in the Silurian-Devonian boundary sequence of the Malka River. They are:

1) about 7m of black shales with graptolites and rare cephalopods. The graptolites *Monograptus cf. riccartonensis, M. flexilis* and *Testograptus testis* have been found in the black shales;

2) about 20m of grey to black limestones with interlayers of cephalopod limestones. Conodonts indicate the beds belong to the *K. variabilis – S. aff. sagitta bohemicus* Biozone, *P. siluricus – S. snajdri* Biozone, and *S. siluricus eosteinhornensis* Biozone;

3) about 5-6m of grey limestones with a high concentration of cephalopods and bivalves in the basal part of the sequence. The first representatives of *Icriodus woschmidti* occur at this level.

Cephalopod beds from Northern Caucasus have a special value as they represent one of the patterns of cephalopod biofacies that were formed during the Silurian period at regular intervals, and in most cases globally distributed. The aim of this project was to incorporate data from the Caucasus into this larger study.

The Silurian fauna of Bohemian-type was found in Northern Caucasus of Russia in 1915 by A. Gerasimov. A brief description of this fauna, mentioning 69 species deriving from the lenses and intercalations of massive grey and dark cephalopod limestones, was given in a note published in the Bulletin of the Russian Geological Committee (Gerasimov & Yanishevskij, 1916). Two years later, several characteristic representatives of cephalopods, bivalves, trilobites and gastropods from the same area were described by Michael Yanishevskij, one of the notable Russian palaeontologists of international fame. No new palaeontological work has been published since his paper (1918). To be more correct, it should be noted that some years later G. Eger, who succeeded Yanishevskij in his studies of the Caucasus fauna, in an unpublished MS recorded from the same locality several other forms of bivalves (the author suddenly "disappeared" from Russian geological life, which was not very surprising during Stalin's years in the USSR).

All these forms, however, were not figured, and the collection's placement is so far unknown. Reexamination of the cephalopods and bivalves from Yanishevskij's collection together with restudy of the type species and their distribution, both stratigraphical and geographical, demonstrates that these forms, described as one Silurian assemblage, belong to different stratigraphic levels: Upper Silurian and Lower Devonian. The Upper Silurian assemblage consists of *Michelinoceras michelini, M. currens,* *Plagiostomoceras pleurotomum*, *Parakionoceras originale* (revision of the other cephalopod forms determined by M. Yanishevskij is in process now), *Cardiola conformis*, *Slava sp.*, *Dualina (?) sp*. The most stratigraphically significant among the cephalopods are *Plagiostomoceras pleurotomum* and *Parakionoceras originale*. *Plagiostomoceras pleurotomum*, described by Barrande from the Upper Silurian of Bohemia, occurs in the upper Ludlow (*P. siluricus – O. crispa* Biozones) of the Carnic Alps of Austria (Cardiola Formation and the lower part of the Alticola Limestones) (Bogolepova, in prep.). *Parakionoceras originale*, which was noted as an indicative species for the Pridoli of Bohemia (Marek & Turek, 1983), is recorded in the Pridoli of Sardinia (Kriz & Serpagli, 1993 with reference to M. Gnoli, pers. com.), in the Pridoli (*S. eosteinhornensis* Biozone) of the Carnic Alps of Austria (the upper part of Alticola Limestones and Megaerella Formation) (Bogolepova, in prep.), and the Upper Silurian of Southern Kazakhstan (Barskov, 1972).

According to Kriz & Serpagli (1993), in Bohemia, *Cardiola conformis*, which is a characteristic form for the high Ludlow (*M. fragmentalis* Biozone), is also known to occur in the lowermost Pridoli (*M. parultimus* to *M. ultimus* Biozones). Besides Bohemia this species was found in the upper Ludlow of Germany and lower Pridoli (*M. parultimus* Biozone) of Sardinia. The distribution of these bivalves corresponds to that of orthoconic cephalopods, and is related mainly to the cephalopod biofacies. The presence of *Hercynella aff. bohemica*, *Lunulicardium carolinum*, *Isocardia sp.*, *Panenka sp.*, *Vlasta pulchra* and *Vevoda cf. expectans* indicates a Lockhov age of this younger assemblage.

The affinity of the late Silurian assemblage from Northern Caucasus is closest to contemporaneous faunas from the Carnic Alps of Austria and Sardinia, as demonstrated by the Orthocerida. Siberian affinities may be illustrated by the number of Caucasus taxa, which occur in the late Silurian strata of Tajmyr (Bogolepova, 1996). To continue with Eurasiatic faunal connections I will refer to the record of two Barrandian species of *Michelinoceras* from the Upper Silurian limestones from Shikoku of Japan (Kobayashi, 1983), which belong to the same group of "Orthoceras michelini" as in Northern Caucasus. The new insight into this collection, based on recent studies of the Silurian cephalopod limestone biofacies in the Prague Basin (Kriz, 1991; Ferretti & Kriz, 1995), Sardinia (Gnoli et al., 1979), the Carnic Alps (Bogolepova in Schonlaub et al, 1994; Bogolepova, 1996), and in the basins of North Asia (Bogolepova, 1996; Bogolepova, 1997, in press) emphasises its importance for palaeogeographic reconstruction as well as for interbasinal correlation. The on-going examination of newly collected specimens based on precisely-dated stratigraphical levels will show whether the development of the cephalopod facies in the Caucasus follows the same patterns of evolution as in the other basins. This work is in progress now.

This research was supported by a Sylvester-Bradley Award 1997.

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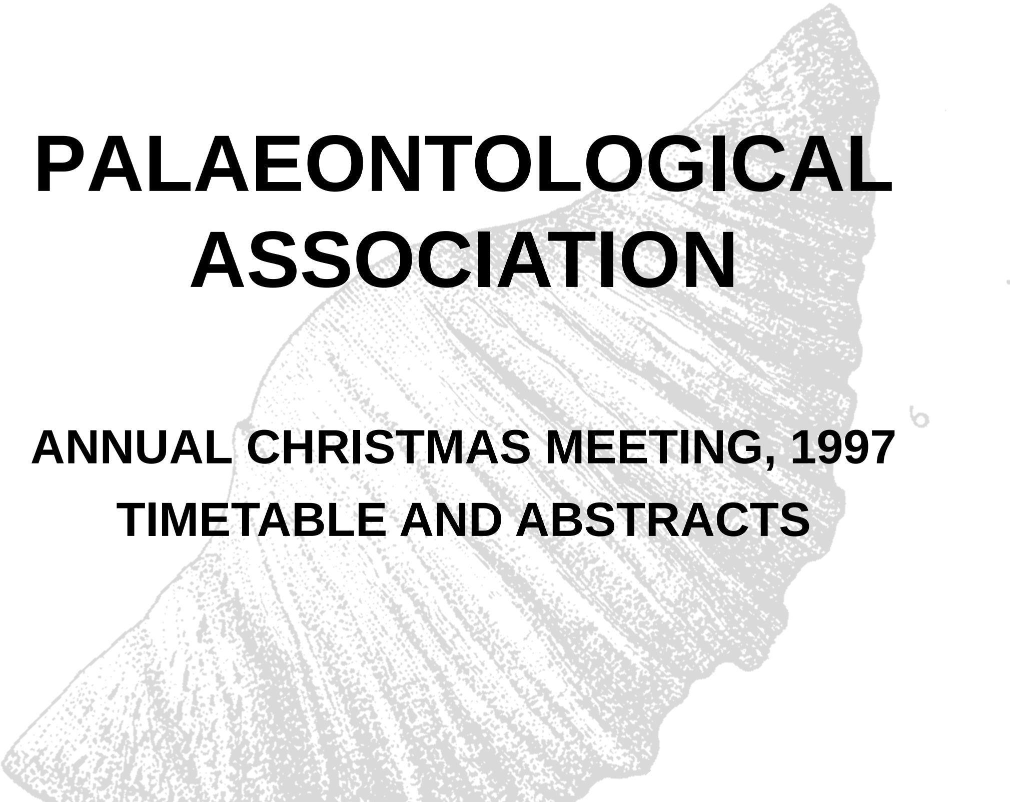

PALAEONTOLOGICAL ASSOCIATION

ANNUAL CHRISTMAS MEETING, 1997

TIMETABLE AND ABSTRACTS

PROVISIONAL TIMETABLE

Monday 15th December

4.00pm Registration, University Hall
5.30pm Buses to National Museum of Wales
6.00pm Reception, National Museum of Wales
7.30pm Buses return to University Hall
8.00pm Dinner

Tuesday 16th December

* indicates a candidate for the President's Award;
\+ indicates the speaker in multi-authored contributions if not a candidate for the President's Award.

8.50 Welcome

9.00 *C.J. Smith, H.A. Armstrong and A.W. Owen
Late Ordovician deep water conodonts: patterns of species change during a marine transgression

9.20 Phil Donoghue
Solving the conodont growth conundrum

9.40 +Ivan J. Sansom, M. Paul Smith and Moya M. Smith
Astraspis – reconstructing and recoding an Ordovician fish

10.00 D.M. Unwin
Hind limb kinematics of pterosaurs during terrestrial locomotion

10.20 +N.N. Bakhurina and D.M. Unwin
Soft tissue preservation in the pterosaur *Sordes pilosus* and its palaeobiological significance

10.40 Coffee

11.10 Ian Jenkins
Finite Element Analysis of cranial mechanics in Permian therapsid 'sabretoothed' predators

11.30 Mags Duncan
Ichthyoliths as biostratigraphic and palaeoenvironmental tools in the Carboniferous of Ireland

11.50 Clive N. Trueman
Geochemical vertebrate taphonomy: rare earth element analysis of terrestrial vertebrate assemblages

12.10 +Taniel Danelian and Kenneth G. Johnson
Long-term evolutionary patterns of Jurassic low latitude Radiolaria

12.30 *Helen Coxall, Paul Pearson and Nick Shackleton
Evolution and habitat changes in Eocene hantkeninids

12.50 Lunch

2.00 +Julio Aguirre and Robert Riding
Diversification of coralline and dasycladalean calcified algae during the Cretaceous and Cenozoic

2.20 Kenneth G. Johnson
Miocene diversification of the Caribbean reef-coral fauna: new data from the Tamana Formation, Trinidad

2.40 *Jeff Lord
The taphonomy of a Waulsortian carbonate buildup

3.00 +Graham A. Young and Robert J. Elias
Relationships between internal and external morphology in *Palaeofavosites*

3.20 +Michael J. Weedon and Paul D. Taylor
Comparative biomineralization in cheilostome and cyclostome bryozoans

3.40 Afternoon tea

4.10 Richard Bettley
The Middle Ordovician fauna of the Welsh Basin; its use in defining a chronostratigraphic standard

4.30 Kay Mannifield
Crinoid stem ossicles as biostratigraphical and palaeoecological tools in the Carboniferous of northwest Ireland: problems and potential

4.50 Olga Bogolepova
Endocerida in the Silurian of Siberia

5.10 *Vivian Alexander Ratter
Lower Silurian palaeotaxodont bivalves from Wales and the Welsh Borderland

5.30 *Chris Peel
The life and times of *Dunbarella*

6.15 Buses leave University Hall

6.30 Reception, University of Wales Cardiff

7.30 Annual Dinner, National Museum of Wales

Wednesday 17th December

9.00 +Andrew C. Scott, John Anderson and Heidi Anderson
Plant-insect interactions in the Triassic of South Africa and the problem of taphonomic bias

9.15 +S. Henry Williams and Lorne C. Clarke
Structure and taxonomic significance of the graptolite prosicula

9.30 David K. Loydell
Early Silurian sea-level changes

9.45 +Paul Wignall and Richard Twitchett
The Permo-Triassic mass extinction in East Greenland

10.00 Malcolm B. Hart
The evolution and biodiversity of Cretaceous planktonic Foraminiferida

10.15 +Paul D. Taylor, Frank K. Mckinney and Scott Lidgard
Ecological competition and macroevolutionary patterns in post-Palaeozoic bryozoans

10.30 +Stephen Kershaw and Graham A. Young
Palaeozoic stromatoporoid and tabulate growth bands and their palaeobiological implications

10.45 +Simon R.A. Kelly and Peter F. Rawson
The Boreal ammonite succession and zonal sequence in the Early Cretaceous of Greenland

11.00 Coffee

11.30 Joanna L. Wright
Trackways of juvenile dinosaurs

11.50 Simon Braddy
Keeping track of Palaeozoic terrestrial arthropods

12.10 Jason Hilton
Implications of members of the Permian Cathaysian flora on spermatophyte phylogeny

12.30 Kate Habgood
Coprolites as evidence of nutrient cycling in early terrestrial environments

12.50 Lunch

2.00 Matthew A. Wills
Phylogenetic and phenetic approaches to crustacean evolution

2.20 +R.D.K. Thomas and Rebecca M. Shearman
Evolutionary implications of the extent and pattern of exploitation of skeletal morphospace by animals of the Burgess Shale

2.40 +Graham E. Budd and Ruth A. Dewel
Getting a head in the Cambrian: cephalic composition and evolution in early arthropods

3.00 +Sarah Gabbott, Richard Aldridge and Johannes Theron
A new enigmatic fossil from the Ordovician Soom Shale Lagerstätte

3.20 *Juliette Dean
Morphological and palaeobiological diversification of the earliest ophiuroids [Echinodermata]

3.40 Coffee

4.10 +David J. Siveter and Mark Williams
Cambrian bradoriid and phosphatocopid Arthropoda of North America

4.25 +Leonid E. Popov, Lars E. Holmer, Michael G. Bassett
Class Obolellata – the earliest rhynchonelliformean (calcareous shelled) brachiopods

4.40 Tatiana Tolmacheva
Late Cambrian and Early Ordovician conodont clusters in abyssal deposits of south-central Kazakhstan

4.55 David H. Evans
The cephalopod fauna of the Durness Group of northwest Scotland

5.10 J.E.A. Marshall
A novel early Mid Devonian reproductive structure

7.30 Dinner

Thursday 18th December

Field trips

a) Lower Palaeozoic of Builth (P. Sheldon)

b) South Glamorgan Coast (M. Bassett)

ABSTRACTS

Diversification of coralline and dasycladalean calcified algae during the Cretaceous and Cenozoic

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Coralline red algae originated in the Early Cretaceous, diversified almost continuously to the Early Neogene, and reached their maximum species diversity in the Early Miocene. Thereafter, diversity dramatically collapsed to a Late Pliocene minimum of 55 species, the lowest level since the Cretaceous. The Cretaceous-Pliocene diversification history of dasycladalean green algae is quite different, with two maxima and two troughs. Following a maximum in the Barremian-Aptian, diversity fell sharply in the Albian and this continued until a minimum was reached in the Campanian. Dasycladaleans then diversified in the Maastrichtian to reach a peak in the Palaeocene, followed by progressive decrease throughout the remainder of the Cenozoic. At the present-day, only about forty species of dasycladaleans are extant.

These two algal groups differ considerably in their light and temperature ranges. Corallines occur to depths of 270 m, and occupy habitats from tropical reefs to polar shelves. They are much less sensitive to both sea-level and temperature change than the shallow warm-water dasycladaleans. These differing requirements of corallines and dasycladaleans may, at least in part, account for the differing diversity patterns of these two major groups of calcified algae, as they responded to global environmental change during the past 145 Ma.

Soft tissue preservation in the pterosaur *Sordes pilosus* and its palaeobiological significance

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Evidence of soft tissues has contributed important details to our knowledge of pterosaur anatomy, but, frequently, the limited extent of preservation (in terms of quantity and/or quality) has restricted understanding of important structures such as the wing membranes and the integument. *Sordes pilosus*, a long-tailed pterosaur from the Upper Jurassic of Karatau, in Kazakhstan, is exceptional in that there are extensive tracts of well preserved soft tissues including wing membranes, the integument, 'hair-like' structures, claw sheaths, a tail-flap and foot-webs. Soft tissues are preserved in two ways: as impressions and pseudomorphed by what appears to be mineralised organic residues.

The wing membranes are completely preserved and clearly demonstrate extensive attachment to both fore and hind limbs. Exceptionally well preserved wing fibres show that these structures were composite, with a variable morphology, and present throughout the flight patagia. Short fine filaments arising from the external surface of the integument covering the head and body seem to be remains of 'hair-like' structures. Otherwise the integument appears to have been relatively smooth and there is no evidence of scales or scutes.

The Middle Ordovician fauna of the Welsh Basin; its use in defining a chronostratigraphic standard

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Proposals have been made to redefine the Ordovician series boundaries of the historical type area (Fortey et al 1995) at more globally recognisable horizons. Extensive fieldwork in the Anglo-Welsh region has aimed to study these horizons, to relate them to the regional zonal schemes, and provide potential GSSP sections for use as regional or global reference standards. Mixed trilobite-graptolite faunas have been collected from single, measured sections across the region to produce a database of appearance-extinction events and a composite standard sequence. Quantitative methods can be applied to the data and offer greater accuracy and resolution over the classical methods previously used in correlating these isolated inliers.

The collecting of large populations from closely spaced stratigraphic intervals has also resulted in representative populations suitable for quantitative measurement. One particular line of study is of great interest in allowing the comparison of parallel evolutionary shifts in trilobite species of the Builth Inlier (Sheldon 1987), with those of new areas. This not only tests their candidature as genuine evolutionary changes, but also tests their stratigraphic usefulness.

Endocerida in the Silurian of Siberia

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Very rare Silurian representatives of the Order Endocerida (Cephalopoda), which flourished during the Ordovician Period, are described for the first time from the Mojerokan Formation (Llandovery) of eastern Siberia. These data complete the Silurian record of Endocerida described previously from Wales and the Canadian Arctic (Evans & Holland, 1995).

Keeping track of Palaeozoic terrestrial arthropods

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Trace fossils have tremendous potential to provide information on the timing, palaeoenvironmental distribution and diversity of the early terrestrial arthropods. Arthropod trackways occur in situ, may extend the range of some groups (e.g. arthropleurids) and can record the behaviour (e.g. walking techniques) of the producer. Ichnological data are also fraught with conceptual problems and considerable reinterpretation and taxonomic rationalization is required before the temporal and palaeoenvironmental distribution of the terrestrial arthropods can be assessed. Some ichnotaxa have been established on the basis of only slight behavioural and preservational variations from other

ichnotaxa. The translation of ichnological evidence into diversity data is inhibited by the convention that ichnotaxa are based on the morphology of the trace rather than the identity of the tracemaker (i.e. different arthropods could create a single ichnotaxon or a single individual could produce various ichnotaxa by using different behaviours).

Understanding the functional mechanics of trackway production is fundamental to interpreting the trace fossil record of arthropod terrestrialization. Computer modelling (using LocoBug) is used to analyse the locomotion and identify the trace maker. LocoBug enables a generic, three dimensional arthropod body plan to be animated by the three gait parameters (i.e. Gait, Opp., Suc.). LocoBug determines which legs are on the substrate at each instant of the step cycle and plots a 'stability polygon' relative to the animal's centre of mass, allowing the speed-stability relationship and optimal walking techniques for different body plans to be determined. LocoBug also generates theoretical trackways, which can be used to determine the degree of morphological variation that results from behavioural variation. Reinterpretations of various arachnid, eurypterid and arthropleurid trackways are presented and discussed, using data derived from LocoBug.

Getting a head in the Cambrian: cephalic composition and evolution in early arthropods

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The composition of the arthropod head has provided a focus for some of the most protracted and heated arguments in arthropod research. Modern arthropod heads are complex capsules of fused segments with the possible addition of a presegmental 'acron', of which the exact number and homology are controversial. However, stem-group arthropods have a much simpler arrangement, ranging from the remarkably primitive system of the onychophorans through the linear heads of tardigrades and basal anomalocaridids. The complexity of the euarthropod head seems to have arisen as a correlate of shifts in feeding strategy from predominantely cephalic appendage-feeding in lobopods through to predatory gnathobasic thoracophagy in advanced anomalocaridids and basal euarthropods.

Recognition of homologies between anomalocaridids and euarthropods allows the insights gained from the simplest arthropod heads known to be applied to more advanced forms, and provides important data for phylogenetic reconstruction. In doing so some fascinating problems arise. For example, an appendage present in the earliest forms (the 'frontal appendage'), undergoes a mysterious vanishing act in more derived taxa – unless of course it is homologous with the first antenna, which raises difficulties all of their own. The resolution of these issues will require information from fossils, molecular development and classical morphology: but new advances in all of these fields mean that an answer may be closer than ever.

Evolution and habitat changes in Eocene hantkeninids

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The hantkeninids are a group of attractive, planispiral planktonic foraminifera that evolved in the early middle Eocene and went extinct at the Eocene-Oligocene boundary. Because they are widely distributed and have ornate, character-rich shells, there is great potential for biostratigraphic, evolutionary

and palaeoceanographic studies. SEM observations and the discovery of rare "missing links" demonstrate that Clavigerinella eocanica was the ancestor. The group then underwent substantial morphological evolution, such that a total of 32 morphospecies have been described. Nevertheless, it is doubtful whether more than two cladogenetic (branching) events occurred.

Previous geochemical evidence for the life habitat of the hantkeninids is very sparse. In this study, hantkeninids from a number of localities and ages were subjected to oxygen and carbon isotopic analysis, including material from various DSDP and ODP sites and some beautifully preserved specimens collected from the upper Eocene of the U.S. Gulf Coast. The results show that the early hantkeninids were relatively deep, thermocline-dwelling forms, but later hantkeninids were surface-ocean dwellers. The period in which the group shifted its habitat corresponds to the phase of most rapid morphological change, during a time of global oceanic and climatic cooling. The possibility that this evolution was driven by the acquisition of photosynthesising symbionts is discussed.

Long-term evolutionary patterns of Jurassic low latitude Radiolaria

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We analyse a compilation of 3227 Middle and Upper Jurassic (175-135 Ma) radiolarian occurrences of 341 species in 131 samples which come from western Tethyan and central (proto-) Atlantic oceans. All samples are independently calibrated by other age diagnostic fossil groups, such as ammonites, calcareous nannofossils and calpionellids, and isotope stratigraphy. A negative peak in diversification is revealed for the early Bajocian, which is formed mainly by accelerated extinctions. Moreover, the mid/late Tithonian is characterized by an increase in originations combined with very few extinctions. These peaks correspond with well known palaeoenvironmental (geochemical and sedimentological) events in western Tethys, including the dramatic environmental changes during Tithonian time marked by the widespread accumulation of calcareous nannofossil oozes in western Tethys and the proto-Atlantic. However, analysis of sampling completeness and stratigraphic permutation tests suggest that the observed patterns might have resulted from uneven sampling.

Morphological and palaeobiological diversification of the earliest ophiuroids [Echinodermata]

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Asteroids and ophiuroids first appear in the lower Ordovician, and numerous Lagerstätten provide an unrivalled record of their early divergence. Although a number of features distinguish extant asteroids and ophiuroids, these differences are much less apparent in the Ordovician, resulting in many problematic taxa. Type material for at least one species of every genus of Ordovician 'ophiuroid' has been re-examined and incorporated into a morphological analysis to produce a phylogenetic hypothesis of ophiuroid origins and relationships. This information has been used to map out the functional and ecological diversification of early ophiuroids.

Solving the conodont growth conundrum

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Despite the recognition that the conodont feeding apparatus represents one of the earliest experiments

with a mineralised skeleton amongst the vertebrates, we are still relatively ignorant as to how the elements of the apparatus grew. The reason why this has remained the most intractable problem in conodont palaeobiology is because of the paradox between evidence that the elements must at least periodically have been embedded in soft tissue, and evidence indicating that they functioned as teeth. Bengtson's classic model of element evertion, analogous to the claws of cats, neatly obviates this problem, but is incompatible with homology between the hard tissues of conodonts and vertebrates. An alternative model must be sought.

A comprehensive study of the way in which conodont feeding elements grew has revealed that elements of similar morphology were constructed in dissimilar ways. The way in which the elements of ancestral taxa grew elucidates a mode of growth compatible with evidence of soft tissue cover, the function of conodont elements, the mode of growth of more derived taxa, and also comparable systems of exoskeletal growth in other vertebrates. Conodont elements grew in alternating phases of extended function punctuated by considerably shorter phases of growth. This pattern of growth is directly comparable with the 'growing dentition' of lungfish and acanthodians, although it is suggested that the locus of formation of conodont elements was shallow, so closer comparison with growing scales of these and other groups of fish may be more appropriate.

Ichthyoliths as biostratigraphic and palaeoenvironmental tools in the Carboniferous of Ireland

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Irish Carboniferous marine biotas as portrayed in the literature are almost exclusively composed of invertebrates. In fact, a majority of limestone samples subjected to acid etching yield ichthyoliths, microscopic hard tissues of fish.

The ichthyoliths recovered comprise teeth, scales, and in some instances bone fragments, most of which can be assigned to major taxonomic groups of fish, such as chondrichthyans, actinopterygians and acanthodians. Taxonomy of ichthyoliths at the level of genera and species raises problems analogous to, but more acute than, those encountered in conodonts. At present, most ichthyoliths are treated as morphospecies using open nomenclature.

Many ichthyoliths such as palaeoniscoid type teeth are ubiquitous and apparently will not be useful in detailed biostratigraphy or facies analysis. These taxa are particularly poorly recorded members of the Carboniferous biotas. Other taxa, for example the chondrichthyan *Thrinacodus ferox* are more restricted in their distribution both in terms of stratigraphy and palaeoenvironment.

Many Carboniferous chondrichthyans, actinopterygians and acanthodians appear to have a worldwide geographic distribution.

The cephalopod fauna of the Durness Group of northwest Scotland

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Cephalopods have been known from the Lower Ordovician carbonate successions of Durness and Skye since the middle of the 19th century. The North American affinity of the fauna was recognised by Salter (in Murchison 1859), although very different inferences were drawn regarding climate and geographical distributions. Many individuals are dolomitised or incompletely silicified, leading to problems in preparing material through acid digestion. Apart from specimens collected during the past 20 years, very little is known as to the precise horizons and locations from which much of the material came. To some extent, the more recently collected material has helped to resolve this problem. The cephalopod fauna consists so far of a range of taxa including representatives of the Ellesmeroceratidae, Bassleroceratidae, Tarphyceratidae, Piloceratidae, Proterocameroceratidae, Endoceratidae, and Protocycloceratidae. Piloceratids from the Durness Group show an extraordinary range in morphology, suggesting that the group is far more diverse than previously understood; while studies of Protocycloceras indicate that North American forms of this genus are over-split at species level. In the terminology of Flower and others, this cephalopod fauna indicates the presence of the Gasconadian, Demingian, Jeffersonian and Cassinian stages within the Durness Group, although breaks in the succession may occur.

A new enigmatic fossil from the Ordovician Soom Shale Lagerstätte

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The Ashgill Soom Shale Lagerstätte preserves the soft tissues of several taxa, sometimes with a subcellular level of fidelity. A number of specimens of a new enigmatic fossil have been found at three localities; the affinity of these animals is most likely to lie among the arthropods, although none displays jointed appendages. Aspects of the soft-tissue anatomy are, however, excellently preserved with some three-dimensionality. The most complete specimen is dorso-ventrally compacted, and exhibits forty segments, a gut trace, lateral lobes and other features. An incomplete specimen in lateral aspect shows details of the internal features including fibrous musculature and an axial row of triradiate structures. The soft tissues are preserved through replacement by illitic and alunitic minerals and are associated with concentrations of rare earth elements. Complete feeding apparatuses of prioniodontid conodonts occur close to two of the specimens, suggesting that the conodonts may have been scavenging.

Coprolites as evidence of nutrient cycling in early terrestrial environments

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Numerous fossil assemblages and palaeosols indicate that terrestrial communities were in existence by the Late Silurian. These localities include the remains of vascular and non vascular plants, fungi and primitive arthropods. The existence of simple food webs has been inferred from this evidence, although evidence for plant-animal interaction is rare.

Coprolites have been recovered from Upper Silurian and Lower Devonian localities in the Welsh Borderlands. These contain abundant plant matter and are interpreted as evidence of a cycling of primary productivity. The nature of the source of such coprolites is enigmatic since non-predatory animal remains of an appropriate size have not been recovered from these localities. A majority of the coprolites recovered are predominantly composed of (apparently) undigested plant spore walls suggesting that little nutrient was extracted.

Comparison of spore size distributions in coprolites with those of in situ and dispersed spore assemblages has potential to provide evidence for the origin of the spores within coprolites and hence the feeding strategy of the coprolite producer.

Experiments on the palatability of various modern fern, moss and liverwort spores to modern myriapods

(*Julus scandinavius*) have been undertaken. These have provided faeces comparable to the Silurian and Devonian coprolites in size, shape and composition. Experiments currently in progress test the effects of spore age, size, ultrastructure and degradation by fungi on the palatability and digestibility of spores.

The evolution and biodiversity of Cretaceous planktonic Foraminiferida

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Planktonic Foraminiferida originated in the Triassic (?) or Early Jurassic but only expanded markedly in the Early to mid-Cretaceous. It is during the mid-Late Cretaceous that they evolved into a wide range of morphotypes and were able to colonise a much greater range of environments and regions. During the mid-Cretaceous, in particular, they developed a range of strategies (‘k’ and ‘r’ selection) which allowed them to move from eutrophic surface-water environments into oligotrophic environments, especially those much deeper in the water column.

The general increase and/or turnover of taxa was punctuated by a number of major ‘events’ – e.g., the Bonarelli event in the latest Cenomanian. Between these major biotic crises there are a number of smaller events, some of which can be attributed to small anoxic events, although others may be more closely related to eustatic changes.

The data appear to indicate that there are patterns of extinction and radiation that relate to cyclical stimuli. The major changes in taxonomic composition of the fauna are also related to major extinction/radiation events where, if proper criteria are followed, individual taxa appear to change genus rather than species! The mechanisms involved in such changes are complex, but in the Cretaceous the level of dissolved oxygen in the water column, coupled with sea-level changes, appear to be quite important.

Implications of members of the Permian Cathaysian flora on spermatophyte phylogeny

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The Cathaysian flora of the Sino-Korean platform dominated floral assemblages in China from the Late Carboniferous through the Permian. The flora was initially termed the Gigantopteris flora due to the preponderance of the members of this spermatophyte lineage in its assemblages. However, subsequent investigations identified the Gigantopterid flora to be representative of only the latest stages of the floral transition, leading to the adoption of the term Cathaysian flora to encompass the entire East Asian flora of this period. From what is known about the spermatophyte composition of this flora it is abundantly clear that they, like the other components of this flora, are distinct from other contemporaneous floras (e.g. Glosspterid and Angaran floras). In particular there is a lack of reliable information on the Cathaysian conifers, although data from contemporaneous floras indicate this to be a crucial period of evolutionary diversification for this group. As such, the Cathaysian flora presents a great potential for adding new data on spermatophyte evolution and phylogeny. A detailed and systematic study of several new taxa of spermatophyte ovulate structures will be presented from this important palaeogeographical area, and the implications of these new findings on the evolution and phylogeny of the spermatophytes considered.

Finite Element Analysis of cranial mechanics in Permian therapsid 'sabretoothed' predators

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Permian therapsid (mammal-like) 'reptiles' exhibit considerable skull diversity. The constructional anatomy of their crania is weakly analogous to extant predators – both sauropsid and mammalian. Hence the approach of basic physical principles was used to study structural aspects of their cranial evolution. This was especially pertinent for the 'sabretoothed' forms of the Permian: gorgonopsians, plus scylacosaurid and lycosuchid therocephalians. The skulls of long-snouted forms are theoretically weak in axial skull torsion arising from unilateral canine biting. However, their abundance during the Permian testifies to an adaptive success. Finite Element Analysis (FEA) was used to model the rostra of these groups. Model-generated stress trajectories were compared with the pattern and orientation of force transmission pathways observed in fossil crania. Stress trajectories extending from the canines to the supraorbital region were produced at unilateral canine loading. The primary palate functions as a spring, restricting stress to its working side. Significant compressive forces occurred at the supraorbital rim and region of the contralateral ectopterygoid. Gorgonopsians exhibit a unique adaptation to strengthen this region of the primary palate. Anatomical reinforcings show congruence with modelled stress patterns. Morphological variation between these groups suggests trophic partitioning resulting from diverse structural skull mechanics.

Miocene diversification of the Caribbean reef-coral fauna: new data from the Tamana Formation, Trinidad

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Ongoing analysis of the patterns of Neogene Caribbean reef coral species occurrences suggests that the Early and Middle Miocene reef-coral fauna was characterized by low species richness and low rates of species turnover. However, these older deposits are not as extensively preserved as Late Miocene and Pliocene material, and differences in estimated rates of faunal change are likely to be a function of differential sampling. To describe better the older Neogene coral fauna, large collections were made from the Middle Miocene Tamana Formation of Trinidad. Nearly 50 species were recovered, including 20 species first occurrences (FOs) but only 7 last occurrences (LOs). Approximately 30 of the records are new, including 7 FOs and 4 LOs. New rates of species turnover estimated using these additional data are still not as high as Pliocene estimates. Local diversity levels are similar to other assemblages from throughout the Neogene, suggesting that greater species diversity during the Pliocene is caused by local to regional variation in species assemblages (patchiness) rather than more speciose local communities. Therefore estimates of regional species richness and turnover rates are likely to remain underestimated for Early and Middle Miocene corals.

The Boreal ammonite succession and zonal sequence in the Early Cretaceous of Greenland

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The Early Cretaceous ammonite succession in Greenland is reviewed and placed in a zonal framework. During recent field work in East Greenland several ammonite faunas have been discovered which have been hitherto unknown in Greenland. Over forty ammonite genera are now recognised

and are distributed in at least 17 principal faunas. Comparison of these faunas is made with the standard 37+ zones identified in the northwest European Early Cretaceous succession. Locally correlation can be achieved down to subzonal level. Correlations with other boreal as well as tethyan ammonite successions are discussed.

Palaeozoic stromatoporoid and tabulate growth bands and their palaeobiological implications

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Examination of stromatoporoids and corals from selected Ordovician and Silurian sites in several facies and regions demonstrates that both groups generated growth banding with consistent patterns. The regularity of such banding in some samples is interpreted as due to episodic factors such as sedimentation or seasonality because, in both groups, banding commonly coincides with ragged margins generated by sedimentation killing the flanks of the skeleton, followed by recovery. Tabulate coral growth banding consists of an alternation of denser and more closely spaced skeletal elements with less dense and more widely spaced elements. This pattern is similar to that seen in modern scleractinians; each couplet is considered to represent one year's growth. Tabulate banding varies in scale and intensity among taxa, facies and regions; recorded vertical growth rates range from estimated 1-20m/yr. Stromatoporoid growth banding is a more subtle phenomenon. Where clearly visible, it falls into two scales; latilamina scale with prominent growth disruptions, commonly c.10mm; and lamina scale, commonly 1-3mm. Modern calcified sponges grow 0.1-0.5mm/yr, but at such rates Palaeozoic stromatoporoids would have taken thousands of years to grow even moderately large individuals, and comparison with intergrown corals indicate fast growth in the fossils. Preliminary measurements suggest that reefal stromatoporoids grew faster than those in muddy facies, because the banding is thicker in the former, although interpretation of the banding as annual remains uncertain. The present study is the first comprehensive comparison of banding in corals and stromatoporoids, permits an improved understanding of its controls, and illustrates the potential of banding as a tool for assessment of ancient environmental parameters influencing the sea bed.

The taphonomy of a Waulsortian carbonate buildup

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Recent work has suggested that parts of the surface of Waulsortian buildups were covered by a mucilage-rich, microbial film, which stabilised the surface sediment to the extent that depositional dips of up to 40° were maintained. The taphonomy of a diverse assemblage of crinoids, bryozoans, brachiopods and molluscs in a Waulsortian carbonate buildup of late Tournaisian age at Mullawornia, County Longford, Ireland has been investigated in order to establish the physical conditions on the surface of the mound.

The fauna is parautochthonous. The brachiopods and bivalves are mostly preserved as conjoined valves and show little evidence of transport. However, their orientation is random and they are rarely preserved in life position. There is no evidence of bioturbation; the re-orientation of shells must have resulted either from currents or through the collapse and settlement of the semi-coherent sediment as organisms such as sponges decayed. The component parts of crinoids in many cases do not appear to

have been dispersed very far. Fenestrate bryozoans, in contrast, are commonly comminuted, suggesting that at least at sometimes current energy levels on the bank surface were high. Sorting ratios of conodont elements may provide some information as to what extent currents were an important feature of the surface of a buildup.

Early Silurian sea-level changes

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Global sea-level fluctuated markedly during the early Silurian, probably as a result of the waxing and waning of ice-sheets in the South American portion of Gondwana. A new sea-level curve for the Early Silurian is presented which appears to differ significantly from those published previously.

Facies (and faunal) changes in the Lower Silurian do not support the P and S model, but are consistent with the sea-level changes proposed here.

Mid Telychian marine red beds appear to have been deposited during a minor sea-level fall immediately after a period of very high sea-levels, rather than during a transgressive episode as previously suggested.

Comparison of the sea-level curve presented herein with those constructed in the past is hampered by the lack of precision currently possible in the correlation of early Silurian deep water (graptolitic) and shallow water (shelly) sequences. Improving the precision of this correlation should be a priority for future research.

Crinoid stem ossicles as biostratigraphical and palaeoecological tools in the Carboniferous of northwest Ireland: problems and potential

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Complete crinoid specimens are rare in the Carboniferous shale and limestone sequences of northwest Ireland. By contrast, columnals and pluricolumnals are abundant.

More than 40 different columnal types have been distinguished. However, relating the columnal morphotypes to biological taxa is difficult. Few complete crinoids have been found with which to compare the disarticulated stem material; as a result columnals cannot usually be identified in terms of species erected on the basis of complete material. In some crinoid families there appears to be little variation in column morphology, so that it is unlikely that it will be possible to distinguish species and even genera within them on the basis of columnals. In other families, individual species appear to have distinctive columnals, which are useful biostratigraphical and palaeoecological tools. However, in xenomorphic stems two or more columnals of different appearance may in fact be conspecific. This may lead to an overestimation of taxonomic diversity.

Despite these problems, it is clear that different stratigraphical horizons in the Carboniferous of northwest Ireland are characterised by distinct assemblages of crinoid columns. Crinoid columnals also yield a much less biased estimate of crinoid diversity than that given by counts of thecae.

A novel early Mid Devonian reproductive structure

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A new early land plant reproductive structure has been discovered in East Greenland in rocks of Early Mid (Eifelian) Devonian age. This reproductive structure is relatively large (9x7x4 mm) and borne on a specialized stalk with an abscission structure. It contains a single internal organic walled inner body invested by an external tissue and appears to have an apical opening. It is interpreted as a large dispersed megasporangium containing a single megaspore rather than a specialised spore filled sporangium. It is of possible lycopod affinity. It shows parallels with the unrelated progymnosperm and lycopod ‘seed-megaspores’ which it significantly pre-dates. Functionally it is interpreted as an adaptation to reproduction in a seasonally ephemeral upper fan environment.

The life and times of *Dunbarella*

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Black shale biodiversity is often dominated by thin-shelled, flat-valved bivalves referred to here as ‘paper pectens’. Throughout the Namurian and Westphalian marine bands of the UK, the genus Dunbarella was prolific and often formed pauci- or mono-specific assemblages. The interpretation of Dunbarella autecology will contribute to understanding the palaeoecology of black shales. The life strategies of this enigmatic taxon are discussed here. Functional morphology and faunal relationships suggest that Dunbarella was a benthic epibyssate animal. Size frequency plots show that individuals, within a population, are clustered around a narrow size range, indicating brief colonisation by single cohorts. An inflated prodissoconch and the lack of specimens much less than 10mm imply a teleplanic larval stage, and hence a dichotomy in the *Dunbarella* life cycle. The presence of shell damage may be evidence of predation in these harsh dysaerobic environments.

Class Obolellata – the earliest rhynchonelliformean (calcareous shelled) brachiopods

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Recently revised classifications of the brachiopods recognise three subphyla and nine classes, replacing the traditional subdivision into “inarticulates” and “articulates”. The Class Obolellata represents the earliest known calcareous-shelled brachiopods, appearing in the early Atdabanian and becoming extinct at the end of the Middle Cambrian. The obolellates include forms both without articulation, and those with primitive articulatory structures, consisting of paired ventral denticles and dorsal sockets; this type of articulation appears to have evolved independently from other Cambrian calcareous shelled lineages. The muscle system in the Obolellata is closely comparable with that of other rhynchonelliformean brachiopods. In Obolella, the ventral muscle scars are located peripherally within the visceral area, but in the majority of genera they form a single muscle field, with the adductor scars located medially. In some “articulated” obolellides and naukatides, the attachment scar of the internal oblique is located posterior to the axis of rotation, suggesting that the internal oblique muscles may have served as diductors. In the Order Naukatida, a high ventral muscle platform is developed, somewhat comparable with the free spondylium of protorthoideans, but probably evolved independently.

Obolellides are the most abundant Early to Middle Cambrian rhynchonelliformean brachiopod faunas of North America and Siberia, whereas naukatides are known mainly from tropical Gondwana (Australia) and associated island arcs as well as occurring sparsely in North America.

Lower Silurian palaeotaxodont bivalves from Wales and the Welsh Borderland

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Lower Silurian palaeotaxodont bivalves from Wales and the Welsh Borderland have received little attention since the last century, and consequently are poorly understood. Current research is revising the taxonomy and resolving their phylogeny and autecology.

Attention is presently focused on bivalve assemblages dominated by palaeotaxodonts from the Llandovery of the Malvern Hills and the Wenlock of Pembrokeshire and Cardiff. An investigation of the Llandovery succession has established two new genera, whilst the Wenlock sediments in South Wales have yielded a further two new genera and four new species. Several taxa bridge gaps in the knowledge of palaeotaxodont morphology between the Upper Ordovician and Devonian, and indicate the rapid evolution of some nuculoid families during the lower Silurian. A new nuculid species is one of the earliest examples of a bivalve possessing a resilifer, whilst new ctenodontid genera suggest a distinctive evolutionary lineage from the Ordovician genera *Ctenodonta* and *Tancrediopsis*.

The autecology of a number of palaeotaxodont assemblages has also been investigated. Life habits have been ascertained using morphology and biometric data. Results reveal that the majority of deposit-feeding nuculoids were medium-depth, rapid burrowers, and consequently, well adapted for the near-shore, unstable substrate in which the majority lived.

***Astraspis* – reconstructing and recoding an Ordovician fish**

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Articulated specimens of Ordovician fish are rare, with reports from only three localities: in Australia, Bolivia and the USA. Amongst these, the Harding Sandstone Formation (Caradoc, Ordovician) of Colorado is the only one that has also yielded histologically identifiable material. A new specimen of the pteraspidomorph *Astraspis desiderata* Walcott 1892 was recovered from the Harding in 1994, which exhibits details of the structure of the headshield and tail scales. Together with a reassessment of the previously recorded articulated specimens and the exoskeletal histology, these new data permit the first integrated anatomical account of an Ordovician fish. Many of the features seen in previous reconstructions of Astraspis prove to be erroneous, and a number of the published character codings for the genus also require revision.

Plant-insect interactions in the Triassic of South Africa and the problem of taphonomic bias

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The Molteno Formation of Late Triassic (Carnian) age in South Africa has yielded more than 200 plant species from 100 plant assemblages at 69 localities (30,000 catalogued slabs) as well as more than 300 species of insect. Damage to leaves caused by insects is widespread on a diverse number of plant species at numerous localities. The damage includes feeding traces, predominantly continuous marginal feeding traces, leaf mines including linear and possible blotch varieties and probable leaf galls. Damaged taxa include a wide variety of gymnosperms including the conifer *Heidiphyllum*, the ginkgophytes *Ginkgo* and *Sphenobaiera* and the pteridosperms *Dicroidium*, *Taeniopteris* and *Dejerseya*, and the genera of uncertain affliliation *Yabeiella* and *Taeniopteris*. Quantitative data (3000 specimens examined) on the insect damage was obtained for four sites: Waldeck, Kapokkraal, Aasvoelberg and Birds River. Quantitative data indicate that leaf damage between sites varies from 3 to 25% and within species from 1 to 50%. Some evidence of host specificity is presented. The variation in damage to the same taxon between sites, and even the overall herbivory seen at the different sites, makes the interpretation of the general levels of herbivory in the Molteno difficult to assess.

Herbivory levels in Northern Hemisphere Triassic plant assemblages appears to be significantly lower and this is also the case with the succeeding Jurassic floras worldwide. It is not yet clear to what extent taphonomic bias may influence the calculation of overall herbivory levels for a given time period.

Cambrian bradoriid and phosphatocopid Arthropoda of North America

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North American species were among the first bradoriid and phosphatocopid arthropods documented. They occur throughout the Cambrian of N America most abundantly in the Canadian Atlantic Provinces, British Columbia and Arizona, and to a lesser extent in New York State and Tennessee. The total known fauna comprises 16 genera and 26 species and is much less diverse at the specific level than previously indicated (about 100 species). Several genera have a phosphatic carapace, thus endorsing the notion that carapace composition cannot be used as a diagnostic criterion for distinguishing bradoriids and phosphatocopids. The bradoriid and phosphatocopid faunas of N America occur as low diversity marine assemblages and were probably mostly benthic or nekto-benthic. Most species are short ranging but have only local geographical occurrence. A few species have intercontinental biostratigraphical potential being coeval in Canada, Britain and Scandinavia. Provinciality of the bradoriid and phosphatocopid faunas supports the notion of an Iapetus Ocean in the Cambrian. Eastern Canadian (Avalonian) faunas are characterized by *Beyrichona*, *Cyclotron* and *Hipponicharion*; Arizona (Laurentia) has *Walcottella* and *Dielymella*. Bradoria is known from both the Avalonian and Laurentian parts of N America; the cosmopolitan *Anabarochilina* occurs only in the Laurentian part. Faunas of the distal shelf of Laurentia have Asiatic (*Liangshanella* and cambriids) and Australian (*Indota*) bradoriids.

Late Ordovician deep water conodonts: patterns of species change during a marine transgression

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Until recently it was assumed that deep water environments would be impoverished in species but recent studies have revealed them to be ones of prolific speciation and high species diversity. Ocean state models predict that deeper water faunal assemblages will appear at progressively higher levels on the continental slope at times of transgression as a response to changing conditions. Transgressive episodes can therefore provide a window into both deep water faunas and their environments, allowing patterns and processes of speciation to be elucidated.

The widespread Nod Glas Formation represents a late Caradoc deepening of the Welsh basin. Sedimentological analysis of the phosphatic limestones from this unit suggests that the initial deepening occurred during the deposition of the lower part of the formation. Further deepening is reflected by the shales with graptolitic horizons towards the upper part of the formation. Although conodont samples have only been obtained from the basal few metres, distinctive faunal assemblages there reflect the changing environmental conditions and have wider implications for both deep water conodont palaeobiology and basin evolution.

Ecological competition and macroevolutionary patterns in post-Palaeozoic bryozoans

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Do biotic interactions over ecological time shape macroevolutionary patterns through geological time? Post-Palaeozoic bryozoans consist mainly of two orders – Cyclostomata (Ordovician-Recent) and Cheilostomata (Jurassic-Recent) – which develop a similar range of colony-forms and generally co-occur. On average, recent cheilostomes outcompete cyclostomes for food and living space. Furthermore, evidence from skeletal overgrowths shows that cheilostomes have won the majority of spatial competitive encounters with cyclostomes since at least the mid-Cretaceous. But has this long-term ecological superiority led to faunal replacement?

Three alternative measures of changes in the relative 'success' of cyclostomes and cheilostomes are now available: (1) global taxonomic (family) diversity; (2) within-fauna species richness; and (3) within-fauna skeletal mass. Concurrently with the mid to late Cretaceous radiation of cheilostomes, the slower radiation of cyclostomes that had commenced in the late Triassic reached a plateau in terms of global family diversity. At the same time, within-fauna species richness of cyclostomes declined slightly from its mid-Cretaceous peak. Within-fauna skeletal mass of cyclostomes relative to cheilostomes decreased through the late Cretaceous before rising abruptly after the K-T boundary and then decreasing again towards the present day. Therefore, different measures of relative success may provide different perspectives on the relationship between ecological competition and macroevolutionary pattern.

Evolutionary implications of the extent and pattern of exploitation of skeletal morphospace by animals of the Burgess Shale

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A comprehensive analysis of the skeletons of Burgess Shale animals reveals that they incorporate 146 of the 182 design elements that constitute our multivariate Skeleton Space. Within 15 million years of the emergence of animal skeletons, 83% of design elements recognized among all living and extinct marine organisms had been exploited.

The morphological disparity of skeletal design elements increased in parallel with the diversity of higher taxa, much more rapidly than the diversity of families and genera. The rapid saturation of available morphospace following the emergence of a key innovation confirms that maximum disparity is determined by the passive constraint of limited viable options. In contrast, emerging developmental mechanisms and the adaptive exploitation of environmental opportunities are efficient causes of increasing diversity.

A similar analysis of Tommotian skeletons from the Lena River region shows that these are composed largely of simple rods, plates and cones. The Burgess Shale animals record an extraordinary proliferation of design elements involved in the growth of metamerically segmented, external skeletons. Internal and remodelled skeletal elements are greatly under-represented. Developmental controls associated with the growth of internal lever-skeletons, based on the duplication of Hox gene clusters and diversification of bone matrix proteins, must have evolved much later than those responsible for the growth of otherwise similarly complex external skeletons.

Late Cambrian and Early Ordovician conodont clusters in abyssal deposits of south-central Kazakhstan

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Early Palaeozoic ophiolites in southern Central Kazakhstan include condensed sequences of radiolarian cherts, which originally formed some of the earliest known radiolarian oozes formed on an abyssal plane. Together with radiolarians these cherts contain numerous conodonts of the Upper Cambrian *Eoconodontus nothchpeakensis* Biozone to the Middle Ordovician *Pygodus anerinus* Biozone. Sporadic occurrences of lingulate brachiopods, e.g. Paterula, and hexactinellide sponge spicules, provide possibly the earliest direct evidence of benthic faunas inhabiting abyssal depths. A unique character of the conodont faunas is the abundance of natural assemblages of elements. The conodonts preserved in clusters includes proto-, para- and eoconodont taxa, e.g., *Phakelodus tenuis*, *Prooneotodus* aff. *P. rotundatus*, *Coelocerodontus bisulcatus*, *Drepanodus arcuatus*, *Oepikodus evae*, *Oelandodus* sp., *Paracordylodus gracilis*, *Paroistodus proteus*, *Periodon flabellum*, *Prioniodus adami*, *P. elegans*, *Rossodus* sp., *Scolopodus*? *peselephantis*, *Teridontus* sp., etc. Almost all the natural clusters are preserved in coprolites, including elements of various sizes and growth stages, but juveniles are the most abundant. The material makes it possible not only to add detail to characters and the composition of some multielement conodont apparatuses, but also to study ontogenetic development of elements in some species of paraconodonts and eoconodonts, and to trace the succession of formation of distinctive units of conodont elements.

Geochemical vertebrate taphonomy: Rare earth element analysis of terrestrial vertebrate assemblages

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Several studies have determined the rare earth element (REE) distribution patterns of ancient vertebrate remains from terrestrial samples, but no extensive data are available to assess the variation in REE distribution patterns of fossil bones either within or between assemblages; or the effect of varying sedimentological conditions on bone preservation.

In this talk, data are presented from two broadly contemporaneous terrestrial assemblages from the Campanian (Upper Cretaceous) of Montana, U.S.A., and Alberta, Canada. Although both of these assemblages were produced in fluvial environments, the sedimentology of the two deposits differs significantly in detail. The Two Medicine Formation of the Willow Creek Anticline, Montana, is dominated by flood plain sediments and is characterised by low rates of reworking, whereas the Dinosaur Park Formation of Dinosaur Provincial Park is dominated by channel sediments and is characterised by high rates of reworking.

The REE chemistry of the vertebrate remains differs significantly between these two assemblages, and may be used to distinguish between channel and flood plain environments of early diagenesis. Both assemblages also contain bone bed vertebrate accumulations. In the Willow Creek Anticline assemblage, the variation in REE patterns of bones from the bone bed can be compared to that found in 'background' bone accumulations. The bones from the bone bed show much more consistent REE patterns, suggesting that the bone bed was not formed by simple concentration of 'background' bones, but had a unique, environmentally restricted source.

The REE are therefore shown to present a powerful new tool for the taphonomic analysis of terrestrial vertebrate assemblages.

Hind limb kinematics of pterosaurs during terrestrial locomotion

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Two different interpretations of how pterosaurs used their hind limbs during terrestrial locomotion have emerged in recent years. Some have argued that pterosaurs were bipedal digitigrades, with their legs tucked under the body in a fully erect position, permitting a nimble and rapid gait. Others opt for a more traditional, quadrupedal, plantigrade reconstruction with the legs sprawling outwards in a semi-erect position, allowing an effective, if ungainly waddle. So far, the imperfect preservation of pterosaur bones has fueled rather than resolved this controversy.

New, complete, uncrushed hind limbs of pterosaurs from the Santana Formation of Brazil, show that the traditional view is largely, if not entirely correct. The femur jutted out sideways and forwards from the pelvis and progression was largely achieved by flexion and extension of the lower leg at the knee. The digits could not hyperextend, as in birds, thus the foot was plantigrade and typically angled forwards and outwards. This interpretation of hind limb posture perfectly matches tracks attributed to pterosaurs and is also consistent with their role as the posterior wing spar of the flight apparatus.

Comparative biomineralization in cheilostome and cyclostome bryozoans

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Modern bryozoan faunas largely comprise two orders which independently evolved calcified skeletons: the dominant Cheilostomata and the Cyclostomata. Biomineralization in cyclostomes originated in the Ordovician, whereas calcified skeletons in cheilostomes first appeared in the Jurassic. Colony forms in the two orders occupy similar morphospace. However, at the zooidal level cheilostomes display a much greater disparity than cyclostomes. Is this contrast in disparity between the orders paralleled at the level of skeletal ultrastructure? Cyclostome skeletal walls are invariably dominated by laminar fabrics, with small amounts of granular and planar spherulitic structures. Cheilostome skeletons comprise a much wider range of fabric types, with wall perpendicular prismatic fabrics (absent in cyclostomes), wall-parallel prismatic and planar and transverse spherulitic fabrics, rod-like fabrics (again unique to cheilostomes), as well as a range of laminar fabrics including rhombic "semi-nacre". Furthermore, many cheilostome species have aragonitic skeletons, skeletons of mixed mineralogy or weakly-calcified, flexible skeletons: conditions unknown among cyclostomes. Therefore the two closely-related clades exhibit strikingly different skeletal ultrastructures, reflecting their independently evolved calcification and the strong influence of biological control on details of skeletal growth and fabrics.

The Permo-Triassic mass extinction in East Greenland

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The Permo-Triassic boundary in East Greenland is ostensibly complete and occurs within a siltstone and mudstone dominated marine succession. A major facies change occurs near the end of the Permian with highly bioturbated silty mudstones of the Foldvik Creek Formation giving way to finely laminated, pyritic shales of the Wordie Creek Formation. The shales contain concretions which yield ammonoids and beautifully preserved fish, some showing preservation of soft parts. Many Permian taxa disappear near to this facies change but the precise level of the mass extinction has long been controversial due to the presence of Permian fossils (brachiopods and bryozoans) from up to 100m above the base of the Wordie Creek Formation. These Permian taxa have prompted some authors to suggest that a Permian fauna survived in Greenland long after the extinction elsewhere; whereas other authors interpret these specimens as “reworked”. This fauna is generally encountered in limestone clasts from conglomeratic lenses that are probably turbidite feeder channels. Many of the limestone clasts are lithologically similar to known Permian limestones in the region implying that they are indeed reworked. However, thin intervals of bioturbated mudstones from within the Triassic contain a “mixed” fauna of Triassic bivalves and Permian bryozoans which are unlikely to be reworked. Furthermore, some turbidite sandstones contain well preserved valves of brachiopods at their base. It would therefore appear that the East Greenland region provided a temporary Triassic refuge for some Permian taxa.

Structure and taxonomic significance of the graptolite prosicula

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Studies on graptolite taxonomy and phylogeny in recent years have placed great emphasis on proximal development of the rhabdosome, particularly the presence or absence of a virgella and early thecal growth patterns. As the prosicula was the earliest part of the graptolite skeleton to be secreted, we consider that it may also reveal fundamental information about evolutionary relationships within the Graptoloidea. Parameters investigated include the overall form, transition into the nema, pattern of secondary longitudinal ridges and spiralled trace. A variety of Ordovician taxa ranging in age from Tremadoc to Ashgill have been examined using a combination of light microscopy, SEM and TEM. In addition to these features, we are also paying attention to peridermal microstructures that may point to the method and order of secretion of the various components of the prosicula. Subsurface samples recovered during recent hydrocarbon exploration in the Lower Palaeozoic of western Newfoundland have shown that graptolite prosiculae are commonly found in palynomorph preparations from strata in which more complete graptolite remains are lacking. If prosicular morphology thus proves to be a useful taxonomic feature, graptolite prosiculae might also be used biostratigraphically in the absence of more complete material.

Phylogenetic and phenetic approaches to crustacean evolution

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The crustaceans exhibit enormous plasticity of form, having evolved many distinctive bodyplans since their origins in the Cambrian. Homoplasy within the clade is high, and there may be superficial similarities in overall form and function for distantly-related taxa in similar habitats. A better understanding of the evolution of the clade requires: 1. a more complete picture of the phylogeny of both Recent and fossil groups; and 2. insights into the pattern of morphospace filling through time. Ultimately, this will necessitate the thorough integration of cladistic, phenetic and stratigraphic data.

A data base comprising 135 morphological characters scored for orders and sub-orders was produced to address some of these questions. Gross cladistic topology is: (Eumalacostraca vs Maxillopoda) vs Phyllopoda (paraphyletic). A few Cambrian fossils (e.g., *Canadaspis, Waptia* and *Odaraia*) fall close to the base of large clades, but occupy key regions of morphospace, such that Cambrian disparity approached half its present level. The Ordovician and Silurian saw a marked decrease. The appearance of the eumalacostracans and branchiopods in the mid and late Devonian signalled two rapid and marked disparity increases, with levels reaching another plateau (about 80% of Recent levels) from the Permian to the Tertiary. Most intervals preserve a range of forms more disparate than the mean of random samples, but not significantly so (with the exception of the end Devonian).

Trackways of juvenile dinosaurs

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Fossil vertebrate trackways are the only direct evidence of the way in which extinct animals moved about on land. Tiny fossil trackways from the early Jurassic of the Eastern United States are thought to have been made by juvenile theropod dinosaurs. The tracks show that these small dinosaurs moved on average relatively more quickly than larger theropods. The makers of these tracks seem to have used some unusual gaits, which would not have been suspected from skeletal morphology alone.

Relationships between internal and external morphology in *Palaeofavosites*

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Growth of coral colonies resulted from the interaction of environmental and genetic mechanisms. Astogenetic and structural factors generated the primary skeletal elements, but the pattern of organization of modules could have been affected if colony form changed in response to environment. By comparing internal and external characters through colony growth, we can determine how factors combined to produce growth form. This study is based on *Palaeofavosites subelongus* from the uppermost Ordovician to lowermost Silurian of the east-central United States. Corals of this species are morphologically simple, but are variable in characters related to corallite size and packing, and in external growth form.

The final colony form was generated by changes in maximum growth angle of marginal corallites through astogeny; this angle changed in concert with growth surface shape. These features were coordinated with corallite characters. Initial colony growth was apparently under a high degree of genetic control; genetic constraint of subsequent growth probably worked through relationships among characters of internal and external morphology. Frequent variations in growth angle and growth surface shape during astogeny indicate fluctuations in the environmental factors affecting growth form. It is likely that sedimentation and possibly colony subsidence were the major environmental factors influencing growth form.

POSTERS

Trepostome bryozoans from the Tramore Limestone (Ordovician), County Waterford, Ireland

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The Tramore Limestone Formation (Llandeilo, Ordovician) crops out on the south east coast of County Waterford, Ireland. It is a muddy nodular limestone reaching 65m at its thickest. The Tramore Limestone Formation contains trilobites and a diverse brachiopod fauna, which have been shown to have affinities with Baltica, as well as bryozoans. The most common bryozoan colonies have a distinctive hemispherical dome-shaped morphology. The zoaria range in size from 9mm to 75mm and have previously been identified as *Monticulipora*, *Stenopora* or *Favosites* species. Unfortunately the majority of the zoaria are re-crystalised, making identification difficult. There are some species in which the internal structures remain. Examination of these have shown them to be *Diplotrypa petropolitana*. The colonies are all abraded and some have *Trypanites* borings on the upper surface. The lower surface of the colonies are rugose and sometimes concave. The bryozoan fauna is not monospecific, decalcified bryozoans of undetermined ramose trepostome forms have been identified.

Chasmataspids come in from the cold

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Arthropods from the Severnya Zemlya Formation, October Revolution Island, Siberia (Lower Devonian, Lochkovian) are reported. The fossils derive from a single collecting trip in 1978 and the palaeoenvironment is interpreted as a quiet lagoon. As well as ostracodes (not described) the fauna includes a new phyllocarid (Crustacea: Phyllocarida). There is also a new, eyeless cheloniellid (Arachnata: Cheloniellida) with probable affinities to the Ordovician genus *Duslia*. Most significant are some 60 specimens of chasmataspids (Chelicerata: Chasmataspida) which resemble previous finds from the Devonian of Germany, e.g. Diploaspis. These new chasmataspids confirm that chasmataspids had 13 opisthsomal segments, a reduced tergite 1, a preabdomen comprising tergites 2-4 and a postabdomen comprising segments 5-13. The material shows that the preabdomen could telescope with fossils preserved as both ‘long’ and ‘short’ forms. Intriguingly these fossils also suggest that chasmataspids had a eurypterid-like metastoma and genital appendage. This implies that Chasmataspida and Eurypterida may be sister groups.

Palynomorph distribution in a late Wenlock shelf sequence, Farley Member, Coalbrookdale Formation, Shropshire, England

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The Farley Member is a 24-27 metre sequence of repetitive alternating nodular argillaceous limestones and calcareous mudstones developed between the Apedale Member of the Coalbrookdale Formation and the Much Wenlock Limestone Formation. Quantitative analysis shows diverse assemblages of acritarchs and chitinozoans to be found throughout at abundances of 200-2000g-1. Typical sample species diversities range between 48-62 for acritarchs and 5-9 for chitinozoans. Selected samples were taken laterally along reference stratigraphic horizons and from adjacent calcareous mudstones and nodular limestones. Results reveal in all samples the main acritarch genera are consistently recorded as *Leiosphaeridia*, *Micrystridium*, *Veryhachium* and *Diexallophasis*. Chitinozoan assemblages are dominated by *Conochitina* or *Ancyrochitina*. Lateral samples were internally consistent with regard to species composition. Palynomorphs in nodules are consistently preserved in three dimensions, reflecting early diagenetic nodule formation, in contrast to their flattened nature in the mudstones from post depositional compaction. Qualitatively assemblages from adjacent limestone/mudstone couplets are broadly comparable, but they differ significantly in absolute abundance. At a broader scale than the limestone/mudstone couplets, there are significant changes in a few key acritarchs. Assemblages are representative of the middle part of the *Eisenackidium wenlockensis* acritarch Biozone.

Biodiversity changes through Late Cretaceous floras from the Antarctic Peninsula

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The radiation and diversification of angiosperms across the Southern Hemisphere is poorly understood since few southern Cretaceous floras have been documented. Although the northern tip of the Late Cretaceous volcanic arc, now represented by the Antarctic Peninsula, was at about 65 degrees south, it was extensively forested and the remains of the plants are now preserved within the James Ross Basin. Surprisingly, new studies of plant fossils show that there was a remarkably diverse angiosperm component within these southern polar forests. The excellently preserved impressions of the leaves are separated into taxa using architectural characters such as venation patterns and marginal features. Comparisons between the angiosperm leaf floras of the Hidden Lake Formation (Coniacian-Santonian) and the Santa Marta Formation (Campanian) are drawn.

The evolution of the scombroid fishes

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The teleost suborder of Scombroidei poses some interesting questions regarding their evolution. Some of the supposed scombroids are warm-blooded, an exceptional feature in fishes. Up to this date, phylogenies of scombroids have been based by including solely Recent taxa. The different phylogenies thus proposed differ radically on some points. Although there is a superb fossil record, it is for the first time now that evolutionary studies are carried out with it. A phylogeny, based on Recent and fossil taxa, will be constructed. The inclusion of fossils will hopefully solve problematic ancestral relationships which cause controversies regarding scombroid interrelationships. Interesting questions like the evolution of warm blooded-ness in this fish group will be looked at. Fossils and Recent specimens from the BM (NH), the Palaeontological Institute in Moscow and the Smithsonian Institute will be described and incorporated in the phylogenetic analyses.

OBITUARIES

Professor Dorothy Hill, AC, CBE, FRS (1907-1997)

Dorothy Hill, without doubt the most influential Palaeozoic coral palaeontologist over the last half century, died on 23rd April 1997 aged 89. Apart from a period of seven years in the 1930s, the whole of her academic life was spent at the University of Queensland in Brisbane. There, apart from fostering her own research school, she received a stream of visitors from all over the world. She made no distinction of age or rank, taking a great interest in the work of students and established researchers alike, and was usually able to pick out a couple of references from her encyclopaedic knowledge of the literature that had not previously come to the notice of the enquirer. Her approachable, friendly, unassuming nature belied her great achievements. Longer term visitors would be invited to tea at her home where she lived quietly with her sister within walking distance of the pleasant riverside campus at St Lucia, leaving, if they were lucky, with a paw-paw fresh from the tree in the garden, providing the flying foxes hadn't got them first!

Dorothy Hill was born in Brisbane and went up to the University of Queensland as an undergraduate in 1925. She graduated with first class honours in geology and a University Gold Medal in 1928, having also won an Australian universities blue for hockey. After an M.Sc. completed in 1930, a travelling scholarship took her to Cambridge, where, her interest having been fired by fossil coral reefs in Queensland, she started postgraduate research on the Palaeozoic corals of England and Europe. Following the award of her Ph.D. in 1932, she held a fellowship at Newnham College before returning to Brisbane and the University of Queensland in 1937. She quickly established her pre-eminence in the field of Palaeozoic corals with a long stream of important publications, many on the faunas of Australia. She also made fundamental contributions to other aspects of palaeontology, notably the archaeocyathids, as well as to Australian geology in general. Her world leadership in these fields resulted in her joint authorship of the anthozoan section of Part F of the Treatise on Invertebrate Palaeontology which appeared in 1956, and later, sole authorship of the revised and enlarged treatment of the Archaeocyathida in volume 1 of Part E published in 1972. Her greatest achievement was undoubtedly her single-handed, much enlarged revision of the Rugosa and Tabulata as a supplement to volume F of the Treatise published in 1981. The latter was a work of immense scholarship, hugely influential to the present day, and it is unthinkable that such a revision will ever be undertaken by a single person again.

Dorothy Hill received many honours and achieved many firsts. She was the first woman to graduate Doctor of Science at the University of Queensland (in 1942), the first female fellow of the Australian Academy of Science (1956) and its first female President (1970), the first woman to be appointed to a chair at an Australian university (1959) and the first and so far only Australian woman to be elected a Fellow of the Royal Society (1965). She was appointed CBE in 1971 and a Companion of the Order of Australia in 1993. Not surprisingly, she always encouraged young women, firstly by persuading

Queenslanders to send their daughters to university at a time when it was not the usual practice, and secondly to consider careers in the earth sciences. Among her other contributions to her own department and University she promoted the development of a first class geology library to which she donated much of her own vast collection of literature. This was named the Dorothy Hill Library in 1985. Much of the library was later removed to the University's Physical Sciences and Engineering Library, which this year was also renamed in her honour. On her retirement in 1972, the University created the Dorothy Hill Chair of Palaeontology, and in 1981, as a particular mark of esteem, a grotesque of Professor Hill was added to the collection of eminent alumni gazing down from the façade of the University's Great Court.

Dorothy Hill was regarded with admiration and affection by Palaeozoic coral workers around the world. She will be greatly missed, but her outstanding contributions mean that she will continue to influence the fields in which she worked for many years to come.

Colin Scrutton
University of Durham

Thomas Henry Clark (1893-1996) – In Memoriam

Thomas Henry Clark, Ordovician stratigrapher and palaeontologist, for forty years Professor of Geology at McGill University in Montreal, died after a brief illness in his 103rd year on 28th April 1996, in the Town of Mount Royal, Quebec.

Thomas H. Clark was born on 3rd December 1893, in London, England, the third youngest of a family of six sisters and one son. He attended primary and private schools in London and in 1911, at the age of 18, came to the United States to live with family friends who had no children in Boston. Clark first attended the Boston Normal School and in 1913 entered Harvard University to study palaeontology under Dr Percy Raymond. In 1917 he received an AB. in Geology, magna cum laude. Recalling his first encounter with Raymond in a letter to Stephen J. Gould dated 9th February 1990, he stated that he "was greeted with this apparent pessimistic reception and advice and the words, 'Very well. But I warn you that if you continue in such foolishness you'll be the last palaeontologist alive by the time you retire. There is no future in it.'"

During the First World War in 1917, Clark joined the U.S. Army and in 1918 was sent to France as a lieutenant in the medical corps of the 87th Infantry Division. The division had been ordered to move to the front on 10th November 1918, but the Armistice was signed the next day. Back in the United States, he re-entered Harvard and obtained an A.M. in 1921 and a Ph.D. in 1923. His Ph.D. thesis subject was a continuation of Raymond's (1914) preliminary work on the graptolite succession and zonal assemblages of the Early Ordovician Levis Formation at Levis, Quebec, but he also took an interest in the Cambrian trilobites in the boulders of the conglomerate lenses. He was Assistant in Geology at Harvard from 1915 to 1918 and from 1919 to 1921, and Instructor from 1921 to 1924. In the summer of 1924 he was "second in command" of the Harvard Summer School in the southern Rockies at Field, Alberta, where he met the visiting Charles D. Walcott and Mrs Walcott. He spent two days at Walcott's Quarry in the Burgess Shale "collecting what I thought was a wonderful lot". On the way to Alberta he stopped in the Logan basin of northern Utah to collect graptolites from the base of the Swan Peak Formation that were long believed to be *Didymograptus bifidus* (Hall) until they were described as *Yutagraptus mantuanus* by Riva in 1992.

In the fall of 1924 Dr Clark came to McGill University as an Assistant Professor in Geology and began an association with the university that was to last for 69 years. In 1925 he was named Curator of the

Geological Collections of the Redpath Museum and in 1927 promoted to Associate Professor. In 1929 he was named Logan Professor of Palaeontology and elected to the Royal Society of Canada. In 1932 he became Curator and in 1943 Director of the Redpath Museum and the McGill University Museums and Chairman of the University Museums Committee. He resigned all his museum charges, however, in 1951, when he became Chairman of the expanding Department of Geological Sciences. He taught until his retirement in 1962 at the age of 69 and then for two more "post-retirement" years, for a total of 40 years. In 1964 he was named Logan Professor of Palaeontology Emeritus, but went on working at first almost every day, including often Saturdays and holidays, but latterly two or three days a week, at the University and the Redpath Museum until his final retirement on 30th May 1993, at the age of 99. He gave his last formal public lecture on the subject of the Burgess Shale on 28th March 1990, in the lecture hall of the Redpath Museum. Professor Stephen J. Gould, who had come up from Boston to hear the lecture, wrote "… the Burgess fossils were laid out on a table in the middle of the pit, but Clark stood at the end of the table and spoke for forty minutes without notes on the life and works of Charles Doolittle Walcott – a beautiful presentation chuck-full of information and organized, as all good talks must be, around a distinctive and integrative point of view."

T.H. Clark co-authored with C.W. Stearn the classic textbook on The Geological Evolution of North America, first published in 1960. A second edition was published in 1968 and a third in 1979. He was also a consultant to industrial companies in the St. Lawrence Lowland and to Hydro Quebec, and logged many wells for gas and oil companies. His 1959 Presidential Address to the Geological Association of Canada is partly based on the logs of 44 cores drilled between Montreal and Quebec City, five from south of Montreal and three from the Island of Anticosti.

In the last twenty years of his life T.H. Clark would spend two or three days a week curating the palaeontological collections stored in the basement of the Redpath Museum as an Advisor in Geology. He worked from a small table in the corridor next to the collections, cleaning, washing and evaluating specimens, sending out collections to specialists to be studied, rewriting new labels in his distinguished handwriting and assisting Michel di Vergilio in computerizing the collections.

T.H. Clark received the Logan Gold Medal from the Geological Association of Canada. On 15th January 1993, he was made an honorary member of the Association of Professional Geologists and Geophysicists of Quebec; on 30th April as he was approaching his 100th birthay he received from the Association the Prix du grand mérite géoscientifique, and gave to a hushed audience his last public speech, without notes, dwelling on his career as geologist and comparing in unflattering terms the teaching of today with teaching as he had known and practised it.

Dr Clark gave his last interview in December 1993 to the McGill Reporter on the occasion of his 100th birthday. "I was never happier", he said, "than when I was in front of a class. I never used notes and made an effort to look at every single person in the audience during the course of the lecture. I wanted to make it a personal affair."

The Thomas H. Clark Chair in Petroleum and Sedimentary Geology is presently being established in his honor at McGill University.

J.F.V. Riva

Palaeo-Comment

Most good palaeontologists are adept at communicating their results and thoughts to other palaeontologists. However, a disturbingly large proportion of palaeontologists seem to overlook an even more important part of their work, which is to communicate it appropriately to audiences outside palaeontology. These audiences can be loosely divided into three – other geologists, other biologists, and the general public. Sadly, too few palaeontologists seem to realise that this communication is necessary and indeed vital if our profession is to survive – why should geology departments, biology departments or the great general public use us and give us money if we are not perceived as relevant to them?

The centre of geology in Britain is the Geological Society, and I am disturbed at how few palaeontologists there seem to be who are keeping the fossil flame burning brightly within that society. Of course it can be argued that the Palaeontological Association was founded ahead of its time from the point of view of the Geological Society. In other words, if the foundation of the Pal Ass was 20 rather than 40 years ago, it would probably be a natural Specialist Group of the Geological Society rather than an independent outfit. However, since the Palaeontological Association is thriving in most of what it does for palaeontology, there seems to be little call for such a realignment, and I for one would not now think it appropriate. But the downside of this lack of formal connection with the Geological Society (apart from the Joint Committee for Palaeontology) is that in the perceptions of many earth scientists palaeontology is becoming progressively marginalised. This is both a pity and also completely unnecessary. One only has to look at the key work in geology that palaeontology is doing, for example, correlation, sequence stratigraphy, global change, geological environments, basin analysis and palaeogeography, to realise that our subject provides as much for geologists now as it ever has.

So if you are primarily a stratigraphical palaeontologist then you should ask yourself why you are not a fellow of the Geological Society? Comparably, if you are primarily an evolutionary biologist, then are you pulling your weight in the broader life sciences? In either case, we should also all be searching our souls in wondering how more opportunities can be made and taken to sell interest in our subject to the general public. Dinosaurs are wonderful in the public perception but how many people know much of palaeontology beyond them?

In fact (despite gloomy mutterings in bars), a great number of NERC and other research grants, research student awards, medals from the Geological Society and other learned bodies, and various other key performance indicators, have been well won by palaeontologists over the last ten years, even in higher proportions than in most other branches of the earth sciences. Nevertheless, these good results have been achieved by a smaller proportion of the palaeontological population than might be.

I hope that these comments will be encouraging rather than taken as negative. I perceive that palaeontology in general and the Palaeontological Association in particular are thriving – it just seems that more of us should be better and more persistent at communicating palaeontology to a variety of wider audiences.

Robin Cocks
Keeper of Palaeontology,
The Natural History Museum

Palaeo-Note

A note on the Palaeo-Comment in the last *Newsletter:* "The four Lapworth plates referred to in Euan Clarkson's *Palaeo*-Comment 'Lapworth's Graptolites', Newsletter 35, p14, have been reproduced in Isles Strachan's 1996 Bibliographic Index of British Graptolites, p11-14, and are now available for all to see."

(ENKC/IS)

Palaeo-News

New Purchase for Portsmouth!

SUE

We have just bought at auction a new specimen of the fossil ostracod *Cytherella rex*. Bidding was brisk, although our telephone bid of $2.75 did not quite match the expected $7.8 million reserve. Nevertheless the vendors and auction house were said to be ecstatic at such a price and accepted our bid without hesitation. We are grateful to our sponsors, who not only provided funds for the purchase, but have also agreed to fund full time appointments for three preparators to extract the ostracod from its matrix in a custom built laboratory. Although the ostracod is not new to science, this is one of the most famous ostracods and is the largest example of the species, being nearly 2.7 mm long. Our sponsors have also agreed to fund a scientist to study the specimen, said to be in an excellent state of preservation, and almost 100% complete.

It has been called Sue after the legal wrangling that it attracted over who originally owned the specimen. Now safely stored in a matchbox in my bottom drawer, the specimen will be available to the palaeontological community, which clearly has gone bonkers, for further study.

David M. Martill
University of Portsmouth

FUTURE MEETINGS OF OTHER BODIES

Palaeobiogeography of Australasian Faunas and Floras
University of Wollongong, NSW, Australia
8 – 11 December 1997

The Organising Committee (Tony Wright, John Talent, Gavin Young) cordially invites all interested scientists to attend this conference and to submit papers for publication and/or oral presentation. The rationale behind the conference is the urgent need for a comprehensive monographic publication summarising the changing patterns of biogeographic affinities of the Australasian region through geological time.

This meeting will be the only 1997 conference sponsored by the Association of Australasian Palaeontologists, so papers on other palaeontological themes (e.g. evolutionary studies, palaeoecology, precision in biostratigraphy) are welcome. In keeping with the major theme, papers dealing with the biogeography of any group for any geological period are particularly welcomed.

For further information, contact Tony Wright, School of Geosciences, University of Wollongong, Wollongong NSW 2525, Australia. Tel: +61 42 213 329; Fax +61 42 214 250; Email: `t.wright@uow.edu.au`

1998 Lyell Meeting: Palaeobiology Meets Geochemistry: Concretions as Tombs
Burlington House, London W1V 0JU
18 February 1998
Convenors: Dr J.C.W. Cope & Professor C.D. Curtis

This interdisciplinary meeting aims to bring together workers from diverse backgrounds, all of whom share interest in concretions. The objective is to discuss how the processes of concretion formation and the evidence that they preserve may be interpreted in terms of processes and organisms that were present at the sediment/water interface.

International Symposium: Palaeodiversifications, land and sea compared
Lyon, France
6 – 8 July 1998

The Conference is held under the auspices of the UMR 5565 of the CNRS and is organised by Mireille Gayet, UFR des Sciences de la Terre, Université Claude Bernard, Lyon I, 27-43 bd du 11 novembre 1918, 69622 Villeurbanne cedex, France (tel +33 (0)4 72 44 83 98, fax +33 (0)4 72 44 84 36, email `gayet@univ-lyon1.fr` or `lysiane.thevenod@univ-lyon1.fr`).

5th International Symposium on the Jurassic System
Vancouver, B.C., Canada
17 – 20 August 1998

Organised by the IUGS Jurassic Subcommission. There will be pre- and post-meeting field trips to the Canadian Rockies, the Coast Mountains, the Queen Charlotte Islands and Nevada. Contact Paul L. Smith, Earth and Ocean Sciences, University of British Columbia, 6339 Stores Rd., Vancouver, B.C. V6T 1Z4, Canada. Tel: (604) 822-6456; Fax: (604) 822-6088; Email: `psmith@eos.ubc.ca`

Symposium Website: `http://www.eos.ubc.ca/jurassic/announce.htm`

Geoscience 1998: Exceptionally preserved fossils
University of Keele
1998
The Geological Society, in conjunction with the UK Geophysical Assembly and supported by the British Geological Survey, are hosting the biennial conference at the University of Keele. There will be a wide range of symposia including this symposium organised by Professor Derek Briggs.

Contact Convenor: Derek E.G. Briggs, Department of Geology, University of Bristol, Wills Memorial Building, Queen's Road, Bristol BS8 1RJ (tel: 0117 928 7793, fax 0117 925 3385, email `D.E.G.Briggs@bristol.ac.uk`).

A symposium on the formation of exceptionally preserved ("soft bodied") fossil deposits, which provide a wealth of palaeontological information and are also a source of data on the growth of authigenic minerals and the diagenesis of organic matter in sediments.

KEYNOTE SPEAKER:

Dr Hendrik Poinar (University of Munich, Germany): "DNA in fossils"

INVITED SPEAKER:

Dr Karin Liebig (Hessisches Landesmuseum, Darmstadt, Germany): "Fossil bacteria and their role in soft-tissue preservation"

OTHER CONTRIBUTIONS FROM:

Professor Richard Aldridge and Sarah Gabbott (University of Leicester, UK)
Dr Peter Allison (Imperial College, UK)
Dr Jane Francis (University of Leeds, UK)
Professor Dianne Edwards (University of Cardiff, UK)
Dr Artur Stankiewicz (University of Bristol, UK)
Dr David Martill (University of Portsmouth, UK)
Dr Derek Siveter (University of Oxford, UK)
Dr Margaret Collinson (Royal Holloway College, University of London, UK)

Registration forms and the Second Announcement are now available by email from `lakinj@geolsoc.org.uk`, or by fax from 0171 494 0579.

BOOK REVIEWS

Late Triassic (Carnian and Norian) Tetrapods from the Southwestern United States

Robert A. Long and Phillip A. Murry, 1995, New Mexico Museum of Natural History and Science, Bulletin 4. 254pp. No ISBN/ISSN number provided. Softcover $45.

Due largely to the work of Alick Walker in the l960s and 1970s, and his protege Mike Benton through the early 1980s, studies of UK Triassic vertebrate fossils have become an important and busy field. Indeed, for much of the early 1990s "Triassic vertebrate fossils" was a 'buzzword' for often dynamic and ingenious research. In terms of terrestrial vertebrate evolution, the Triassic ranks – arguably – as one of the four most significant geological periods (the others being: the Carboniferous, the Permian and the Palaeocene). The Carboniferous represents the initial radiation of the very earliest tetrapods, subsequent to the emergence of the basal tetrapods such as *Acanthostega* from the aquatic realm. During the Permian, the terrestrial amniote lineages had already diverged and were now diversifying into the early representatives of all our modern tetrapod groups. The Palaeocene contains the major radiation of derived mammals subsequent to the extinction of the dinosaurs. With the possible exception of the Permian, the Triassic period was possibly the most significant age for the evolution of tetrapod groups. It was during this time that the ancient synapsid-dominated terrestrial tetrapod faunas declined and were replaced by an entirely different faunal component: archosaur diapsids – including dinosaurs. At no prior or subsequent time has an intermingling of such radically different tetrapod groups coexisted to such an extent.

In the USA, Triassic vertebrate studies are equally as vigorous as in Great Britain – even accounting for the vast size of that country, and its facile preoccupation with dinosaur "studies". Perhaps the most important Triassic localities are grouped in the South-western US: Arizona, New Mexico and Texas. This volume is the fourth in – presumably – a more-or-less ongoing series devoted to the Triassic strata of this region. All the four bulletins are from the New Mexico Museum of Natural History and Science (NMMNH).

Bulletin 1: "Dawn of the age of Dinosaurs in the American Southwest", Lucas and Hunt.

Bulletin 2: "Vertebrate Palaeontology in New Mexico", Lucas and Zidek.

Bulletin 3: "The nonmarine Triassic", Lucas and Morales.

And now this offering, "Late Triassic (Carnian and Norian) Tetrapods of the South-western United States", by Long and Murry. This latest addition is certainly the bestlooking production of the four, although at 254 pp it is the thinnest as well. In twelve chapters, the volume covers history of vertebrate fossil collecting in upper Triassic strata of the South-western US, Triassic Amphibia, primitive archosauromorphs, "phytosaurs" (a large section), aetosaurs, rauisuchids, crocodiles, a small ornithosuchid, dicynodonts (a mere two pages), the inevitable dinosaur component, and faunal turnover. Appendix 1 lists Upper Triassic Vertebrate fossil-bearing localities and their geology. Appendix 2 is an account of Lower Triassic referred specimens of Amphibians and Reptiles. In the main body of the book each fossil is named, a full synonymy follows, then type specimen(s) horizon and locality, collector, (revised) diagnosis, distribution, referred specimens, and a full anatomical description of the fossil. A discussion finishes the piece on each fossil: this is invariably taxonomic in nature, with a little in the way of taphonomic/preservational details. The sections are each concluded with a summary. A contribution on functional morphology, feeding or ecological aspects would be welcome, and the omission of such a detail detracts a little from the overall form of the book.

The page layout of the book is good. Line drawings are of a very decent standard, black and white photographs are quite clear and on the whole nicely reproduced. That said, occasionally they lose clarity in size reduction, but the larger ones are fine. The drawings and photos are juxtaposed – allowing access for personal interpretations. Scale bars are evident throughout. All illustrations (photos and drawings) are contained within "line boxes". This has a pleasant effect, and helps to separate the illustrations from the text. The overall standard of production for a paperback book is excellent, even to the extent of using high quality "semi-glossy" paper.

Researchers wishing for a detailed overview of Late Triassic faunal vertebrate components in the American Southwest will find this volume of significant use. Having said that, perhaps it was too much to expect the important Triassic strata of Scotland to be included in their correllations – even to a small extent. They are not. Passing mention of these deposits are made ??? book. It may seem a superfluous item to complain about, but when names such as *Parrishia mccreai*, *Lucasuchus hunti*, *Longosuchus meadei* and *Chatterjeea elegans* are encountered it leads to a sense of parochial, reciprocal back-slapping smugness that is almost incestuous. "Let's all name our fossils after one another", one can almost hear the cry. It is an irritant, but it is there. Quibble apart, it is a nicely produced softback volume, interesting and packed with information on Triassic faunal vertebrate components which will prove useful for UK Triassic vertebrate palaeontology workers, if they can be bothered to send off to the New Mexico Museum of Natural History for it.

Ian Jenkins
Earth Sciences
University of Cambridge.

Fossils: the Story of Life

Sue Rigby, BGS, 1997, softback, 65pp, £6.50.

When this book landed on my desk for review I did hesitate for one moment simply because Sue Rigby is a friend and recent colleague. Then I realised what an excellent tome this is, so decided to review it anyway! To tell the truth, I'm a bit of a sucker for this kind of popular science, where the writer is an expert/professional and has simplified the subject accurately. I have, by way of contrast, recently examined some amateur publications on fossils which have been simplified rather inaccurately. There is, it seems, an unquenchable amateur demand for palaeontology these days, and it is up to us the professionals to present the subject well, whether it is in leaflet form or, as in this case, manageable book size.

Sue Rigby's book is aimed at keystage 4 and A-level, but in truth it would be quite useful for any person just starting palaeontology. The illustrations alone (more than 100 colour photographs and diagrams) are valuable, and the accompanying text is tightly written and very clear almost everywhere. Just a few of the diagrams don't seem to me to work very well, such as the Game of Life on pp 20/21 – very eye-catching, but what else? I have very few quibbles of this nature, and I doubt if they detract from the usefulness of the book in any way at all.

The book begins with an illustrated two-page definition of what is meant by the word "fossil", and this is followed by four pages on how fossils form and on exceptional fossils. The sensibly logical approach continues with a section on how fossils aid our understanding of evolution, and how they are used in relative dating of rocks.

There follow sections on fossils in a plate tectonic context, in environmental interpretation, and in palaeoecology.

From page 22 she deals with fossils through time, including major events, in more detail, ending with the evolution of man, and ice ages. Six pages of case histories follow: a Jurassic forest; early man the hunter; food chains in Jurassic seas; structure of the Southern Uplands; conodonts; and temperatures and oxygen isotopes. Each of these puts past life in a whole, and shows how we use knowledge of palaeontology to illuminate other disciplines.

The section on great collectors and great British museums is a good read, and this is followed by a précis of the major fossil groups (I'm glad she included graptolites in this section! Normally they are omitted, which is entirely the fault of graptolite workers themselves).

There is a useful index and a brief glossary of terms. It is a splendid book which would be enjoyed by any intelligent person whether beginner or not. It can be ordered direct from: Sales Desk, British Geological Survey, Keyworth, Nottingham NG12 5GG. Postage and packing are extra, so you should get in touch first to find out the total cost (by telephone on 0115 936 3241, fax on 0115 936 3488, or by email to `sales@bgs.ac.uk`).

Barrie Rickards
University of Cambridge

The Value and Valuation of Natural Science Collections

Edited by J.R. Nudds and C.W. Pettit, published by The Geological Society, 1997, hardback, 276pp, £55.

This is not a book I would choose to read a second time. If I found myself using it for reference – which is quite likely – I'd have to be in a depressed state, for it is a depressing subject, by and large. Basically, natural science collections are undervalued in almost every sphere; and in the UK, parts of Europe and the USA, have no valuation recognition in accountancy terms (unlike Australia and a few other countries where collections are considered as part of the financial assets of an institution).

The book results from the International Conference, in Manchester in 1995. The editors, John Nudds and Charles Pettit, should be congratulated on bringing this dreadful subject to heel, as it were.

Part 1 (80 pages) considers the scientific value of collections. It seems a pity really that this has to be a subject for discussion at all, yet it is clear from the rather diverse topics covered that it *is* necessary. The Earl of Cranbrook, who claims that he is not, now, a practising systematist, sets the scene very clearly: he emphasises more the value than the valuation, and he drifts into the related and important subject of curation (which is not really part of this volume). The volume proper begins with Simon Knell's chapter "What's important?". It seems a logical start, and my own problem with it was that I couldn't get his drift. What I really mean is that I didn't really understand it. All curators ask the question, naturally, and they answer it subjectively. One or two papers (e.g. Blackmore *et al*) might have been better located in part 3 (see below), but others do look very closely at many valuable aspects of natural science collections, some of which the reader will be unaware, if they are anything like me. It's impossible for me to summarise part 1 briefly and simply, because it is a diverse and piecemeal compendium. But much of it is most interesting.

Part 2 deals with the cultural value of collections. Although the cultural value should be obvious to all intelligent people, it is perhaps a good thing to have everything spelt out in this way. Some of the papers seem a bit abstract and waffly to my mind, but when this whole subject is discussed by politicians that's exactly what happens to hitherto clear concepts of value (a good parallel might well be what the educational gurus did to the school curriculum concept). So I suppose such thinking *is* important. It just depresses me somewhat. Other papers pack more of a punch, and I enjoyed Baird's "Slaying the sacred cow" which argues that our woes are our own fault. It's difficult to argue the contrary.

Part 3, on the financial value of collections, is a minefield. It is marvellous reading in places, a completely crazy world in others. It deals with loss adjustment, insurance, accountancy of collections, and professional valuations, all subjects that any curator would hope that someone else would deal with. Clearly, again, it is important to have these views set down for reference.

The general discussion which took place at the Conference is recorded in nine pages. There is a four-page international Accord which, in brief, expresses many of the views expressed in the preceding text, and additional (poster) presentations as published in a further fifty or so pages. The invited lecture by Shelton "Murder in the museums a case of natural selection?" was probably as enjoyable to listen to as it is to read. In fact, as I read the books from the beginning to the end, I might have enjoyed my read more had I begun with Shelton's paper.

I want to emphasise something: this is a most valuable tome for anyone in museums, and the editors have dealt splendidly with a subject which is not only depressing, but interesting, exciting, irritating, boring, and well capable of raising far more emotions than that. It is also very important that we have these views and problems documented in such a volume.

Barrie Rickards
University of Cambridge

Palaeontology

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