Progressive Palaeontology 2008

THE UNIVERSITY OF MANCHESTER
Alumni Association, Faculty of Life Sciences, School of Earth, Atmospheric and Environmental Sciences and The University of Manchester Palaeontology Society.

CONTENTS

Introduction and Welcome

Welcome to the 2008 Progressive Palaeontology Conference hosted by the University of Manchester. There is a long history of Palaeontology at the University, going back to the palaeobotanist William C. Williamson (1816-1895) Professor of Natural History (1851) and William Boyd Dawkins (1837-1929) Curator of The Manchester Museum (1869-1890) and Professor of Geology (1874) who did extensive work on Quaternary mammals. Throughout the years the University of Manchester (Earth Sciences) has produced important research on palaeobotany focusing mainly on the Lower Cretaceous of Britain, and arthropod palaeobiology with work done on eurypterids, spiders and insects. The direction of research in recent years has begun to shift from the more traditional to a hi-tech multidisciplinary approach to palaeontology. This new approach has led to cross-faculty collaborations within the University with Material Science, Computer Science and the Faculty of Life Sciences and numerous collaborations with external institutions. Some of this new research will be presented at the conference in the department's 3D Visualization Suite.

Pre-conference (29th) starts with a public open day at The Manchester Museum "Meet the Fossil Detectives" with public lectures from Mike Benton (Bristol) and Phil Manning (Manchester), and throughout the day delegates will be able to talk about their research to the public. The conference starts on the 30th with oral and poster presentations, with a session in the 3D Visualization Suite. The post-conference field trip will be to Castleton, Derbyshire looking at the local Carboniferous geology and palaeontology. The social events include a pre-conference drinks reception in the museum, lunch on the day of the conference and the annual dinner held in Christie's Bistro.

We hope you enjoy Progressive Palaeontology 2008 and we would like to wish all the best to next year's host Birmingham.

James Jepson, Karl Bates, Peter Falkingham and Nick Edwards

ACKNOWLEDGEMENTS

We would like to thank the generous support of our sponsors: The Palaeontological Association, 3D Laser Mapping, Cambridge University Press, Manson Publishing, Oxford University Press, Manchester Geological Association, Mercury Computer Systems. Inc., Advanced Visual Systems (AVS), The University of Manchester Alumni Association, The University of Manchester's Faculty of Life Sciences and the School of Earth, Atmospheric and Environmental Sciences, The Manchester Museum and the University of Manchester Palaeontology Society. Thanks to Anna Davies for catering and Wendy in the gift shop (Manchester Museum). Thank you to Tim Palmer (Palaeontological Association) for his help. Many thanks go to Jane Ratchford and Elizabeth Wilkinson (The University of Manchester's Careers Service) and Professor Alan Dickson (The University of Manchester's Faculty of Life Sciences) for help with funding. Thank you to Anna Bunney (The Manchester Museum) for help organizing the *Meet the Fossil Detectives* open day at the museum, Professor Mike Benton for giving a public lecture on that day and all who attended the open day. Graeme Lloyd (University of Bristol) for his advice. Thanks go to Phil Manning, John Nudds, Dave Hodgetts, Duncan Irving (The University of Manchester) and David Gelsthorpe (The Manchester Museum) for help and support in organizing the conference. Thank you to Lisa Abbott, Verity Bennett and Andrew Parker for their help moving tables and pointing people in the right direction

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PROGRAMME

THURSDAY 29TH MAY 2008:
The Manchester Museum public engagement event.
Venue: The Manchester Museum.
Time: 13:00-16:00

THURSDAY 29TH MAY 2008:
Pre-conference wine & cheese reception
Venue: The Manchester Museum.
Time: 18:30-20:00

FRIDAY 30TH MAY 2008:
Annual Meeting.
Venues: Kanaris lecture theatre, The Manchester Museum.
3D Visualization Suite, Williamson Building, SEAES.

Schedule:
Kanaris lecture theatre, The Manchester Museum.
08:45-09:15: Registration with refreshments.
09:20-09:30: Introduction.
09:30-14:50: Talks and Poster Sessions complete with Refreshments and Buffet Lunch.
15:00-16:15: Visualization Suite.

19:00: Annual Dinner at Christie's Bistro.

ORAL PRESENTATIONS

KANARIS LECTURE THEATRE, THE MANCHESTER MUSEUM

FIRST SESSION

09:20–09:30 Introduction by Dr. Phillip Manning
09:30–09:45 Marco Brandalise de Andrade
09:45–10:00 Josep Fortuny
10:00–10:15 Phillip Mannion
10:15–10:30 Nick Edwards

10:30–10:50 BREAK AND POSTER SESSION

SECOND SESSION

10:50–11:05 Bernat Vila
11:05–11:20 Bryony Caswell
11:20–11:35 Roger Benson
11:35–11:50 James Jepson

11:50–13:30 LUNCH AT KRO BAR

THIRD SESSION

13:30–13:45 Mark Johnson
13:45–14:00 Caroline Sogot
14:00–14:15 Mark Bell
14:15–14:30 Peter Tickle

14:30–14:50 BREAK

14:50–15:00 TRAVEL TO VISUALIZATION SUITE

VISUALIZATION SUITE, SEAES, UNIVERSITY OF MANCHESTER

FOURTH SESSION

15:00–15:15 Jonathan Antcliffe
15:15–15:30 Imran Rahman
15:30–15:45 Peter Falkingham
15:45–16:00 Russell Garwood
16:00–16:15 Karl Bates

ORAL PRESENTATION ABSTRACTS (A-Z)

DARWIN'S DILEMMA: USING NEW TECHNIQUES TO SOLVE OLD PROBLEMS

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When did the animals originate? Why do the whole range of major animal body plans appear in a geological instant? Is there a long prehistory to the animal evolution? These are problems that were as puzzling to Darwin as they remain today. To decode these enigmas then we must look at the fossil record both before the Cambrian explosion and during these evolutionary events. The worldwide Ediacara biota immediately predates the Cambrian events and has been the source of much controversy as candidates for the earliest animal fossils. Here is presented the first phylogenetic analysis of the Ediacara biota. This analysis is based on high resolution three dimensional laser mapping of the morphology of these fossils. Further, the significance of the worldwide and pervasive preservation of soft bodied fossils in the Ediacaran is examined and the later decline of these processes in the Cambrian

SENSE AND SENSITIVITY ANALYSIS: QUANTIFYING THE UNKNOWN IN BIOMECHANICAL MODELLING OF FOSSIL VERTEBRATES

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Constructing musculoskeletal models of extinct taxa requires subjective assumptions about soft tissue morphologies rarely preserved in the fossil record. Sensitivity analysis of dynamic simulations of dinosaur running have confirmed that numerical values chosen for poorly understood mass and soft tissue properties have a significant effect on the predicted locomotor ability of these animals, emphasizing the need to better constrain plausible `bio-realistic' ranges.

In this study I have used state of the art laser scanning technology and computer modelling software to create a range of 3D musculoskeletal models of five specimens of non-avian dinosaur. LiDAR scanning allows the full mounted skeleton to be imaged providing a highly detailed 3D model in which each bone retains its spatial position and articulation. This provides a high resolution skeletal framework around which body cavities and internal organs can be reconstructed, allowing calculation of body segment masses, centres of mass and moments or inertia for each animal. An extensive sensitivity analysis has subsequently been carried out, in which the volumes of body segments and air sacs were varied in an attempt to constrain the likely maximum bio-realistic range of mass parameters for each animal. The results highlight the need to conduct higher level biomechanical and evolutionary analyses of extinct taxa in an iterative fashion, with on-going critical evaluation of mass and soft tissue properties used in analytical models.

TRILOBITE BODY SIZE ACROSS SPACE AND TIME

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Trilobites are a highly diverse group of extinct arthropods, which ranged through the whole Palaeozoic. An important component of Sepkoski's Cambrian fauna, they diversified to a peak in the Upper Cambrian-Lower Ordovician then following a decrease across the Ordovician extinction they declined for the rest of the Palaeozoic until there demise during the end Permian extinction event. Dimensions of trilobite specimens have been collected for 12,000 individuals from museum and literature sources. The database now covers the entire taxonomic and temporal range of the group and contains representatives from most of the major terranes.

During their 300 million year history trilobites displayed a large range in size. Holaspids `adults' vary from several millimetres to over 700 mm, with giants known from several localities across the world. There has been some speculation about the causes for the size distribution of trilobites; however until now there has yet to be a class-wide study undertaken to fully understand this problem. Individuals were placed into stage bins according to the range of the strata. A history of trilobite body size is here presented, discussing strong correlations with their generic diversity and morphological disparity. Finally, trilobites display a downsizing across the Ordovician/Silurian boundary associated with the mass extinction event, the so called 'Lilliput' effect, potential reasons to explain this are also discussed.

A REVIEW OF BASAL TETANURAN (DINOSAURIA, THEROPODA) RELATIONSHIPS: IMPLICATIONS FOR 'MEGALOSAUR' ENDEMISM AND FAUNAL TURNOVER BETWEEN THE MIDDLE AND LATE JURASSIC.

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Tetanurae is a major clade of carnivorous dinosaurs (Theropoda) that comprised the most abundant and diverse assemblage of terrestrial predators from its origin at the end of the Early Jurassic, until the end Cretaceous extinction of the dinosaurs approximately 115 Mya later. Tetanurae includes giant carnivores weighing upwards of 7 tons: the Early Creaceous carcharodontosaurids and spinosaurids and the Late Cretaceous tyrannosaurids. It also includes birds, which are part of a diverse array of mainly small-bodied theropods, the coelurosaurs. Birds originated no later than the Kimmeridgian (Late Jurassic) and phylogenetic ghost lineages imply that the most tetanuran diversification occurred during the Middle Jurassic and Oxfordian. Unfortunately the Middle Jurassic dinosaur record is poor. Middle Jurassic theropods are known from Argentina, China, and Europe, of which the European record is arguably the best. Interpretation of the Middle Jurassic European theropod record has been obstructed by confused taxonomy and lack of study.

A new theropod phylogeny constructed to resolve basal tetanuran interrelationships draws on the results of recent work reviewing the Middle Jurassic record of British and French theropods. The study includes almost all non-coelurosaurian theropod taxa and critically evaluates characters from all previous phylogenetic studies of basal theropods. Most European Middle Jurassic theropods form a monophyletic clade within Spinosauroidea, Megalosauridae, that also includes *Torvosaurus* from the Late Jurassic of North America and *Afrovenator* from the Early Cretaceous of Africa. Two new clades are resolved within Spinosauroidea, one comprising Chinese Middle Jurassic theropods *Chunadongocoelurus* and *Monolophosaurus,* and one comprising the Argentinian Middle Jurassic theropods *Condorraptor* and *Piatnitzkysaurus* with *Xuanhanosaurus* from the Middle Jurassic of China and *Marshosaurus* from the Late Jurassic of North America. This result suggests a limited degree of endemism among Pangean theropod faunas during the Middle Jurassic, particularly with respect to the European megalosaurids.

Spinosauroids formed the dominant predators in Middle Jurassic dinosaur ecosystems. By contrast, most Late Jurassic theropods are allosauroids or coelurosaurs. This implies faunal turnover between the Middle and Late Jurassic with the diversification of Allosauroidea and Coelurosauria at the expense of Spinosauroidea.

A NEW SPECIMEN OF *GONIOPHOLIS* FROM THE INTERMARINE MEMBER (BERRIASIAN, LOWER CRETACEOUS) OF DURLSTON BAY, ENGLAND

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Goniopholis was a semi-aquatic estuarine mesoeucrocodilian, which closely resembled the living crocodilians, although possessing a `mesosuchian' type of choana. Even though *Goniopholis* has been known for over a century, the original descriptions were vague regarding the precise stratigraphical provenance of the specimens. Other reports of the genus include finds from Portugal, Germany, North America, Thailand and Brazil. Fieldwork by RE (2007) recovered the skull of a goniopholidid, provisionally identified as *Goniopholis* cf. *simus*, from an outcrop in the northern section of Durlston Bay, Swanage (Dorset, England). The skull (482 mm long; 325 mm wide) lost part of its three-dimensional structure, but still preserves delicate features (e.g. pterygoid laminae, postorbital bar). Mechanical preparation and CT scanning were used to access the morphological features, including: nasals excluded from the naris; frontal excluded from the orbit; maxillary depressions present. In the bottom of the right maxillary fossa, the bone is eroded and roots of maxillary teeth are exposed. The new specimen was recovered from a distinctive laminated shale (beds 128/129; Clements, 1993), part of the Intermarine Member ("middle" Purbeck). The shale preserving the skull is packed with bivalve shells and also holds one turtle scute, one coprolite and at least one unidentified fish tooth. Although the Intermarine Beds were previously suggested as the probable origin of the Owen's specimens (Salisbury *et al.*, 1999), the actual provenance of the genus needed clarification. However, other related sediments may also bear remnants of *Goniopholis,* further expanding the current geographical and stratigraphical range of this group of crocodilians in Britain. The specimen was recovered with assistance from Chris Moore and Steve Etches and prepared by Chris and Alex Moore, with the support of the Jurassic Coast Trust, England. MBA receives support from CNPq (Proc. 200381/2007-8), Brazil.

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Salisbury, S. W., Willis, P. M. A., Peitz, S. & Sander, P. M. 1999. The crocodilian *Goniopholis simus* from the Lower Cretaceous of North-Western Germany. In: Unwin, R. L. (ed.). Cretaceous Fossil Vertebrates. *Special Papers in Palaeontology*, 60:121-148

RESPONSE OF THE MARINE BIOTA TO A PERIOD OF ENVIRONMENTAL CHANGE IN THE TOARCIAN (EARLY JURASSIC)

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During the early Toarcian (183 Ma) there was a large perturbation to the Earth's climate which lasted for approximately 250 ka. This is marked by a large global input of isotopically light carbon into the ocean-atmosphere system, a 6-13^{o}C seawater temperature increase and a large increase in the rate of global weathering (Cohen et al., 2007 and references therein). Associated with this environmental change is a species level extinction event (Little, 1996) of the marine fauna and a crisis in the phytoplankton. This study documents the changes in the biota across this event at a high resolution and explores the links between the biota and geochemical changes.

New species range data collected during this study from Toarcian sections in Whitby, N Yorkshire show distinct relationships with existing high resolution geochemical datasets (Cohen et al., 2007 and references therein, Pearce et al., 2008). Biometric data from the dominant species *Pseudomytiloides dubius* and *Bositra radiata* have also been collected from the sections near Whitby and relationships with the geochemical data are being explored from over 226 stratigraphic levels which span the climate perturbation. Links with geochemical proxies have been found and are most clearly discernible on a 20 ka timescale.

Additionally, detailed geochemical data (total C, S, N and δ^{13}C) is presented from field sites in Leicestershire, where contemporaneous shallower water facies were deposited on the East Midlands Shelf. This new data shows a very similar geochemical record to that found in facies deposited in the Cleveland Basin.

Cohen, A. S., A. L. Coe, and D. B. Kemp. 2007. The Late Palaeocene - Early Eocene and Toarcian (Early Jurassic) carbon isotope excursions: A comparison of their time scales, associated environmental changes, causes and consequences. Journal of the Geological Society 164(6):1093-1108.

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MOLECULAR PALAEONTOLOGY

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Reports of preservation of biochemical or biomolecular signals from fossil material goes back to at least as far as the middle of the 20th Century, but in the last 15 or so years, there has been increased research into the preservation of organic compounds or "biomolecules" in the fossil record. This increase in research has been driven with the advance and use of geochemical and biological analytical techniques (such as mass spectrometry and the polymerase chain reaction) on archaeological and palaeontological material. A great deal of information about extinct organisms may be revealed through the study of molecular preservation. Biomolecules are synthesized in the cells of organisms, and therefore can be phylogenetically informative. They could also give an indication as to the properties and biological processes of the organism that produced them. Presented here is an overview of biomolecules, their role in living organisms and consequently how they can be used in the interpretation of extinct organisms.

APPEARANCES CAN BE DECEIVING: EFFECTS OF SOIL MECHANICS AND BIOMECHANICS ON VERTEBRATE TRACK MORPHOLOGY - IMPLICATIONS FOR INTERPRETATION

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The importance of fossil vertebrate tracks is often underestimated in light of the more immediate knowledge gained from body fossils. However, unlike the animal's remains, its tracks are a record of life, rather than death. A track can be a record of behaviour, biomechanics, and ecology. In order to correctly interpret tracks, we must fully understand how variations in parameters intrinsic to track formation affect the final morphology. These parameters fall into two categories, those above the sediment surface - biomechanics - and those below the sediment surface - soil mechanics. Both biomechanics and soil mechanics employ methods from the engineering disciplines. Presented here are the results of simulations made using a Finite Element Track Simulator. Soil properties and the mechanics of track formation are shown to grossly affect the morphology of resultant tracks including the appearance of `webbing' between toes, and the disappearance of digits.

CT TOOLS FOR THE VERTEBRATE VIRTUAL PREPARATION: THE CASE OF THE TEMNOSPONDYL CAPITOSAUR SKULLS IN THE BUNTSANDSTEIN ROCKS

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Capitosaurs were one of the most abundant groups of temnospondyls amphibians during the Triassic. In contradiction to this fact, the presence of this group in the Iberian peninsula is rather scarce. In 1990 several capitosaur individuals (including skulls and articulated postcrania) and reptilian bones were recovered in Olenekian (Early Triassic) outcrops from the Catalan Prelitoral mountain range (Eastern Iberian peninsula).

La Mora site provided slices of hard fine sandstone from Buntsandstein facies, fully embedded with fossil remains. The hard matrix hinders the preparation process and makes it difficult to study the material due to the impossibility to recognise all the anatomical characters. This circumstance is solved using non-invasive techniques, like CT scans, that allow us the possibility to distinguish individual bone elements and help us to test doubtful or difficult morphological characters. Additionally, an almost entire CAD skull has been reconstructed using the cranial elements attributed to the same taxa and scanned from different rock blocks. It allows us to observe hidden characters that were impossible to prepare with the traditional mechanical techniques. The reposition of the cranial elements has shown differences in size between remains of adult and subadult specimens. This fact has helped us to evaluate ontogenetically the recovered skulls.

Capitosaurs from La Mora were initially assigned to *Parotosuchus* (Gaete et al., 1993) but a posterior review of the material (Suñer, 2006) and the new insights about the capitosaurid phylogeny of the last years (Damiani, 2001) seem to classify this material more closely to *Eryosuchus.* In any case, both genera are known from the European platform, former having had a more widespread distribution. Despite this fact, the complete phylogenetic relationships of the different capitosaur taxa around the world remain unclear. Based on the new cranial reconstruction from La Mora skulls and the systematic study in progress, the capitosaurid specimen is now regarded as an *Eryosuchus*-like form with several unusual and plesiomorphic features.

BRINGING THE THYLACOCEPHALA OUT OF THEIR SHELL: 3D RECONSTRUCTION OF ENIGMATIC ARTHROPODS

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The Thylacocephala are an unusual, enigmatic arthropod class. Current knowledge of the group's anatomy and origins is extremely limited, their study with conventional palaeontological techniques being hampered by an all-encompassing carapace. This problem, compounded by a combination of very primitive and highly derived features, has fuelled three decades of debate over thylacocephalan affinities and palaeobiology. With the aid of tomographic reconstruction, however, anatomy hidden within the carapace can be studied. Computer models of a three-dimensionally preserved specimen of the thylacocephalan *Dollocaris ingens* (La Voulte-sur-Rhône Lagersätte, Jurassic, France) are presented. Datasets obtained through both serial grinding/photography and X-ray microtomography have revealed, for the first time, the internal anatomy of the Thylacocephala. As with the group's external features this exhibits a dichotomy between highly evolved aspects - for example pleurobranch gills, hypertrophied eyes and a complex digestive system - and seemingly primitive ones such as an undifferentiated trunk. The findings help solve some long-running disputes concerning the class, but data do not yet allow an authoritative conclusion on their phylogenetic position. This study demonstrates the power of tomographic reconstruction to resolve problematic anatomy in groups such as the Thylacocephala.

SNAKEFLIES (INSECTA: RAPHIDIOPTERA) FROM THE PURBECK LIMESTONE GROUP, DORSET, UK.

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For the first time raphidiopterans (Insecta: Neuropterida) have been formally described from the Lower Cretaceous Purbeck Limestone Group. Four species are described from the family Mesoraphidiidae and the genus *Mesoraphidia*. They are thought to have lived in an arboreal habitat similar to that of modern day raphidiopterans. All the species from the Purbeck have a reduced venation and a smaller size (with the exception of *M. durlstonensis,* which is of an average size for the genus) than other species of *Mesoraphidia*. Out of the four species one is different to the others *M. mitchelli*, this species is the oldest of the four. The difference of *M. mitchelli* to the others hints at a faunal change within the Purbeck, the most likely explanation being the change in climate through the Purbeck, from an arid to a more humid environment.

Finite Element Method approach to functional analysis of the terminal ungual phalanx in both extinct and extant predators

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The manus claws of *Velociraptor mongoliensis* bear a striking resemblance to the terminal ungual phalanx of the Eurasian Eagle owl (*Bubo bubo*), both in morphology and the distribution of cortical and trabecular bone. A null hypothesis was formulated that the claws of *Velociraptor* were not used for prey dispatch but were instead used for a climbing or clinging function (Manning et al., 2006).

We developed a finite element model of the terminal ungual phalanx of digit III of a Eurasian Eagle owl to analyze the strains occurring during the simulated static loading of the claw whilst gripping a perch. The bone easily withstood the load applied, whilst the stresses and strains were well within both the yield strength and Young's modulus of bone.

The finite element models revealed the 3D micro-architecture of the internal structure of the Eagle owl terminal ungual phalanx and the *Velociraptor* manus claw. The CT scan of the fossilised *Velociraptor* claw revealed it to be broken into two pieces, and when repaired these were mis-aligned. This prevented us from performing finite element analysis, but future work will look to address this problem and reveal the stresses and strains experienced by the manus claws of *Velociraptor*. This work will potentially reveal the capabilities of dromaeosaur claws and provide a more robust interpretation of their biomechanical function with the potential to provide new insight to their ecology and behaviour.

MAPPING SAUROPODS: USING GEOGRAPHICAL INFORMATION SYSTEMS (GIS) IN PALAEONTOLOGICAL ANALYSES

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Geographical Information Systems (GIS) are an extremely useful computer-based tool for both analysing and visualising large amounts of spatially distributed data. GIS contains numerous tools for geostatistical analysis which allow the testing of palaeobiological hypotheses. Taxonomic, palaeoenvironmental and geological data can be integrated with palaeogeographic maps, enabling analysis of both spatial and temporal distributions of organisms. This technique can also play an important role in teasing apart real evolutionary patterns from the artefacts created by a patchy fossil record and sampling biases. Sauropod dinosaurs are well suited to such analyses. They had a near global distribution during the Mesozoic and show numerous fluctuations in their diversity. These changes in diversity took place against a backdrop of profound geological and biotic events. Thus it should be possible to determine whether there is a correlation between certain types of sauropod and particular habitats. If such ecological preferences can be detected, this will provide important insights into the evolution and diversity of the group. So far this work has revealed a statistically significant positive association between non-titanosaur sauropods and coastal environments, in comparison to titanosaurs, which has implications for the "sauropod hiatus" of the early Late Cretaceous of North America. GIS has also proved useful in analysing the global distribution of sauropods, and currently this work has looked for spatial and temporal patterns in the distribution of their trackways.

EVOLUTION OF THE ECHINODERM WATER VASCULAR SYSTEM IN THE CARPOID CLASS CINCTA

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Like all carpoids, cinctans are an extremely controversial fossil group, and there is little consensus regarding their palaeobiology or phylogenetic position. We report a new species of cinctan from the lower Middle Cambrian of northeast Spain. Three-dimensional computer models were produced for this species using X-ray microtomography and the custom SPIERS software suite; novel morphological data from `virtual fossils' are used to test alternative palaeobiological and phylogenetic hypotheses. Cinctans are interpreted as stem-group echinoderms possessing a water vascular system, internal gill slits and a U-shaped gut. They are critical to understanding the early evolution of echinoderms as cinctans illustrate the transition from a paired water vascular system to one derived from the left hydrocoel only (as seen in extant echinoderms). The former construction is also observed in another group of carpoids, the ctenocystoids, and was the condition in the latest common ancestor of echinoderms and hemichordates.

TESTING FOR ECOLOGICAL AND LATITUDINAL SELECTIVITY DURING THE K/T MASS EXTINCTION

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Mass extinctions have been studied extensively in terms of their taxonomic impact, but with a few exceptions (e.g. Droser *et al*., 1997; McGhee *et al*., 2004; Jablonski, 2005) little is known about their ecological impacts. It has been suggested (Jablonski, 2000; Gould, 2002) that "higher level characters" of taxa such as geographical range, abundance, size etc. may enhance survivorship during mass extinction. If correct this hypothesis would indicate that processes operating during mass extinction can act as an agent of natural selection at higher taxonomic levels and, by implication micro-evolutionary processes and macro-evolutionary patterns are decoupled.

Here we classify marine families by feeding tier and motility to define the occupation of ecospace (*cf* Bambach *et al*., 2007) and use these to test for, 1) ecological selectivity during the K/T mass extinction and, 2) variable extinction across latitude. This quantitative study of ecological selectivity provides an insight into the ecological importance, mechanisms and evolutionary significance of the K/T mass extinction. Our results show that whilst ecospace groups survived the mass extinction preferential familial extinction occurs in pelagic and erect epifaunal tiers and at lower latitudes within these tiers. This pattern indicates complex causal mechanisms affecting primary ecological factors (e.g. sea surface temperature, productivity).

We support the hypothesis that during the K/T mass extinction fundamental ecological parameters affected survivorship and thus the processes operating during the mass extinction acted as an agent of natural selection at the family level.

Uncinate processes in extant birds and extinct dinosaurs

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Uncinate processes are bony projections which extend posteriorly from the vertebral ribs in most species of extant bird. Originally thought to function in stiffening the rib cage, recent work in geese has demonstrated that the processes play an integral role in the mechanics of avian ventilation. Uncinate processes act as levers, improving the mechanical advantage for the forward rotation of the vertebral ribs and lowering of the sternum thereby facilitating inspiration and expiration. Uncinate processes also occur in extinct non-avian maniraptoran dinosaurs, providing more support for the presence of an avian-like air-sac respiratory system in theropod dinosaurs. Here we investigate the distribution, homology and potential significance of the uncinate processes in maniraptoran dinosaurs with reference to studies in modern birds.

A TAPHONOMIC APPROACH ON DINOSAUR NESTING BEHAVIOUR: 3D MODELING OF MEGALOOITHID EGGS

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The study of nesting behaviour in dinosaurs is based on the micro- and macrostructural characteristics of eggshells, eggs and nests. Several lines of evidence (nest structure, taphomony of individual eggs, and porosity studies) provide data to infer incubation mode and nesting paleoenvironment. In the southern Pyrenees (NE Iberian Peninsula) the great abundance of megaloolithid eggs and clutches provides excellent key-data to characterize the clutch geometry, egg taphonomy and general reproductive traits. The use of laser tools allows the developing of macrotaphonomic studies and 3D modeling of multiple clutches which indicate that Pyrennean megaloolithid eggs were deposited within a bowl-shaped excavated pit. However, whether the eggs were covered with sediment or whichever were the hatching conditions (subaerial/buried nesting) and timing remain unclear. Taphonomic studies on individual eggs provide significant data on the processes that affected the eggs before their definitive burying. After the possible occurrence of biological processes (hatching), the remaining eggshell can be affected by taphonomic processes such as biostratinomic abrasion and/or fossildiagenetic cracking, ore precipitates or collapse. All these processes and their relative occurrence in time introduce significant differences in the fracture pattern and inner eggshell fragments distribution. Analysis of multiple CT scans of eggs allows us to raise a theoretical model with two scenarios discerning differences in the conditions and timing of such processes. The dichotomic model allows to establish inferences on the incubation mode of dinosaurs.

Poster Presentation Abstracts (A-Z)

Kanaris Lecture Theatre Foyer, The Manchester Museum

Sensitivity analysis in evolutionary robotic simulations of bipedal dinosaur running

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Constructing musculoskeletal models of extinct vertebrates requires subjective assumptions about soft tissue parameters rarely preserved in the fossil record. Despite these necessary assumptions about fundamental input values paleobiologists rarely perform objective tests of best-estimate models before reaching conclusions based on predicted results. In this study a One-At-A-Time (OAAT) sensitivity analysis is performed on an evolutionary robotics model of the non-avian theropod dinosaur *Allosaurus fragilis*, used previously to estimate maximum running speed in this extinct animal. A range of muscle parameters (contraction force and velocity, and fibre length) were varied over the range observed in extant vertebrates, while mass related parameters (total body mass, torso centre of mass) were altered across the range of published estimates for *A. fragilis*. This analysis reveals that muscle parameters have a linear relationship with maximum running speed, whilst surprisingly total body mass and torso centre of mass have little effect. Muscle force values (equivalent to muscle mass, physiological cross sectional area or force per unit area) produced the greatest range in predicted running speeds (4.5 - 10.7 m/s) and stride lengths (4 - 5.8 m) in the sensitivity analysis, equating to 65.9% and 30.7% variation about the original best-estimate prediction. These results highlight the importance of sensitivity analyses in biomechanical modelling of extinct taxa, particularly where values for soft tissues parameters are not tightly constrained by an extant phylogenetic bracket. Future work is clearly required on the muscle geometry and physiology of extant vertebrates in order to better constrain possible soft tissues values for extinct dinosaurs. The development of more bio-realistic models will reduce the range of possible running gaits for these animals and allow model predictions to be used in higher level paleoecological and evolutionary hypotheses.

PTEROSAUR DISTRIBUTION: A GLOBAL DATABASE

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Recent compendia of dinosaur occurrences are greatly facilitating studies of dinosaur palaeobiogeography, macroecology and macroevolution. These databases are (almost) exhaustive and provide accessible summaries of a vast literature, placing details of stratigraphical horizons and faunal composition in a geographical context. Consequently, they have become tools that allow researchers to rapidly locate basic site information and find relevant citations. Moreover, such compilations can help to focus future fieldwork efforts by highlighting regions that remain relatively undersampled. Here, we present the first iteration of a global database for pterosaur occurrences. This new compilation should be viewed as a dynamic database that will need to be refined periodically in order to incorporate new localities and taxa as they are discovered, and to account for future changes to existing stratigraphical and taxonomic terminology. We hope that this database will provide a firm foundation for broader scale evolutionary studies on pterosaurs and Mesozoic ecosystems in general, including investigations into topics such as palaeobiogeography and controls on species-richness. Our aim is not to provide a complete bibliography of pterosaur research, but to provide key references that record all known pterosaur localities. Information on pterosaur occurrences was taken directly from searches of the primary literature.

FINITE ELEMENT ANALYSIS OF DINOSAUR TRACKS

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Finite element analysis (FEA) is a tool familiar to many palaeontologists as a method for investigating properties of materials (such as bone) under stress. Here, FEA is proposed to be a valid method for understanding track formation and resultant morphology throughout a three dimensional volume. Initial results provide quantitative analysis of the pressure transmission of a virtual dinosaur foot within a 3D soil volume. This provides insight into surface and transmitted 3-D track geometry. The use of an FE track simulator will provide a robust tool to undertake repeated and quantifiable track studies.

Convergence of Horn-like Structures in Eutherian Mammals

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Horn-like organs have evolved independently numerous times in eutherian mammals. The phyletic occurrence of horns was investigated and, using the relative position of horns on the skull, convergences of similar morphotypes in different groups were evaluated. Thirty genera (24 extinct, 6 extant) in fifteen families had their horns assigned into eight morphotypes. In the artiodactyls, morphotype 8 (a single pair of parietal horns) seemed to dominate (even when accounting for homologies) and in non-ungulate animals, morphotype 4 (a pair of conical horns located halfway up the rostrum) was more prevalent. The proposed functional hypotheses of horn-like organs are discussed, before being used to briefly infer morphotype function.

THE RED HILLS MINE FLORA: A DIVERSE PALYNOLOGICAL ASSEMBLAGE FROM THE LATE PALAEOCENE OF MISSISSIPPI

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The well-preserved Palaeocene sporomorph record of the eastern U.S. Gulf Coast (Mississippi and Alabama) represents an extinct paratropical vegetation type. Studying this record therefore provides a valuable insight into the reassembly of floral communities following the K-T extinction, and can thus shed light on the abilities of highly diverse plant communities to diversify over time. We present data from lignite (swamp) deposits from the Red Hills Mine, Mississippi, that span the boundary between the Late Palaeocene Nanafalia and Tuscahoma formations (c. 57-56.5 Ma). The Red Hills Mine samples contain a diverse (99 morphospecies) angiosperm-dominated assemblage, including 22 morphotypes that have not been recognised in the consulted published literature. The samples are compositionally variable from one another, indicating local patchiness in these swamp communities. These assemblages are significantly more diverse than published accounts from strata of a similar age, and suggest that a reappraisal of Palaeocene sporomorph diversity trends from the Gulf Coast is warranted.

NEUROPTERAN (INSECTA) PALAEODIVERSITY WITH PREDICTIONS FOR THE CRETACEOUS FAUNA OF THE WEALDEN

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The Wealden Group of southern England is a succession of non-marine sediments from the lower Cretaceous (*c.* 141-119Ma), which also outcrop in Belgium and northwest Germany. Most insect orders are present as fossils, including Neuroptera, one of the most archaic holometabolous order. The fossil record of Neuroptera is diverse, spanning Permian-Recent, with all major family radiations having occurred by the Jurassic. However, Wealden Neuroptera have received little attention to date, with only three families reported and one species described. The fossil record in general is notoriously incomplete, and palaeoenvironmental reconstructions can facilitate predictions of what other organisms were present in the habitat, but which were either not preserved or only occasionally preserved and yet to be found as fossils. We examine the Wealden palaeohabitat and global neuropteran palaeodiversity and consider these in relation to palaeo/biogeography of fossil and extant taxa (including habitat preferences). We predict that the following families will form components of the Cretaceous Wealden fauna: Nymphidae, Polystoechotidae, Chrysopidae, Hemerobiidae and Coniopterygidae.

POST CONFERENCE FIELDTRIP GUIDE

ITINERARY

- Meet on Brunswick Street at **09:00**, by the side of the Williamson Building (where the visualization suite is).
- Travel to Castleton in a fleet of cars.
- Geology and Palaeontology led by Dr. Phillip Manning.
- Lunch at one of the delightful pubs in Castleton.
- Return to Manchester by no later than 16:00

A BRIEF GUIDE TO THE GEOLOGY AND PALAEONTOLOGY OF CASTLETON, DERBYSHIRE

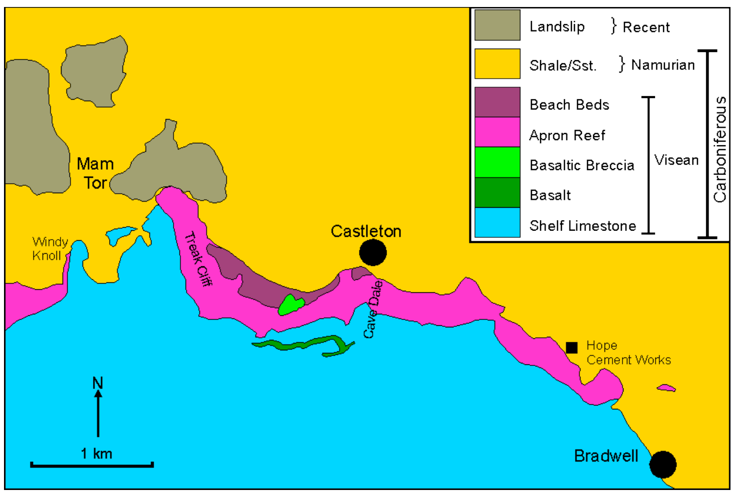

Figure 1. Simplified Geological Map of Castleton

Castleton is a village on the northern edge of the limestone area of the Peak District. The rocks are Carboniferous (Figure 1); with limestone of Visean age (345-327Ma) and sandstones and mudstones of Namurian age (327-316Ma). The area is famous for its extensive cave systems and its galena and Blue John (Fluorspar) mines. Mam Tor and Winnat's Pass dominate the scenery in the area.

The Visean (Lower Carboniferous) limestones formed in tropical seas with little terrigenous clastic input, south of Castleton was a shallow carbonate shelf, where these limestones accumulated. Castleton represents the edge of the shelf and to the north deeper waters were present. The topographic high areas of Winnat's Pass and Treak Cliff were the top of the old marine slope and the edge of the shelf. Winnat's Pass and the slope down into Hope Valley are the original palaeoslope, which led to the basin below. At the margin of the shelf and on the palaeoslope is the 'Apron Reef'. Also on the margin, carbonate sands accumulated forming a grainstone; wave action worked the limestone fragments to form the 'back reef' limestones. On the slope there are highly fossiliferous beds and algal stromatolite concentrations present (algal reefs). The fossils include the corals: *Lithostrotion* and *Dibunophyllum*, brachiopods: *Productus, Pugnax* and

Schizophora and goniatites: *Beyrichoceras*, numerous crinoid ossicles and trilobites: *Brachymetopus*.

The Namurian (Upper Carboniferous) saw the deposition of mudstones and sandstones that overlapped the carbonate platform; this heralded the coming of the deltas. The deltas started in the north and moved southwards. The deepwater muds (Edale Shales) were deposited first, far from the delta front and the deltaic sands (Mam Tor beds) were deposited later.

In the 1870s Professor William Boyd Dawkins excavated a cave at Windy Knoll. What he found were the remains of 5000 Quaternary animal skeletons of mainly bison and reindeer with wolf, fox, grisly bear, hare, rabbit, shrew, bat and water vole. The cave represents a swallet hole where the animal bones accumulated. The animals were using the early post-glacial period migration route between Edale and Cheshire. Many of the bones excavated were deposited in The Manchester Museum and are now on display.

Source material:

Boyd Dawkins, W. 1875. The Mammalia found at Windy Knoll. *Quarterly Journal of the Geological Society*. 31, 246–255.

Stevenson, I.P. and Gaunt, G.D. 1971. *Geology of the country around Chapel en Frith*, British Geological Survey, HMSO, London.

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