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The Palaeontology Newsletter

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Reminder: The deadline for copy for Issue no 73 is 22nd February 2010.

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Association Business

Annual Meeting

Notification of the 2009 Annual General Meeting and Annual Address

This will be held at the University of Birmingham, 14th December 2009, following the scientific sessions. Please note that following the October Council meeting, additional items may be added to the agenda. All the information relating to the Annual Meeting and the Annual General Meeting, to be held this year in Birmingham, is provided in the supplement printed on coloured paper in the second half of this edition of the Newsletter.

Grants and awards

Palaeontological Association research grants

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

Lapworth Medal

The Lapworth Medal is awarded by Council to a palaeontologist who has made a significant contribution to the science by means of a substantial body of research; it is not normally awarded just on the basis of a few good papers. Council will look for some breadth as well as depth in the contributions in choosing suitable candidates.

Nominations should be supported by a resumé (single sheet of details) of the candidate's career, and by a brief statement from two nominees. A list of ten principal publications should accompany the nomination. Council will reserve the right not necessarily to make an award in any one year. Details and nomination forms are available on the Association Website. The deadline for nominations is **1st May**. The Medal is presented at the Annual Meeting.

President's Medal

Council is instigating a mid-career award for palaeontologists in recognition of outstanding contributions in their earlier careers, coupled with an expectation that they are not too old to contribute significantly to the subject in their further work.

Nominations are invited by **1st March**, supported by a single sheet of details on the candidate's career, and further supported by a brief statement from a seconder. A list of ten principal

publications should accompany the nomination. Council will reserve the right not necessarily to make an award in any one year. Details and nomination forms are available on the Association Website.

Grants in Aid

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

Grants-in-Aid: Workshops and short courses

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

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

The Palaeontological Association runs a programme of travel grants to assist student members presenting talks and posters at the Annual Meeting. For the Birmingham meeting, grants of **up to £100** (or the Euro equivalent) will be available to student presenters who are travelling from outside the UK. The amount payable is dependent on the number of applicants and the distance travelled. Payment of these awards is given as a disbursement at the meeting, not as an advance payment. Students interested in applying for a PalAss travel grant should contact the Executive Officer, Dr Tim Palmer, by e-mail to <**palass@palass.org**> once the organisers have confirmed that their presentation is accepted, and before **8th December 2009**. Entitle the e-mail 'Travel Grant Request'. No awards will be made to those who have not followed this procedure.

H. A. Armstrong
Secretary

ASSOCIATION MEETINGS

53rd Annual Meeting of the Palaeontological Association
School of Geography, Earth & Environmental Sciences,
University of Birmingham, England *13 – 16 December 2009*

The summary, programme and abstracts for the 53rd Annual Meeting of the Palaeontological Association are included as a supplement in the second half of this issue of the *Newsletter*.

The deadline for late registration is Friday 20th November. Registration is via the Palaeontological Association website (<**http://www.palass.org/**>).

The meeting will take place in the Haworth large lecture room, Chemistry Building at the University of Birmingham on the main Edgbaston campus.

Please note that accommodation is not included in the online registration form and must be booked separately. We recommend that delegates stay in the city centre, which is approximately three miles from the University and connected by a very frequent direct train service.

Birmingham is easily accessible from throughout the UK and very well served by trains into New Street (main station connecting to the airport and London Euston), Snow Hill and Moor Street (both connecting to London Paddington via the Chiltern Line). Birmingham International Airport (code BHX) serves many different European and international destinations including direct flights from Newark (Continental Airlines) and Philadelphia (US Airways). Several flights a day shuttle to Frankfurt, Amsterdam and Paris. Birmingham is 1.30 hours from London Euston by train but if flying to Birmingham, we suggest routing through mainland Europe and into Birmingham rather than hitting London Heathrow direct.

The opening symposium entitled "Macroecology in deep-time" begins at 1.30pm on 13th December, followed by a reception at the Birmingham Museum and Art Galleries at 7pm.

The Annual Address will be given at 5.15pm on Monday 14th December by Prof. Larry Witmer, on "Digital dinosaurs: Unlocking the riddles of the past using advanced 3D imaging".

The Annual Dinner will take place at 7pm in the Birmingham Botanical Gardens, Edgbaston.

The meeting will conclude on Wednesday 16th December with a field excursion to the south Cotswolds area to view and collect freshly-quarried sections in the Oxford Clay.

We would like to express our appreciation to the following for providing financial assistance towards this meeting: Wiley-Blackwell, Paleontological Institute University of Kansas, and The Geological Society of London Publishing House.

Progressive Palaeontology
Department of Earth Sciences, University of Bristol *26 – 28 May 2010*

Progressive Palaeontology is the annual conference for postgraduatesl who wish to present their results at any stage of their research. Presentations on all aspects of palaeontology are welcome. The meeting includes oral and poster presentations, the annual dinner and a field trip.

There are full details at <**http://www.palass.org/modules.php?name=propal&page=57**>.

International Palaeontological Congress IPC3
Imperial College & Natural History Museum, London *28 June – 3 July 2010*

IPC is a major international meeting held once every four years under the auspices of the International Palaeontological Association. The meeting provides a showcase for all that is exciting and new in the fields of palaeontology and palaeobiology. IPC3 in 2010 is hosted by the Palaeontological Association and partner organizations the Natural History Museum, the Palaeontographical Society and the Micropalaeontological Society. It will be based in Imperial College and the Natural History Museum in the heart of London's 'Albertopolis'.

The programme will comprise field trips, plenary lectures, workshops, contributed talks and posters, and thematic symposia, including:

- Comparing the geological and fossil records, and the implications for biodiversity studies
- Macroevolution and the Modern Synthesis
- The micropalaeontological record of global change
- The Great Ordovician Biodiversity Event
- Geomicrobiology at critical periods of Earth history
- Palynology and the Palaeozoic Earth system
- Biotic recovery after mass extinctions
- Microfossil contributions to understanding the tree of life
- Modelling the climate of Palaeozoic Earth
- Rates of morphological evolution in fossil lineages
- Molecular palaeobiology

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

Abstract submission and registration open on 1st November 2009. For full details see the IPC3 website at <**http://www.ipc3.org/**>.

INTERNATIONAL PALAEONTOLOGICAL CONGRESS

LONDON

2010

June 28 - July 3

WWW.IPC3.ORG

University of BRISTOL

PROGRESSIVE PALAEONTOLOGY

BRISTOL 2010

26th - 28th May 2010

Department of Earth Sciences, University of Bristol

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

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

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

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

The Bristol 2010 organising committee are:

Aude Caromel, Roger Close, Jenny Greenwood and Duncan Murdock

From our Correspondents

The meaning of palaeontology

It is the brief biographies at the end of the book that catch one's eye. The ending of many was all too similar. Take Professor Wacław Roszkowski, for instance. A zoologist, he studied in Kraków, Freiburg, Lausanne; travelled widely; was interested in the phylogeny, zoogeography and ecology of invertebrates; and was murdered by the Nazis in 1944. Then Dr Adam Łuniewski, a geologist who studied at the Sorbonne and then in Warsaw: a Mesozoic biostratigrapher who also described fossil mammoths, he lived a little longer, dying in 1945 of typhus in Belsen. Or Aleksander Kelus, a palaeontologist who studied Devonian brachiopods; he survived the war, despite being active in the underground, but was arrested immediately afterwards (there are different types of peace) and died in 1946.

These were all – had all been – colleagues of one of the last century's[1] remarkable palaeontologists, Roman Kozłowski, whose eventful life has been described in a book recently published by his son, Witold Kozłowski. It is in itself a remarkable construction. In part it is a two-sided biography (there is a long preface by Adam Urbanek, Roman Kozłowski's protégé, a palaeontologist who followed in his footsteps and became almost equally well-known); in part it is autobiography (with some apologies for this that are entirely unnecessary, for they throw essential light upon protagonist and context); and in part meditation (admixed with his, Witold's, poetry). I had been sent it by Anna Kozłowska, Roman Kozłowski's grand-daughter and also a graptolite palaeontologist of distinction. Now, on part-holiday by the sublime shores of Lake Garda under a cloudless Italian sky[2], I could finally settle down to read it.

Today, Kozłowski has become a well-nigh legendary figure in palaeontology: the man who solved the mystery of what those strange but very useful fossils, the graptolites, were. Stick-like things more resembling those lacy ice crystals on a windowpane than anything living today, these fossils had encouraged all manner of speculation as to their affinities. Hydroids, for instance (a reasonable guess) – though I particularly like the exotic suggestion that they were (if my memory serves me true) the stings of ancient stingrays (now those would have been exciting Silurian seas for a time-traveller to swim through). Then, along came Kozłowski to dissolve marvellously-preserved Polish specimens out of cherts, to make the link – quite correctly – with that obscure but fascinating group of those colonial, submarine animal-architects, the pterobranch hemichordates.

Well, that's the outline history. But the details in this book make the narrative considerably less linear. The history of Kozłowski's discovery – and of his whole life – was governed by chance, the kind of chance that operates in the kind of history where human lives are blown along like so many leaves in a gale. He made the most of his chances, mind, and lived – perhaps partly because of that pervasive history – as though he was in charge of history: not in general, but

[1] almost a decade in, one still automatically thinks 'this century's', although that is probably a measure of how long in the tooth one is.

[2] the Italians, never having saddled themselves with cricket nor Summer-long Ashes series, can be confident of good weather in its proper season.

more privately – of his own history, that is, and of that of those immediately around him. He certainly didn't set out, though, as a young man, to solve the graptolite mystery, any more than Fleming set out to discover an antibiotic, or Pasteur determined to manufacture a vaccine.

photo courtesy of Anna Kozlowska

Roman Kozłowski

He set out for Bolivia, instead. Not directly, perhaps (it is that kind of story), but as a glancing blow, as it were, from the turbulence of turn-of-the century central Europe. This is a history now rarely remembered, so overprinted it has been by the more dramatic – and more horrific – events that succeeded them. Poland was then – well, not a country, any more than is, say, Kurdistan today. It was a nation divided completely between Russia, Prussia and Austro-Hungary, having seen its fortunes decline – to nothing, at that stage, from a high point in the sixteenth century, when it was one of the great powers of Europe.

Divided, perhaps – but still a nation, nationalist sentiment expressed from abroad by Chopin, by the poet Mickiewicz, and by the novelist Sienkiewicz (best known in England – or rather dimly remembered, these days – as the author of the Roman-era saga *Quo Vadis*, but known to everyone in Poland for his novels set among the serial invasions of Poland of the 15th and 16th centuries, and the battles to repel the invading hordes: stories of the glory days, written deliberately to lift the spirits of the stateless people). For the Poles who stayed, there was day-to-day life under the ruling power (whichever it happened to be), punctuated now and then by protests or local trials of strength with the authorities.

Kozłowski was then a schoolboy in Włocławek, a town north of Warsaw. Teaching was in Russian – but in 1904 the pupils demanded to be taught in Polish. There was a stand-off between them and the school director, a Tsarist officer. There were demonstrations, marches; the pupils, including Kozłowski, went on strike. Eventually the striking pupils succeeded – up to a point. Polish schools were to be officially allowed – but were not to have any rights. Studies were resumed, but the atmosphere remained tense, with violence not far below the surface and sometimes breaking through – the head of police being shot dead in his own home the following year.

Kozłowski finished school and, then, to escape compulsory service in the Russian army, left for Paris, then Freiburg, then back to Paris, graduating from the Sorbonne in 1910, and then immediately starting studies with the palaeontologist Marcellin ('Sam') Boule[3] that was to culminate in his first paper – *Les fossils devoniens de Parana*. A near neighbour, then, was Marie Curie, while it was at the Sorbonne that he met his wife-to-be, Maria Szmit, a botanist. The career had begun, and the South American connection was to continue, in earnest. In 1912, he sailed for Bolivia (later joined by Maria), and was to live there until 1921. He thus lived out the First World War in relative peace (he was not to be so lucky with the second).

In Bolivia, Kozłowski showed two of the qualities that were to characterise him throughout his long life: a talent for organisation, and a slow care and attention to detail in science. He founded, organised and directed (and persuaded the Bolivian government to fund) the School of Mining Engineering in Oruro – the only school of its type in the country. It addressed a central concern of the country, for the tin mines (centred around Oruro) had bankrolled the country for the last couple of decades, taking advantage of the decline of Cornish tin. And it was in Oruro, at an altitude of 3,750 metres above sea level, that the son Witold came into the world.

The father's success as an organiser of practical teaching was undoubted (his fame lingers in the country still). But for the next couple of decades it was systematic palaeontology that predominated. He had amassed extensive collections in Bolivia, and studied them first at the Sorbonne (for his doctorate) and then later, on his return to a Poland that had regained its independence, where (eventually: the new country was short of funds) he obtained the newly-established Chair of Palaeontology at Warsaw University. At that time he worked on brachiopods, producing three monographs in the process (Kozłowski did not accrue as many publications as did some other palaeontologists, but the ones he did produce were not short of avoirdupois). His work was technically ingenious and meticulous, and labour-intensive too. He made serial sections to bring out the details of the internal structure, thermally shocked the material to loosen the shell material, acid-etched it to reveal further detail.

But then, that chance find of graptolites, preserved in cherts in the Holy Cross mountains, famously diverted his attention, and shaped a career. His colleague Jan Samsonowicz had shown him cherts of Tremadocian age that contained some brachiopods. Kozłowski collected some material, but it was only six months later that he stumbled upon the organic remains of the graptolites, while he was trying to excavate some brachiopods from these specimens. The tiny blackened organic scraps may not have looked very imposing, but he quickly recognised their significance, and set about studying them, using all the ingenuity he had shown with the brachiopods.

He dissolved them from the chert with hydrofluoric acid, a technique pioneered by Carl Wiman in Sweden around the turn of the century[4]. Kozłowski took Wiman's technique, and characteristically developed it on an almost industrial scale, pioneering the embedding of

[3] a renowned palaeoanthropologist who made an influential reconstruction of Neanderthal Man, interpreting this hominid as dull-witted, shambling and brutish, a view that inspired a thousand Hollywood cavemen. Alas, the main specimen of *Homo neanderthalensis*, from La Chapelle-aux-Saints, on which Boule based his view, turned out to be of an individual severely affected by rickets, arthritis and a jaw deformity. Happenstance, one might say, as a prelude to outright libel.

[4] when he wasn't studying fossil penguins, turtles or duck-billed dinosaurs: a versatile man, Wiman, and imaginative, too, as he was the first person to think of the hollow crests of the latter as sounding-boards, for the dinosaurs to sing their songs.

the delicate acid-extracted remains in paraffin wax, so that they could be sectioned with a microtome, and so treated just as one might do the remains of a modern, just-dead organism. And from there, of course, he amassed the evidence to show the world that the graptolites were not hydroids or stingray stings, but closely (there is still some discussion over quite how closely) related to the modern pterobranchs. The story, though, was delayed. It almost didn't see the light of day at all. Indeed, the odds at the very end were almost impossible. For the war was coming.

Life in those pre-war years was, if not idyllic, at least settled and peaceful for Kozłowski and his wife and his young family, including Witold, whose memories of that period are acute. Kozłowski was an organised and hardworking man. He rose early, did gymnastics, and was at his office by 6 a.m., to return by quarter to two. At two punctually was lunch, the main family meal. Then a short rest: and again to the office, returning at quarter to seven for supper at seven. He was also a family man – Sundays and holidays were entirely for the family – albeit strict and something of a disciplinarian of the old school (it was a serious thing for a child to be late for mealtimes).

Strict, perhaps, but the school was not so old, at that. Witold was a sensitive child (a trait which shows in the writing of his book); he loved animals to the extent that he simply did not want to eat them, and became a vegetarian. He also became an atheist. These were (and remain) unusual traits in Poland. His parents tolerated these characteristics, which was also a little unusual. Others did not. Children were quite as cruel in those golden pre-war years as they are today. Witold spent some time at a sanatorium, and his fellow playmates – once they found out that their little friend would not eat meat or join them in prayers – made life hell for him. They would leave pieces of meat in his bed or, showing particular refinement of imagination, dead frogs that they had filled with air with a straw. Distraught, Witold wrote to his parents. Roman Kozłowski reacted immediately. He travelled to the sanatorium, and made it clear to the carers there that respect should be shown for the views of others – even for those of a ten-year-old boy. Wonder of wonders, the bullying stopped.

Similar symbolism is used at the entrance of the true storm. In September 1939, Witold and his father were on holiday in northern Poland, kayaking and swimming. There was there a tame swallow that used to fly to them. Watching it one day, they saw it suddenly fall, dead, into the water, knocked out of the air by someone's slingshot. That was the start of the terrible memories. The air now included, too, enemy warplanes. Father and son returned to Warsaw as the Nazi army entered the country. This was a new reality. As the Polish army began their final, hopeless defence, Witold remembers his father – a man who cared for flowers and for order and cleanliness – running into the street with a knife to cut meat off a dead horse.

There was a chance to escape that reality. In the early days of the occupation – when the pattern of arrests, of the deportations to the concentration camps was already becoming clear – the Bolivian ambassador called on Kozłowski, offering him and his family safe passage to that country. Kozłowski thanked him for the offer, but turned it down. He felt he had to stay in Poland to help – and this is probably an inexact translation – the Polish scientific legacy endure.

During the war he was employed as curator at the local geological survey museum (renamed the Amt für Bodenforschung) in Warsaw. In truth, part of the legacy that Kozłowski had tried to build up was already smashed, as the observatory, with the geological collections (and with the

manuscript of his work on graptolites), had been destroyed by bombing in the last few days of the defence of Warsaw. Typically, he and his colleagues and family had then combed through the ruins to rescue what they could.

During this time, his fate was entwined with that of another famous palaeontologist. Roland Brinkmann had been given the job by the Nazi administration of directing the new institute. *Brinkmann?* I thought – he of that classic, painstaking study of Oxford Clay ammonites published in 1929, one of the most detailed stratigraphic and evolutionary studies ever undertaken (and, indeed, author of much more)? The very same, it turned out.

Brinkmann doesn't emerge as a sympathetic character: choleric, irascible, and generally thoroughly unpleasant in manner to the Polish scientists under his direction. Worse, he seemed to do little to prevent the arrest by the Gestapo (and subsequent murder by them) of a Jewish geologist, Ludwik Horwitz, employed at the Institute. Was he really so bad? A few years after Brinkmann's death, at the age of 97, Jerzy Głazek and Jerzy Znosko, two well-known Polish geologists, published an account (2003) of Brinkmann's life, focusing on those wartime years when his reputation was seemingly irreparably sullied. The reality – as ever – was more complex.

Brinkmann in fact was captured, a couple of years after the war, by the NKVD and sent to be tried for war crimes in Poland. He spent two years in jail there before being put before a tribunal. A death sentence, one might have thought, especially so soon after the war, when memories were still sharp and public sentiment was thoroughly anti-German. In fact, he was completely exonerated in the process, and returned to his career in Germany. How so?

Firstly, there was the context that he created. At the Institute, he provided employment for a good many Polish geologists, including Kozłowski. Some, indeed, he had released from Auschwitz to be employed there, somehow convincing the Gestapo that the work they could do (mapping out natural resources) was essential to the Third Reich.

Remarkably, also, there were no arrests at the Institute itself throughout his four-year tenure, despite the everyday risks of being picked up by the SS on the street. Brinkmann was aware of Polish underground activity there, carried out by Kozłowski among others (as an old man, he met Znosko at an IGC meeting, and told him he had been perfectly aware of what was going on, not least by informers who came to him, unasked), but turned a blind eye.

His unpleasant manner was partly for real (before the war he was known as a dedicated scientist, a veritable engine of work – and also for his grumbling, his severity with students and colleagues, and his sarcasm) and partly also, it seems, camouflage. He had a wife and six children to keep safe as well as himself, and his own actions also were observed, not least because he had lost his job in Germany a couple of years before the war for expressing anti-fascist opinions. Within his lights, it seems he had tried, with some success, to walk the tightrope between morality and self-preservation – and perhaps personal ambition too. At the tribunal, there were people, such as the former Institute librarian under his regime, Dr Regina Fleszarowa, who openly detested him as a person – but who nevertheless spoke in his defence.

The case of Ludwik Horwitz, too, was not straightforward. Brinkmann had given him not only a job at the Institute, but also lodgings there for him and his wife. Horwitz was a Polish Jew, and all too obviously looked like one. Out on the streets, he would be picked up sooner or later. In

the Institute, buried amongst the many employees, he had a chance if he kept his head down. He didn't. At a scientific meeting attended by prominent Nazis, he spoke up first in discussion. It was a suicidal action, drawing attention to himself. Thrown out of the Institute, the Gestapo soon picked him up. Could Brinkmann have saved him? According to one account he tried, but was sent away by the Gestapo with a flea in his ear; Horwitz had obviously already been shot. War, as General Sherman observed quite some time ago, is all hell.

In the strange parallel lives of those wartime years, Kozłowski looked after the collections as best as he could, and also took part in the underground university movement which, in secret and in considerable peril, tried to preserve 'normal' study and academic endeavour in those terribly abnormal times. There were other forms of resistance. Kozłowski and his colleagues hid the best specimens in the basement, so that only less important material was exported to the collections of the Third Reich. Witold organised secret concerts and poetry readings – a kind of salon of the underground.

Strange, perhaps, to consider that in times as hard as these, the priority was not simply the basics of human existence: food, water, physical security. Rather, lives were risked (and lost) to preserve what might be considered a luxury in happy and stable times – academic study, museum collections, the arts. It's the essence of humanity, perhaps, the keeping alive of a sense of a culture, a way of life, of what palaeontology (by way of specific instance) means in its widest sense, and what might be lost if it disappeared.

Some stability was kept in the war years. Most of Kozłowski's family survived, though not all (his other son, Jan, had a heart condition; the effort he put to trying to help keep the family fed brought on a fatal haemorrhage). The last throes of the war shattered that precarious stability. The family was caught up in the Warsaw uprising, the house destroyed, the family dispersed, Witold himself arrested once by the Nazis, but rescued – bought out – by a colleague. Eventually, though, the war ended. Reconstruction could begin.

After the war, Kozłowski could return to his studies, and finally publish his ground-breaking study, essentially completed before the war, that finally pinned down what those enigmatic graptolites essentially *were*. But it almost, almost didn't happen. If there are miracles in palaeontology, then this was one.

The story of how the work survived is related in a rather more linear fashion – and in English – in a dedication to Kozłowski published by two of his most gifted students, Zofia Kielan-Jaworowska and Adam Urbanek in 1978, the year following his death.

During the initial Nazi bombardment of Warsaw, Kozłowski had hidden the text and his original specimens in the observatory basement. The hiding place didn't survive the bombing and subsequent occupation. A month later, though, he found some of the pages among the ruins; a colleague found more later in a snowdrift. During the Warsaw uprising, he hid the text, again, in the central heating pipes of his house. The house was destroyed, yet the document somehow survived in its hiding place. He had sent negatives of the plates to Paris before the war and, retrieving these also, managed to reconstitute the entire manuscript and publish, eventually, in 1949.

In Witold's account, the post-war years are less revealing, more opaque – perhaps because the wartime experiences had been so acute. In Roman Kozłowski's life, the drive towards organisation rather than research seems to have taken the upper hand once more, perhaps because here was so much to rebuild (and perhaps because, once more, the world of science in Poland needed dedicated and organised advocates, when there were so many demands on the few resources that were then available). He returned to re-establishing the teaching of palaeontology at Warsaw University, using his pre-war contacts to acquire books and journals from around the world for the library, and re-building the collections (initially, once more, from those that could be retrieved from among the ruins). Of the politics of those days – especially of the Stalinist times of the early 1950s – there is little. Perhaps there had been enough of hardship in the account.

Perhaps, simply, we should be grateful that so much was preserved, despite the odds. And, that the science continues, as new generations develop the science. We might hope that the vicissitudes of the future world will be less testing for those generations (for vicissitudes there are bound to be: who among us would like to bet on the rest of this century being placid and trouble-free?). Maybe the search for the past, though, with such past form, really will be never-ending.

Jan Zalasiewicz

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PalaeoMath 101
Form & Shape Models

There's no getting around it. Some of the material covered in the last two columns was difficult. If you're feeling a bit lost at the moment it's perfectly understandable. But don't despair. The more you use *Procrustes* superposition and *Procrustes* principal component analysis (PCA), the more familiar it will become. More importantly, the easier it will be to design analyses and interpret the results. So, to give you a bit of a break before we dive into the *really* hard stuff we're going to spend this column equipping you with a conceptually simple but highly useful tool that, when applied correctly, will amaze your friends and make it much easier for you to interpret the results of a *Procrustes* PCA analysis. In addition, gaining an understanding of this tool will serve to illustrate how much of a practical advance geometric morphometrics is over the older

multivariate morphometric approach, as well as illustrating important aspects of the conceptual roots of multivariate data analysis in general and geometric morphometrics in particular. All this will be yours once you understand heuristic PCA models.

Recall that PCA is really a form of multivariate linear regression through a space defined by the original measurements (= variables) taken or observations made on the sample. The number of regression lines produced by PCA is equal to the number of variables or number of specimens present in the dataset, whichever is smaller. These regression lines are aligned with the major dimensions of covariation among the variables, with the constraint that they are (normally) oriented at right angles to each other. As such, PCA lines can be used to construct an alternative data display space within which similarity relations among the objects comprising the sample can be visualized. These visualizations can then be used to test hypotheses about the nature of the observed variation. In effect, this means that the PCA space is a simple rotation and shearing of the space formed by the original variable axes (Fig. 1). If the covariance matrix is used as the basis for the PCA the original scaling relations among the variables is preserved (Fig. 1B). If the correlation matrix is used, the original variables scaling relations are standardized so that each variable contributes an equal amount of variance to the result. This means the ordination space of a correlation-based PCA has, in addition to being rotated and sheared with respect to the original variable space, also been compressed or expanded in certain dimensions (Fig. 1C).

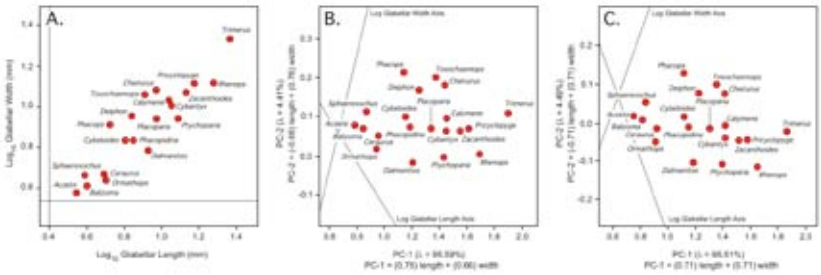


Figure 1. Comparison of raw (A) and PCA-transformed plots of the trilobite glabellar length and width data for covariance-based (B) and correlation-based (C) solutions. The thin horizontal and vertical lines in (A) represent the traces of morphometric axes in the space of the original variables whose transformed orientation is shown in the PCA score scatterplots. These provide an indication of how the transformed PCA spaces differ from the space of the original variables. Note that the angle between these original-variable axis lines in B and C has been artificially accentuated due to differences in the scaling of the PC-1 and PC-2 axes. See text for discussion.

Comparing the scatterplots of the PCA scores in figures 1B and 1C to the raw data in Figure 1A, it's easy to see the regression-like nature of PCA. The equations of the PC axes relate the original variables to the new PC axes and are used to project the original data points into the PC ordination space. If you understand the PCA procedure you already know these same equations can be used to project any combination of values for the variables analyzed into the PCA space. But what isn't as widely appreciated as it should be is that these same equations can also be used to solve the inverse problem of projecting coordinates from the PC ordination back into the space of the original variables.

At this point you're probably saying, 'OK, so you can use the PC axis equations to go both ways. I understand why I want to get my data into the PC ordination space. But I don't quite see why I'd ever want to return to the space of the original variables. After all, the PC ordination space is a better space in which to represent and study relations between the objects in the sample, right?' The answer to this question is, for the most part, yes; but there are some aspects of the variation problem that are more naturally and compellingly assessed in the space of the original variables. The most important of these aspects is the interpretation of the PC axes and the PC ordination space itself.

In order to illustrate the problem let's take a close look at the PCA solution for the simple, trilobite glabellar dataset illustrated in Figure 1: two variables, both $\log_{10}$-transformed. For this discussion we'll focus on the covariance-based result (Fig. 1B) as there's no obvious reason why we would not wish to take differences in the scaling of the variables into consideration. By log-transforming the variables we've already put them into a form in which differences between the variables' scales have been minimized in a way that still allows us to recover the original scalings any time we wish.

The equations of these axes are as follows.

$$\mathrm{PC1} = 0.755\, x_1 + 0.655\, x_2 \qquad (18.1)$$

$$\mathrm{PC2} = -\,0.655\, x_1 + 0.755\, x_2 \qquad (18.2)$$

In these expressions x_1 refers to $\log_{10}$ glabellar length and x_2 refers to $\log_{10}$ glabellar width.

The loading coefficients shown in equations 18.1 and 18.2 form the matrix we use to calculate the scores of the original variables in the new covariance-optimized PC space. A quick inspection of the ordination we achieved for these data (Fig. 1B) indicates that a variety of interesting sub-groupings appear to exist, at least for the individuals included in our trilobite dataset. Along the PC-1 axis (which represents over 95% of the form variance[1] in our sample) three subgroups seem to be present. *Acaste*, *Balizoma*, *Ceraurus*, and *Sphaerexochus* appear to form a unified group at the low end of the axis, *Trimerus* appears to be an outlier at the high end, and the remaining genera form a complex group in between. Along the PC-2 axis, *Dalmanites*, *Ptychoparia* and *Rhenops* form a subgroup at the low end, *Cheirurus*, *Deiphon*, *Phacops* and *Toxochasmops* form a group at the high end, and the remaining genera form another complex group in between. Taken together, it appears as though glabellar variation in our sample is organized into five broad categories or classes, as shown in Figure 2.

[1] Form is represented in a morphometric dataset when size information is embedded in the data. Raw inter-landmark distances and non-superposed landmark coordinate datasets express form. Shape is the information remaining in a dataset once variation due to differences in object position, rotation and size has been standardized, usually through *Procrustes* superposition.

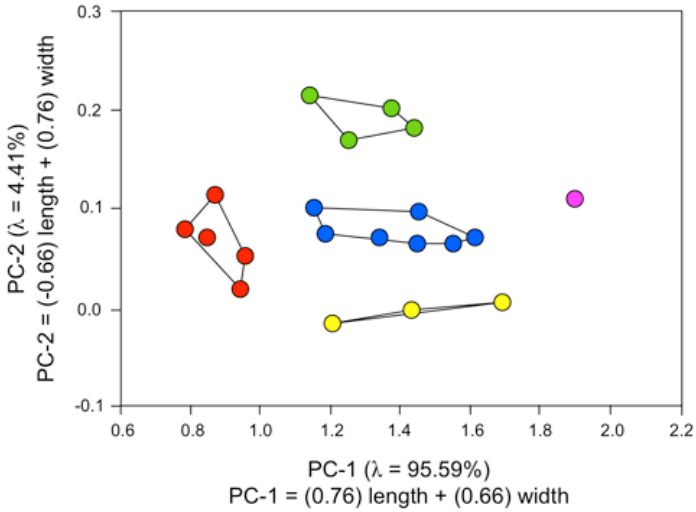


Figure 2. Covariance-based PCA of the $\log_{10}$*-transformed trilobite glabellar data with apparent form groups labelled by symbol colour.*

Whether these individuals are truly representative of their genera, and whether these groups would remain if more individuals were included in the sample, is doubtful. But that's not the point I'm after with this example. Let's simply accept these provisional geometric subdivisions for the sake of argument.

If all we want to do is get a quick and dirty answer to the question of whether glabellar form is distributed continuously or discontinuously in our sample we could conceivably stop here. The answer is clearly the latter. But that answer more-or less begs the further question 'What does glabellar variation in the sample look like?'. I would like to think any competent data analyst would be as interested in providing an answer to this further question as they are in answering the original variation-mode question. But when we try to interpret even this simple PCA space we run into problems.

In terms of the standard approach to PCA analysis, the only information we have about the character of variation in this PC space are equations 18.1 and 18.2. Even though there are only two numbers to keep track of per axis it's surprisingly difficult to construct a comprehensive and accurate picture of what the glabella of these groupings looks like—much less confirming that the result is a reasonable summary of reality—just by staring at them. What we can say is that variation along PC-1 is strongly size controlled, with a subtle component of relative elongation as one moves up the PC-1 axis. Along PC-2 the glabellar groups change from being relatively long and narrow (the *Dalmanites*, *Ptychoparia* and *Rhenops* group) to short and wide (the *Cheirurus*, *Deiphon*, *Phacops* and *Toxochasmops* group). But note that the amount of form variation expressed by PC-2 is so small relative to that expressed by PC-1 that it's uncertain whether we would expect this pattern to be noticeable to the taxonomist's eye just from the information provided by these numbers. What's missing in the number-comparison approach,

of course, is any good way of getting at the inherent geometry of the system. This missing bit isn't just annoying. It severely constrains our ability to interpret the results of even this simple PCA analysis in a way that's biologically meaningful, either to ourselves in the context of our investigations or to others in the context of communicating the hard-won results of our analysis.

At this point most morphometricians would launch into a discussion of geometric morphometrics and wax eloquent about the advantages of working with landmark coordinates. I've already done that over the last few columns and I hope you've come to appreciate the power of using the sorts of graphic representations of form and shape variation we've generated up to this point. But the fact is, none of the superposition tools or shape-coordinate plots we've seen up to now help us much with the problem of interpreting the ordination space that results from a PCA analysis regardless of whether that analysis is performed on linear distances as I've done in the example above or on *Procrustes* superimposed shape coordinates. Indeed, if anything the problem gets worse for shape-coordinate datasets because the number of variables needed to represent distances between landmarks in shape coordinates is up to four times larger than the number of variables needed to quantify the same distances in a multivariate morphometric dataset. To keep things simple I'm going to stick with the glabellar distance data to develop the mathematical concepts we need to translate equations 18.1 and 18.2 into pictures we can inspect and compare, just as we'd inspect and compare pictures of organisms. Then I'll apply these same concepts to a landmark dataset to show how this technique improves our ability to take advantage of the more geometry-rich information recorded by landmarks in a *Procrustes* PCA analysis.

The basic tool we need is a way of solving the inverse projection problem: taking coordinate values in the PCA space and projecting them back into the space defined by the original variables. It's actually easier than you might suspect. Expressed in matrix notation the equation we use to calculate the PC scores (S) is:

$$S = XU \tag{18.3}$$

where X is the original data matrix of distances or landmark coordinates (in our example the 20 objects by two variables [= glabellar measurements] matrix of raw data each of which has been $\log_{10}$-transformed), and U is the 2 x 2 matrix of eigenvector coefficients (see equations 18.1 and 18.2). In order to perform the back-transform, all we need do is pre-multiply the matrix of PC scores (S) by the inverse of the eigenvector matrix (U^{-1}).[2]

$$X = SU^{-1} \tag{18.4}$$

Of course, in our trilobite glabella example once the back-transformation calculation has been made the original data will be expressed as $\log_{10}$ values of the original measurements. The original scale of the distances can be recovered by sequentially raising 10 to the power of corresponding values in the *X* matrix. If we perform this operation correctly for the matrix of PC scores we should end up with the values of our original data. I know that's not too interesting. However, the magic comes when we realize that we can use the same matrix arithmetic operation to calculate the hypothetical 'raw data' values for any coordinate position in the PCA space.

[2] See the PalaeoMath 101-2 spreadsheet for complete details of these calculations.

In other words, all the possible coordinate positions in the PC space correspond to hypothetical or theoretical objects in the sense that there is a complete, one-to-one mapping between the original variable space and the PC space. Our set of observed data points is simply a subset of an infinite mathematical universe of all geometrically possible objects occurring in the space that we happen to have found and measured. The U matrix is the door that allows us to travel from the original variable space into the PC space. Similarly, the U^{-1} matrix is the door that allows us to travel in the opposite direction. Most data analysts know how to use the U matrix door. But they've either forgotten, or were never taught, about the other door. Consequently, if there are any interesting coordinate locations in the PCA space, we don't have to simply stare at them, scratch our heads and try to figure out what they might represent by looking at observed points that may—or may not—plot in the vicinity of those we're interested in. We can take any point in the PCA space and create a geometric picture of the hypothetical object that exists at that location.

Let's take an obvious example, the accuracy of which can be checked independently. Each of the groups shown in Figure 2 has an average PC-1 and PC-2 score that can be plotted as a specific coordinate position in the PC space. We can calculate this set of group-averaged PC scores, back-transform these coordinate locations into the space of the original length and width variables, then compare those estimated values to the group means calculated directly from the raw data. The *PalaeoMath 101-2* spreadsheet details all these calculations. There is, with the exception of rounding error, perfect agreement between the average values calculated from the raw data and those estimated from the back-transformed group-average coordinates in the PC space. But once we have these values we can also create a direct graphic representation of the form of the glabellas for each group by drawing an ellipse with the specified mean length and width dimensions. Figure 3 shows the reconstructed gross glabellar form based on these group mean glabellar lengths and widths.

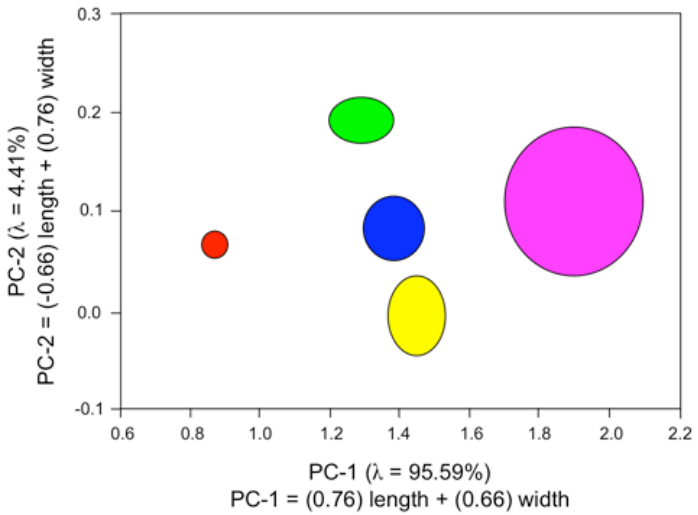


Figure 3. Reconstructed group-mean trilobite glabellar forms based on length and width measurements. Symbol colour codes as in Figure 2. See text for group membership.

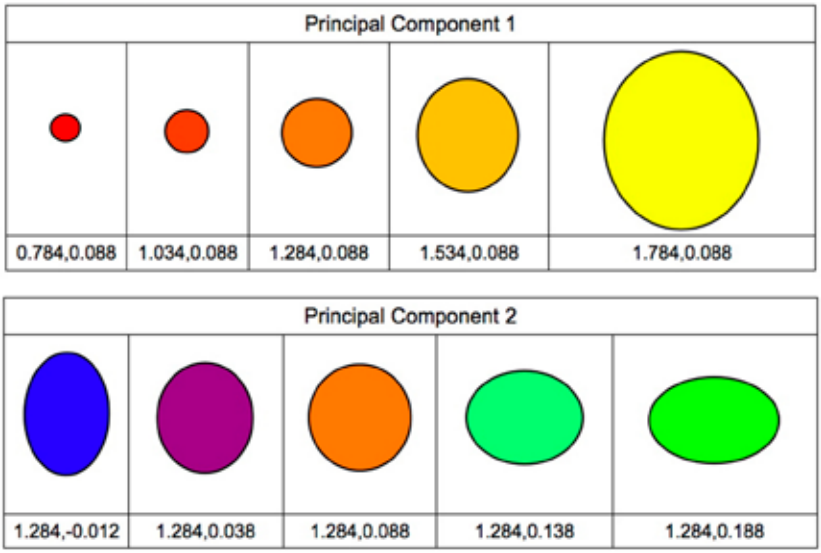
Now we can see images of the hypothetical forms lying at the group centroid locations. As a result, the differences between groups have been made clear. The glabellas of the groups arrayed along the PC-1 axis (red, green-blue-yellow, magenta) are distinguished primarily by size. This is, of course, signalled by the fact that both the PC-1 eigenvector coefficients are positive. But the value of the reconstructions is that now both analysts and readers are provided with a direct visual impression as to the magnitude of the size differences. Similarly, the glabellas of the groups arrayed along the PC-2 axis (yellow, red-blue-magenta, green) are distinguished primarily by shape. The glabellar width is much shorter than its length for the yellow group, subequal to the length for the red-blue-magenta group, and much longer than the length for the green group. This agrees with our gross interpretation of equations 18.1 and 18.2. But for those not used to interpreting such data geometrically, getting a sense of the form/shape lying behind the numbers is very difficult. By using this simple back-transformation method a direct and perfectly accurate visual representation of the geometric meaning of these equations can be created. These simple mathematical models of the underlying geometry can now be used to guide interpretation and facilitate communication in a manner much more accessible to most palaeontologists than visual inspection of the matrix equations themselves.

Since we've developed the method and proved it works, let's use it to explore this simple PC space. One common challenge in interpreting PC ordinations is getting an accurate and complete understanding of exactly what the PC axes represent. Note that while the models we constructed for the group means are approximately aligned with the PC axes, they are not precisely aligned with them. There is also a question about which axes we're talking about. Since the space occupied by the glabellar data in the PC space is far away from the origin of the coordinate system it makes little sense to model forms/shapes along the system axes *sensu stricto*. Rather, what we really want to know is what shape variation in the direction of the PC axes, but within the region of the theoretical form space occupied by our data, looks like. This effectively focuses our exploration on the region containing the mean form in a manner wholly consistent with geometric morphometric conventions.

Table 1 shows the coordinate values and associated form models along glabellar form PC-1 and PC-2 centred on the mean form (coordinates: 1.284, 0.088).

As with the group mean models, there is no information in Table 1 that is not present in Figure 2. But in terms of accessing the information present in that figure to make valid biological interpretations of the PCA result it is difficult to think of a more useful technique than the calculation, plotting, inspection and comparison of heuristic form/shape models. In this example note the particular clarity with which the dual nature of PC-1 has been shown. The standard (but for the most part erroneous) interpretation of the first principal component of a set of distance data is that it represents size. The form models calculated for this axis do differ in size, with small glabellas projecting low on the axis and large glabellas projecting high. But in addition to this there is a distinct pattern of size-independent glabellar shape variation that is also being expressed along PC-1. For this dataset small glabellas exhibit a slight but noticeable tendency for the glabellar width to be greater than the glabellar length, whereas large glabella exhibit the opposite relative length-width relation. Although the difference in the rates of change in glabellar length and width along PC-1 are clear in equation 18.1, the shape-state of the space occupied by the sample cannot be inferred from the information in equations 18.1

Table 1. Form models for the glabellar principal component axes. Coordinates (= PC scores) used to construct the model are given below each graphic.



and 18.2 alone, which is all most analysts are taught to use in making an interpretation of PCA axes. By translating selected locations within the PC coordinate space back into their equivalents within the original variable space, and then using those reconstructed values to devise a graphic representation of the distribution of (hypothetical) shapes in the space, a much more complete and meaningful interpretation of the set of abstract PC axes can be made quickly, easily, and in a manner that invites further exploration. As shown in Figure 4, any location along any trajectory through the PC space can be represented by a theoretical model of form (or shape) and used to interpret the PCA result. Moreover, this general approach can be applied to any eigenanalysis-based data analysis technique (*e.g.*, factor analysis, principal coordinates analysis, canonical variates analysis, partial least-squares analysis, *etc.*).

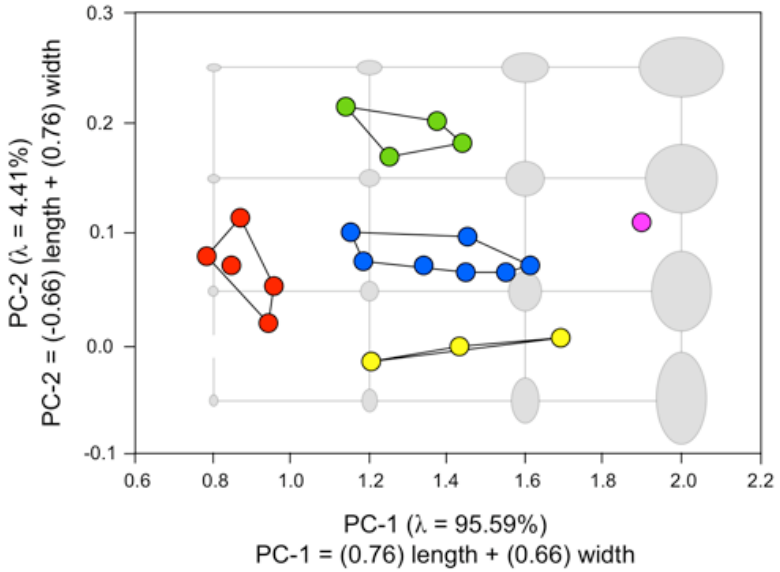


Figure 4. Distribution of trilobite glabellar forms within the space of the two principal component (PC) axes superimposed over a set of heuristic form models illustrating the underlying geometry being expressed by the PC ordination space.

I've purposefully introduced the concept of heuristic shape modelling using a simple dataset of inter-semilandmark distances to show that such an approach can be applied to any dataset susceptible to PCA analysis. This is contrary to the published assertions of many adherents to the geometric morphometric paradigm, who often imply that only landmark data can be modelled in ways that inform biological interpretations. As a matter of fact there is an extensive and somewhat neglected literature on the graphic representation of multivariate data analysis results (see Everitt 1978, Tufte 1983, Cleveland 1985, Myatt & Johnson 2009). Curiously though, I've yet to come across the straightforward and computationally compact back-transformation method for modelling multivariate results I've described above.

Naturally, model-based approaches are relatively easy to devise for structures whose shape is regular—at least in gross aspect—and lends itself to characterization by simple geometric forms or form descriptors. With a little creativity though, even datasets composed of variables that have no geometric relation to one another can often benefit from the model-based approach. This point having been made, the data types that have come to be associated with geometric morphometrics are, perhaps uniquely, well-suited to this modelling approach. As a last example I'll apply the back-transformation method to a trilobite cranidial landmark dataset (Fig. 5) to show how this procedure can be applied in the context of a *Procrustes* PCA analysis.

Only 18 of the 20 trilobite images could be used for the cranidial analysis as two genera lack the eyes necessary for location of landmarks 3 and 9. *Procrustes* superimposition of these ten landmarks across the specimens representing these 18 genera, along with the sample mean shape, is shown in Figure 6.

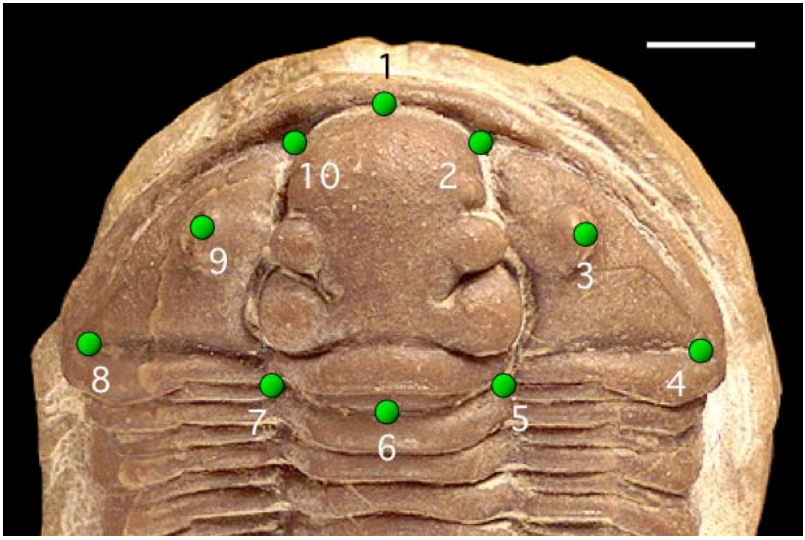


Figure 5. Landmarks used to quantify shape variation in the trilobite cranidium. Scale bar = 7.87 mm. 1: anterior glabellar mid-line terminus. 2,10: intersections of the lateral anterior glabellar margin with the pre-glabellar field. 3,9: eye centroids. 4,9: latero-posterior librigenal margins. 5,7: posterior lateral glabellar termini. 6: posterior glabellar mid-line terminus.

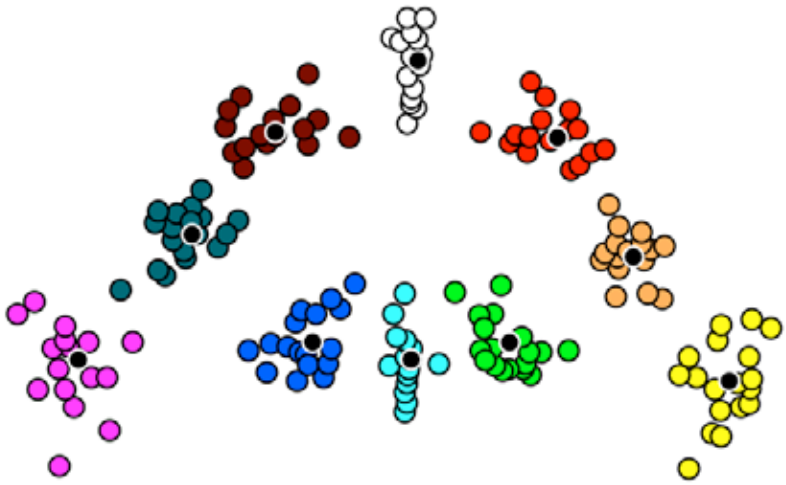


Figure 6. Procrustes *superposition of ten cranidial landmarks (see Fig. 5) for 18 specimens. Black symbols mark position of mean shape landmark coordinates.*

A *Procrustes* PCA analysis of these shape coordinate data yields 17 eigenvectors with non-zero lengths. This result is consistent with expectations of the removal of translation, scale and rotation information from the raw landmark coordinate values. Of this shape-vector set, the first three vectors represent more than 75 percent of the observed shape variation. The distribution of the 18 trilobite specimens within the ordination space formed by these three shape axes is shown in Figure 7.

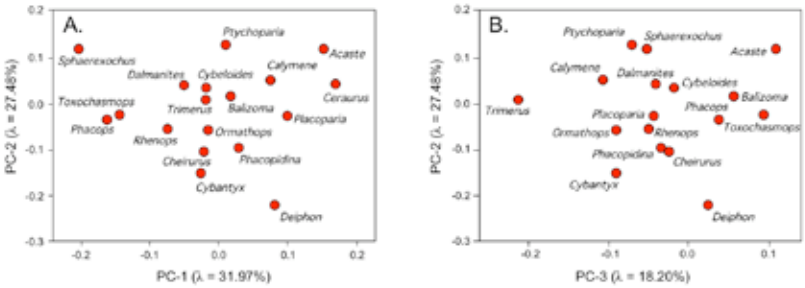


Figure 7. Comparison of shape similarity–dissimilarity patterns among landmark data collected from the sample of 18 trilobite genera in the ordination space formed by the first three Procrustes *principal components. Together these components express 77.66% of the observed shape variation. Note that the arrangement of plot axes facilitates visualization of the distribution in a three-dimensional space.*

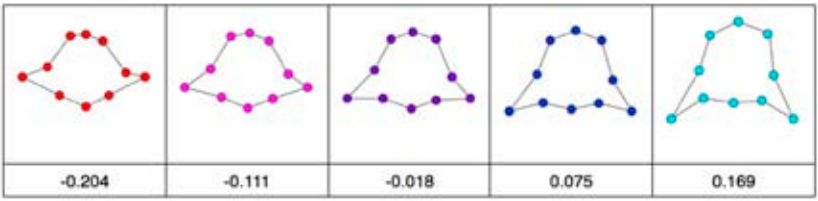
Unlike the previous glabellar form analysis, there are no obvious subsidiary groupings of taxa within the cranidial data used to construct this PCA ordination space. Therefore, it makes no sense to calculate shape models for arbitrary groupings of genera. But there is always a need to gain a detailed geometric understanding of the character of the shape space itself. Visual inspection of the table of shape coordinate loadings on these principal components is an option. This information is provided in Table 2.

Table 2. Variable (= shape coordinate) loadings for the three Procrustes PC axes shown in Fig. 7.

Shape Coordinate	PC-1	PC-2	PC-3	Shape Coordinate	PC-1	PC-2	PC-3
x_1	0.038	-0.030	-0.018	x_6	-0.047	0.036	0.015
y_1	0.247	0.312	0.153	y_6	0.299	0.031	-0.277
x_2	0.191	0.396	-0.259	x_7	-0.031	-0.169	-0.305
y_2	0.129	-0.222	0.290	y_7	0.144	-0.229	-0.328
x_3	-0.153	-0.004	-0.110	x_8	0.168	0.368	0.105
y_3	0.082	0.008	0.097	y_8	-0.562	0.265	-0.060
x_4	-0.187	-0.188	-0.185	x_9	0.161	-0.099	0.279
y_4	-0.548	0.134	0.006	y_9	0.057	-0.010	0.116
x_5	-0.014	0.201	0.287	x_{10}	-0.126	-0.511	0.192
y_5	0.124	-0.158	-0.363	y_{10}	0.029	-0.131	0.367

Taking the first cranidial principal component as an example of how such an inspection-based interpretation would be undertaken, note that the maximum positive and negative loading coefficients on the PC-1 axis are associated with variables y_6 and y_8 respectively, with variables y_1 and y_4 also exhibiting notably high and low values. This suggests that, as one moves along PC-1 from left to right, the glabella of the cranidia migrates to a more anterior position relative to the lateral cranidial margins which, relative to the glabella, migrate to more posterior positions. While this interpretation is clear and relatively easy to determine for an experienced analyst, it still only provides an understanding of how these two regions of the cranidium are changing position relative to one another. It would be considerably more difficult to arrive at—much less describe in words—the full set of relative changes in the location of each landmark in the x and y directions as the position along the *Procrustes* PC-1 axis is changed. Compare this rather daunting task to the level of geometric insight into the geometry of PC-1 provided via calculation of heuristic models for a set of regularly-spaced positions along that axis (Table 3).

Table 3. Heuristic trilobite landmark shape models for the first principal component of the trilobite cranidial landmark data. Values of the PC-1 coordinate used to construct the model are shown below each model graphic.



These models confirm the previous shape transformation interpretations gained through visual inspection of the principal component loading values (Table 2), and also extend these interpretations in a manner that is both natural and intuitive. Using this model set, and without having to inspect any table of numbers or search for high and low values, it can be readily appreciated that PC-1 incorporates a moderately strong component of cranidial narrowing in addition to lengthening, and that this narrowing is confined to the middle region of the cranidial structure (the eye landmarks 3 & 9).

Visualization of further, and even more subtle, contrasts between these models can be seen if one overlays them in a single system such that each landmark position forms a displacement track as the position along PC-1 changes (Fig. 8).

Pat Lohmann, who first developed the overlay modelling display technique for the interpretation of PC axes, referred to them informally as 'strobe plots'. Colour coding the landmarks associated with each strobe plot based on axis position allows the polarity of each landmark's displacement to be assessed. Also, joining landmarks located on or close to the outline together with straight lines provides a sense of shape change in the overall structure.

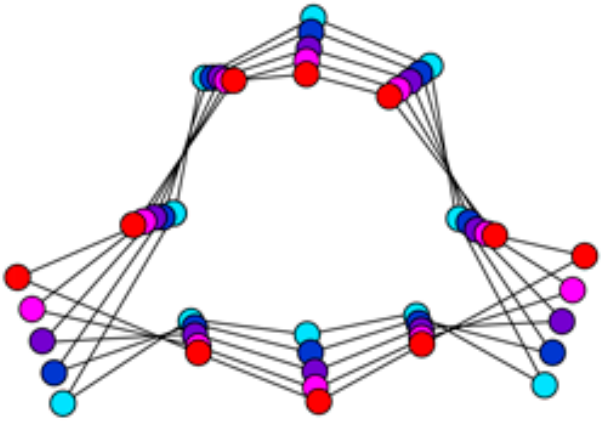
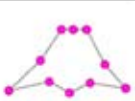
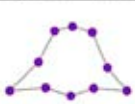
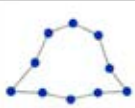
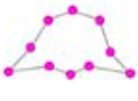
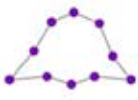
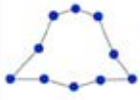
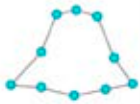
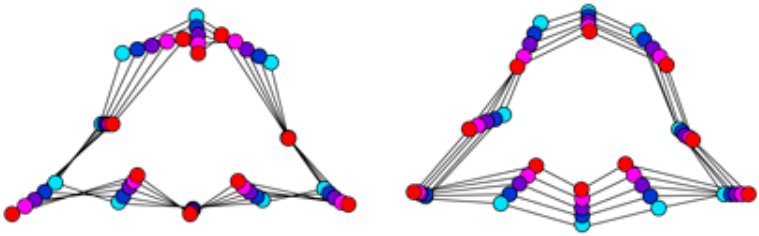


Figure 8. Overlay (or strobe) plot of the heuristic PC-1 shape models shown in Table 2. Landmark position symbol colours denote location of the model along the PC-1 axis (as in Table 3). See text for discussion.

Use of these strobe plots allows complete freedom for the analyst to focus on changes in a particular landmark in isolation from all others, on changes in landmarks defining or located in a particular region, or on changes in the entire landmark ensemble—whatever is needed to understand those aspects of shape variation present in the sample relevant to the particular systematic or biological question(s) at hand. Finally, for completeness, shape model sequences and strobe plots for the trilobite cranidial PC-2 and PC-3 (Fig. 7) are provided in Table 4 and Figure 8. The geometric interpretation of these axes is left as an exercise for the reader.

Table 4. Heuristic trilobite landmark shape models for axes PC-2 and PC-3. Modelled coordinates shown below each model.

Principal Component 2				
				
-0.218	-0.131	-0.045	0.041	0.128
Principal Component 3				
				
-0.213	-0.133	-0.053	0.027	0.107



Principal Component 2 Principal Component 3

Figure 9. Overlay (or strobe) plots of the heuristic shape models shown in Table 4.

As this procedure for constructing form/shape models is, for some reason that's totally inexplicable to me, not used routinely in multivariate data analysis, essentially no options in any of the standard software packages are available to implement it. Fortunately, the computations involved are so simple they can be performed by anyone with access to MS-Excel and the eigenvector loading matrices that are the basis for the back-transformation procedure. The procedure can also be implemented in any of the standard mathematics software systems (*e.g.*, Mathematica, MATLAB, Maple, R) where they can be executed with a single line of macro-language code. Indeed, production of colour-labelled graphics to express the results of such calculations is a far more challenging programming problem than implementation of the mathematics that stand behind this simple, but eminently useful, data-analysis tool.

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

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

Meeting REPORTS

14th International Symposium on Dental Morphology
Greifswald, Germany *27 – 30 August 2008*

The International Symposium on Dental Morphology is a meeting that, as one might expect, hosts research on dental anatomy. It takes place every three years usually at a European Institution. The first was held in 1965 by P. O. Pederson, V. Alexandersen, B. Kraus, and A. A. Dahlberg in Fredensborg, Denmark (Orland, 1965; Dean, 2009).

The 14th meeting was hosted by the Department of Anatomy and Cell Biology at the Ernst Moritz Arndt University in Greifswald, Germany. This University is one of the oldest in Europe, established circa 1450, when the town itself was part of Sweden (it only became part of Germany in 1815). Previously the overall perspective of this conference has been clinical, with any evolutionary themed talks generally limited to humans and other primates. However, at this year's conference there was clearly an active drive to increase the discussion of evolution and broaden the range of phylogenetic groups represented. The composition of the attendance was also diverse, comprising over 150 people from more than 25 countries (Figure 1). As well as providing a very impressive line-up of keynote speakers, it featured presentations of imaging techniques and statistical methods that could be applied in non-dental research.

Figure 1. The conference group photo.

The organisers, Thomas Koppe, Kurt W. Alt and Georg Meyer, not only brought together researchers from around the world to present and discuss their cutting-edge work on many aspects of dental morphology of primates and other vertebrates, they also provided many opportunities for informal discussion during social events and excursions. Each participant was provided with an attractive and useful booklet outlining the conference programme with abstracts from each of the presentations (Koppe *et al.*, 2008).

Their choice of refreshments was as impressive as that of the International Congress for Vertebrate Morphology which took place in Paris the previous Summer (no mean feat). Moreover, the fruit, cake, sandwiches and selection of drinks were often available outside the already generous set of

breaks between talk sessions and rivalled that in any of Europe's best cafes. The zoology collection on display just a flight of stairs away from the refreshments is equally impressive and provided either an excellent distraction or an added attraction to and from the world of teeth (Figure 2).

Figure 2. A small part of the impressive Ernst Moritz Arndt Zoology collection.

The talks were grouped into six sessions according to topic, each session starting with one keynote lecture and two invited lecturers. The lecture theatre appeared to have been constructed in order to allow dentistry demonstration and as a result the seating was so steep that it sometimes really did feel like we "were standing on the shoulders of giants" (Figure 3).

Figure 3. The lecture theatre in the Department of Anatomy and Cell Biology at the Ernst Moritz Arndt University in Greifswald, Germany.

The first day began with **Holly Smith** who spoke about the lives of three recently deceased colleagues (Daris R. Swindler, Stanley M. Garn and Coenraad F.A. Moorrees), all of whom had made a substantial contribution to the understanding of human and primate tooth biology. The first session was titled 'dental evolution' and contained several talks directly related to palaeontology. **Ottmar Kullmer** started with an overview of the evolution of teeth with an emphasis on mammalian dentition and function inferred from wear facets. He suggested a link between angiosperm radiation and diversification of some tooth types. **Thomas Martin** demonstrated that tribosphenic-like teeth have evolved at least

three times independently (docodonts, multituberculates and docodonts), and that early mammals were much more diverse than previously assumed. **Laurent Viriot** showed that the house mouse does possess anterior cheek teeth during early development, but that most of these are resorbed soon afterwards with the remainder contributing to posterior cheek teeth. **Meredith Moya Smith** used computed tomography (CT) to investigate the sequence of mineralised cusp development in a developing catshark (Scyliorhinidae) and used this as an outgroup for comparison with other gnathostomes. **Marc Jones** described the surprising degree of tooth diversity present in the Rhynchocephalia (*Sphenodon* and its fossil relatives), and used geometric morphometrics to quantify its correspondence with skull shape. **Lazzari Vincent** presented work using microwear and sophisticated topographic measurements that indicated complex chewing had been achieved within muroid rodents independently and in three different ways. **Wendy Dirks** showed that two 'condylarths' (archaic ungulates) possessed differences in enamel formation that indicated substantial differences in life history. She then asked whether this new data could resolve current phylogenetic and taxonomic disputes in this part of the mammalian tree. Using CT data **Kornelius Kupczik** tested the relationship between the proportional volume of different tooth components (enamel, dentine, pulp) and mandible dimensions in anthropoid primates. The degree of enamel contribution was found to be indicative of mandible robusticity. **Ling Zhao** described teeth from the large-bodied hominoids of southern China. The Late Miocene *Lufengpithecus* was found to share similarities in life history to extant non-human hominoids ('great apes') but also exhibited evidence of stress that may be associated with a monsoonal climate. The teeth of the Pleistocene *Gigantopithecus* were found to be different in terms of enamel prism pattern but exhibited a high incidence of caries (areas of decay) that perhaps suggest a carbohydrate-rich diet. A particularly impressive study was presented by **Bill Hylander** who had amassed data from over 600 anaesthetised primates regarding canine height, gape and sex. This elegantly showed that reduction in canine size is linked to a reduction in gape which in turn permits greater bite forces without requiring larger jaw muscles. **Paul Tafforeau** presented a computer model of jaws from the Thai Eocene primate *Siamopithecus eocaenus* constructed from scanned fossil material using X-ray synchrotron microtomography. This was used to demonstrate the types of masticatory movements possible and showed that their enamel structure was more compatible with a folivorous diet than one focusing on seeds.

The afternoon session titled 'dental morphology' again contained several talks of wide interest. Keynote speaker **Callum Ross** presented a wealth of data regarding jaw movements in primates and lepidosaurs, which suggested that they are modulated in response to differences in food material properties. Callum argued that the periodontal ligament and associated gamma afferent axons found in mammals may allow greater control and precision compared to other taxa. **Peter Ungar** reviewed the new techniques for molar topographic analysis and microwear texture analysis in primates, and discussed how the two methods can be combined to tell us how often a taxon is feeding on material that it is adapted to feed on. **Peter Lucas** discussed the mechanical principles of tooth form as a function of diet, in particular the different types of crack that can occur in a tooth and how enamel thickness, enamel structure and topographic features such as the cingulum in mammals can prevent these. Using a unique double guillotine device **Phil Anderson** tested the cutting ability of different blade arrangements. This work showed that notched blades (which have evolved independently in a number of different groups) considerably reduce the amount of energy required to fracture food items. **Netta Lev-Tov Chattah** used Electronic Speckle Pattern

Interferometry to map surface deformations in complex surfaces such as teeth when loaded. This work showed that tooth crowns bend toward the direction of the applied load and that to some extent this movement can be accommodated by the tooth socket. **Una Strand Viðarsdóttir** used geometric morphometric data of teeth from the Pacific rat (*Rattus exulans*) to examine the patterns of human dispersal in South East Asia and Oceania. **Heather Edgar**'s presentation evaluated the usefulness of morphological dental traits in assigning race to forensic cases. She concluded that whereas particular traits, such as shovel-shaped incisors, often indicate an Asian ancestry, they cannot be used with enough certainty to be useful in forensic case work.

Using electromyographic data **Alfred Crompton** showed that there is considerable variation in jaw movement and muscle activation patterns between different Australian herbivorous marsupials which can be related to tooth arrangement. **Mark Purnell** demonstrated how tooth microwear data can be used as a proxy for direct observation of feeding in non-mammalian vertebrates. His examples included work on sticklebacks, cichlids, pycnodont fishes, and ornithopod dinosaurs. **Wighart von Koenigswald** showed that mastication patterns in rodents and rabbits (lagomorphs) are more complicated than generally appreciated and do not correspond well to descriptive terms previously used such as propalinal.

The morning of the second day comprised the session 'dental tissues'. This began with a keynote lecture from **Christopher Dean** who gave a historical account of dental tissue science and terminology as well as showing the potential of dental tissue for reconstructing life history traits in palaeoanthropology. **Tom Diekwisch** followed with an animated talk about enamel development and apatite structure; this included a preliminary report on the differences between the enamel of frogs and mammals. **Daniela Kalthoff** presented an interesting paper on tooth microstructure in fossil and recent sloth (Mammalia, Folivora). Other talks from this session covered a range of topics from tooth development to enamel thickness in primates.

'Dental growth and development' was the subject of the afternoon session on the second day. **Tanya Smith** gave a thought-provoking keynote lecture on life and death in juvenile hominins from the Middle Paleolithic, in which she discussed their life histories and when the modern pattern of growth may have emerged. She also explored the use of spectacular non-destructive techniques to view dental micro-structures and concluded that while early modern humans possessed dental and skeletal development patterns that were within the range of living groups of modern humans, Neanderthal infants did not. She suggested a pattern of more advanced dental development and eruption for the Neanderthal specimens analysed in her study. **Karin Becktor** also gave an interesting talk on the aetiologic aspect of human dental eruption, in which she discussed a number of defects and conditions that can disrupt the eruption process. She also noted that dental eruption is a continual process stimulated by face growth and/or tooth wear. **Helen Liversidge** made an important point during her talk on permanent tooth formation as a method of estimating age, that current standards for tooth eruption timings are Eurocentric and that there was a strong need for worldwide collaboration in providing new standards on tooth formation. Another presentation which focused on the eruption of teeth was given by **Susanna Mihalidis** on the timing and sequence of emergence of primary incisors in twins. Her work comparing incisal eruption in monozygotic and dizygotic twins found that although there is some genetic control over the timing of their emergence, none was found in relation to asymmetry, which fluctuated.

The evening's entertainment included a barbeque dinner as well as a poster session hosted in an exotic location. A free bar was provided throughout the evening, promoting lively debate of the diverse topics covered by the posters – which reached almost 50 in number. Authors included **Wendy Birch, Ian Corfe, Luca Fiorenza, Jay Kelley, Jules Kieser, Randi Klinge, Matthew Skinner, Masanaru Takai, Christine Verna** and the prize winners **Cyril Charles** (Poitiers, France) and **Gary Schwartz** (Tempe, USA).

The third day focused on the clinical aspects of dental morphology. With the increasingly widespread use of 3-D computer models it is becoming harder and harder to create that 'wow factor' they first generated as little as five years ago. Nevertheless, **Paul Brown** achieved just that, presenting examples of highly detailed, complex, colour models obtained through a combination of serial grinding and X-ray microtomography. This work is being incorporated into a *Dental Anatomy and 3D interactive Tooth Atlas* (Brown and Herbranson, 2007). **Grant Townsend** gave an interesting presentation on how studies of twins can reveal how genes and environment both contribute to the expression of certain traits. Another noteworthy talk was given by **Jukka Jernvall** on development and evolution: the balancing act of the wisdom tooth. Work on hominin molar formation suggests that molar proportions are highly integrated developmentally and that hominin molar sizes and proportions are regulated during their evolution by a single developmental parameter. Exceptions to this rule included *Homo floresiensis* and pituitary dwarfs.

During the afternoon, conference attendees were provided with a guided tour of the historic town of Greifswald, followed by a boat cruise on the Baltic seas to visit Europe's oldest moving bridge and the remains of a monastery in Eldena, frequently depicted by the landscape painter Caspar David Friedrich (1774–1840) who was born in Greifswald. The pinnacle of the social events was a conference dinner at the Pomeranian State Museum (<**http://www.pommersches-landesmuseum.de/**>).

The final day of the conference focused on teeth and reconstruction of the past. The keynote lecture for this session was given by **Simon Hillson** on teeth as a resource for reconstructing the biology and behaviour of past human populations. This session contained a diverse amount of talks on subjects such as dental caries, deciduous tooth growth and development, tooth cementum annulation, dental morphology and anterior dental extraction, and discussed ideas such as dental fingerprinting. **Anna Clement** also gave the only paper directly related to fossil material. After extensive study of modern Inuit tooth wear she has concluded that the Inuit are not necessarily a useful cultural group for understanding tooth wear in the Neanderthals (contrary to previous suggestions). Short papers based on research presented at the conference have recently been published in a combined volume (Koppe *et al.* 2009).

After the close of the final session of the conference **Thomas Terberger** gave a special lecture on the archaeology of Rügen Island which corresponded to the following day's fieldtrip. The fieldtrip itself was an excellent opportunity to continue discussions of ideas for projects and possible grant applications as well as enjoying some very picturesque scenery. The latter included several interesting burial mounds (Figure 5), a post-medieval church (Bergen), and Jasmund National Park – which contains the largest chalk cliffs in Germany (the *Königsstuhl*) (Figure 6).

Figure 5. One of the many prehistoric burial sites present on Rügen Island.

Figure 6. The chalk cliffs of Jasmund National Park on the north east coast of Rügen Island that correspond to chalk units found on the south coast of England.

Not long after returning home, participants received a CD full of excellent photos to remember the conference by. This conscientiousness again illustrates the enterprise and enthusiasm shown by the organisers. The effort towards making this conference work from convenors and so many students and staff in the background was second to none. The only disappointment of the meeting was perhaps the absence of Griffins…

The next meeting will take place in Newcastle upon Tyne, UK, at Northumbria University, from 24th to 27th August 2011, and I encourage any palaeontologists interested in hard tissues of the vertebrate jaw seriously to consider attending, and indeed presenting at, this next meeting. Please contact Wendy Dirks for further information: <**wendy.dirks@newcastle.ac.u k**>.

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12th International Palynological Congress and the
8th International Organisation of Palaeobotany Conference
Bonn, Germany *30 August – 5 September 2008*

The 12th International Palynological Congress and the 8th International Organisation of Palaeobotany Conference (IPC-XII/IOPC-VIII) have long passed, but the conference organisers – Thomas Litt, Hans Kerp and I – hope that fond memories of the congress still remain.

This joint congress, held in Bonn, Germany, from 30th August to 5th September 2008, was an historical event, as it was the first time that the IPC and IOPC have ever met at the same place at the same time. The synergetic effect of this union was, for example, reflected in the over 800 scientists who came together in Bonn, which added up to more than the sum of the usual number of registrants at each conference. In all, palaeobotanists and palynologists from 52 countries presented their research in 536 talks and 238 posters, which sorted out into eight parallel sessions and 48 symposia during the five days of sessions. A huge diversity of topics was offered, ranging from basic research, such as reconstructing the gymnosperm tree of life, to applied topics, such as palaeoenvironmental analysis and biostratigraphy, or melissopalynology. This great outpouring of information resulted in a great interchange of new data and innovative ideas, as well as in the general euphoria of being at such a stimulating world congress. The bright, picture-perfect weather and delectable German food and beer helped to sustain the sunny mood in Bonn all week.

Food for thought was also served up at a series of plenary lectures by five leading palaeontologists. These included **Sir Peter Crane** , who had come full circle from organizing the first IOPC in Reading to being an honoured plenary speaker at the eighth IOPC. At the Opening Ceremony, Peter Crane offered his thoughts on "Fossils and Angiosperm Evolution: Lessons and Prospects for the Future," while **Jonathan Overpeck** , a 2007 Nobel Peace Prize Winner and a Coordinating Lead Author for the UN Intergovernmental Panel on Climate Change (IPCC), 4th Assessement, reflected on "Palynology, Palaeobotany and Key Research Unknowns" in the wake of the IPCC 4.

Later in the week, palaeobotanist **Edith L. Taylor** spoke on "Life at Polar Latitudes: Permian and Triassic Peat Floras from the Central Transantarctic Mountains, Antarctica," palaeoentomologist **Conrad C. Labandeira** gave "A Brief History of Insect Herbivory on Land and Why It Is Important," and population geneticist **Rémy Petit** explained how "Palaeoecology Meets Genetics: Deciphering Past Vegetation Dynamics."

New discoveries were not only made in the lecture rooms, but also in the field. More than half of all participants (447 people) took advantage of day trips in and around Bonn on the Mid-Congress Break to see something of the region, or explored eastern and southern Germany on the field trips before and after the congress. The link to a short film of Field Trip B3 and PDFs of the last congress circular ("The Congress Wrap-Up"), abstract volume and printed programme are all available on the congress website at <**http://www.paleontology.uni-bonn.de/congress08/index.ht m**>.

Thanks to the low registration fees for the congress and an even lower student rate, a large number of students (a total of 190, or 24%) were prompted to participate in the congress. Nevertheless, some of them had trouble finding funds to cover the cost of travel, room and board. For 30 students, it was thus a great stroke of fortune to receive a student bursary from the Palaeontological Association, which had generously donated a total of £4,000 (nearly €5,000 at that time) to the congress in support of student participation. These students came from 14 countries from all parts of the globe: Argentina, Australia, Brazil, China, Czech Republic, Denmark, Finland, France, Ireland, Portugal, Russia, Slovakia, Spain, UK. We, the congress organisers, offer our thanks on behalf of these 30 young people who were able to enrich the cultural and intellectual diversity at the IPC/IOPC in Bonn with their participation.

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Evolution Rocks! – The Lyme Regis Fossil Festival 2009
Lyme Regis, Dorset, UK *22 – 24 May 2009*

Lyme Regis, nestled into the coast where Dorset meets Devon, lying at the heart of the Jurassic Coast World Heritage Site, is the home of this three-day event, which must be one of the biggest celebrations of natural history in the world. Spring Bank Holiday weekend, fine weather and half-term holidays brought thousands of visitors to Lyme for a huge celebration. Organisers estimated that the town (population 4,400) was hosting 15,000 visitors at the Festival's peak on Sunday, 24th May.

This year's Festival was themed around the Darwin celebrations and was the fourth such event in five years. Insufficient funding in 2008 had led to the Festival's cancellation, which organisers – led by the Lyme Regis Development Trust – more than compensated for in 2009. The main event was spread across five marquees on the seafront, centred on Cobb Gate and the Lyme Regis Museum. Street performers, art activities on the beach and around the town, fossil walks by local palaeontologists, evening lectures and shows made for an eventful weekend. Other events and activities were held along the coast from Exmouth to Durlston and away from the coast at Bridport and Dorchester.

The first day of the Festival was dedicated to local schools which toured the marquees and explored the range of activities; the second and third days were for the general visitor. This year coincided with a meeting of UNESCO, where the local team was able to demonstrate the splendid work they are doing in conserving the geology, while using the site to promote the local economy.

The main exhibitors were The Natural History Museum (Palaeontology, Mineralogy and Learning departments), National Museum of Wales, British Antarctic Survey, National Oceanography Centre, University of Plymouth and Bournemouth University. The Jurassic Coast World Heritage Team, Natural England, Rockwatch, Geologists' Association along with local groups including the Dorset GA and Medway Fossil and Mineral Society and Dinosaur Isle brought both local and national interest together. Local fossil collectors including Charmouth Fossils, Lyme Bay Fossils and David Sole exhibited fossils for sale. Local artists including Richard Bizley showed their work inspired by local geology and fossils, while at the Cobb sat the R V Callista, the research vessel of the National Oceanography Centre (University of Southampton).

With so very much going on it is indeed difficult to pick out highlights. With complete bias, The Natural History Museum's display had fossils, meteorites, microscopes, SEM, and fossil sieving. The sieving was heroically led by David and Allison Ward, also sponsored by them and Vinnie Valle. This activity provided hundreds of visitors with little collections of Moroccan and Abbey Wood shark's teeth, for free. With the University of Plymouth you could walk like a dinosaur and calculate stride and height – without bias this was the best palaeontology activity I have ever seen. The National Museum of Wales focused on James F. Jackson, a predecessor of mine in my old job on the Isle of Wight, who having retired to Charmouth demonstrated his great skill as a field palaeontologist, and built an outstanding collection of fossils.

The British Antarctic Survey display included fossils and equipment, just the right stuff to enthuse young minds to the prospect of a career in geology. At such events I am always impressed by the efforts of local groups such as the Dorset GA, to promote their passion, and Rockwatch for always looking to the future for our science. With so much happening I regret not seeing enough of the street performance, but with *Darwin and the Dodo* wandering the streets, plus Herbie Treehead's re-working of *Duria Antiquior,* there was plenty of entertainment for all ages. Art activities culminated with local artist Christine Allison building Darwin's Tree of Life, which it was, a tree, made of paper, recording life on earth. Smaller scale activities included a giant sand ammonite.

Evening talks were held at the local 'lodge', which proved to be a challenging venue, not compensated by the magnificent views. The challenge came from the bar facing onto the audience, not for the faint-hearted speaker. However, the talks were well attended and appreciative audiences were entertained by a range of talks including by Brian Rosen (Darwin coral reefs), Richard Twitchett

(Permian extinctions), Tom Sharpe (Henry De la Beche), Cindy Howells (J.F. Jackson), Hilary Blagbrough (Antarctic climates) and Hugh Torrens (Mary Anning).

Walks to look for fossils were offered by a number of local palaeontologists and organizations. These included Paddy Howe who operates out of Lyme Regis, and the Charmouth Heritage Coast Centre, who take groups west along the coast from the centre. I joined a group from Charmouth and was very impressed by the work they are doing with the public. Enthusiasm and local knowledge, combined with taking control of collecting activities, are very positive ways of managing access to these invaluable geological sites.

So what's in it for the promotion of palaeontology? Is this just clever marketing by the local development trust? I see both happening and in harmony. Tourism is central to Lyme's economy; the local development plan recognises this, the benefits of which are also flowing along the World Heritage Site. Lyme Regis is enshrined in palaeontology's birth as a science, and events such as this contribute towards keeping our science in the public domain. With attendance figures between 20,000 and 30,000, that's a lot of people encountering natural history in general, and palaeontology in particular, first-hand.

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Walking like a Dinosaur with Gregory Price from University of Plymouth.

Progressive Palaeontology 2009
University of Birmingham, UK *27 – 29 May 2009*

A glorious Spring evening ushered in the 52 delegates of this year's *Progressive Palaeontology* to the opening icebreaker reception, held at the Lapworth Museum of Geology at the University of Birmingham. New friends were acquainted, old friends were reacquainted, the air was filled with tales of intrepid research and fieldwork, and much wine was consumed. Early registration was also available for those too eager to wait until the morning to find out what the rest of the conference held (or who just wanted to feel more important by wearing their name badge). Eventually delegates sidled off to the OVT pub in Selly Oak, to continue jovial discussion (and drinking). Anticipation for the coming day, packed with a wide-ranging mix of 24 talks and 11 posters, was high, and delegates retired to their respective accommodations filled with excitement.

Bright and early on another beautiful day, delegates began to reappear at the School of Geography, Earth and Environmental Sciences for the full day of conference proceedings. Talks were held in the Dome Lecture Theatre at the top of the Earth Sciences building. Welcoming remarks were made by Dr **Guy Harrington**, kicking off the first session which was chaired by **Helen Hughes**. **Leila Battison** (Oxford) had the dubious honour of being first to speak, postulating that life on land began with freshwater algae over a billion years ago. This was followed by **Karl Bates** (Manchester), who advised caution when estimating soft tissue parameters for inputting into models of bipedal dinosaur locomotion. Next was **Aodhán Butler**, enlightening us on the role of microbial activity in taphonomic processes. **Andrew Storey** (Birmingham) then compared the palaeoenvironmental settings of Silurian trilobites, before **Kelly Richards** (Bristol) gave a well-rounded account of the Early Jurassic basal mammal *Morganucodon watsoni*. Closing the first session was **Nicholas Edwards** (Manchester), providing further detail on vertebrate soft tissues by analysis with Synchrotron X-ray Fluorescence (SXRF) and Environmental Scanning Electron Microscopy (ESEM).

A well-earned coffee and nibble break, courtesy of our dear dinner lady Cynthia, provided the first opportunity to peruse the posters on display in the Lapworth Museum. An eclectic mix of subjects covered the monospecificity of the sabre-tooth cat *Homotherium* (**Martha Koot**, Plymouth), the revelation that aspidin is acellular bone (**Chloe Marquart**, Cambridge), and the influence of sedimentology and taphonomy on trilobite associations in north Greenland (**Helen Hughes**, Birmingham). **Nikita Jacobsen** (Plymouth) won the hard-fought prize of a £50 book token for best poster, with her account of the importance of methodology in assessing palaeoecological change across the Permian–Triassic mass extinction. **Jennifer Hoyal Cuthill** (Cambridge) investigated repeated convergent evolution across different clades, **Phil Jardine** (Birmingham) used palynomorphs to assess the paratropical plant communities on the western U. S. Gulf Coast in the latest Paleocene, and **James Lamsdell** found that the developed sweep-feeding strategy of stylonurid eurypterids rendered them immune to feeding competition from other invertebrates and jawed vertebrates of the time. **Karl Bates** (Manchester) proposed the use of digital, 'virtual' fossils to engage and increase public interest in palaeontology and science as a whole, **Sarah King** (Birmingham) emphasised the importance of some Pennsylvanian ('Late Carboniferous') floras from South Wales, **James Neenan** (Bristol) used a combination of methods to determine the feeding strategy of *Acanthostega gunnari*, a Devonian stem tetrapod, and **Andy Rees** (Birmingham) showed us how POT (Physical Optical Tomography) can give us new insights into the 3D workings of fossil plants.

Coffee and posters in the Lapworth Museum of Geology.

The second session, chaired by **Phil Jardine**, began with an account of the taphonomy of Triassic marine vertebrates from **Susan Beardmore** (University College Dublin). **Sarah King** (Birmingham) followed this by asking whether wetland plant communities were able to travel from Euramerica to China across the Carboniferous–Permian boundary, and **Javier Ortega-Hernandez** (Bristol) announced findings on aglaspidid arachnomorph arthropod affinities. **Ben Slater** (Bristol) described a rare Jurassic basal turtle, **James Jepson** (Manchester) gave an account of Cretaceous arboreal lacewings, and **Philip Mannion** (UCL) wrapped up the session using residuals to confirm that the fossil record of sauropodomorphs is a biological signal and not affected by variation in the rock record.

A tasty lunch in the Lapworth Museum, again courtesy of the lovely Cynthia, preceded session three, chaired by **Andrew Storey**. **David Legg** (Bristol) began, speaking on the Devonian scorpion *Acanthoscorpio mucronatus*, followed by **Peter Falkingham** (Manchester) with a fresh take on the significance of vertebrate palaeoichnology from his authoritative position as the new breed of palaeontologist. **Alexander Liu** (Oxford) then showed evidence of mobility of the organisms in Ediacaran ecosystems in Canada, and **Duncan Murdock** (Bristol) investigated the microstructure of small shelly fossils (SSFs) from the early Cambrian using synchrotron radiation X-ray computed tomography (SRXTM). **Mark Johnson** (Manchester) gave the first of two talks based around the 3D modelling and reconstruction of a terminal ungual phalanx from *Velociraptor mongoliensis*, before **Nicholas Crumpton** (Bristol) closed the session with a rip-roaring account of quantitative microwear analyses of the molars of Jurassic basal mammals *Morganucodon* and *Kuehneotherium* from South Wales, by comparison with extant bats with different dietary preferences. The committee was so impressed by the slick slideshow and the fact that Nick crammed so much information into twelve minutes at the expense of breathing, that they were compelled to award him the £50 book token prize for best talk.

After the second coffee break, the final session (chaired by **Sarah King**) was started off by **Russell Garwood** (Imperial) presenting high resolution 3D models of Carboniferous trigonotarbid

arachnids, followed by **Muhammad Hanif** (Plymouth) speaking on high resolution biostratigraphy and isotope stratigraphy of the Paleocene–Eocene Thermal Maximum (PETM). **Zartasha Mustansar** (Manchester) followed up Mark Johnson's earlier talk on the *Velociraptor* claw, extolling the virtues of X-ray tomography for inferring missing soft tissues, and then **Peter Heintzman** (Bristol) discussed a supertree of the Perissodactyla. **Alex De Jonghe** (Plymouth) revealed an interesting and highly diverse Middle Jurassic squid breeding ground, and **Matthew Larvan** (Bristol/Birmingham Thinktank) rounded off the day detailing the increasing diversity and robustness in sauropodomorph skulls through the Mesozoic, after analysis with relative warps (RWA) and finite element analysis (FEA).

The conference proper was closed with final remarks by lead organiser **Phil Jardine**, and his well-deserved award of a crate of beer, before delegates slowly reassembled, via the handy University train station, in the city centre at the Brass House bar on Broad Street. After suitable lubrication, they eagerly ascended the stairs to the Celebrity Balti restaurant above the bar, for a hugely enjoyable traditional Birmingham curry. The after-dinner prize-giving and speech were given by **Phil Jardine**, before delegates dispersed around the city centre to continue the frivolities.

Delegates outside the Lapworth Museum of Geology.

The organisers after dinner – note the empty glasses.

This may have contributed to the proportion of slightly dishevelled delegates who appeared the next morning for the post-conference field trip to the Silurian reef facies of the Much Wenlock Limestone Formation, Wenlock Edge, Shropshire. The Much Wenlock Limestone Formation is a well known lagerstätte containing a diverse fauna of over 600 species, and has attracted geologists since the early 19th century. The field excursion consisted of two localities, Lea Quarry and Ippikins Rock, which contain some of the best exposures of the reef facies in the area. Lea Quarry, located to the west of Much Wenlock, was the first stop and yielded many fossils including tabulate corals, crinoid ossicles, brachiopods and the odd trilobite. A pub lunch at the excellent Wenlock Edge Inn went down very well, and was followed by a short walk to view the stromatoporid reef complex of Ippikins Rock to round off the day of geology. Despite there not being enough time to visit the Much Wenlock Museum the day was a productive one, and was complemented by some superb weather.

Eagerly inspecting the reef at Ippikins Rock.

The abstract book is still available on the Pal Ass website for those who wish to recap. It was an extremely enjoyable few days, with much cutting-edge research being reported and discussed. Increasingly novel approaches are now being taken in modern palaeontology to extract more information than ever before from the fossil record and interpret and apply it in new ways, and it was great to see such a range of work in such a short time. We would like to say thank you to all who presented, attended and helped out with this year's conference, and wish the best of luck to next year's organisers in Bristol. We'll see you in Birmingham in December for the main Pal Ass conference!

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Towards a new phylogeny and classification system for scleractinian corals
National Museum of Natural History, Washington *15 – 19 June 2009*

Scleractinian coral systematics is in the midst of a revolution resulting from advances in molecular systematics and in the microscopic technology used for extracting morphologic information. New research (*e.g.*, Fukami *et al*. 2008) has shown that the majority of taxa at the suborder and family level are polyphyletic. On 15–19 June 2009, the Scleractinia Working Group (SWG) convened a five-day workshop entitled "Systematics and evolution of scleractinian corals" at the National Museum of Natural History Museum of the Smithsonian Institution in Washington DC. The main goal of the workshop was to develop a strategy for revising the traditional phylogeny and classification system for Scleractinia and creating a new taxonomic synthesis, which integrates morphologic and

molecular data. The synthesis will replace out-dated systems currently used in marine ecology, conservation biology and palaeontology. The workshop was sponsored by the *Encyclopedia of Life* (EOL), with additional support from the *Treatise on Invertebrate Paleontology* (TIP), and led by **Ann Budd**, **Stephen Cairns**, and **Nancy Knowlton**. The twenty-six participants (18 professionals, three postdocs, five graduate students) consisted of marine biologists and palaeontologists based in ten countries (Australia, France, Italy, Jamaica, Japan, Netherlands, Poland, Taiwan, UK, USA), and included both taxonomic experts and those skilled in modern systematics techniques.

SWG is currently engaged in three community database projects:

(1) Corallosphere (**www.corallosphere.org**), led by Ken Johnson. Corallosphere is a publicly-accessible taxonomic database containing over 1,600 fossil and modern genera. It provides a dynamic central system for collecting, editing and disseminating data and images. All data and images are first entered into Corallosphere before they are shared with other databases.

(2) Scleractinian volumes of the Treatise on Invertebrate Paleontology (**paleo.ku.edu/treatise**), led by Jarek Stolarski. These volumes will be part of a printed series of volumes published by the Paleontological Institute, University of Kansas; recent volumes are available online as downloadable chapters and a searchable database. The series synthesizes taxonomic information about all known invertebrate fossil genera.

(3) Encyclopedia of Life (**www.eol.org**). EOL is a web-based species-level database covering all living organisms (~1.8 million known species) on Earth. The classification system adopted in Corallosphere is being shared with EOL.

Figure 1: Workshop participants.

Day 1: Introductions and primers

The first day of the workshop was devoted to reviewing new advances in molecular systematics and in the microscopic technology used for extracting morphologic information. **Nancy Knowlton** set the stage by reviewing the molecular phylogeny provided in Fukami *et al*. (2008), which shows that 11 of 16 families of modern reef-building scleractinian families (Acroporidae, Astrocoeniidae, Pocilloporidae, Euphylliidae, Oculinidae, Meandrinidae, Siderastreidae, Agariciidae, Fungiidae, Pectiniidae, Merulinidae, Mussidae, Faviidae, Trachyphylliidae, Poritidae, Dendrophyllidae) are polyphyletic. **Allen Chen** reviewed molecular analyses examining the monophyly of the Scleractinia, and concluded that the Order Scleractinia is monophyletic. The discrepancies in the results of different research teams concerning scleractinian monophyly appear to be the result of taxon sampling. One result that is repeated in all analyses is the existence of two distinct clades, termed "complex" and "robust" by Romano and Palumbi (1996), which do not conform to the five suborders of Wells (1956) or the suborders of other authors. **George Stanley** reviewed the "naked coral" hypothesis (*i.e.*, the ephemeral nature of the skeleton and the close evolutionary relationships between corallimorpharians and scleractinians) from a palaeontological perspective, and showed that this hypothesis does not conflict with scleractinian monophyly.

Other new unpublished molecular phylogenies were presented by **Marcelo Kitahara** and **Marcos Barbeitos**. Kitahara's trees included representatives of ten primarily azooxanthellate families (Gardineriidae, Micrabaciidae, Flabellidae, Turbinoliidae, Fungiacyathidae, Guyniidae, Anthemiphyllidae, Caryophyllidae, Stenocyathidae, Rhizangiidae) in addition to the 16 families treated in Fukami *et al*. (2008).

The disagreement found between the molecular results and traditional scleractinian classification indicates that many traditional morphologic characters are not effective at diagnosing groups above the genus level (subfamilies, families, suborders, *etc*.) and that new diagnostic morphologic characters need to be discovered based on models of skeletal growth and assessed for homology. Several new micromorphological and microstructural characters were proposed in presentations by **Jarek Stolarski** (at scales >1,000x), and by **Nancy Budd** (at scales of 50–500x). The effectiveness of these characters can be evaluated by mapping their states onto molecular trees. The shapes of teeth and granules along the margins and faces of septa conform better with molecular trees than do traditional macromorphological characters, such as colony shape and form (cerioid, plocoid, meandroid, phaceloid *etc*.), corallite diameter, and number of septal cycles. Preliminary attempts at morphological phylogenetics indicate that molecular data are more effective at diagnosing nodes at the base of the tree, whereas morphological data are more effective at branch tips. **Ken Johnson** described problems in usage of morphological terms and ongoing efforts to create a glossary of such terms as part of Corallosphere. The first-day session spilled over into the second day with **Ewa Roniewicz**'s description of her previous attempt to construct a phylogeny for the Scleractinia using microstructural data and the fossil record (Roniewicz and Morycowa, 1993). Although diverse in growth forms and architectures, the early Mesozoic record contains many taxa that do not readily fit into the complex and robust clades found in Recent corals.

Day 2: Robust *-vs-* complex corals

The second day of the workshop was devoted to examining morphologic characters that distinguish complex and robust corals. The session began with a presentation by **Sandra Romano**, who reviewed her earlier work (Romano and Palumbi, 1996, 1997; Romano and Cairns, 2000), which noted the following morphologic differences between robust and complex corals:

- Robust: "relatively solid, heavily calcified skeletons that result from solid (septothecal or parathecal) construction of corallite walls".
- Complex: "less heavily calcified, perhaps as a result of the relatively porous (synapticulothecal) construction of corallite walls. In addition, in all but one of the taxa in this clade, the septal walls are built from simple trabeculae that form a porous and loose network of skeletal elements, resulting in a relatively light, complex architecture".

The session continued with discussion of the morphology of five traditional families whose members belong to both complex and robust clades in the Fukami *et al.* (2008) tree:

- Siderastreids [Benzoni]: *Siderastrea* (complex, clade IX) *-vs- Psammocora*/*Coscinaraea* (robust, clade XI)
- Astrocoeniids [Klaus]: *Stephanocoenia* (complex, clade VIII) *-vs- Madracis*/*Stylocoeniella* (robust, clade X)
- Oculinids [Kitahara]: *Galaxea* (complex, clade V) *-vs- Oculina/Cladocora* (robust, clade XIII)
- Euphylliids [Hoeksema]: *Euphyllia* (complex, clade V) *-vs- Physogyra* (robust, clade XIV)
- Meandrinids [Budd]: *Ctenella* (complex, clade V) *-vs-* other meandrinids (robust, clade XII)

These comparisons involved a review of the taxonomy of each family, followed by a series of photos illustrating various macromorphological, micromorphological and microstructural features. In general, no single character or character combination appeared to separate complex from robust corals; there are no apparent synapomorphies. Synapticulae and porous walls/septa are common in complex corals, but there are many exceptions, *e.g.*, as indicated in the table above, complex siderastreids have compact walls, and complex astrocoeniids, complex euphylliids, complex oculinids and complex meandrinids do not have synapticulae. Parathecal walls (*e.g.*, complex meandrinids, robust euphylliids) and septothecal/trabeculothecal walls (*e.g.*, complex astrocoeniids, complex euphylliids, robust oculinids, robust meandrinids) occur in both complex and robust groups. Pali occur in complex astrocoeniids but not in robust astrocoeniids; pali occur in robust oculinids but not in complex oculinids. The best possible distinguishing characteristic appears to be related to thickening deposits; in general, robust corals tend to be more heavily calcified than complex corals. This feature warrants further microstructural investigation, as does the size and complexity of septal dentition and other micromorphological features.

Other problematic taxa that were discussed include:

- *Blastomussa* (Benzoni, Stefani), clade XIV: *Blastomussa* is similar to *Physogyra* (also in clade XIV) in that it has strong median lines, smooth septal margins, septal lobes, and well-developed thickening deposits. However, it differs by having a septothecal wall and trabecular columella. One of the two species is similar to *Parasimplastrea*.

The afternoon began with discussion of the morphology of three families that more clearly fit into either the complex or the robust clade. For the complex corals, **Carden Wallace** described the morphology of acroporids and **Michel Pichon** the morphology of the poritids:

- Acroporidae: Extracalicular budding; synapticulothecate; spiniform septa; absent or weak columella; extensive reticulate coenosteum, generally spinose or striate on surface.
- Poritidae: Extracalicular budding; synapticulothecate; lacking coenosteum; perforate

septa formed by loosely connected vertical trabeculae; innermost trabeculae sometimes differentiated as 'pali'; columella formed by a single trabecula.

- *Alveopora* has many traits that are more similar to the acroporids (*e.g.*, spiniform septa, absent columella) but it lacks the extensive reticulate coenosteum.

For the robust corals, **Bert Hoeksema** summarized the fungiids: Mono- or polystomatous; laminar septa connected laterally by bar-like elements called "compound synapticulae" or "fulturae" (a synapomorphy for the family); teeth on the margins of septocostae vary in shape from simple to complex, and are usually species-specific. *Leptastrea* and *Oulastrea* do not fit because they lack fulturae.

The discussion of complex *vs* robust corals then turned to the fossil record. **Ken Johnson** presented an overview of the Late Cenozoic fossil record in which he compared evolutionary patterns in the Caribbean and SE Asia. Extinction events occurred at the Oligo–Miocene and Plio–Pleistocene in the Caribbean, but not in SE Asia. Robust corals are more diverse in both regions, and were more susceptible to Plio–Pleistocene extinction in the Caribbean. **Tom Stemann** provided a review of modern families that extend back to the Eocene as well as extinct early Cenozoic families. **Bernard Lathuilière** then summarized many of the problems involved in determining whether robust and complex corals extend back into the Mesozoic. Among the problems – in addition to there being no diagnostic characters of robust and complex corals – are (1) a lack of clear diagnostic characters of the suborder Scleractinia (and how to distinguish it from other similar Mesozoic anthozoan groups, which have skeletons); (2) many Triassic families appear to be evolutionary experiments (a "lawn" rather than a tree) and bear no relationship to modern robust *vs* complex corals; and (3) many Jurassic families have presumed diagnostic characters similar in nature to modern families, but no comprehensive or rigorous comparisons have been performed as yet. Lathuilière emphasized the need for further detailed study of microstructure.

Day 3: Morphological character matrix of scleractinian families (taxonomically-defined breakout groups)

On the third day of the workshop, the SWG made an initial attempt to construct a morphological character matrix for selected members of ~100 valid scleractinian families. This matrix will serve two purposes: (1) to provide the basis for a morphologic phylogenetic analysis, which includes fossils, and (2) to construct morphological diagnoses of families for Corallosphere and TIP. Prior to workshop, a list of ~100 scleractinian families was constructed by the editors of Corallosphere and TIP (Roniewicz for Triassic, Lathuilière for Jurassic, Baron-Szabo for Cretaceous, Budd for Cenozoic zooxanthellates, Cairns for Cenozoic azooxanthellates). The editors then either composed morphological diagnoses for these families themselves or recruited experts to compose diagnoses. The diagnoses were used to construct a list of 49 morphological characters (185 states) based on the glossary in Corallosphere (written for the most part by Brian Rosen and Jill Darrell, and organised by Ken Johnson). The list of families and the list of characters were provided to workshop participants to serve as a guide in selection of taxa and characters for the workshop character matrix.

The workshop then split up into four taxonomically-defined breakout groups. Each group first decided on 5–10 taxa, which it would code, and suggested 5–10 characters, which are especially important for coding these taxa. The suggested characters were used to construct a list of characters and character states for all four breakout groups to use in coding. Altogether the four breakout

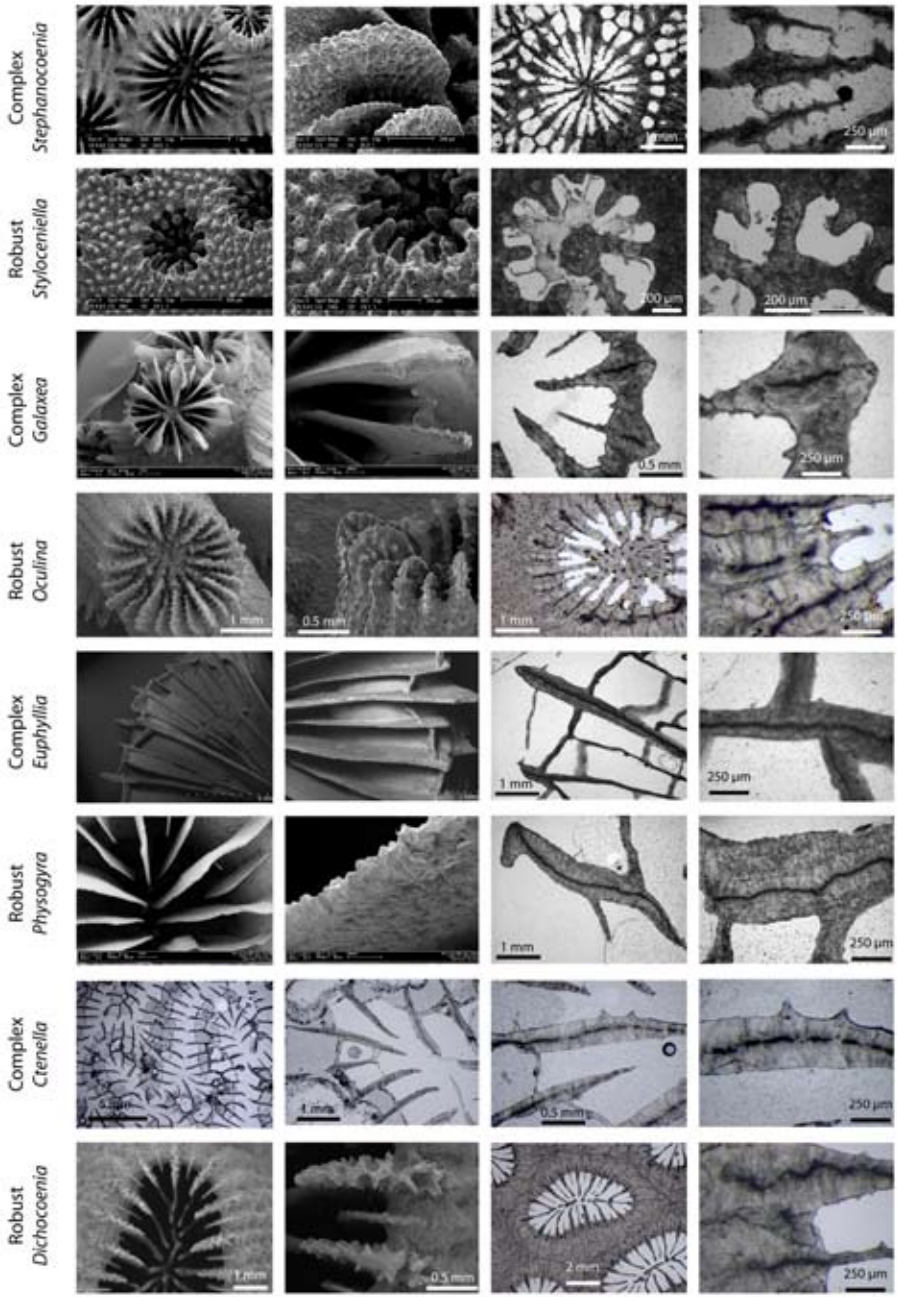

Figure 2: Comparisons between robust and complex corals within families that contain members of both molecular groups.

groups selected 42 taxa and 34 characters with a total of 90 states. The characters consisted of:

- Colony-level macromorphology [11 characters]: corallum type (solitary *vs* colonial); attachment; intracalicular and extracalicular (coded as separate characters); types of calical arrangement such as cerioid, meandroid, phaceloid, circumoral (coded as separate characters); presence/absence of coenosteum and epitheca; costae continuous over the coenosteum (=confluent septa)
- Corallite-level macromorphology [10 characters]: septal fusion of higher cycles; compactness of radial elements; presence/absence of costae, endotheca, fulturae, paliform lobes, pali, synapticulae; columella development and structure
- Micromorphology [9 characters]: costal distal ornamentation shape; septal axial margins ornamentation (orientation, shape, size); septal distal margins ornamentation (tooth orientation, shape); septal lateral faces ornamentation (arrangement, shape); simple *vs* compound trabeculae
- Microstructure [4 characters]: parathecal, septothecal, synapticulothecal, trabeculothecal walls (coded as separate characters).

Day 4: TIP and molecular breakout sessions; Corallosphere, EOL, BHL

During the morning of the fourth day, the group split up into two subgroups to discuss logistics and future directions associated with ongoing community projects. These included: (1) *Treatise on Invertebrate Paleontology*(TIP) breakout session (led by Steve Cairns), and (2) Discussion of unresolved issues in molecular analyses (led by Allen Chen and Nancy Knowlton).

During the afternoon, demonstrations were provided of:

(1) EOL, Encyclopedia of Life, **http://www.eol.org/** [Cyndy Parr]

(2) BHL, Biodiversity Heritage Library, **http://www.biodiversitylibrary.org/** [Tom Garnett]

(3) Corallosphere, **http://www.corallosphere.org/** [Ken Johnson]

Day 5: Museum tours and final wrap-up

The morning of the fifth day was devoted to museum tours and the afternoon to a wrap-up session. **Bert Hoeksema** began the afternoon session with a review of ongoing work on coral biodiversity and biogeography, and the importance of individual species ranges and species richness patterns in understanding biogeographic shifts. He suggested that the study of coral symbionts may provide further insight into phylogenetic patterns of the coral hosts and coral reef biodiversity.

A preliminary phylogenetic analysis using the character matrix constructed on the third day was performed, and inadequacies with morphological characters were discussed. Problems identified included: (a) the plethora of existing terms, (b) the lack of homology in character definition, (c) the relative newness of micromorphological and microstructural characters and lack of usage and rigorous definition, and (d) the need for character weighting. In addition, several unresolved issues in the molecular analyses were discussed. A follow-up meeting was planned to finalise the character matrix and identify synapomorphies for families and higher taxa.

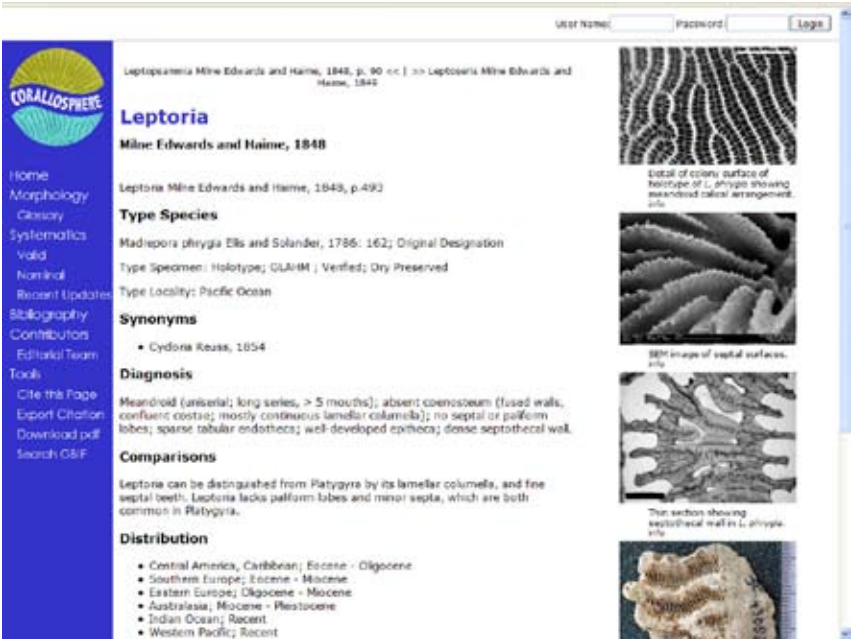

Figure 3. Example of a genus page in Corallosphere.

In conclusion, SWG agreed that existing classification systems for scleractinians are inadequate, and a revised system that better reflects new molecular results needs to be adopted as soon as possible. It was agreed that the classification system used in Corallosphere would be shared with EOL, and wherever possible, family compositions (*i.e.*, included taxa) would be based on the Fukami *et al*. (2008) tree. In order to share the classification system in Corallosphere with EOL, family pages are being implemented in Corallosphere.

A detailed report is available for downloading from the Corallosphere website.

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9th North American Paleontological Convention

Cincinnati, Ohio, USA *21 – 26 June 2009*

Hot and humid is the best way to sum up Cincinnati. The five of us representing the University of Plymouth at the 9th North American Paleontological Convention were greeted by this oppressive climate after arriving at Kentucky International Airport across the state line from Ohio on 20th June. We were generously picked up by Tom Algeo (University of Cincinnati). He managed to fit the five of us, plus our luggage, into his car and after a 20 minute drive, we arrived at the University halls on campus where we'd be staying for the week to come. A little later on, after enjoying authentic American-style pizza with Tom and his family, we were set loose to find our own way round the local offerings of shops and bars, and generally get our bearings while resisting the urge of turning in for the night.

Rooms in the University halls on campus were made available for all convention participants. Those that booked a shared room were situated in Calhoun Hall and in many cases didn't know their room-mate unless they had specified someone to share with. If you booked a single room then you were situated in Residence Hall. The accommodation in general was very good but, strangely, the beds were quite high off the ground. We found a chair to be very useful in order to get into bed! The best thing about where we were staying though was the close proximity to the local pub everyone seemed to be frequenting.

The weather was beautiful (while slightly suffocating) the next morning, when small groups of palaeontologists started gathering to depart on the Sunday field trip. Some of them were already feeling the effects of spending time in the field (or was it the pub?) on the Friday and Saturday beforehand.

The Sunday field trip was focused on a site called Big Bone Lick and primarily run by **Richard Arnold Davis** (College of Mount St. Joseph). We were told very early on that a few of the organisers had a condition called *Punitis*, (Richard included), and that it would be best not to encourage them. We soon found out why! At the first stop of the day, one lucky member of the group was asked to be the Ohio River in a practical overview of the geological setting and history of Cincinnati. The next stop was a lovely white Victorian-style house near to the Big Bone Lick State Park, where we were told about the geology of the region. While this was going on, much to our surprise, the woman who owned the house brought out some amazing Clovis points that had been found in the area.

When we finally got to Big Bone Lick State Park, we had a refreshment break and then an overview of previous ideas on why large mammal bones were found here along with the history of who

recovered them (*e.g.* Thomas Jefferson and the McAfee brothers). While the midday sun beat down on our heads, we went to look at an outdoor diorama exploring the theory of how large mammals sank into the mud, got stuck and then died. There was also an area close by that was originally used as a health resort during the 1800s as the water from the saline-sulphur spring claimed to have mildly curative qualities, although ironically it was more likely to have shortened your life rather than extended it. However, the spring was also used for making salt. We were shown where many of the famous bones had been collected, but saw no real examples *in situ*.

The outdoor diorama at Big Bone Lick State Park, which illustrates the original theory on why the large mammalian bones were found here.

Back in the minibuses, we went off to have a late lunch in Rabbit Hash, Kentucky, where the toilets were labelled 'does' and 'bucks' rather than 'ladies' and 'gents'. The food was very good, albeit in large portions, but what else do you expect in the good ol' U S of A? Rabbit Hash for some altogether unknown reason was infested with avid motorbike riders while we were there and we'd never seen so many congregated together before. We stopped off at a couple of places on the way back, including a Bison trail and a house that Charles Lyell slept in before he started his trek to Big Bone Lick. Back in Cincinnati they took us to Union Terminal (an amazing Art Deco building), which now houses the Cincinnati Museum centre, to show us round the Pleistocene exhibit which included a remarkable diorama on the last ice age. On the way back to the University we were taken on a short tour around what appeared to be some of the poorer areas in Cincinnati, but the architecture and history were rather interesting.

Registration for the convention had started earlier in the day in the Tangeman University Centre, so everyone went and registered when we arrived back. The registration pack included a free t-shirt with a trilobite on the back (oddly enough there was no size S available), a green eco-friendly mug to use for the duration of the convention, and the obligatory convention paperwork. Everyone then went straight on to the welcoming party being held downstairs for the free food and drink.

The NAPC convention sign in the Great Hall that was lit up at the opening of the convention by Darwin.

The following day the convention started proper with Charles Darwin – or rather **Carlton E. Brett** (University of Cincinnati) dressed up as Darwin – entering the room throwing free copies of his *Origin of Species* book into the audience and lighting up the NAPC convention sign at the front of the hall. **Arnold Miller** (University of Cincinnati), the convention organiser, made the opening remarks with **Anthony Perzigian** (University of Cincinnati), before the plenary session, entitled "What Darwin didn't know: Evolution in the 21st century", got under way.

We only realised we were in a tornado region when we saw the signs above the stairwells indicating tornado safe zones. Most of the rooms we were in were small lecturing rooms, with the exception of the Cinema and the Great Hall. During some of the more popular sessions and talks, people could be found crowding around the entrances to some of the smaller rooms in order to listen to the talks. The University itself looked really nice, with all the buildings seemingly wrapping around one another and surrounding the sporting venues in the centre. This meant that a lot of the buildings were strange shapes, with no direct routes between them. Besides the convention and a few school Summer camps, the University was closed for the Summer vacation so it was nice and quiet.

The event had around 650 people in attendance. However, due to the swine flu pandemic, most of the Chinese delegation did not attend, which meant that the symposium entitled "Progress and perspectives on paleontology in China" had to be cancelled. The convention was organised into several parallel sessions, normally with five symposia in the morning and seven in the afternoon, with half-hour coffee breaks mid-morning and mid-afternoon and an hour for lunch. Each session comprised of a large number of talks of 12 minutes in length with a time for questions afterwards. However, most sessions inevitably overran due to technical difficulties or because of talks going on longer than they should have (one was nearly 20 minutes long!), making it difficult to get to a following talk in a different session on time.

Some of the sessions were very discipline-specific, like "Symposium S6: Through the end of the Cretaceous in the type locality of the Hell Creek Formation and adjacent areas", "Symposium S14: Crisis in reefs: Is the past the key to the present?" or "Symposium S18: Paleozoic Brachiopods: Morphology, evolution, and stratigraphy". Some of the other sessions were more based around introducing science to the public, such as "Symposium S10: The nature of science and public science literacy" and "Symposium S11: Paleontology in K-12 Education". There was also a plenary session entitled "Evolution and Society", which took up all of Thursday morning and covered topics like the necessity of teaching evolution and the ongoing feud between evolutionists and creationists, which was a big topic at the convention and which tied in with the lunchtime Hot Topic Sessions ("Countering Creationism", "Interacting with the media", "Communicating with Legislators" and "Drafting a position statement on evolution").

Each day, there was an afternoon poster session from 2pm until 6pm. Some of these posters were very large, much bigger than anything we usually see, and one had actually been printed on fabric. On the Monday evening there were also a number of Special Group Meetings, which included "Friends of the Crinoid Treatise", "Paleobiology Database Advisory Board" and "Business Meeting for IGCP 572: Restoration of Marine Ecosystems Following the Permian–Triassic Extinction". The talks and symposia were far too numerous to describe in detail here, and full schedules and abstracts are available on the conference website (<**http://www.napc2009.org/technical-program-and-abstracts**>).

Posters session in the atrium of the convention venue.

Jake Speed & 2 Freddies playing at the student social event.

Tuesday night saw the much anticipated Student Party at the Fries Café, which was off-campus. We all had to wear name tags, but rather than put our names on them we had to draw a picture of the fossil group that we were researching. This led to some rather amusing pictures of sharks eating humans, gastropods, lingulids, fossil bones, and much more. Free beer along with free pizza was supplied for the night as well as the local band Jake Speed & 2 Freddies playing excellent regional music until midnight. Over the course of the evening, free prize draws were held by matching up playing cards from custom-printed NAPC decks with cards randomly chosen by everyone on their arrival at the party. The first lot of prizes were mystery prizes in paper bags and contained things ranging from mugs to food to sports bottles, whilst towards the end they were giving out free canvas bags celebrating the 100th anniversary of the Paleontological Society. The party ended around 1am when most people moved on to another pub or continued drinking back at their accommodation until very late. Many did not get much sleep before the field trips the next day and some even turned up still apparently a little drunk (no names need to be mentioned here!).

There were several mid-meeting field trips all starting from the same location at the same time, which made things a little confusing to begin with, but once everyone had worked out where they were supposed to be and which trip they were booked on, the buses could finally head off. The day started very hot and humid and this only got worse as the day continued, causing many people to become dehydrated to varying degrees. One of the most popular trips was a visit to the Creation Museum, because the consensus was that it was safer to go there in large numbers rather than alone. The resulting horde of palaeontologists roaming the museum attracted media attention and made headlines in the *New York Times* (<**http://www.nytimes.com/2009/06/30/science/30muse.html** >).

Examining trace fossils on the observation deck of the Carew Tower during the "Stoned in Cincinnati" field trip.

Another trip was entitled "Stoned in Cincinnati – Building stones of The Queen City," and took the (mostly senior) participants on a tour around Cincinnati and its 'geological history', but also allowed us to get a taste of its rich culture and architecture. We first set out to a viewpoint, where the geological setting of Cincinnati was explained by **Richard Arnold Davis** (College of Mount St. Joseph) and **Joseph T. Hannibal** (Cleveland Museum of National History) who continuously interrupted each other (leading Richard to explain to one of us how to gag Joseph on his cue). Some trip participants were also found randomly chasing after lizards which kept things interesting. We continued on to the Roebling Suspension Bridge (completed in 1867), which spans the Ohio River to connect

Cincinnati and Covington (Kentucky), and was constructed using Mississippian limestone and sandstone from local quarries. The next stop was Fountain Square, a popular spot with the locals and includes the Tyler Davidson Fountain (constructed of bronze and igneous rock). After examining the Sunset Red Granite (1.1 billion years old) that adorns the Westin Hotel, we moved on to look at the 'black granites' that face the lower floors of the Art Deco style Carew Tower. It is the tallest building in Cincinnati (574 feet) and boasts an observation deck where we enjoyed a marvellous 360° view. It also houses the geologically-rich Netherland Plaza Hotel: a lobby floor made of pink Tennessee Marble, a foyer characterised by Roman Breche Marble and the abundant purple breccias of dubious geographical origin (either Fleur de Pêche Marble or Fior di Persica Marble) in the Hall of Mirrors. We spent some time finding chain corals and numerous other fossils in the Silurian Dayton Limestone that makes up the exterior walls of The Cathedral of Saint Peter in Chains before going inside to look at the remarkable interior. The most impressive thing we looked at was the Precambrian metamorphosed Morton Granite Gneiss (3.3 billion years!) in both the Cincinnati Bell and the Union Terminal. The latter is an Art Deco masterpiece, completed in 1933, and was one of the last great railway stations to be built in the United States. It is now home to the Museum Centre. Many fossils can be found in the outer Salem Limestone facing, but the most impressive were the relatively well-preserved fossil ammonites (up to 22 cm in diameter) in the Italian Red Verona Marble (Middle to Late Triassic age) that lines the inner walls of the expansive main rotunda. The last amazing feature of the building was the fact that you could whisper to another person while on opposite sides of the rotunda because the sound bounces off the arch-shaped ceiling of the façade.

"Middle Paleozoic sequence stratigraphy and paleontology of the western flank of the Cincinnati Arch" was another field trip organised on the Wednesday. It was mainly run by **Carlton E. Brett** (University of Cincinnati), and the rumour was that if you wanted to get back before 9–10pm you should not go on this trip… On this particular occasion, however, we returned pretty much on time (which may have disappointed some people). The trip consisted of a lot of driving between locations and the first stop was a large road cutting that was extremely fossiliferous, which led

Carlton Brett discussing the stratigraphy and palaeontology during the Middle Palaeozoic field trip.

to discussions on depositional sequences and localised stratigraphy. This led on to further road cuttings before lunch at the Ohio State Park, overlooking the extraordinary and very fast-flowing falls of the Ohio River. We had a look at the geology and had the field trip photo taken next to two piles of sediment before we got back in the vans. These piles were labelled "Waldren Shale Silurian period" and "Dirt Devonian period" and you had to pick which one you belonged to. We then went to a quarry and had to sign our lives away before entering, so that in case of an accident we would not be able to sue them even if it was their fault. In the quarry, we examined the Silurian–Devonian boundary as well as some very interesting fossil beds and other features. We stopped at a few more locations to look at the major depositional sequences and the diverse faunas, as well as to discuss the changes in the sequence stratigraphy, depositional environments, biostratigraphy and palaeoecology in further detail. We then headed back to Cincinnati with the obligatory stop for ice cream in a Dairy Queen to help us all cool down. Once we got back we all felt it was time for some food and a stiff drink, so we headed to the Hungarian pub the convention attendees had been frequenting all week.

Socialising at the Celebratory Banquet in Union Terminal.

On Thursday evening, the Celebratory Banquet was held in the rotunda of Union Terminal, to which we were transported by a fleet of traditional, yellow, American school buses. Upon arrival, everyone began mingling over their free drinks. The banquet featured a main buffet offering a selection from various cuisines, which were all equally delicious, with a wide range of desserts to choose from. All dinner guests were addressed by **Arnold Miller** (University of Cincinnati), and the organisers of the convention were applauded for an excellent convention. After dinner we were allowed to explore Union Terminal. Nature films were being shown in its IMAX Theatre and both the Natural History Museum and the History Museum had opened their doors. The very life-like recreation of a bat cave was definitely worth a visit (or two) as was the dinosaur exhibit. Many of the attendees (and we don't mean just the students…) could be found in the Children's Museum, where one could crawl through narrow spaces, slide down chutes, and play with balls (the opportunity to drop a bucket of balls on other people's heads was definitely one not to miss!).

The last bus from Union Terminal departed at 22:30, but back on campus most of us felt it was still too early to go back to our rooms, so we headed off to the Hungarian pub. Sitting in the outside seating area, we watched a massive storm getting closer while drinking lots of alcohol and socialising together for the final time. Silent lightning lit up the sky for hours until just before closing time (around 2am) when the wind picked up dramatically and a torrential downpour ensued. We were allowed to shelter in the pub for a further thirty minutes to see if it died down, but it only got worse. Because we were being forced to leave the shelter of the pub (and they felt guilty), the bar staff handed out white bin bags which we converted into makeshift ponchos, and made a run for it.

On the last day of the convention a lot of people started departing in the late afternoon and early evening, many left on the Saturday. Some people stayed, to participate in the post-meeting field trip called "Middle and Upper Devonian sequences, sea level, climatic and biotic events in east-central Laurentia: Kentucky, Ohio, and Michigan", which was the last entry on the official convention programme.

It will be a while before the next instalment of the North American Paleontological Convention comes around, as it is only held once every four years. We nonetheless look forward to it with much anticipation. We would like to say thank you to the meeting organisers, all the delegates who attended and presented at the meeting, all the volunteers and the many sponsors for their generous support, including the Palaeontological Association which supported the attendance of a number of UK students. It was a really well organised and successful meeting with lots of interesting talks and posters, mixed with some good fun too.

Nikita Jacobsen & Martha Koot
University of Plymouth

Darwin in the Field: Collecting, Observation and Experiment
Sedgwick Museum of Earth Sciences, Cambridge *11 – 12 July 2009*

In the bicentenary year of Charles Darwin's birth, the Sedgwick Museum of Earth Sciences has promoted many Darwin-related educational projects. On 6th July 2009, the new permanent exhibition 'Darwin the Geologist' formally opened. The majority of the Beagle Collection rocks and minerals are now on public display for the first time. As part of the programme of events associated with that week, the Sedgwick Museum held a multi-disciplinary conference examining how Darwin operated as a field scientist. We thank the Palaeontological Association for providing financial assistance through the grant-in-aid meeting support scheme. The monies received were used to subsidise registration costs for students attending, and for providing some assistance in travel expenses for two invited overseas speakers. One of these, a history graduate from the University of Montana, presents his report on the conference below.

Lyall I. Anderson
Sedgwick Museum of Earth Sciences, University of Cambridge

Conferences about Charles Darwin abound in 2009. Most are broad in scope, exploring Darwin and his legacy, the impact of *On the Origin of Species*, evolution and society, and a myriad of other

themes. Few conferences, however, have focused (or will focus) on rather narrow topics of research. 'Darwin in the Field: Collecting, Observation and Experiment' was one such conference that brought together both historians of science and scientists interested in a very specific aspect of Darwin's life and work: his practical work in the field, broadly interpreted. Whether geological, zoological or botanical, this conference explored how Darwin collected and observed in the field. Mostly revolving around the voyage of HMS *Beagle* in 1831–1836, and the many geological pursuits Darwin carried out then, papers also concerned regional excursions (Wales and Glen Roy), experimentation at Down House, and Darwin's connection to botanical taxonomy.

"*Hence, both in space and time, we seem to be brought somewhat near to that great fact – that mystery of mysteries – the first appearance of new beings on this earth*," Darwin wrote in his *The Voyage of the Beagle* (2nd ed., 1845). For a conference mostly about Darwin's geological work, the Sedgwick Museum of Earth Sciences (<**http://www.sedgwickmuseum.org/**>) at the University of Cambridge was a fitting place to gather, especially since the museum now has an entire permanent exhibit devoted to Darwin as a geologist. Opened in 1904 in memory of the geologist Adam Sedgwick, and containing the collections he and John Woodward had previously accumulated, the Museum houses a vast collection of geological and palaeontological specimens, including those collected by Darwin himself. The timing of the conference was also very suitable, for it followed on from the week-long Cambridge Darwin Festival (5–10 July 2009, <**http://www.darwin2009.cam.ac.uk/**>), giving the opportunity to conference attendees to get their fill of Darwin beyond 'Darwin in the Field' by way of lectures, panels, exhibits, art, theatre and music.

Eleven participants from the UK and the United States presented their research over two days. **John van Wyhe** (University of Cambridge) and **Gordon Chancellor** (University of Essex) began the first day with their research on Darwin's 15 field notebooks used during the voyage of HMS *Beagle*. This research is part of their project, *The Complete Work of Charles Darwin Online* (<**http://darwin-online.org.uk/**>), and the publication of their *Charles Darwin's Notebooks from the Voyage of the 'Beagle'* (Cambridge University Press, 2009). After describing the field notebooks as objects and their content, van Wyhe and Chancellor discussed how these notebooks can be used to understand Darwin's field methods and the process of turning his raw material into later publications. Rev. **Michael Roberts** of Lancaster presented on '*Darwin's Welsh Connections,'* and how skills learned on excursions in Wales prepared Darwin for his time on the *Beagle*. Dr **Michael Howe** of the British Geological Survey outlined Darwin's data management system and how the Survey adopted an almost identical system for numbering specimens in the field. Howe also described other connections between Darwin and the Survey. Following Howe's presentation, the group broke for lunch and a special outdoor performance of the comedic "*Under the Floorboards: a time travelling adventure with the Rev. Adam Sedgwick*" by the street theatre group Pif-Paf Arts (<**http://www.pif-paf.co.uk/index.php**>).

Returning to Darwin, Professor **Paul Pearson**, a micropalaeontologist at Cardiff University, highlighted Darwin's attempt to synthesize his geological observations during the *Beagle* voyage into a unified theory of igneous geology, including a similar process to natural selection in the separation and settling of crystals that could cause changes to igneous rock compositions (a "*liquid line of descent*" according to Pearson). Professor **Martin Rudwick** (University of Cambridge), geologist turned historian of science, discussed Darwin's excursion to the Parallel Roads of Glen Roy in Scotland, his most substantial post-*Beagle* fieldwork, the resulting theory about its formation

being "*one long gigantic blunder*," and the relationship between fieldwork and scientific reasoning. "*I give up the ghost*" said Darwin when he reluctantly gave up his interpretation decades later. Dr **Jim Endersby** (University of Sussex), author of *Imperial Nature: Joseph Hooker and the Practices of Victorian Science* (University of Chicago Press, 2008), presented on the practice of botanical taxonomy in light of Darwin's theory of evolution by natural selection. Joseph Dalton Hooker, one of Darwin's strongest supporters, downplayed Darwin's theory when applied to botanical taxonomy, stressing that since species are stable in human lifetimes, the theory of evolution should not have an impact on practice. In essence, Hooker allowed himself only to the naming of new species in London, while his collectors, notably William Colenso, were limited in what they could do philosophically with their specimens. Since Hooker worked as a botanist for a living, unlike the independently wealthy Darwin, keeping the number of plant species to a minimum allowed him to more easily manage the herbarium at Kew, in turn crucial to continuing government support. Dr **Jon Hodge** (University of Leeds), long-time Darwin historian, looked at the relationship between Darwin's fieldwork in South America with *Mastodon* bones and his reading with respect to accounts of species extinction.

Following the first day's presentations was a wine reception and viewing of the Museum's handsome new exhibit *Darwin the Geologist* (<**http://www.sedgwickmuseum.org/exhibits/darwin.html**>), focusing on Darwin's fieldwork, research and publications concerning geology. Of all the Darwin exhibits I was able to see in Cambridge, this was my favourite, aesthetically pleasing in its layout and wonderful in its diversity of material. I particularly enjoyed how the material is displayed in older wooden cabinets while a few computer-based activities are included in the exhibit, notably the giant touch screen globe allowing visitors to follow the *Beagle* voyage through the rocks Darwin collected.

The second day of 'Darwin in the Field' consisted of five more presentations, mine included. Dr **Phil Stone** of the British Geological Survey gave an appreciation for Darwin's fossil collection from the Falkland Islands and its use by his scientific contemporaries. Dr **Brian Rosen**, of the Natural History Museum in London, explored Darwin's long-overlooked coral reef collection and his related exhibit. Dr **Gowan Dawson**, Senior Lecturer in Victorian Literature at the University of Leicester, presented on how fossils collected by Darwin during the *Beagle* voyage found a place in nineteenth-century popular culture. He focused on how the *Megatherium* became a metaphor for understanding novel technologies in a rapidly-changing era. My own paper, written as a history undergraduate at Montana State University, described Darwin's experimental programme with seeds at Down House. Darwin placed various seeds in salt water, then planted them to see if they would germinate. These experiments shed light on the possibility of transoceanic dispersal for various plants and animals, a crucial consideration to Darwin's transmutation theory. Joseph Dalton Hooker, however, argued against Darwin on these experiments, holding to the idea that land bridges and continental extensions explained the distribution of plants and animals across the globe. While I explored what occurred in these experiments and the dialogue between Darwin and Hooker, I argued that more was at stake with Hooker's dismissal of Darwin's ideas. Hooker did not approve of Darwin's conducting the experiments at his home rather than a scientific institution such as Kew. In debating questions of geographical distribution, Darwin and Hooker were debating the geographical context of science itself. Following my presentation was **Alistair Sponsel**, a post-doctoral fellow at the Smithsonian Institution Archives in Washington, DC, and the only other presenter from outside the UK. Sponsel re-examined Darwin's claim that he developed his theory of coral reef formation

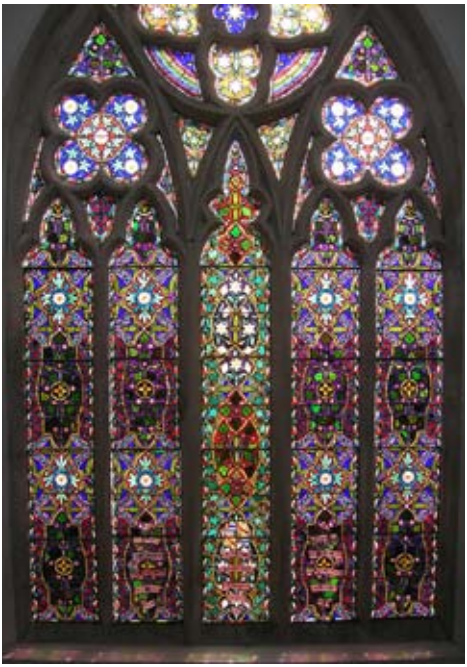
on the west coast of South America, arguing that Darwin only developed the theory after leaving South America.

Personally, for a budding historian, the opportunity to present my undergraduate paper at this conference was a great experience for several reasons: one, for the actual experience of presenting a paper (my first beyond a strictly student conference); two, for the chance to meet a variety of scholars interested in the same kinds of history I am; and three, for being able to explore a place that I have read about for some time now: Cambridge. Being in Montana, far removed from the significant places in the life of one of my favourite historical figures, visiting Cambridge and all the associated Darwin and history of science sites was a real treat. Thank you to the organizing committee of the conference for accepting my paper, and to the Palaeontological Association for the travel funding making my trip possible. You can read more about my experience at this conference and in Cambridge on my blog The Dispersal of Darwin, at <**http://thedispersalofdarwin.wordpress.com/2009/08/18/cambridge-trip-posts/**>.

Michael D. Barton
Montana State University, Bozeman, Montana, United States

8th International Symposium on the Cretaceous System
University of Plymouth *6 – 12 September 2009*

The meeting brought together a global contingent of over 200 geoscientists to focus on present advances in our understanding of the period, as well as promoting dialogue about past, present, and future research. The meeting was held in the Sherwell Centre, a renovated church, which was, at least from an American perspective, an intriguing venue given the inherent tensions between fundamentalist religion and geology. Despite this juxtaposition, the retrofitted venue provided an exceptionally functional space. Other than the opening plenary session, the meeting was structured around two concurrent sessions, each of which was introduced by keynote lectures. Strategically, poster sessions were left until at the end of the day and various sponsors provided sufficient food and drink to keep the participants engaged, conversing, and sated; usually with stragglers being herded out of the building so our hosts could get on with their lives.



The Sherwell Centre window (photo Doug Nichols).

In terms of the stimulating programme, the talks and posters covered a wide range of themes (the programme is available at <**www.cretaceoussymposium.org**>). The majority of them fit into what I consider to be four broadly defined, often overlapping themes. These were: 1) regional stratigraphy and palaeontology, including specific foci on various boundary issues, 2) mass extinction/bioevent research, 3) refinement of Cretaceous geochronology, and 4) latest Mesozoic palaeoclimatology.

Given the fortunate confluence of their relative geologic youth, in combination with their deposition during intervals with relatively high eustatic sea level, Cretaceous rocks are quite widely represented globally. This implies that significant research efforts continue to be devoted to examining and interpreting these rocks, and numerous talks dealt with descriptions of new sections as well as reinvestigations of known sequences, often at finer levels of lithological, palaeontological, biostratigraphic and/or geochemical resolution. Therefore, from both temporal and biogeographic perspectives, we are slowly reconstructing an increasingly complete, more highly resolved picture of the Cretaceous world. Certainly, however, there still remain numerous gaps in the existing record and there is little doubt that continuing and necessary work will add to completing knowledge of it.

The meeting also had a series of talks that were devoted to various Cretaceous bioevents. These intervals of biotic overturn continue to be sources of scientific interest and disagreement, as exemplified by continued debate over the causal mechanism(s) for the former K–T, now begrudgingly K–P, event. Unfortunately, the entrenched positions that exist on this issue have resulted in an atmosphere where there is little chance that people's opinions will be changed. Fortunately, there are less contentious events, such as those associated with various oceanic anoxic events (OAEs), which, despite their reduced effects on extinction intensity, are nevertheless critical components of Cretaceous evolutionary history. Our understanding of the environmental and palaeobiological dynamics of these events continues to be refined, and the data collected offer important insights into the nature of global greenhouse conditions.

As in symposia of years past, a number of talks were devoted to issues revolving around chronostratigraphy. The crux of Cretaceous geochronology fundamentally remains largely biostratigraphic in nature, and there were a broad range of talks that discussed advances in this field within various stages and taxonomic groups. Furthermore, continuing a trend that has been developing over the past decade or so, carbon-isotope stratigraphy and the so-called 'wiggle matching' of the various $\delta^{13}C$ curves remains an ever more frequently used tool for high-resolution correlation. The general application of this approach has been demonstrated throughout the Phanerozoic, but the Cretaceous appears to be at the cutting edge of efforts to push this technique to its limits. It remains to be seen to what level of resolution this technique will remain effective, but it offers significant promise. There are also groups working to refine numerical dating of various events by taking advantage of recent advances in precision of radiometric dating techniques. This effort is especially critical given the ultimate goal of using cyclostratigraphy and inherent Milankovitch-frequency lithological responses as recorded in sedimentary cycles; the development of a rigorous, highly refined geochronology is truly critical to this effort.

From my perspective, one of the most exciting and fertile areas of research in the Cretaceous revolves around palaeoclimate issues. There is an intriguing dichotomy in the evolving interpretations and the climatic implications of various proxies now current. Fundamentally (or

perhaps simplistically?), the argument revolves around whether and when the Cretaceous was warm, equable, and ice free. Traditionally, the perspective has been that the Early Cretaceous was relatively cool whereas the Late Cretaceous was warmer. For the past few years, various research efforts focused on those two intervals are attempting to turn the pre-existing interpretations on their respective heads. Several talks focused on the application of the relatively new proxy, TEX_{86}, both in terrestrial and marine settings. Although the use of this proxy may still be in the 'euphoric' stage, and some of the problems that commonly develop with proxies as their usage becomes more widespread remain yet to be uncovered, this technique offers the potential to reshape Cretaceous temperature history. This apparently is especially so given the requirement for unaltered, 'glassy' foraminifers for the more commonly employed $\delta^{18}O$ palaeothermometry; the lack of which precludes reliable isotopic results for much of the available material. Results based on the TEX_{86} proxy apparently solely reflect sea-surface temperature, thus avoiding some of the depth complications associated with other proxies, such as planktic foraminifers. The data suggest that not only was the mid-Cretaceous warm at high latitudes, but that even previously hypothesized cooler intervals may also have been warmer. These results contrast with some others from the mid-Cretaceous, which interpret the record of sea-level change as having been forced by glacio-eustacy. I'm intrigued as to how these new data will develop as well as how they will influence and potentially revolutionize our view of Cretaceous climate.

I would be remiss not to mention one of the meetings' highlights: a half-day excursion to the Devon coast attended by the vast majority of participants. We all boarded a vessel that simply ploughed into the beach at Seaton, and then partook in a trip up and down the coastline with its spectacular Cretaceous exposures.

Conference delegates take to the waves (photo Richard Twitchett).

This was followed by a further 'up-close' examination of the mid-Cretaceous exposures at Beer where the chalk sequence is well developed. It is unlikely that any on the trip, especially those of us on the first bus, will ever forget the bus-auto ballet as we attempted to get to Beer; the bus drivers were exceptionally capable and patient in herding on-coming traffic back down the hill. There was also a post-conference fieldtrip that further explored the Mesozoic sequence along Devon's coast extending east to the Isle of Wight.

View of the Cretaceous Chalk cliffs at Beer (photo R.J. Twitchett).

The symposium also provided a forum for meetings of various working groups. These ran the gamut from two Cretaceous-oriented IGCP groups (507 and 555) to the Tanzanian Drilling Project, to various working groups, including the Cretaceous Sub-Commission. The latter has been capably led by Isabella Premoli Silva, and she was the recipient of an honorary degree from the University of Plymouth for her leadership in Cretaceous research. Hopefully, with her continued tenure as chair, the group will drive more 'Golden Spikes' in the near future.

Of course, no meeting occurring this year, especially one that has a more-or-less direct connection to Charles Darwin, can ignore a reference to him on this 200th anniversary of his birth year. Darwin spent approximately two months in Plymouth awaiting the departure of the *Beagle* and commented that this period was 'the most miserable which I ever spent'. This symposium, in contrast, was exhilarating, the weather more than cooperated, the Hoe was overrun with Cretaceous geoscientists, and it afforded a magnificent chance to reconnect with colleagues from around the globe. For its success, we are hugely indebted to the co-conveners, Malcolm Hart and Gregory Price, and numerous other members of the University community – including lecturers, instructors, staff and students – for their excellence in organizing this meeting, and to the sponsors, including the Palaeontological Association, for helping defray some of the costs. I'm sure the Cretaceous community is looking forward to the 9th symposium to be held in Ankara, Turkey in 2013!

Peter Harries
University of South Florida

SPECIAL MEETING
of the French Geological Society (S.G.F.)

LYON: 22-23-24 April 2010

Jurassic Environments and Faunas

Under the auspices of the **C**omité **F**rançais de **S**tratigraphie,
the **G**roupe **F**rançais d'**E**tude du **J**urassique and the **A**ssociation **P**aléontologique **F**rançaise

A tribute to Serge ELMI

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

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

Informations: SGF-elmi.univ-lyon1.fr

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

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

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

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

This field workshop aims to investigate the recovery of ecosystems following the end-Permian mass extinction through analyses of the rock and fossil records, via studies of biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry. The topics of the one-and-a-half day conference at the Gutech, Muscat, on 21 & 22 February 2010 will address recovery patterns of various fossil groups; reconstruct global Permian–Early Triassic oceanic and climatic conditions; outline P/Tr ecosystem types; and correlate these types of data with a global stratigraphic framework. New data on the Permian–Triassic transition in Oman will be presented.

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

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

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

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

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

This multidisciplinary meeting will consist of two days of indoor sessions and a one-day field-trip, and is planned to address various aspects in sedimentary geology, palaeoecology, biostratigraphy and palaeobiogeography. Scientific sessions will consist of keynote lectures, oral presentations and posters. The proceedings of the meeting will be published in the peer-reviewed journal Bulletin of the French Geological Society. The post-meeting excursion will include a visit to the well-known Jurassic localities around Lyon (southern Beaujolais and Mont d'Or lyonnais).

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

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

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

The symposium aims to update the studies on the P/Tr mass extinction and possible causes, investigate the mechanisms and processes of marine ecosystem restoration following the P/Tr mass extinction through studies of biostratigraphy, palaeontology, palaeoecology, sedimentology, geochemistry and biogeochemistry, and elucidate the growth mechanisms and environmental significance of the Early Triassic microbialites. Three potential field excursions will be organised before and after the symposium: 1) Meishan-Chaohu: examining the P/Tr mass extinction and its aftermath from platform ramp to basin setting; 2) Guizhou: assessing recovery pattern and processes of palaeo-communities in various facies settings; 3) Southern Tibet: collapse and re-building of marine ecosystems at the margins of Gondwana. Funds are available to help students and presenters to participate in the meeting and field excursions. More information can be found at <**http://geobiology.org.cn/2010meeting**> and <**http://www.igcp572.org/**>.

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

Third International Palaeontological Congress (IPC3)
London, UK *28 June – 3 July 2010*

IPC is a major international meeting held once every four years under the auspices of the International Palaeontological Association. The meeting provides a showcase for all that is exciting and new in the fields of palaeontology and palaeobiology. IPC3 in 2010 is hosted by the Palaeontological Association and partner organizations, and will be based in Imperial College and the Natural History Museum in the heart of London's 'Albertopolis'. The programme will comprise field trips, plenary lectures, workshops, contributed talks and posters, and thematic symposia.

For further details and announcements visit the meeting website at <**http://www.ipc3.org/**>.

8th European Palaeobotany–Palynology Conference
Budapest, Hungary *6 – 10 July 2010*

EPPC conferences usually host a small but enthusiastic group of Quaternary (Pleistocene and Holocene) pollen and plant macrofossil scientists. In accordance with the tradition of EPPC conferences, oral and poster presentations are invited to introduce the latest findings and results of palaeobotanical and palynological research. We are looking forward to receiving presentations focusing on Paleozoic, Mesozoic and Cenozoic taxonomy, palaeofloristics, taphonomy, palaeoecology and palaeoclimate studies. Symposia, poster sessions, and meetings associated with workshops will be included in the scientific programme.

Call for Symposia
We invite proposals from scientists dealing with any field of palaeobotany, palynology and associated sciences to organise symposia and workshops, and we encourage all of you to contribute new ideas, topics and concepts to enhance the scientific quality of the conference and attract more participants. Symposium proposals may address any topic related to palaeobotany and palynology.

The preliminary scientific programme includes Palaeozoic, Mesozoic, Cenozoic (Palaeogene–Neogene and Quaternary) palaeobotany and palynology sessions giving the framework for symposia. Please send proposals in electronic format to Boglarka Erdei (email <**paleobot@bot.nhmus.hu**>). The deadline for proposals is 15th November 2009.

For further information on the call for symposia, see
<**http://www.eppc2010.org/modules.php?name=scientific**>

Registration
Registration and hotel information are published on the EPPC conference website. Conference registration will open on 1st November 2009.

Social Programmes
You can find detailed information at <**http://www.eppc2010.org/modules.php?name=soc_prog**>

Professional field trips
Various pre- and post-conference field trips will be organised for participants, to ensure that all can select the one that fits their personal interest; see
<**http://www.eppc2010.org/modules.php?name=professional**>

If you are interested in EPPC 2010, please contact the conference secretariat via the following link, so that we can keep you informed about the latest news:
<**http://www.eppc2010.org/modules.php?name=contact**>.

Come and join the 8th European Palaeobotany–Palynology Conference and experience Hungarian hospitality!

Flugsaurier 2010: Third International Symposium on Pterosaurs
Beijing, China *5 – 10 August 2010*

Pterosaurs are among the most fascinating and enigmatic of all extinct creatures. Thanks to some spectacular fossil finds in recent years our understanding of the palaeobiology and evolutionary history of these 'flying reptiles' has seen several dramatic advances. Some of the most important discoveries, including the first eggs with embryos, have been made in China, where the Late Jurassic/Early Cretaceous is currently producing new species of pterosaurs at a faster rate than anywhere else in the world. In recognition of this the Third International Symposium on Pterosaurs, 'Flugsaurier 2010', will be held in China in August 2010. This will be the third international pterosaur symposium and follows successful meetings in France in 2001 and Germany in 2007.

The meeting will be organised by the Geological Survey of China, sponsored by the Institute of Geology, Chinese Academy of Geological Sciences, and co-sponsored by the Bureau of Fossil Protection, Liaoning Provincial Department of National Land Resources, and the People's Government of Yixian.

The meeting is planned for 5–10 August 2010. Talks, posters, at least one open discussion session and (subject to availability) examination of specimens, are planned for the first three days of the meeting. This will be followed by an optional three-day field excursion to view exposures of the

Jehol Group and exhibitions/collections of fossils from this sequence which has yielded more than 100 specimens of pterosaurs in the last ten years. All those interested in pterosaurs and the communities and environments in which they lived are encouraged to attend.

1. Meeting aims:

As in previous symposia this meeting is intended to cover all aspects of pterosaur palaeobiology and the world in which they lived:

(a) The origin and evolution of pterosaurs

(b) Taxonomy, systematics and phylogeny

(c) Palaeobiology including anatomy, functional morphology and ontogeny

(d) Taphonomy, sedimentology and environments of preservation

(e) Ecosystems and contemporaneous fauna and flora

2. Meeting Programme:

(a) Academic sessions (three days): Oral presentations: These will consist of key-note lectures (45 minutes) and talks (30 minutes). These times include at least five minutes for discussion. Posters: There will be at least one poster session (further details will be given in the second circular). Language: English.

(b) Field excursion (three days): North-east China. This will include visits to field sites, exhibitions and collections primarily in Liaoning Province.

3. Abstracts and Symposium Volumes:

An abstract volume will be prepared for distribution at the meeting. The abstract submission deadline is 31st March 2010. No abstracts will be accepted after this date. Abstracts of up to two printed pages (A4) are preferred, but longer abstracts will be considered. Preferred formats are 'Word' for text files and 'JPG' for figures. A symposium volume is planned for publication in 2011 and will be available to both attendees and non-attendees. The manuscript deadline will be 31st December 2010 (further details will be given in the second circular).

4. Expressions of interest/information:

If you are interested in attending this meeting please send us an expression of interest indicating your plans to attend the academic session and the field trip, possible talk/poster title(s) and likelihood that you will be accompanied.

All correspondence (e-mail preferred), including any questions or suggestions, should be sent to Lü Junchang and Dave Unwin:

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

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

Preliminary schedule:

20 August: Registration and welcome reception
21 August: Opening Ceremony and group photo, Conference symposia and general sessions
22 August: Conference symposia and general sessions; Congress Banquet
23 August: Mid-conference social programme and conference excursion
24 August: Conference symposia and general sessions
25 August: Conference symposia and general sessions, workshops, Closing Ceremony
26–28 August: Post-conference field excursions

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

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

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

The registration fee is US$350 (students US$200, accompanying person US$200), which will cover the expenses of the meeting resources and support, congress publication (congress special issues, abstract volume and programme, not provided for accompanying members), conference bag, T-shirt, tea and coffee breaks, all meals from 20th to 26th August, Mid-Conference social programme to Great Wall and Ming Tombs on 23rd August, icebreaker reception, and conference lunch and dinner. The Congress Banquet on the evening of 22nd August will be available for regular registrants without additional charge.

Note:

1. Registration fees are subject to modification depending on the exchange rate between the Chinese Yuan RMB and US$. The rate of exchange on 23rd January was US$100 = 680.37RMB Yuan.)

2. Payment: A down-payment for the meeting and field trips will be requested in the Second Circular. The balance will be due at the time of the meeting, payable in US$.

3. Outstanding students and distinguished retired palaeoentomologists may apply for limited financial support (free of charge for Registration Fees and Accommodation from 20th to 26th August). All applicants should give an oral presentation and contribute an original manuscript to the Proceedings for evaluation by the Organizing Committee.

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

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8th International Symposium, Cephalopods – Present and Past (8ISCPP)
Dijon, France *31 August – 3 September 2010*

The 'International Symposium, Cephalopods Present and Past' – ISCPP – brings together all scientists working on extant or extinct cephalopods. The diversity of this group of molluscs, together with its broad temporal and spatial distribution, makes it a successful model for addressing key scientific issues. We are proud to host the 8th ISCPP at the University of Burgundy, Dijon, France from 31st August to 3rd September 2010. It will be a unique opportunity for sharing research ideas and recent findings on all aspects of cephalopod biology and evolution. We strongly encourage young scientists to attend this symposium. Studies using cutting-edge techniques and original approaches are particularly welcome. Dijon is located 310 km (186 miles) from Paris and it takes only about 90 minutes to get there by train. Two fieldtrips will follow the symposium: a one-day fieldtrip in Burgundy, and a four-day fieldtrip beginning near Lyons and continuing in the "Réserve Géologique de Haute-Provence" (South of France).

For further details e-mail <**Pascal.Neige@u-bourgogne.fr**>.

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

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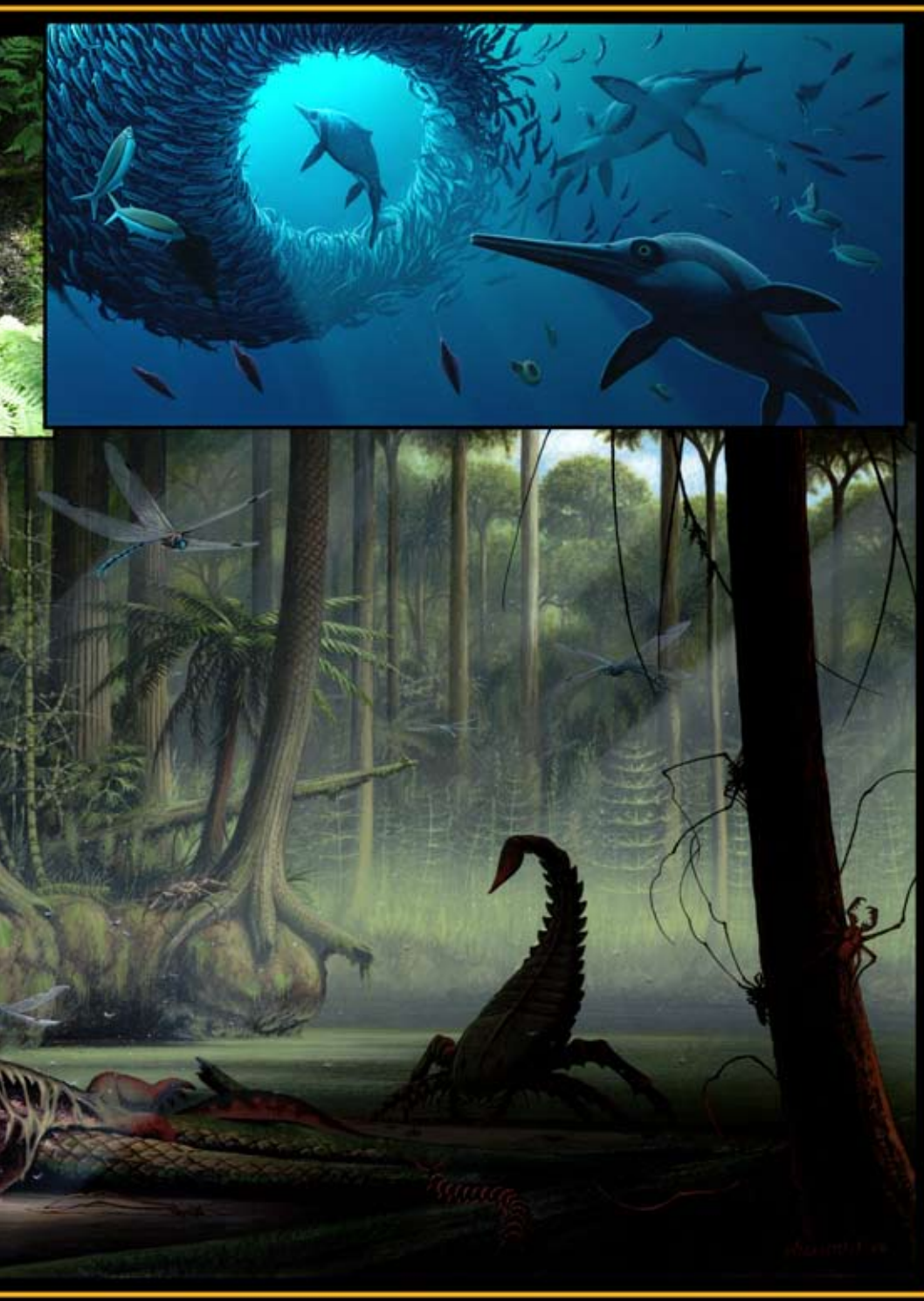

A crinoid on the corner

Edinburgh buildings are not short of plaques and armorial shields bearing creatures and beasties, both real and imaginary. I was intrigued to come across a plaque, with what appeared to be a crinoid design, on a wall at the junction of East Claremont Street and Broughton Road in the New Town area.

Figure 1. Plaque with crinoid design on the exterior wall of 133–135 East Claremont Street at the junction of East Claremont Street and Broughton Road, Edinburgh.

Closer examination confirmed that the plaque did feature a stylized crinoid calyx with arms, surrounded by an octagonal arrangement of columnals. The presence of the plaque at this unremarkable junction, and the lack of any indication of what it signified, was an enigma that seemed worthy of some further investigation.

My enquiries began inside the building to which the plaque was fixed, 133–135 East Claremont Street. By good fortune this turned out to be a pub. At the bar I discovered that the plaque had been restored around 2003 or 2004. The bartender couldn't give me any further details, but was able to tell me that the whole building was leased from the Scottish Midland Co-operative Society (SCOTMID). In return for this information, I did my best for the public understanding of palaeontology with an explanation of crinoid morphology.

My next visit was to the Edinburgh Room of Edinburgh Central Library, seeking reference material relating to the building and the help of the Local Studies librarians who are familiar with researching such topics. The photographs of the plaque led to a search on the listed buildings register of Historic Scotland, a consultation of a book of plaques and coats of arms found in Edinburgh, and a gazetteer that detailed points of historical and architectural interest on a street-by-street basis. No listings of any sort were to be found relating to the building or plaque.

Figure 2. Close-up shot showing more detail of the crinoid calyx and arms. The carving does not appear to include a stalk attached to the calyx.

Finding out whether the SCOTMID records of the building contained any useful material relating to the plaque was the next task. Graeme McLean, the property manager for SCOTMID, kindly spoke to me about the property. He was somewhat surprised to get an enquiry from a palaeontologist, but was able to confirm that SCOTMID owned the building, which had been built in 1923. The only additional information he was able to provide was that the building had originally belonged to the St Cuthbert's Co-operative Association that was established in 1859,

which went on to become SCOTMID when it merged with Dalziel Society of Motherwell in 1981. The significance of both of the dates on the plaque was now clear, but why the plaque featured crinoid elements remained unanswered. The more astute among you will already have worked out the connection between this co-op and crinoids. However, I missed the link, so the search for an answer continued.

Dr Tim Palmer, the Executive Officer of our Association, also has a particular interest in building stones and historic buildings. So, I sent my findings to him and asked his advice about other possible resources that might help to uncover the history of the plaque. Tim helpfully reminded me of the connection between St Cuthbert and crinoids that many readers will already know of. Crinoid columnals are known in some parts of England and Scotland as St Cuthbert's Beads. Of all of the connections between palaeontology and folklore, the key one to solving the puzzle had slipped my mind.

St Cuthbert was a monk who lived at the monastery on the island of Lindisfarne during the 7th century. Two legends exist that link the saint with the Carboniferous crinoid columnals found on the beaches of Lindisfarne. The legends are summarized in a paper in a folklore journal by two echinoderm researchers (Lane and Ausich 2001), which also explored the geological and palaeontological background to the legends. The first tale claims that the columnals are part of St Cuthbert's rosary, as some of the columnals have had the sediment filling the central hole (lumen) in the columnal eroded out, enhancing their beadlike appearance and allowing them to be strung together by the locals. This explains the octagonal arrangement of the ossicles around the crinoid calyx on the plaque. The second, altogether more fantastical, legend is that St Cuthbert makes the beads sitting on one rock while using another rock as an anvil to form each one.

The legend of St Cuthbert's Beads is a regional one, most strongly associated with parts of northern England and southern Scotland. Other folk beliefs associated with crinoids can be explored on the website of the Natural History Museum, London, which has a collection of pages about fossils and folklore at <**http://www.nhm.ac.uk/nature-online/earth/fossils/fossil-folklore/**>.

An online scan of the title page of a history of St Cuthbert's Co-operative Association suggests that the design on the plaque was adopted at the founding of the Association in 1859 (Maxwell, 1909), although I await an inter-library loan of the book to confirm this. So the reason for the crinoid plaque on the corner is now clear: it was the logo of the Association and is perhaps one of many examples, as St Cuthbert's Co-op had premises across Edinburgh. Interestingly, the inclusion of the crinoid calyx and arms indicates that at least some of the founding members of the St Cuthbert's Co-operative Association were aware of the palaeontological explanation for the columnals. This is somewhat surprising, as the relationship of isolated crinoid elements to the whole organism was the subject of much speculation and misunderstanding until the early 19th century (Ausich and Lane 2005). However, Chambers' (1864) *Book of Days* contains the legend of St Cuthbert's Beads followed by a concise paragraph explaining that the columnals were parts of crinoids, which are correctly assigned to Echinodermata. Chambers also includes a theory that the columnals were being eroded from an offshore shale unit before washing up on the beaches of Lindisfarne. Perhaps the non-miraculous explanation of their occurrence was more widely known by the mid-19th century than we might suppose.

The choice of a fossil associated with a 7th century monk from Northumbria, the northeasternmost county of England, as the logo of a 19th century co-operative association in the Scottish capital of Edinburgh may seem odd to some readers. But the use of ancient names on modern maps can be deceptive. Northumbria used to be a much larger Anglo-Saxon kingdom that stretched as far north as the Firth of Forth, where Edinburgh lies. Cuthbert himself is thought to have come from near the town of Dunbar, which is now found in the Scottish county of East Lothian and has associations with places on both sides of the modern border.

Today, the plaque certainly provides an eye-catching splash of colour on an otherwise drab sandstone wall, but how many passers-by could pull together the strands of palaeontology, folklore and local history required to interpret this piece of street corner heraldry? Nobody I spoke to in the course of researching this article, other than Tim Palmer, knew what a crinoid was. And, as I have confessed, I needed to be reminded of the legendary association between crinoid ossicles and Cuthbert that explained the crinoid on the corner. Science may replace superstition, but sometimes deciphering the history of a building or monument requires knowledge of both.

Acknowledgements

I would like to thank Mr Graeme McLean of SCOTMID for taking time to speak to me about the plaque. Dr Tim Palmer is thanked for his rapid response to my request for help in investigating the plaque. I would also like to acknowledge the staff of the Edinburgh Room of the Central Library for their efforts on my behalf.

Al McGowan
Newsletter Reporter

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Sylvester-Bradley REPORT

Palaeogene vegetation and climate change from the U.S. Gulf Coast

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Current environmental change has given the ecologists' interest in the distributions of taxa and their controls a new relevance and urgency. It has become increasingly clear that the fossil record provides an invaluable source of empirical data to examine the responses of species and communities to environmental reorganization over a variety of temporal and spatial scales (Bennington *et al.*, 2009). By now the geologic and fossil records are well known enough for us to begin targeting specific time periods, regions, environments and taxa to produce results relevant to scientists working on modern ecological systems.

One such 'archive' is the early Palaeogene dispersed sporomorph (pollen and spore) record of the U.S. Gulf Coast. This documents extinct plant communities that are homologous to modern tropical to subtropical forests (Harrington, 2008). It therefore allows for the testing of hypotheses concerning the history of tropical diversity, and the response of diverse, warm-adapted plant communities to climate change, sea level change, and the immigration of potentially competitive plant taxa.

The goals of my PhD are to properly quantify patterns of biodiversity and compositional change using up-to-date ecological and macroevolutionary techniques, and to carefully set up and test hypotheses concerning their underlying processes. The broad-scale patterns of species composition and turnover across the Gulf Coast are already known through monographs and taxonomic treatments (Carroll, 1999; Elsik, 1968a; Elsik, 1968b; Frederiksen, 1980b; Frederiksen, 1988; Nichols, 1973; Srivastava, 1972; Tschudy, 1973a; Tschudy, 1973b; Tschudy, 1975), biostratigraphic studies (Frederiksen, 1980a; Frederiksen, 1991; Frederiksen, 1998), and high-resolution analyses of the response of these floras to the Palaeocene–Eocene Thermal Maximum (PETM) (Harrington, 2001; Harrington and Kemp, 2001; Harrington, 2003; Harrington *et al.*, 2004; Harrington and Jaramillo, 2007; Harrington, 2008). As can be seen, many of these studies were carried out in the 1970s and 1980s, and much remains to be done in terms of putting these general patterns onto a more rigorous statistical footing, and asking questions that have only started to interest ecologists and palaeoecologists more recently.

A Sylvester-Bradley award funded a two-week field trip to the U.S. Gulf Coast in May 2008. We collected almost 400 samples from Late Palaeocene outcrops in Texas, and from sediment cores spanning the Early Palaeocene to late Early Eocene interval in Mississippi and Alabama. The majority of samples collected are marginal marine deposits, and therefore contain pollen from a potentially sub-continental source area (Colinvaux and De Oliveira, 2001; Haberle and Maslin, 1999). Lignite samples, representing swamp development, are parautochthonous deposits and thus provide a much more local signal (Traverse, 1988), albeit one biased towards swamp-tolerant plants.

The sporomorph record in Texas has received much less interest than that of the eastern Gulf coast. A lack of calcareous microfossils in the Late Palaeocene sediments (Breyer, 1997) also means that the dating of these deposits is more poorly constrained than in Mississippi and Alabama. Using pollen as a biostratigraphic tool has allowed us to date the Texan Calvert Bluff Formation to the last one million years of the Palaeocene (equivalent to the Tuscahoma Formation on the better-dated eastern Gulf Coast), meaning that the ever sought after Palaeocene–Eocene boundary, and the PETM, must lie in or at the base of the overlying Carrizo Formation. The lack of fine-grained sediments in this formation will impair microfossil-based biostratigraphy.

The next stage was to compare the microfloras of the Calvert Bluff Formation on the western Gulf Coast and the age-equivalent Tuscahoma Formation on the eastern Gulf Coast. This provided an opportunity to consider the spatial heterogeneity of these diverse, paratropical forests. Analytical techniques employed include distance metric-based approaches (ordination, ANOSIM and NPMANOVA) and additive partitioning of species richness compared against a randomised null model. Despite the lack of a geographic barrier between the western and eastern Gulf Coast during the Late Palaeocene, a statistically significant compositional difference does exist between the sporomorph assemblages on each side of the coastal plain. This implies a limited level of interchange between the two assemblages, perhaps as a remnant from the epeiric mid-continental seaway that would have divided the Gulf Coast during the Cretaceous and earliest Palaeocene (Tschudy, 1981). Whether dispersal limitation or habitat heterogeneity maintained this compositional separation will require further testing, as will determining the long-term spatial dynamics of the Gulf Coast vegetation type. These results do show that even deposits with a low spatial resolution, such as the marginal marine samples discussed here, can contain meaningful spatial information on a within-biome scale. The lignite samples also show the same compositional pattern. This suggests that these deposits have much potential for studying finer scale spatial trends than is possible from marginal marine deposits alone.

Current work is focusing on the eastern Gulf Coast, which has one of the best-known Palaeogene pollen records in the United States (Frederiksen, 1994). Once processed and counted, these samples will cover approximately 12 million years of the early Palaeogene. Topics of interest include the long-term ecological evolution of the Gulf Coast paratropical vegetation type, the significance of the PETM in the context of a longer timescale, and the response of the paratropical biome to post-PETM early Eocene warming (Lourens *et al.*, 2005; Nicolo *et al.*, 2007).

This research has already resulted in a greatly improved knowledge of Late Paleocene floral dynamics on the U.S. Gulf Coast. The dataset being assembled will be invaluable for future analyses of Palaeogene microfloral change, plant migrations, and the responses of tropical plant communities to climate change. I would like to thank the Palaeontological Association

for generously funding this work. I would also like to thank my supervisors, Guy Harrington and Paul Smith, as well as Tom Stidham (Texas A&M University), David Dockery (Mississippi Office of Geology) and Richard Carroll (Geological Survey of Alabama) for their indispensable assistance during fieldwork.

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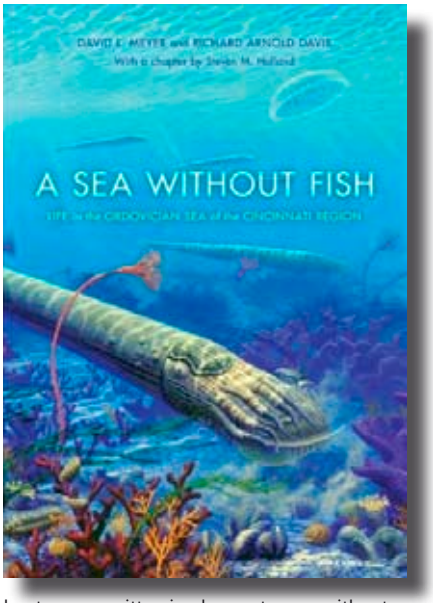
Book Reviews

A Sea Without Fish: Life in the Ordovician Sea of the Cincinnati Region

David L. Meyer and Richard Arnold Davis with a chapter by Steven M. Holland. 2009. Indiana University Press. 368 pp. 102 b&w photos, 14 colour. $44.95.



Although I have not yet been fortunate enough to see the famous fossils of the Cincinnati region in the field, *A Sea Without Fish* does a superb job of bringing alive what is obviously an extraordinary example of Ordovician biodiversity. In this multi-authored work, copiously illustrated chapters on the main groups (algae, poriferans and cnidarians, bryozoans, brachiopods, molluscs, annelids, arthropods, echinoderms, graptolites and conodonts, and trace fossils) are preceded by several scene-setting chapters, documenting the fascinating history of the Cincinnati School of Palaeontology and explaining some of the principals of the science.

As intended, this book is very accessible to the general public and amateur geologist, and does a great job in "recounting the history of the Cincinnati region in deep time". It will also be of use to students and academics, as well as those interested in the history of science. The taxonomic chapters are written in eloquent prose without too much technical jargon. Where technical terms are encountered for the first time they are printed in boldface type and some are linked to the glossary. The reference to living relatives of the fossils described, along with photographs of some of them, adds an extra dimension to the book. Several of the group chapters are more detailed than others and only occasionally I wished that the authors had gone a bit further with their explanations and examples. Scattered throughout the book's margins are occasional quotes and notes which, although I found them a little distracting to begin with, are appropriately placed and relevant.

A fourteen page colour 'Gallery' marks the half-way point of the book and includes a wonderful diorama of the Ordovician Cincinnati underwater world by John Agnew (also used on the cover of the book) who has skilfully illustrated other parts of the book with clear black and white line drawings. The production quality of the book in the hardback version I read was very high and the format/layout clear and well thought out.

The penultimate chapter by Steven Holland is a succinct review of the palaeogeography and palaeoenvironments of the region, and is supported by global and local scale maps. The final chapter, *Life in the Cincinnatian Sea,* is a thorough synthesis of Cincinnati palaeoecology addressing

topics such as predator–prey interactions, assemblages, associations, and the concept of guilds. But that is not the end. The rather 'academic' last chapter is followed by an epilogue, *Diving in the Cincinnatian Sea,* which treats us to a guided diving tour where individuals from earlier chapters are met along the way. This is a great way to end the book, and brings together all that has been previously discussed.

A Sea Without Fish benefits from a resources section that lists publications, field guides, museums and outdoor education areas, societies and scientific institutions, as well as a list of individuals and institutions associated with the type-Cincinnatian, a useful glossary, reference list and an index. Priced at $44.95 (~£30) this book is good value for money. Perhaps one day I'll make it to see these wonderful fossils in the field and join the authors in Ohio, and perhaps we will search for those elusive early fish that are unknown from the Cincinnati region and from where this book gets its intriguing title.

James R. Wheeley
University of Birmingham, UK

Books available to review

The following titles are available for review. If you are interested in reviewing any of them, please contact our Book Review Editor, Dr Charlotte Jeffery-Abt, via email to <**chj@liverpool.ac.uk**> or at the Department of Earth and Ocean Sciences, University of Liverpool, 4 Brownlow Street, Liverpool L69 3GP.

- *Origins: Selected Letters of Charles Darwin, 1822–1859* Anniversary edition. Edited by Frederick Burkhardt.
- *Evolution: Selected Letters of Charles Darwin 1860–1870* Edited by Frederick Burkhardt, Alison M. Pearn, and Samantha Evans.
- *The Young Charles Darwin* by Dr Keith Stewart Thomson.
- *The Age of Dinosaurs in South America* (Life of the Past), by Fernando E. Novas.
- *Patagonian Mesozoic Reptiles* (Life of the Past), by Zulma Gasparini, Rodolfo A. Coria and Leonardo Salgado.
- *Fishes and the Break-up of Pangea*, Geological Society of London, Special Publication no 295.

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