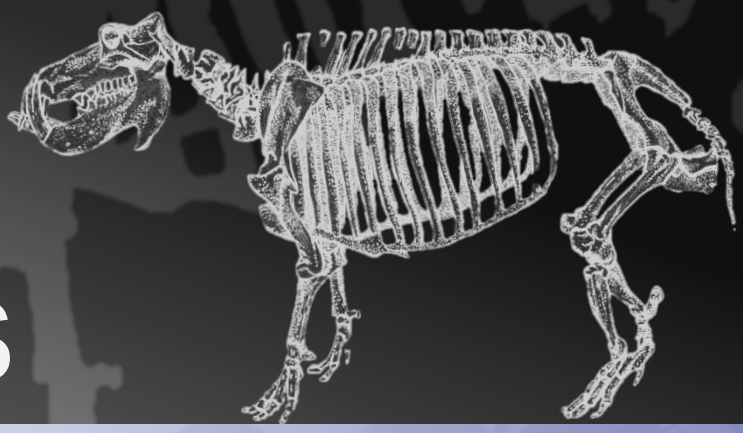
Progressive Palaeontology



@LEEDS

Programme & Abstracts

22nd–24th May 2013

Delegate Copy

@ProgPal2013

Progressive Palaeontology @ Leeds

22nd-24th May 2013

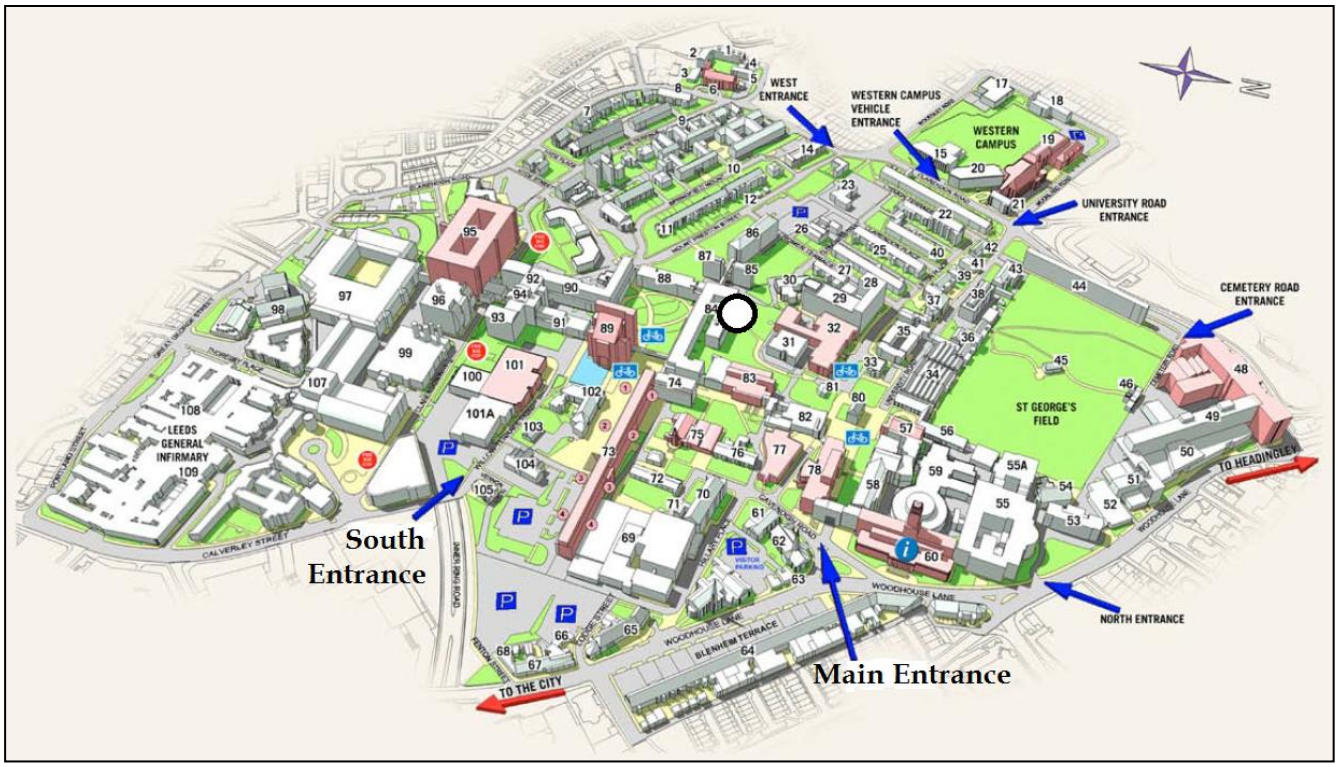
School of Earth and Environment, University of Leeds

Welcome to Leeds

This year Progressive Palaeontology is taking place in the vibrant northern city of Leeds, bringing together workers from over 20 universities from 3 countries and a huge range of research areas. Whether you're staying for one day or a week we hope you enjoy the conference, the University, and your time in our city!

Venue

The conference will be held in the School of Earth and Environment, University of Leeds. The department (marked on the map below) is best reached via the South or Main Entrance. At the South Entrance follow a gated road past The Edge sports centre until you reach a ramp and stairs leading to fountains, walk around these fountains following the trees until you see another longer ramp leading undercover to a large quad. From here the department is signposted but there will be volunteers in ProgPal T-shirts helping direct delegates on campus.



Travel

Road: Regrettably we cannot provide onsite parking for delegates, but we instead recommend using The Light, or The Rose Bowl city centre parking facilities, both of which are secure and within a short walking distance of the university. There are regular coach services to Leeds (for booking information visit www.nationalexpress.com), and connections directly to campus are available every 10 minutes via the Leeds City Bus for 50p to the South Entrance. If taking a taxi, ask for 'the Parkinson building', which is the main entrance labelled on the map.

Rail: This is by far the easiest way to travel to a from the University. Leeds train station is approximately 15 minutes walk from the department, and the restaurant is located between the two. The Leeds City Bus links the train station and university South Entrance. To walk from the station, head away from The Queens hotel along Quebec Street to your left, and follow this road until turning right on to Kings Street. Follow this

main road, which changes to East Parade and then Calverley Street. Carry on along this road passing Millennium Square and the city hall, crossing over a road bridge to the South Entrance of the university campus.

Air: The nearest airport is Leeds Bradford International Airport (~8 miles away) with regular buses in to Leeds (http://www.wymetro.com/howtogetto/airports/leedsbradfordinternationalairport.htm). The larger Manchester International Airport (~55 miles) has very frequent connections to Leeds via coach and train.

Registration
Registration will take place on the 22nd May at the icebreaker reception from 17.30, and the morning after from 7.30. The desk will be at entrance of the School of Earth and Environment foyer area.

Icebreaker
We will provide food and refreshments in the department before going to Veritas, a bar towards the city centre. We advise speakers to use the icebreaker to test their presentations on our system, especially if they feature movies, sound, or other effects. Organisers will be wearing PalAss or ProgPal shirts.

Poster Sessions
Delegates presenting posters are asked to submit these at registration along with any additional instructions or requirements we can reasonably accommodate. The poster session ends at 18.00 on 23rd May, after which you can either remove your material, or leave it for us to safely store overnight (recommended if attending the dinner/fieldtrip).

Oral Sessions
Sessions will take place in the seminar rooms immediately next to the reception area and will last 10-15 minutes with 5 minutes for questions and feedback. Speakers are requested to submit their talks in advance if possible but at the latest by 8.30am of 23rd May to Tom Fletcher, either by email eetmf@leeds.ac.uk, or on a USB in person. Our guest speaker Professor Jane Francis will welcome delegates to the University of Leeds.

Progressive Palaeontology 2013

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Live Streaming
This year we will be streaming talks live with Palaeocast to expand the potential audience and invite feedback and questions from across the globe on **Twitter** and **Facebook**.

Annual Dinner
This year the annual dinner will be held at Spice Quarter (http://www.spicequarter.co.uk/leeds-home/), a buffet restaurant in Leeds' city centre that serves a wide range of world cuisine. This will cost £15 per person, payable on arrival (either at the icebreaker or before talks the following morning). Here we will also announce the conference prize winners, with over £350 worth of books to give away.

T-shirts
ProgPal relies entirely on volunteers and sponsorship to run free of charge each year. To show your support we have T-

shirts for sale priced at £12.50. All the cool kids are wearing them…

Committee

This year's committee are:

- Tom Fletcher (eetmf@leeds.ac.uk)
- Lyndsey Fox (eelrf@leeds.ac.uk)
- James Witts (j.witts@leeds.ac.uk)

Acknowledgements

The organisers are hugely grateful to ***Taylor & Francis***, and the ***Earth Surface Science Institute*** of the University of Leeds for their sponsorship, which has allowed ProgPal to run free of charge once again for early career palaeontologists. Talk and poster prizes were generously donated by ***Springer***, ***Elsevier***, ***Dunedin***, and ***Siri Scientific Press***.

We would also like to thank the **School of Earth and Environment** for use of their facilities, **Palaeocast** for their assistance streaming talks, and this year's volunteers for their invaluable help running the conference.

Programme

22nd May 2013

17.30	Icebreaker Reception (School of Earth and Environment)
19.30	Veritas Bar

23rd May 2013

07.30	Registration Open
09.00	Welcome to Leeds ***Professor Jane Francis & Tom Fletcher***
	Session 1 - Reconstructing Life Habits
09.20	Reconstructing Ammonite Life-Habits: A Modern Perspective on a Centuries Old Question ***Robert Lemanis***
09.40	Determining the dietary preferences of the Port Jackson shark ***Laura McLennan***
10.00	Getting geometric with ruminant rostra ***Jon Tennant***
10.25	Biomechanical evidence for niche partitioning between sympatric sauropod dinosaurs ***David Button***
	Coffee Break and Poster Session
	Session 2 - Palaeoenvironments
11.20	Dark and Disturbed or Sunny and Bright: A new approach to determine early angiosperm habitat ***Alexandra Lee***
11.45	Late Pliocene lakes and soils: A global data set for the analysis of climate feedbacks in a warmer world ***Dr Matt Pound***
12.05	TBA (unfortunately the original speaker's visa could not be processed in time for the meeting) ***TBA***
12.25	Adventures in the Atacama: a high fidelity record of Neogene seasonality for the East Pacific? ***Nicola Clark***
	Lunch Break and Poster Session
	Session 3 - Vertebrate Evolution
14.00	Early Vertebrate Skeletogenesis ***Joseph Keating***
14.20	Rates of morphological evolution in the origin of the birds ***Mark Puttick***
14.40	Redescription of Elachistosuchus huenei and a reappraisal of the phylogenetic relationships of basal Sauria (Neodipasida) based on Computed micro-Tomography ***Gabriela Sobral***
15.00	The evolutionary radiation of Triassic marine reptiles ***Tom Stubbs***
	Coffee Break and Poster Session

Session 4 - Exceptional Preservation	
15.55	A Doushantuo-type acritarch assemblage from phosphorite pebbles of the Ediacaran Biskopås Formation of Southern Norway ***Peter Adamson***
16.20	Preserving Cambrian bodies in the Sirius Pass, North Greenland ***Katie Strang***
16.40	Dumbbells and Basil Brushes - painting a new picture of the Ediacaran macrofossils of Charnwood Forest, Leicestershire ***Charlotte Kenchington***
17.00	Experimental decay and disarticulation of phyllocarids and the implications for the arthropod fossil record ***Oliver Knevitt***
17.25	Group Photo and Poster Session
18.00	Poster Session Closes (please collect or arrange to store with us)
19.00	Annual Dinner and Prize Giving at Spice Quarter

24th May 2013

~7.30*	Field Trip (Meeting at SoEE and Parkinson Building Steps)
18.00	Return to Leeds (via Train and Bus Station)

All times are approximate, allowing for overrun. Please arrive promptly for sessions.

****Please ensure you have noted the up to date time and locations for departure***

Field Trip – Yorkshire Coast

LOCATION

The field trip this year will be to Cayton Bay, just south of Scarborough on Yorkshire's rich fossil coast. Here you can expect to find gastropods, ammonites, belemnites, crinoids, shrimp, trace fossils and many others from Callovian and Oxfordian strata of the Jurassic. There is a steep but well paved path down to the beach, and the sites we are visiting will require a maximum 3-4 miles of walking throughout the day.

SCHEDULE

Delegates on the field trip will be given a detailed brief immediately after the last talks, because the schedule is entirely tide and weather dependant. It is likely we will have an early start on Friday morning, with a drive of approximately 1.5 hours to the coast (*it is your responsibility to be at the meeting point on time*). On arrival you will guided through 5-6 million years of Jurassic terrestrial and marine geology with opportunities to collect fossils along the way. After visiting Cayton Bay we will stop for a pub lunch, before eventually heading back to Leeds for late afternoon/early evening. The bus will drive back to the University via the railway and bus stations as required, so ensure you bring your luggage (and posters) if you are leaving Leeds that evening.

WHAT TO BRING

Geological hammers are permitted, and sample bags advised if you intend to collect a lot of material, but we will provide hard hats. Stout footwear is important as we will be walking across a rocky shoreline, as are waterproofs and warm clothing in case we have any unseasonable weather. It may even be sunny!

SAFETY

We are running this fieldtrip as part of the University of Leeds, so we ask for your cooperation as representatives of the department, and that you be vigilant of safety throughout the day. Group leaders will be wearing orange high visibility jackets at all times should you have any concerns, and we will have first aid kits and trained staff with us.

Abstracts

*Alphabetical by presenting author (**emboldened**)*
† Oral Presentation
§ Poster Presentation

A Doushantuo-type acritarch assemblage from phosphorite pebbles of the Ediacaran Biskopås Formation of Southern Norway†

Adamson P. W.[1] and Butterfield N. J.[1]

[1]Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ (pwa24@cam.ac.uk).

The early Ediacaran Period saw the remarkable appearance of large microfossils succeeding the Cryogenian glaciations. This new microfossil biota, best known from the Doushantuo assemblage, consists of large (20-800 µm diameter) acanthomorphic acritarchs and are the only biostratigraphic candidate for the subdivision of the early Ediacaran. In order to understand the significance of this biota it is necessary to consider its evolutionary, taphonomic and biogeochemical context.

Of particular interest is the exceptional preservation of this assemblage in phosphorites from the 600 Ma Doushantuo Formation in South China, which can provide geochemical information about the nature of the biolimiting nutrient phosphorus and new perspectives on the biological systems of the Ediacaran. Exceptionally preserved microfossils from phosphorite pebbles in the Biskopås Formation in Southern Norway provide another such example. Deposition occurred within a shallow marine intracratonic basin on the western margin of Baltica. Thin section analysis of the Biskopås phosphorites reveal a diverse assemblage of Doushantuo-type acanthomorphic acritarchs. Eleven species of acanthomorphic acritarch have been identified, including the Doushantuo Formation Upper Biozone indicator taxon *Ericiasphaera rigida*, providing an approximate biostratigraphic correlation with South China. Preliminary taphonomic study suggests that the acritarchs were bound within the living microbial mats before being transported to a site of active phosphogenesis.

The discovery of another diverse assemblage of Doushantuo-type acanthomorphic acritarchs further demonstrates the global nature of this assemblage and its biostratigraphic potential. Comparative studies between the Doushantuo and Biskopås can offer a greater understanding of this enigmatic microfossil assemblage and the biogeochemical circumstances that induced widespread phosphogenesis during the Ediacaran.

Biomechanical evidence for niche partitioning between sympatric sauropod dinosaurs †

Button D. J.[1]

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The sauropod dinosaurs were the largest terrestrial vertebrates. Given the extreme nature of their biology sauropods present many problems, not least how they secured sufficient food intake to fuel their massive bodies. Furthermore, many sauropod faunas are highly diverse, implying sophisticated resource partitioning between them.

The high craniodental diversity differentiating sympatric sauropod taxa has often been cited in support of niche partitioning. This is particularly so for the well-known Morrison Formation fauna, which contains a high diversity (~9 genera) of sauropod taxa. In particular, the abundant *Diplodocus* and *Camarasaurus* represent extreme end-members in the spectrum of sauropod cranial morphology and have been hypothesised as being adapted towards specialized branch-stripping and the production of higher bite forces, respectively. However, while biomechanical modelling has previously been used to investigate feeding behaviour in *Diplodocus*, no such work has been attempted on *Camarasaurus.* Here we rectify this deficit through muscle reconstruction, functional morphology and application of finite element analysis (FEA) to a skull of *C. lentus*. This model was then compared to that of *Diplodocus* allowing testing of the niche partitioning hypothesis in a biomechanical context.

Myological reconstruction demonstrates a greater importance of the external adductor group versus the pterygoideus musculature than in *Diplodocus*, although overall muscle volumes are similar. Despite this, the more mechanically efficient skull and more favourable lines of muscle action result in significantly greater calculated maximum bite forces for *Camarasaurus*. FEA indicates that the skull of *Camarasaurus* was well-adapted to resist forces resulting from biting and is “stronger” under conditions of static biting than that of *Diplodocus*, with lower stresses in the snout and palate. Under loading conditions simulating other hypothesised sauropod feeding behaviours (bilateral and lateral stripping/tugging) stresses are again very low, indicating that *Camarasaurus* would have been capable of exploiting a varied foraging repertoire.

The results here provide biomechanical evidence for niche partitioning between Morrison sauropod taxa, with *Camarasaurus* capable employing high bite forces and a range of behaviours to deal with a greater range of coarser foodstuffs than sympatric diplodocoids, which were instead more specialized in their feeding behaviours.

Adventures in the Atacama: a high fidelity record of Neogene seasonality for the East Pacific? †

Clark N. [1]

[1]Postgraduate Researcher, Department of Geology, University of Leicester, Leicester (nc118@le.ac.uk).

Darwin's log of the Voyage of the Beagle writes for South America in November 1834 "*Along hundreds of miles of coast is one great deposit, including many Tertiary shells, all apparently extinct.*" These molluscan assemblages are custodians of a huge potential repository of palaeoclimate data. Do they provide a new and potentially accurate measure of the full seasonal temperature variation for time intervals from the late Neogene? Can they be used to assess the climate state of the East Pacific during the critical time interval of the warm Pliocene? Here I present preliminary data of seasonal marine temperature variation in fossil *Argopecten* and "*Chlamys"* bivalves from coastal Chile and speculate on the usefulness of such records.

Biostratigraphical study of the Middle-Upper Jurassic ammonite association of Stretta Arancio's section (Southern Sicily, Italy) §

Cusumano A.[1], D'Arpa C.[2] and Di Stefano P.[1]

[1]Dipartimento di Scienze della Terra e del Mare (Di.S.T.e.M), Università degli Studi di Palermo, 90123, via Archirafi 22, Palermo (Italy) (antonio.cusumano@unipa.it; pietro.distefano@unipa.it) [2]Dipartimento di Scienze della Terra e del Mare (Di.S.T.e.M.), Museo Geologico G. G. Gemmellaro, 90134, corso Tukory 131, Palermo (Italy) (carolina.darpa@unipa.it).

This stratigraphical study is part of the revision work that has been carried out for the last ten years on some Jurassic successions outcropping in Southwestern Sicily. For this purpose, a synthesis of the data on the Middle-Upper Jurassic sequence from Stretta Arancio, near Sambuca di Sicilia (Agrigento Province) have been described in this paper. The deposits, constituting the succession of this area, are part of the Monte Magaggiaro-Pizzo Telegrafo Unit that belongs to a large tectonic unit located in the outer part of the Apennine-Maghrebide chain. During the Mesozoic Era, this Unit was part of the Saccense Domain, an area palaeogeographically located along the southern margin of Tethys. The studied succession consists of about 7 m of condensed pelagic limestones spanning from Middle to Upper Jurassic and covered by Upper Cretaceous limestones of the "Scaglia" type. The biostratigraphic study of Stretta Arancio has allowed us to identify the chronostratigraphic age and some biozones from Middle Jurassic (Middle Bathonian) to Upper Jurassic (Tithonian). Moreover, the taphonomic analysis of the recorded ammonite associations has given evidence of the presence of an important stratigraphic gap at the Bathonian-Oxfordian boundary, involving a registratic gap (i.e. a gap of the corresponding recording entity or Taxorrecord) of variable extent. Furthermore, this study has firstly allowed to assign the fossil assemblages to the Mediterranean Province and, secondly, to increase knowledge of the faunal associations of the area related to the pelagic carbonate platform system of Saccense Domain for the Middle-Upper Jurassic stratigraphic range.

Taxonomic revision of two Mesozoic ammonites collections housed at the "G.G. Gemmellaro" Museum (Palermo, Sicily) §

Cusumano A.[1], D'Arpa C.[2], Meléndez G.[3] and Tavera J. M.[4]

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Two historical collections of Mesozoic ammonites from the Tardàra Mountain (SO Sicily), housed in the "Gaetano Giorgio Gemmellaro" Museum of the University of Palermo, have been revised in this paper. The former and the older collection, studied by Mariano Gemmellaro in the 1919, it is composed of 27 specimens, attributed to 5 genera. All the taxa studied by the Author were referred to the Middle Jurassic, *Macrocephalites macrocephalus* Zone (early Callovian stage).

The second collection, studied by Francesco Bruno in the 1954, consists of 46 specimens attributed to 13 genera. The species identified by Bruno were referred to a chronostratigraphic range spanning from Callovian to Tithonian (Middle-Upper Jurassic).The taxonomic analysis of both historical collections has led to extend, for some taxa, the chronostratigraphic range known from literature and to identify the presence of taxa rarely reported in Sicily until now, including *Spiticeras pseudogroteanum* Djanélidzé, 1922 and *Fauriella* gr. *boissieri* (Pictet, 1867) classically referred to the Lower Cretaceous (Berriasian). Also the determination, in

the Bruno Collection, of specimens such as *Neolissoceras* cf. *grasianum* (d'Orbigny, 1841), *Jabronella* sp. and *Kilianella* sp. clearly indicates the presence of a register referable to the Early Cretaceous, rarely represented in Sicily.

In conclusion, the study of the collections already mentioned has shown, for the Mariano Gemmellaro Collection, a prevalence of species and genera stratigraphically attributable to the Middle Jurassic (Bajocian-Callovian) while in the Bruno Collection genera and species are more related to the Upper Jurassic-Lower Cretaceous interval.

Hydrodynamics of early fishes and the evolution of drag-reducing scales *§*

Fletcher, T. M.[1], Altringham J. D.[1], Peakall J.[2], Wignall P. B.[1]

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Minimising drag is of principle importance to many aquatic organisms, affecting both the efficiency and speed of their locomotion. Fishes, in their myriad forms have developed highly effective biomechanical and behavioural strategies for controlling fluid flow and reducing overall drag, of which skin friction is a significant component. Some of the earliest fishes possessed dermal denticles (e.g. 'Acanthodians' and Thelodonts), which like modern sharks are unlikely to have possessed the outer scale-covering of soft epithelial tissue found in most other taxa. That these scales were directly exposed to the surrounding fluid means we can test their hydrodynamic function without speculating about soft tissue adaptations (e.g. mucus secretion).

The relationship between scale morphology and hydrodynamic function is well documented in modern sharks, with far reaching biomechanical and biomimetic implications. This study aims to review key stages in the evolution of speed and swimming efficiency of early Palaeozoic fishes, and quantify the drag-reducing properties of common scale morphologies.

Using micro-computed tomography of fossil and modern material, three-dimensional plate models of repeating scale units were produced. The size, tessellation and orientation of the scales was standardised after examining specimens of the same or closely related taxa, which preserve intact flank integument. High-resolution rapid prototyping was then used to render detailed reconstructions of the flank surface. These physical models were then subjected to flume tank analysis involving laser Doppler anemometry to measure fluid velocity, and skin friction drag across the plate surface, and particle image velocimetry to observe flow patterns.

This study aims to assess the impact of dermal denticles on overall skin friction and whether , compared to a smooth control surface, they act to reduce total drag by delaying boundary layer separation (or 'stall'). We examine whether scale riblets act to reduce total drag, the possible mechanisms involved, and the occurrence and significance of this adaptation in the fossil record of fishes.

It is from empirical studies and the considered use of comparative biomechanics that we may begin to elucidate the evolution of innovative, drag-reducing scales, in some of the earliest vertebrates. Here we provide evidence that complex fluid principles were already being utilised by fishes to swim quickly and efficiently over 460 million years ago.

Some Like it Hot: A planktonic foraminiferal perspective of the mid-Miocene climate optimum (IODP Site U1338 Equatorial Pacific Ocean) *§*

Fox L. R.[1], Wade B.[1], Holbourn A.[2], and Leng M. [3]

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The middle Miocene (17-13.5 Ma) was the warmest interval of the Neogene. During the early to middle Miocene (23-11.5 Ma) the climate fluctuated greatly, with cyclic periods of Antarctic glaciation and climatic warming termed the "mid Miocene climate optimum" characterised by a negative oxygen isotope excursion. Integrated Ocean Drilling Program Expedition 320/321 recovered lower-middle Miocene sediments with high sedimentation rates (30m/myr), continuous recovery, and orbital cyclicity from the equatorial Pacific. Previous studies of the lower interval have been hindered by the absence of biogenic carbonate (e.g., Leg 199). However at Site U1338 planktonic foraminifera are abundant in the lower and middle Miocene sediments and scanning electron microscopy has shown that foraminifera are well preserved and diverse, allowing for studies of planktonic foraminiferal stable isotopes, biostratigraphy, and biotic evolution.

Despite extensive studies of benthic foraminifera, existing planktonic foraminiferal records of this interval are extremely scarce and of low resolution, with samples representing time intervals of $2x10^5$and $5x10^5$ years. Specimens from U1338 of *Globerinoides subquadratus* and *Globigerinoides* spp. are analysed at 10cm intervals providing 3 kyr resolution. Here I present the initial results from my project, as we endeavour to produce the first orbital scaled record of $\delta^{18}O$ and $\delta^{13}C$ variability throughout 17-13.5 Ma as well as an overview of foraminiferal assemblages from the middle Miocene, examining the preservation and potential for future studies of foraminiferal evolution.

Extremely rapid mineralisation of *Alvinella* tubes at hydrothermal vents: implications for polychaete evolutionary history §

Georgieva M. N.[1, 2], Little C. T. S.[1] and Glover A. G.[2]

[1]School of Earth and Environment, University of Leeds LS2 9JT United Kingdom (eemng@leeds.ac.uk), [2]Life Sciences Department, Natural History Museum London SW7 5BD United Kingdom

Polychaete tubeworms are an abundant and diverse component of hydrothermal vent and cold seep ecosystems. Currently very little is known about their evolutionary history within these environments, such as over what timescales they were able to adapt to a mode of life based on chemosynthesis and to the extreme conditions associated with vents and seeps. The tubes produced by these polychaetes are one of few robust features produced by annelids that are capable of becoming preserved as fossils, and may therefore hold important clues as to how members of this major animal phylum were able to colonise even these seemingly inhospitable environments. Fossil tubes are quite commonly encountered in deposits representing ancient chemosynthetic sites, and rapid mineralisation processes occurring at these localities are a pathway through which the tubes of these worms may become preserved within the fossil record. However, presently very little is known about how these processes act to completely replace a tube. Recent experiments have shown that the tubes of alvinellids at vents can become entirely mineralised within the timescale of just one year. Preliminary results outlining the progression of mineral replacement for these tubes will be presented, as well as the implications for the evolutionary history of the tube-forming polychaetes at chemosynthetic sites.

Evolution of the Lower Jaw (mandible) of Gnathostomes §

Hill J. J.[1], Donoghue P. C. J.[1] and Rayfield E. J.[1]

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The lower jaw is an example of an evolutionary adaptation that ultimately helps an animal survive and reproduce. The more food an organism ingests, the greater its' level of usable energy, and its' higher potential for survival. Successful acquisition of food varies greatly between species and is dependent on the strength & arrangement of bony and cartilaginous elements as well as the size and placement of muscles. Across major transitions in vertebrate evolution, we see a change in jaw structure and as a result expect a change in jaw performance. Theoretically, I plan to create a 3D universal synthetic mandibular model based on idealized morphology and validate it using empirical data against a 3D software-generated model for each representative that best fits the following evolutionary transitions: 1) Earliest Jawed Vertebrates to Bony Fish, 2) Tetrapod to Amniote, and 3) Origin of Mammals. A combination of metric tests will be applied to each model to assess the material properties of the mandible and how morphology has changed under the influence of selection for a particular function. Finite Element Analysis (FEA) will also be used to determine the structural adaption and efficiency of the mandible in various feeding modes. I hope to verify that the overall shape of the mandible affects the functional performance of the lower jaw.

Parrots and parrot-beaked dinosaurs: testing convergence in the fossil record §

Jarvis E.[1], Bright J.[1], Lautenschlager S.[1] and Rayfield E. J.[1]

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Understanding the relationship between skeletal form and function is of great interest within the field of palaeontology, and the concept that convergent skeletal morphology necessarily produces the same function in unrelated taxa is hotly debated among functional morphologists. Research on extant animals has not only shown that different morphologies can produce the same function, but that similar morphologies may be functionally disparate. We therefore cannot assume that animals which appear superficially similar should function or behave in a similar way. A recent study of the dinosaur *Psittacosaurus gobiensis* (Ornithischia: Psittacisauridae) suggested that psittacosaurs and extant parrots (Aves: Psittaciforms) share a similar feeding function, based on a number of osteological and muscular features that are commonly seen in both taxa. However, parrot skulls are highly derived, featuring several evolutionary novelties not seen in psittacosaurs, such as extreme cranial kinesis and a pseudomasseter muscle. As these features are likely to strongly affect function, the hypothesis of functional convergence between these two taxa is questionable. Computed tomography (CT) reconstructions of the skull of a Blue-and-Yellow Macaw *(Ara ararauna)* were used to create finite element (FE) models of a psittaciform bird for comparison with CT reconstructions and FE models of the psittacosaur *Hongshanosaurus houi.* Muscle reconstruction based on iodine-staining and phylogenetic bracketing are also considered. This permits quantitative tests of whether the morphological convergences between these two unrelated species can be used as evidence for convergent function.

Early vertebrate skeletogenesis †

Keating J.[1]

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The skeleton is one of the most important and familiar characteristics of vertebrates, yet surprisingly little is known about its origin and early evolution. Crucially, we lack ontogenetic data for the earliest skeletonizing vertebrates. Historically, ontogenetic and histological data obtained from chondrichthyans, the most primitive living jawed vertebrates, have provided a conceptual framework for skeletogenic evolutionary hypotheses. Yet these hypotheses are incompatible with the fossil record, which reveals the primitive vertebrate skeleton is quite unlike that of chondrichthyans. Heterostracans, an extinct group of armored jawless fish known from the Silurian to Devonian, are among the most primitive vertebrates with an extensively ossified skeleton and hence greater understanding of their ontogeny can reveal the pleisiomorphic condition of vertebrate skeletogenesis. It has long been recognized that heterostracan dermal plates often show a concentric arrangement of superficial tubercles interpreted as “growth lines”, while internally these plates show no evidence of growth. This incongruence between the internal and external architecture of the skeleton has previously been rationalized by several competing growth hypotheses. To this end, a palaeohistological study was devised to test these hypotheses and provide a skeletogenic model for the Heterostraci. Data has been collected from an ontogenetic sequence of corresponding dermal plates permitting a generative model of the dermal skeleton to be devised. This model can subsequently be verified at cellular-level resolution using a comparable ontogenetic sequence of body scales analyzed using synchrotron X-ray tomography. Preliminary results suggest that the internal architecture is more dynamic than has been previously proposed. The middle layer invasively expands through ontogeny and cancellae are subdivided by trabecular cross-walls. These results suggest that the skeleton was systematically remodeled in response to growth.

Drivers of peatland development in Amazonia: palaeobotanical and stratigraphic evidence §

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Amazonian floodplains occupy around 800,000 km^2, yet we know very little about their palaeoecological history. The discovery of large peatland areas in north-east Peru has brought to light a new archive of information in the Amazonian lowlands which can be used to improve our knowledge of these systems. This study uses pollen analysis of lake and peat deposits to investigate the causes of vegetation change in a tropical peatland in Peru over the last 5,000 years.

Comparison of our lake record with an existing peatland record (*cf*. Roucoux *et al*., 2013) reveals some important differences in the pattern and timing of vegetation development recorded. While several vegetation changes are recorded at the same time in both cores (e.g. the decline in the pioneer tree *Cecropia*), in the lake record pollen of the palms *Mauritia/Mauritiella* becomes abundant *c*.750 years before the increase is recorded in the peat record. We believe these differences can be explained by the wider pollen source area of the lake record, and therefore reflect the different timing of species colonisation in the floodplain and peatland.

Vegetation changes in both records are often abrupt and we interpret these to be driven by external factors, primarily river dynamics and climatic change. Where changes are more gradual we interpret them to be driven by internal ecosystem dynamics, for example, gradual changes in composition are characteristic of secondary successional processes.

Dumbbells and Basil Brushes - painting a new picture of the Ediacaran macrofossils of Charnwood Forest, Leicestershire †

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The Avalonian Assemblage of Charnwood Forest, UK and Newfoundland comprises one of the oldest known occurrences of Ediacaran macrofossils. Although long considered the poor cousin of the Newfoundland succession, recent cleaning of bedding surfaces in Charnwood Forest has uncovered an unexpectedly diverse and well-preserved fauna, including at least seven previously undescribed taxa. Two of these, the informally named “Dumbbells” and “Basil Brushes”, have the potential to yield a unique insight into the ecology and biological complexity of these poorly understood organisms.

The fossils of Charnwood Forest, together with those in eastern Newfoundland, comprise the Avalonian Assemblage, a deep-water fauna whose biological affinity remains elusive. The “Dumbbells” and the “Basil Brushes” both show unique adaptations to the environment in which they lived. The “Dumbbells” possess a unusually large holdfast disc, rigid stem and uniquely globular-shaped frond. It is distinguished from known Ediacaran fossils on the basis of its overall morphology and detailed structural architecture.

The “Basil Brushes” bear an intriguing novel structure which is interpreted here as an external sheath or veil, the details of which have been elucidated using a number of imaging techniques. Sedimentological, microbial and tectonic interpretations have been ruled out using numerous lines of evidence, principally the diagnostic regular alternation of higher- and lower-relief ridges and their consistent variance in width in proportion to the size of the organism. The adaptations displayed by these organisms have significant implications for the level of morphological complexity expressed by these enigmatic early Ediacaran organisms.

Experimental decay and disarticulation of phyllocarids and the implications for the arthropod fossil record †

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The study of soft-bodied fossils is fraught with difficulties. Post mortem processes can transform the remains of the organism such that phylogenetic characters are lost; indeed, character based studies of vertebrates have shown that the most derived characters are systematically lost first. It is well known that decay plays a role in the style of disarticulation of arthropods, yet the phylogenetic and taxonomic implications of this have not been studied. Here, we present the first character-based study of decay in arthropods, using the decay of a modern phyllocarid crustacean, *Nebalia bipes*, to evaluate the extensive fossil record of both phyllocarids and the wider malacostracan group. In our study, samples of *Nebalia* were tumbled, simulating post-mortem transport, at varying periods of decay. The morphology of these tumbled specimens compare favourably with examples of fossil phyllocarids, and we use our results to suggest reliable characters for phylogenies and taxonomies.

Dark and Disturbed or Sunny and Bright: A new approach to determine early angiosperm habitat †

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In 1878 Charles Darwin famously referred to the origin of the flowering plants as “an abominable mystery”. Now, over 130 years later, the subject is still of continual interest and debate with key questions remaining unanswered. A central component of current research concerns whether the angiosperms made their ecological entrance as opportunistic weedy species growing in exposed sunny point bar zones of rivers, or in the shady understory of pteridophyte and gymnosperm forests.

In the Cretaceous greenhouse world growing in full sun would risk leaves overheating causing the denaturing of photosynthetic enzymes. Therefore, determining the thermal tolerance of early angiosperms may prove key in placing them in an ecophysiological context. Recent research suggests the low stomatal conductance (*gs*) of early angiosperms would limit their transpirational cooling capacity - possibly restricting them to shaded environments. However, leaf size is also critical in determining leaf temperature and the majority of early angiosperm leaves were small. A small surface area reduces radiation load and increases convective heat exchange which keeps small leaves cooler.

We have developed a leaf energy balance model capable of predicting leaf temperature as a function of air temperature, leaf size, *gs*, solar radiation, humidity, and wind speed. The modelled solution leaf temperature for 14 early angiosperm species suggests a large proportion could have survived in full sun even with complete stomatal closure which would likely occur at midday. Therefore, due to their small size, possessing low *gs* would not necessarily have limited the first flowering plants to a life in the shade.

Reconstructing Ammonite Life-Habits: A Modern Perspective on a Centuries Old Question †

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Ammonites are among the most iconic fossil groups, readily distinguished by their elaborate sutures, yet the function of this unique trait has been fiercely debated for well over a century. Encompassed within this debate is the question of how the physical properties of the phragmocone influenced the life-habits of adult ammonites. Juvenile ammonites are largely considered to be planktonic; however, adult ammonites have been reconstructed as either nektonic or benthic. In modern cephalopods neutral buoyancy, necessary for a nektonic life-style, is achieved by altering the ratio of gas to liquid in the phragmocone in order to balance the weight of the shell and the soft body. Previous attempts to calculate the buoyancy of modern cephalopods and ammonites have utilized mathematical models that have necessarily simplified aspects of shell geometry. We employ high-resolution x-ray computed

tomography (micro-CT and synchrotron radiation) to produce three dimensional models of modern cephalopods (*Nautilus pompilius* and *Spirula spirula*) and Mesozoic ammonites that can be used to calculate physical parameters and reconstruct buoyancy while limiting the amount of necessary assumptions. We first apply this method to extant *Nautilus* and *Spirula* to test the accuracy and limitations of this method. Subsequent tests calculate chamber volume and area of juvenile ammonites. Here we report preliminary data and discuss the implications for ammonite palaeobiology and utilizing computed tomography to examine fossil material.

A new species of Ichthyosaurus from the Lower Jurassic of West Dorset, England §

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We describe a new species of Lower Jurassic (Hettangian/Sinemurian–Pliensbachian) ichthyosaur, *Ichthyosaurus anningae* sp. nov., from west Dorset. The species is assigned to *Ichthyosaurus* on the basis of humerus, forefin, and pectoral girdle morphologies. Diagnostic features of the species include a fairly long, robust snout; a short, robust humerus with prominent processes; and a very small femur (and hindfin) relative to the humerus (and forefin). The holotype of *L. anningae* (DONMG:1983.98), at least a sub-adult, is from the Pliensbachian Stone Barrow Marls Member (Charmouth Mudstone Formation). A fairly complete skeleton of a juvenile (NHMUK 120) from Lyme Regis is referred to this species. With the recognition of *L. anningae*, at least three and possibly as many as five ichthyosaur species, representing three genera, are known from the Pliensbachian.

Herbivorous dinosaur jaw disparity: patterns in functional diversity §

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The radiation of herbivorous dinosaurs was punctuated by ecologically significant events, including the Triassic-Jurassic mass extinction (c.200 Myr ago) and the origin of flowering plants (angiosperms). Assessing biomechanical trait variation within mandibular elements may offer insights into any effects these events may have had on the feeding variation in herbivorous dinosaurs. We conducted, to our knowledge, the first analysis of functional disparity in the jaws of herbivorous (sauropodomorph and ornithischian) dinosaurs. Our results suggest herbivorous dinosaurs rapidly exploited available feeding niches, with discrete 'function-space' occupation by different clades occurring by the Mid-Upper Jurassic. Novel feeding opportunities were exploited in the Upper Jurassic by biomechanically diverse, high-browsing sauropodomorphs. Neither the Tr/J mass extinction nor the proliferation of flowering plants triggered any significant changes in functional disparity. The addition of herbivorous theropods and crocodiles will aid in providing more accurate interpretations of megaherbivore feeding disparity through the Mesozoic

A quantitative analysis of "*Centrosaurus nasicornus*" as a junior synonym of *Centrosaurus apertus* §

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"Centrosaurus nasicornus" is a ceratopsian dinosaur known from a small number of specimens from the Late Cretaceous Dinosaur Park Formation of Alberta, and is distinguished based on features of the skull. Few specimens are assigned to this species mainly because of it's dubious taxonomic position, yet no extensive studies have addressed this issue, and it's current affinities are debated. Numerous analyses were performed on the type specimen of "*C. nasicornus"*, several *C. apertus* skulls, and a *Styracosaurus albertensis* skull to clarify the position of "*C. nasicornus"*. Quantitative, qualitative and phylogenetic analyses combined with comparisons between "*C. nasicornus"* and *C. apertus* suggest that these two species are indistinguishable, and that "*C. nasicornus"* should not be grouped with *Styracosaurus albertensis*, as has been proposed by others. "*Centrosaurus nasicornus"* should, therefore, be regarded as a junior synonym of *C. apertus*.

Determining the dietary preferences of the Port Jackson shark †

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Diet is one of the key driving factors for species evolution, but is difficult to determine within the fossil record. Most dietary assumptions rely upon the interpretation of tooth morphology. Throughout elasmobranch evolution many dental morphologies have evolved. One of the more unusual morphologies is molariform dentition. Molariform teeth have evolved in several elasmobranch lineages independently, including within hybodont lineages and the modern heterodontiforms. The function of molariform teeth is interpreted as shell crushing in both extinct and extant taxa. The extant Port-Jackson shark, *Heterodontus portusjacksoni*, provides an interesting example. Despite having molariform teeth, studies have observed *H.portusjacksoni* crushing hard shelled prey, whereas others based on stomach contents suggest an ontogenetic shift from a high proportion of hard shelled prey in juveniles to a lower proportion in adults. With this discrepancy known we cannot say for sure the function of this dental morphology in extinct sharks, or more importantly, whether diet can be ascertained from the tooth shape alone.

Analysis of 3D-microtextures on worn teeth has been shown to be a powerful tool for dietary discrimination in extinct and extant fish, but remains untested on elasmobranchs. Here we test the hypothesis that 3D-microtextural analyses of modern *H.portusjacksoni* teeth can reflect diet. Understanding the relationship between tooth microtexture and diet will allow the approach to be applied to other elasmobranch dental morphologies to determine ontogenetic, geographical and evolutionary changes in diet. This has the potential to open the door to analysis of ecologies of extinct elasmobranchs and lesser known modern species.

Ichthyosaur diversity in the British Middle and Upper Jurassic §

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Ichthyosaurs are the most iconic fossils from the British Jurassic and one of the first entirely extinct vertebrate groups to be recognised. Besides the copious material from the Lower Jurassic Liassic formations, there have been many finds from the Middle and Upper Jurassic also. Of particular importance are the Callovian–Oxfordian Oxford Clay Formation around Peterborough, and Kimmeridgian Kimmeridge Clay Formation of the Jurassic Coast. To date, several hundred specimens have been recovered. These have been assigned to numerous taxa, of which four are currently considered valid: *Ophthalmosaurus icenicus*, *Brachypterygius extremus*, *B. mordax* and *Nannopterygius enthekiodon*. A re-description of the classic material largely supports these taxa but provides key new diagnostic and comparative features. *Ophthalmosaurus icenicus* is seen to be generically distinct from *O.* ("*Baptanodon*") *natans*, as supported phylogenetically. Further material suggests the synonymy of *B. mordax* into *B. extremus*. However, comprehensive collections that have only recently become available show that greater diversity is present than was previously thought. Geometric morphometric analysis of several humeri referred to *O. icenicus* shows complex morphological variation with no clear intraspecific grouping. Inclusion of further Jurassic taxa largely follows taxonomic groupings. This work is essential in securing the link between the intensely studied Lower Jurassic and Cretaceous ichthyosaurs. The positions of these taxa are in conflict between phylogenetic hypotheses. This reappraisal, and extensive re-encoding of the ichthyosaurs in their entirety, will go towards resolution of these inconsistencies.

A fistful of forams: high-resolution biostratigraphy and morphological evolution of *Globigerinoides fistulosus* §

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Revision of planktonic foraminifer bioevents is an integral component of Cenozoic chronostratigraphy. A prime example of this critical need for bioevent recalibration is the case of the morphologically 'obscure' tropical species *Globigerinoides fistulosus* (ranging from the late Pliocene to Pleistocene). *G. fistulosus* is extensively utilised as a biostratigraphic marker species and has been used to approximately demarcate the former base of the Pleistocene in previous studies (e.g. Parker 1967; Chaisson & Leckie 1993; Chaisson & Pearson 1997; Chaisson & D'Hondt 2000; Sinha & Singh 2008). However, despite its biostratigraphic potential, previous data show inconsistencies in the reported timing of its extinction (last appearance datums; LADs) and calibration to the geomagnetic polarity timescale.

To a certain extent, the discrepancies in the LADs may be attributed to differences in taxonomic interpretation of the species definition. The species evolved from *Globigerinoides sacculifer* in a gradual 'pseudospeciation' event; developing a large, flattened final chamber, with spectacular and peculiar finger-like projections (Kennett & Srinivasan 1983). A comparable situation has been

documented for the *G. fistulosus* extinction; a gradual morphological transition involving the demise of intricate forms and returning to *G. sacculifer* forms (see Chaisson & Pearson 1997). An unanswered question remains: Why did *Globigerinoides* experiment with such elaborate morphologies during the late Pliocene-Pleistocene?

Ocean Drilling Program (ODP) Site 1115 (Woodlark Basin, Papua New Guinea) provides an opportunity to address the biostratigraphic record and morphological evolution of *G. fistulosus* at high-resolution. The cores across the Pliocene-Pleistocene interval have excellent recovery, with abundant, well preserved planktonic foraminifera and high sedimentation rates. In addition, the cores also yield calcareous nannofossils (from which an initial biostratigraphy has been established; Shipboard Scientific Party 1999); and a magnetostratigraphy has also been interpreted from initial ODP palaeomagnetic measurements. This additional stratigraphic data will supplement the preliminary results of this study, aiding with refining the biochronology for the late Pliocene-Pleistocene. The newly established record will be contrasted with different ocean basins in order to assess potential LAD diachrony for *G. fistulosus*.

Late Pliocene lakes and soils: A global data set for the analysis of climate feedbacks in a warmer world †

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Albedo-related soil and vegetation feedbacks are key uncertainties and climate models differ considerably in estimating their strength. For the terrestrial realm, large inland water bodies and wetlands have also been shown to significantly affect surface temperatures and energy balance in past and present climate systems.

Based on a synthesis of geological data we have reconstructed the global distribution of Late Pliocene soils and lakes which are then used as boundary conditions in a series of model experiments using the Hadley Centre General Circulation Model (HadCM3) and the BIOME4 mechanistic vegetation model. By combining our novel soil and lake reconstructions with a fully coupled climate model we are able to explore the feedbacks of soils and lakes on the climate of the Late Pliocene. Our experiments reveal regionally confined changes of local climate and vegetation in response to the new boundary conditions. The addition of Late Pliocene soils has the largest influence on surface air temperatures, with notable increases in Australia, southern North Africa and Asia. The inclusion of Late Pliocene lakes generates a significant increase in precipitation in central Africa, as well as seasonal increases in the northern hemisphere. When combined, the feedbacks on climate from Late Pliocene lakes and soils improve the data to model fit in western North America and southern North Africa.

The onshore Miocene of the UK: The last unknown stratum and its implications for Pennine development §

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Onshore Miocene rocks in the UK are extremely rare. The Brassington Formation of Derbyshire and Staffordshire is an extensive succession of gravels, sands and clays preserved in around 60 karstic hollows. Originally studied in the 1970's a palynoflora was recovered from the lignite and clay beds of the Kenslow Member - the uppermost member of the Brassington Formation. Based on the state of the art at the time, the formation was assigned to the Late Miocene or Early Pliocene. The erosional surface that these sediments rest upon has been used to date the uplift of the Pennines mountain chain of central England. The uncertainties in the dating of the palynoflora has led to uncertainties in the estimated rate of uplift. As the age of the Brassington Formation is of some importance in understanding regional uplift patterns a new palynological study has been undertaken.

A new field campaign at Kenslow Top Pit, Derbyshire has produced a new palynoflora from the coloured clays of the Kenslow Member. This new palynoflora contains many taxa recorded in the original work but also some previously not reported. The palynoflora represents a warm - temperate mixed forest containing taxa common to this biome type such as *Abies*, *Cedrus*, *Icacinaceae*, *Keteleeria*, *Liquidambar*, *Symplocos* and *Tricolpopollenites microhenrici* (?*Quercus*). By comparison of the new palynoflora, and the original palynoflora, with floras from continental Europe, the age of the Kenslow Member can confidently be placed in the Tortonian Stage (11.61 - 7.25 Ma) of the Miocene. This means that the uplift rate of the Pennines has been more modest than previously reported.

Rates of morphological evolution in the origin of the birds †

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The origin of birds from theropod dinosaur ancestors is a key stage in vertebrate evolution, and was once thought to represent a major evolutionary shift. Yet, this episode of evolution is increasingly blurred and 'Avian' characters have been shown to fall outside the Aves, including the furcula, the pygostyle, and famously feathers or feather-like dermal appendages. Even *Archaeopteryx*, widely considered to be the first known bird, has been forced outside the Aves, according to some phylogenetic analyses. So it remains to be seen whether the origin of birds marks a dramatic shift in evolution, or is just a more gradual transition. Using comparative phylogenetics, the rates of morphological evolution of body size and forelimb morphology were tested on a supertree of coelosaurian theropods and Mesozoic birds. Rates were measured according to two assumptions, first with no *a priori* assumption of shift locations, and second with the assumption that Aves would have different rates of evolution from other theropod dinosaurs. Additionally, potential constraints and convergence in avian evolution were also tested, as well as the use of simulations to verify the validity of results. Early results indicate a huge burst in body size evolution leading to the Paraves (Aves + Deinonychosauria), and potentially body size-corrected shifts in forelimb evolution. Interestingly, whilst some shifts are found within the Aves, no unique clade-wide shifts are detected at their origin, increasing support for the idea that early birds lack the uniqueness they were previously assumed to possess.

Redescription of *Elachistosuchus huenei* and a reappraisal of the phylogenetic relationships of basal Sauria (Neodipasida) based on Computed micro-Tomography †

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The diapsid reptile *Elachistosuchus huenei* from the Upper Triassic of Germany has been considered as both a pseudosuchian archosaur and as a sphenodontid lepidosaur. Because it shows many plesiomorphic characters, its taxonomy remains ambiguous, leaving it largely ignored in recent literature. To shed new light on its morphology and phylogenetic relationships, the holotype was scanned using high-resolution micro-computed tomography. The presence of well-developed crista cranii on the ventral surface of frontals and nasals is one striking feature recovered. Basal lepido- and archosauromorphs display a similar, but usually more subtly developed character, although information on presence and distribution of this character remains scarce. Tooth implantation is neither thecodont nor acrodont, but is more similar to, although still different from, the pleurodont implantation of lizards. Scanning of other materials for comparison shows that this implantation type is also present in the basal archosauromorph *Prolacerta*, and has significant implications for the evolution of tooth implantations. Current classifications are anyhow outdated and incompatible with the present technological facilities and deserve a proper reevaluation. Further findings include: open lower temporal fenestra; shagreen of denticles bore by all palatal bones; dorso-ventrally extended, but anteriorly short splenial; anteriorly notched T-shaped interclavicle; and narrow scapula. Phylogenetic analysis indicates it is a lepidosauromorph closely related to rhynchocephalians, or perhaps a basal member of this clade. The addition of *Elachistosuchus* into a basal diapsid matrix also has interesting implications for the classification of basal archosauromorph taxa, sauropterygians and testudines. Our data, however, still needs further processing to become more solid and conclusive.

Preserving Cambrian bodies in the Sirius Pass, North Greenland †

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The Cambrian Explosion represents a significant and important interval in Earth's history. It marks an increase in the diversification of complex animal body plans and the expansion of marine ecosystems. The Cambrian fossil record is incredibly biased towards the preservation of shelly (biomineralised) skeletons, however it is also home to some areas of exceptional soft-bodied preservation, such as the Burgess Shale, Chengjiang and Sirius Passet. There is still a poor understanding of the different taphonomic pathways leading to these spectacular Lagerstätten. The role of preservation is a key factor in mediating diversity and therefore critical in understanding the processes responsible for the Cambrian Explosion. SEM imaging and elemental mapping has been carried out on a variety of specimens from the Sirius Passet (North Greenland). Two styles of preservation have been recognised at this stage. 1) Evidence of bacterial filaments, associated with microbial mat textures may be the cause of reduced oxygen, allowing carbonaceous preservation and associated phosphate deposition. 2) The majority of specimens exhibit Burgess Shale Type (BST) films. Preliminary investigations focussed on *Isoxys volucris* (bivalved arthropod) show no distinct textural differences between the

film and the matrix and the fossils lack defined margins. Elemental mapping shows enrichment in silica (Al and K poor) compared to the matrix, which is composed of clay minerals. These initial findings indicate two distinct taphonomic pathways, the first being a phase of diagenetic silica deposition and the second a phase of phosphate deposition with an absence of carbonate, which would suggest a distinct change in sediment chemistry during decay and preservation. It can be postulated from these preliminary findings that the Sirius Passet material does not appear to show the same taphonomic pathway as BST preservation.

A high-resolution sub-Antarctic record of mid- to late Holocene climate and vegetation change at Fan Lake, South Georgia *§*

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Sub-Antarctic South Georgia is a key region for studying climate variability in the Southern Hemisphere, due to its positioning between the Antarctic Circumpolar Current and the Polar Frontal Zone. Here we present a pollen record from a high-resolution sediment core from Fan Lake off Annenkov Island, South Georgia. The 5.8 m long core covers the last 7,000 years of the Holocene. Preliminary results indicate a local dominance of sub-polar vegetation, with *Poaceae* and *Acaena*, throughout the mid-to late Holocene. Slightly higher *Acaena* percentages suggest cooler and wetter conditions on Annenkov Island after 2,600 cal yr BP. A subsequent increase in *Nothofagus* and *Ephedra* after 2,300 cal yr BP points to an increase in long distance transport from South America possibly triggered by changes in the Southern Hemisphere westerly winds.

The evolutionary radiation of Triassic marine reptiles *†*

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The diversification of marine reptiles in the Mesozoic represents an exemplary evolutionary radiation. It began in the Triassic, when numerous reptilian clades diversified within the marine realm following the Permian-Triassic extinction event, including sauropterygians, ichthyosaurs, thalattosaurs and archosauromorphs. These groups evolved a varied range of feeding ecologies and morphological innovations. In this study I explore the proliferation of ecological variation during the early stages of Mesozoic marine reptile evolution, using a quantitative analysis of morphological diversity (disparity) in lower jaw elements. Results from morphospace analyses show that Triassic marine reptiles evolved an exceptional range of lower jaw morphologies, associated with diverse and divergent ecologies. These included very robust lower jaws with large coronoid processes, characteristic of shell crushing placodonts and thalattosaurs, in addition to more slender and curved jaws found in ichthyosaurs and eosauropterygians, that preyed upon fish and soft-bodied invertebrates. Calculating morphological disparity through time reveals that Triassic marine reptiles were most morphologically diverse in the Carnian (early Late Triassic). During this stage species diversity was in decline following a Middle Triassic diversity maximum. A large reduction in morphological disparity is discovered in the Norian and Rhaetian, and there is no increase or decrease in disparity across the Triassic-Jurassic boundary. Overall this study provides unique quantitative insights into the initial radiation of Mesozoic marine reptiles in the Triassic and reveals that maximum levels of morphological variation did not coincide with times of highest taxonomic diversity.

The evolution of plant microRNAs *§*

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MicroRNAs (miRNAs) are short non-coding RNA molecules that are an important part of gene regulatory networks in animals and plants. Once integrated into the gene regulatory network, miRNAs are rarely lost in ancestral lineages, making them potentially very useful as phylogenetic markers. Furthermore, the gradual accumulation of miRNA families in animal lineages has been shown to correlate with increases in morphological complexity. It has been suggested that a similar correlation is likely to be found in the plant kingdom but this has not yet been demonstrated.

With the advent of cheap deep sequencing technology there has been a rapid rise in the amount of plant miRNA data available and this allows for an examination of whether the dynamics of miRNA evolution in plants is similar to what has been demonstrated in animals. An analysis of existing miRNA plant data reveals that many miRNA genes have been incorrectly annotated, resulting in

possibly erroneous conclusions being drawn about their evolution. All *bone fide* miRNA families are placed here in their phylogenetic context, which acts as a powerful predictive framework for inferring the miRNA repertoire of unstudied species as well as providing a clear picture of what areas of the plant kingdom need further study. In addition, clear differences are apparent in the dynamics of miRNA evolution in plants compared to animals and it seems likely that the number of miRNA families in a plant does not correlate with morphological complexity.

Getting geometric with ruminant rostra †

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Rostral (snout) shape is a prominent aspect of herbivore feeding ecology, controlling both forage selectivity and intake rate. Ruminant feeding classes have an intriguing history, and it has been proposed they can be partially delimited via snout shape; grazing and browsing species attributed 'blunt' and 'pointed' snouts respectively. This is analysed for the first time in a statistically rigorous geometry-based framework, using a two-dimensional profile of the premaxilla in ventral aspect for 121 extant ruminant species. When ruminants are classified ecologically based on a range of independent indicators of their feeding strategy, these profiles cannot be discriminated reliably. However, when 'intermediates' are removed, a discriminant space in which unquestionably blunt and pointed classes become distinct. This space can then be used to objectively identify profiles that fall into these 'unquestionable' regions. Accordingly, a geometric shape-based assessment of snout shape can be used as a way of placing a large number of fossil ruminant snout profile morphologies into feeding classes confidently if used in conjunction with an appropriately edited training set of end-member snout profiles. Furthermore, when snout centroid size is compared to respective body masses as a shape-independent variable and proxy for a geometric form space, grazers are relatively restricted in range compared to browsers.

Heterochrony and the Evolution of Soaring Flight §

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A planned investigation into the role of heterochrony in the evolution of soaring flight mode within modern avians from presumptive non soaring ancestors, based on comparison with related non soaring flighted taxa. The study aims to elucidate whether there are concordant morphological changes in convergent evolution of soaring flight, indicative of common developmental changes, or whether there is convergence upon a soaring morphology. Investigation focuses upon the morphology of the wing skeleton and pectoral girdle, i.e. the pectoral locomotor module. Morphological change will be assessed in the context of heterochrony, to which end a new definition of heterochrony is proposed, which attempts to consolidate extant definitions into a form applicable to extant and extinct taxa where the ontogenetic trajectory may or may not be known, providing a framework suitable for assessment with both knowledge of the specific cellular interactions occurring and without.

Initial work has developed a combined skeletal measurement based on geometric means of pelvic girdle and limb measures that may be used for a proxy for mass in standardisation (thus allowing comparison with fossil taxa) and further investigation of allometry in the pectoral girdle and limb.

Methods developed here will be utilised in the study of the initial evolution of flapping flight and its subsequent refinement, with a focus on the development of appropriate proportions rather than the emergence of specific anatomical characters to elucidate whether there are common patterns of evolutionary change both in flight acquisition and specialisation, perhaps indicative of predispositions towards particular developmental changes.

Evolution, extinction, and biogeography of Late Cretaceous Antarctic cephalopods §

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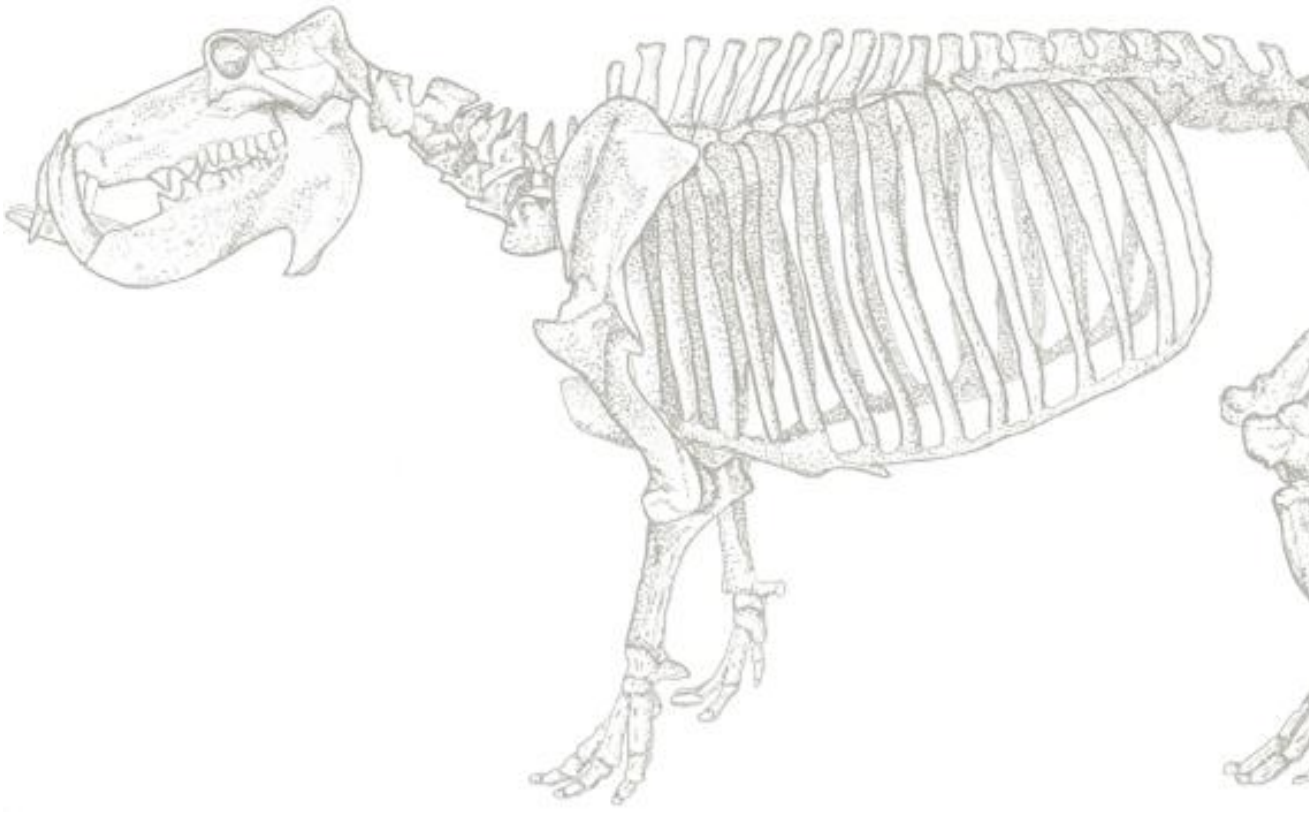
The final demise of the ammonoid cephalopods at the end of the Cretaceous has provided crucial evidence of the rate of extinction in this accelerated crisis. Latest Cretaceous (Maastrichtian 72 – 66 Ma) cephalopod faunas are known from virtually every continent and latitude, although these have in the past been difficult to correlate to the international timescale due to lack of firm biostratigraphic or chronostratigraphic control. This has led to continued debate about the nature of ammonoid extinction during

the Cretaceous/Paleogene (K/Pg) transition, as well as diversity changes throughout the Maastrichtian; a stage known to contain dynamic climatic and oceanographic changes. This discourse is a key component of the ongoing debate about the nature of the K/Pg crisis itself; whether the event was caused by a catastrophic extraterrestrial impact, or a more drawn-out affair with extinctions spread over the final few million years of the Cretaceous.

The López de Bertodano Formation which crops out on Seymour Island, James Ross Basin, Antarctica is unique in containing the highest latitude exposures across the K/Pg interval in the world (65°S), and certainly the thickest stratigraphic record of this important interval in Earth history anywhere in the Southern Hemisphere. The expanded nature of the sedimentary sequence together with the abundant and well-preserved macrofossil fauna, make this a key locality for assessing biotic changes during the Maastrichtian and across the K/Pg boundary at high latitudes.

Here we present data based on new collections of a Maastrichtian cephalopod (ammonites and nautiloid) fauna from the López de Bertodano Formation on Seymour Island. We review and re-evaluate their taxonomy, their record of evolution and extinction in comparison to updated age models, and discuss subsequent implications for the palaeobiogeography of latest Cretaceous ammonoid faunas using a variety of statistical methods and a new global database of Maastrichtian cephalopod occurrences.



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