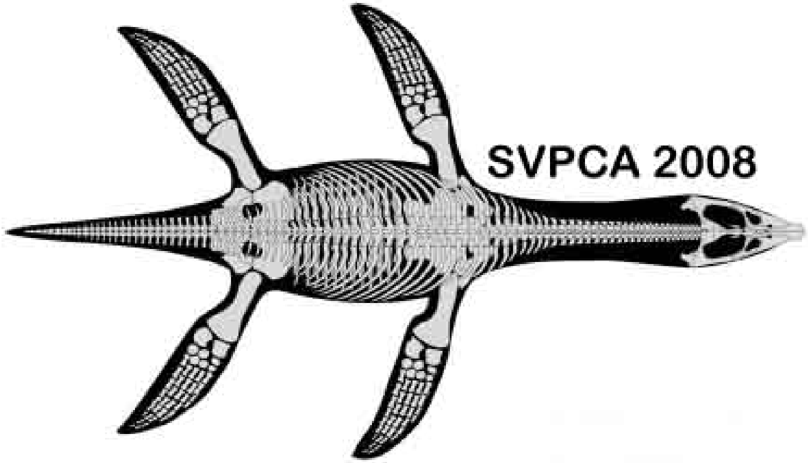

PROGRAMME & ABSTRACTS

DUBLIN, 2008

UCD DUBLIN

museum
National Museum of Ireland
Ard-Mhúsaem na hÉireann

EDITED BY GARETH DYKE, DARREN NAISH AND MATTHEW PARKES

Very little is known of the origins and early evolutionary history of Psittaciformes, and although the monophyly of Psittaciformes is generally accepted (Smith, 1975), sister-group hypotheses range from Coliiformes (Mayr & Clarke, 2003), Strigiformes (Harrison *et al.*, 2004), Piciformes (Van Tuinen *et al.*, 2000), and even without any closely related modern orders at all (e.g. Sibley & Ahlquist, 1990).

New anatomical and molecular studies have given yet different sister-group hypotheses for parrots (Columbiformes [Livezey & Zusi, 2007] and Passeriformes [Hackett *et al.*, 2008]). The question is, what does this all mean for parrot ingroup and outgroup evolution?

Hackett, S.J., Kimball, R.T., Reddy, S, Bowie, R.C.K., Braun, E.L., Braun, M.J., Chojnowski, J.L., Cox, W.A., Han, K, Harshman, J., Huddleston, C.J., Marks, B.D., Miglia, J., Moore, W.S., Sheldon, F.H., Steadman, D.W., Witt, C.C. & Yuri, T. 2008. A phylogenomic study of birds reveals their evolutionary history. Science, 320, 1763.

Harrison G.L., McLenachan P.A., Phillips M.J., Slack K.E., Cooper A, Penny D. 2004. Four new avian mitochondrial genomes help get to basic evolutionary questions in the late Cretaceous. Molecular Biology and Evolution, 21: 974-983.

Livezey, B.C. & Zusi, R.L. 2007. Higher-order phylogeny of modern birds (Theropoda, Aves: Neornithes) based on comparative anatomy. II. Analysis and discussion. Zoological Journal of the Linnean Society, 149, 1-95.

Mayr, G. & Clarke, J. 2003. The deep divergences of neornithine birds: a phylogenetic analysis of morphological characters. Cladistics, 19, 527-553.

Sibley, C.G. & Ahlquist, J. E. 1990. Phylogeny and classification of birds: a study in molecular evolution. Yale University Press, New Haven, USA.

Smith, G.A. 1975. Systematics of Parrots. Ibis, 117, 18-68.

Van Tuinen, M, Sibley, C.G. & Hedges, S.B. 2000. The early history of modern birds inferred from DNA sequences of nuclear and mitochondrial ribosomal genes. Molecular Biology and Evolution, 17, 451–457.

Symposium of Palaeontological Preparation and Conservation Annual Meeting Tuesday, 2nd September, Geological Survey of Ireland

Abstracts p. 7 (alphabetical by first author)

9.00 M. Parkes - Welcome *

Session 1: Chair - R. Schouten (Bristol)

9.20 M. Schiele - The effectiveness of Synocryl 9123s during the acid preparation process

9.40 E-L Nicholls & C. Underwood - Blood, sweat and scars for life: the complications of comparative shark material

10.00 L. Stertz - The pilot conservation of two Blaschka glass models of micro-organisms

10.20 A. Doyle & A. Citores - Environmental damage to palaeontological specimens

Coffee Break

Session 2: Chair - A. Doyle (London)

11.10 R. Schouten - Fossil preparation skills: available information for both ‘amateur’ and pro

11.30 F. Bolton & P. Viscardi - A preliminary investigation into the removal and remedial conservation of labels from fossil specimens

11.50 L. Noè & A. Cruickshank - A *Triceratops* skull in Birmingham at 50 and 100: discovered 1908, transported 1958

Lunch Break, provided at Print Museum café

13.30 Guided tour of Beggars Bush
Discussion about fossil conservation/preparation

15.30 Discussion led by R. Schouten (Bristol)
Fossil collectors and palaeontology
Update on SVP Bristol 2009

18.00 SVPCA welcome reception, Kildare Street Rotunda

* *SPPC posters are on view throughout the day in the foyer of the GSI*

Symposium of Vertebrate Palaeontology and Comparative Anatomy Annual Meeting Wednesday-Friday, 3rd-5th September, National Museum of Ireland

Abstracts p. 13 (alphabetical by first author)

Wednesday 3rd September

9.00 Introduction and Welcome to the National Museum of Ireland

Session 1: Chair - M. Duncan (Dublin)

9.20 O. Otero, A. Pinton, H. Taisso Makaye, A. Likius, P. Vignaud & M. Brunet - Fishes and African palaeogeography drainage basins: first data documenting Mio-Pliocene relationships between Chad and neighbour basins.

9.40 J. Liston - The osteology of *Leedsichthys* (Pachycormiformes): growth, resorption and fragmentation of a problematic Jurassic giant

10.00 M. Richter - Comparative study of Permian shark (Chondrichthyes) faunas of North and South America

10.20 R. Sansom, K. Freedman, S. Gabbott & M. Purnell - When is a lamprey not a lamprey? Taphonomy, anatomy, and phylogenetic significance of the Jamoytiiformes

Coffee Break

Session 2: Chair - M. Benton (Bristol)

11.10 E-L. Nicholls - Sharks indicate a lagoonal environment for dinosaur remains

11.30 A. Pinton, O. Otero, H. Taisso Makaye, A. Likius, P. Vignaud & M. Brunet - Revealing the past diversity of the *Synodontis* catfish

11.50 N. Klein - Winterswijk (The Netherlands), an exceptional early Anisian locality in the Germanic Muschelkalk

12.10 D. Voeten & M. Sander - Larger *Nothosaurus* from the Lower Muschelkalk of Winterswijk, The Netherlands

Lunch Break

Session 3: Chair - J. Liston (Glasgow)

13.30 Z. Johanson J. den Blauuwen, M. Newman & M. Smith - *Palaeospondylus*, a jawless vertebrate from the Devonian of Scotland

13.50 N-E. Jalil - Vertebrate fossils from Morocco: our state of knowledge

14.10 M. Ubilla, D. Perea & A. Rinderknecht - Continental vertebrates of the late Pleistocene of Uruguay (South America): biostratigraphic, bio-geographic and environmental connotations

14.30 P. Maderson - Lightening up: a new approach to understanding integumentary remains in Mesozoic sauropsids

Afternoon Break

Session 4: Chair - P. Maderson (Quakertown)

15.10 J. Mo, X. Xu & S. Evans - A Late Cretaceous lizard fauna from southern China

15.30 J. Desojo & O. Rauhut - New insights in 'rauisuchian' taxa (Archosauria: Crurotarsi) from Brazil

15.50 M. Brandalise de Andrade, R. Edmonds, M. Benton & R. Schouten - A *Goniopholis* skull from the Intermarine Member (Berriasian, Lower Cretaceous), Swanage (England)

16.15 M. Benton & E. Rayfield - SVP Bristol 2009: discussion and updates

16.45 Announcements

19.00 Evening reception in the Trinity Inn Pub

filled numerous ecological niches that became available during the flooding of great parts of the European continent.

The Lower Muschelkalk outcrop near the Dutch town of Winterswijk is among the oldest Germanic Muschelkalk outcrops, and is famous for its well-preserved vertebrate remains. One particular transgressive/regressive cycle within the section has yielded the majority of, mostly isolated, sauropterygian bones from this quarry (e.g. Bickelmann & Sander in press) that are housed in public and private collections thus far.

An inventory and statistical analysis of mandibles and postcranial *Nothosaurus* material from the fourth parasequence (after Diedrich & Oosterink, 2001) were done in order to gain insight in the size distribution of *Nothosaurus* elements. Five percent of the postcranial *Nothosaurus* elements was found to represent a size fraction 150% larger than the previously described species *Nothosaurus winterswijkensis* (Albers & Rieppel, 2003) and *Nothosaurus marchicus* (Albers, 2005) from these beds. This means that nothosaurs diversified early on into different size classes and ecological niches. Furthermore, a comparison of large *Nothosaurus* mandibles from the Winterswijk quarry revealed distinguishable morphologies, which suggests early trophic specialization of the genus *Nothosaurus*.

Albers, P.C.H. & O. Rieppel. 2003. A new species of the sauropterygian genus *Nothosaurus* from the Lower Muschelkalk of Winterswijk, the Netherlands. Journal of Paleontology, 77, 738-744.

Albers, P.C.H. 2005. A new specimen of *Nothosaurus marchicus* with features that relate the taxon to *Nothosaurus winterswijkensis*. Palarch., 3, 1-7.

Diedrich, C. & Oosterink, H.W. 2001. Vertebrate track bed stratigraphy of the Röt and basal Lower Muschelkalk (Anisian) of Winterswijk (East Netherlands). Geologie en Mijnbouw / Netherlands Journal of Geosciences, 80, 31-39.

Rieppel, O. 1994. Osteology of *Simosaurus*, and the interrelationships of stem-group Sauropterygia (Reptilia, Diapsida). Fieldiana (Geology) New Series, 28,1-85.

Psittaciform systematics and fossils: recent work and new insights

David M. Waterhouse

Department of Natural History, Norfolk Museums and Archaeology Service, The Shirehall, Market Avenue, Norwich Norfolk, NR1 3JQ, UK (david.waterhouse@norfolk.gov.uk).

Parrots (order Psittaciformes) are one of the most instantly recognizable groups of modern birds. Extant parrots can be found in most tropical parts of the world. However, by far the most parrot species are found in the southern hemisphere – Australasia and South America.

The few early fossil parrots that have been discovered to date (Lower Eocene) are all from the northern hemisphere (Walton-on-the-Naze, England; Messel, Germany, *etc*.), with only a few, relatively recent, essentially modern parrot remains being found within their present range.

Special Publications, 217, 139-190.

Wang Xiaolin & Zhou Zhonghe 2006. Pterosaur assemblages of the Jehol Biota and their implication for the Early Cretaceous pterosaur radiation. Geological Journal, 41, 405-418.

[poster] **How long is a piece of *Strix*?: methods in measuring and measuring the 'measure-ers'**

Paolo Viscardi [1], Manabu Sakamoto [2] and Julia Sigwart [3]

[1]Horniman Museum and Gardens, 100 London Road, Forest Hill, SE23 3PQ, UK (pviscardi@horniman.ac.uk), [2]Department of Earth Sciences, University of Bristol, Bristol, UK (M.Sakamoto@bristol.ac.uk), [3]CoBiD – Natural History Museum, Merrion Street, Dublin 2 / School of Biology and Environmental Science, University College Dublin Belfield Dublin 4, Ireland (julia.sigwart@ucd.ie).

Quantifying morphology can be complex and at times confusing. The act of taking a measurement may seem simple and intuitive, but for scientific rigour to be maintained that act needs to be repeatable by other workers. Methods also need to be consistent across a dataset. This can be difficult to achieve when working from composite data, collaborating on a project, or even when dealing with specimens represented by a wide range of sizes.

A discussion session about these issues will be held at the 56th SVPCA, with a view to assessing the implications regarding data quality. A simple experiment is planned to numerically test the consistency in measurement of osteological features. This interactive study intends to determine the variation that can be expected from researchers using their individual techniques to take the same set of measurements under controlled conditions. The influence of feature size and complexity will also be investigated.

Through discussion and collaboration within the community, resources and techniques may be created to provide unambiguous solutions to the problems of quantifying morphology.

Please join us in the conference coffee breaks and lend your expertise!

Larger *Nothosaurus* from the Lower Muschelkalk of Winterswijk, The Netherlands

Dennis F.A.E. Voeten[1,2] and P. Martin Sander[1]

[1]Steinmann Institut für Geologie, Mineralogie und Paläontologie, Bereich Paläontologie, Rheinische Friedrich-Wilhelms-Universität Bonn, Nussallee 8, D-53115 Bonn, Germany, [2]Faculteit der Aard- en Levenswetenschappen, Vrije Universiteit Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, Nederland/The Netherlands (dennisvoeten@hotmail.com).

The Sauropterygia made their first appearance about 5 million years after the P/T mass extinction event. This monophyletic clade of secondarily marine diapsid reptiles has seen a rapid initial radiation and diversification (Rieppel, 1994), and

Thursday 4th September

9.00 Announcements

Session 1: Chair - P. Orr (Dublin)

9.20 J. Hellawell, C. Nicholas, R. Goodhue, F. Gill, R. Evershed & R. Pancost - Preservation of nitrogen and carbon isotopes in 50Ma fossil fish from the Green River Formation, Wyoming

9.40 P. Gill, E. Rayfield, K. Robson-Brown, & N. Gostling - Inside and out: a comparison of the lower jaw of two basal mammals

10.00 S. Le Fur, E. Fara, H. Taïsso Mackaye, P. Vignaud & M. Brunet - The mammal assemblages of the hominid fossiliferous area of Toros-Menalla (Late Miocene, Chad Basin): ecological structure and palaeoenvironmental implications

10.20 Y. Tulu - Implications of paleoenvironmental variation in the Judith River Formation (Campanian), Montana through the taphonomy of shark teeth

Coffee Break

Session 2: Chair - R. Asher (Cambridge)

11.10 T. Kemp - The endocranial cavity of a nonmammalian eucynodont and its bearing on the origin of the mammalian brain

11.30 J. Martin - New material of the alleged oldest *Diplocynodon* from the Late Paleocene of northeastern France: revision and implications for crocodylian dispersal

11.50 I. Corfe, S. Zohdy, A. Evans & J. Jernvall - 3-dimensional analysis of dental complexity in tritylodontids and other high fibre plant feeders

12.10 K. Jones & A. Goswami - Morphometric analysis of cranial morphology in pinnipeds (Mammalia, Carnivora): disparity, dimorphism, ecology and ontogeny

Lunch Break

Session 3: Chair - T. Kemp (Oxford)

13.30 R. Asher - Development in 'southern hemisphere' mammals

13.50 B. Mennecart, L. Scherler, D. Becker & J-P. Berger - The Swiss Oligocene ruminants: preliminary results

14.10 A. Goswami & D. Polly - The influence of character correlations on phylogenetic analyses: a test case in the carnivoran cranium

14.30 J. Hooker - Dawn horses and the North American connection

Afternoon Break

Session 4: Chair - N. Klein (Bonn)

15.10 F. Marx - Marine mammals through time: when less is more in the study of palaeodiversity

15.30 E. Hoch - Specialization in the head of a Miocene beaked whale (Odontoceti: Ziphiidae)

15.50 K. Stein, M. Sander, Z. Csìkì, K. Curry-Rogers & D.Weishampel - Nopcsa's legacy supported: *Magyarosaurus dacus* (Sauropoda: Titanosauria) bone histology suggests dwarfism on a palaeo-island.

16.15 *Review*: C. Edwards - Fossil and molecular evidence for evolution of Ireland's mammals

16.45 Announcements

19.30 - Annual JFF Auction in Alliance Française
P. Wyse Jackson - History of Palaeontology in Ireland

Friday 5th September

9.00 Announcements

Session 1: Chair - E. Buffetaut (Paris)

9.20 K. Stevens & E. Wills - Reconstructing gaits kinematically: from sprawling to parasagittal

9.40 G. Lloyd, K. Davis, D. Pisani, J. Tarver, M. Ruta, M. Sakamoto, D. Hone, R. Jennings & M. Benton - Dinosaurs and the Cretaceous terrestrial revolution

10.00 V. Fernandez, E. Buffetaut, É. Maire, J. Adrien & P. Tafforeau - Non-destructive investigation of embryo fossilised *in ovo*: absorption based versus phase contrast x-ray imaging

10.20 N. Ibrahim - Too many theropods? The diversity of predatory dinosaurs in the mid-Cretaceous of Morocco

Coffee Break

Session 2: Chair - D. Naish (Portsmouth)

11.10 C. Hendrickx - Functional interpretation of spinosaurid quadrates (Dinosauria: Theropoda) from the Mid-Cretaceous of Morocco

11.30 E. Buffetaut & G. de Ploeg - A large ostrich-like bird from the Late Palaeocene of the Paris Region

11.50 B. Lindow - A new avian fauna from the early-middle Eocene Lillebælt Clay Formation of Denmark

12.10 D. Waterhouse - Psittaciform systematics and fossils: recent work and new insights

Lunch Break

Session 3: Chair - D. Waterhouse (Norwich)

13.30 D. Naish & M. Witton - The feeding behaviour of azhdarchid pterosaurs

13.50 D. Unwin, X. Wang & M. Xi - How the Moon Goddess, Chang-e, helped us to understand pterosaur evolutionary history

14.10 S. Sweetman & J. Gardner - A new albanerpetontid from the Early Cretaceous (Barremian) of southern Britain

14.30 G. Dyke & G. Kaiser - Egg size and avian reproductive evolution

Afternoon Break

Session 4: Chair - P. Wyse-Jackson (Dublin)

15.10 L. Noè & A. Cruickshank - Eurycleidus arcuatus – placing a problematic historical plesiosaur taxon on a firm footing

15.30 R. Forrest - The biter bit: pliosaur predation on long-necked plesiosaurs

15.50 A. Smith - Did plesiosaurs have a caudal fin?

16.15 - *Review*: E. Teeling - Fossil and molecular evidence for the evolution of bat echolocation

16.45 Announcements/Closing Remarks

19.00 - Conference Annual Dinner

(with very well preserved articulated skeletons). They suggest a likely relationship with the last-glacial-maximum and show biogeographic changes of taxa more related today to arid environments or higher latitudes, that could be in part explained by the retraction of the Paraná/Uruguay river system. This is a contribution to CSIC-Project (M. Ubilla) and IGCP-518 Project (D. Bridgland).

Tambussi, C.M. Ubilla, C. Acosta & Perea, D. 2005. Fossil records and palaeoenvironmental implications of *Chloephaga picta* (Gmelin, 1789) (Magellan Goose) and *Cariama cristata* (Linnaeus, 1766) (Seriema) from the Late Pleistocene of Uruguay. Neues Jarbuch Geologie und Palaeontologie Mh., 5, 257-268.

Ubilla, M., Perea, D.C. Goso & Lorenzo, N. 2004. Late Pleistocene vertebrates from northern Uruguay: tools for biostratigraphic, climatic and environmental reconstruction. Quaternary International, 114, 129-142.

How the Moon Goddess, Chang-e, helped us to understand pterosaur evolutionary history

David M. Unwin[1], Wang Xiaolin[2] and Meng Xi[2]

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To date, more than 50 skeletons of pterosaurs, representing both toothed (istiodactylid, ornithocheirid) and toothless (tapejarid, chaoyangopterid) forms, have been recovered from the Lower Cretaceous Jiufotang Formation of China (Wang & Zhou, 2006). The well preserved skeleton of a new taxon (to be named after 'Chang-e', the Chinese goddess of the moon), provides critical new insights into pterosaur anatomy, phylogeny and evolutionary history. Features of the dentition show that the 'Moon Goddess' belongs within the Lonchodectidae, currently one of the most poorly known of all pterosaur clades (e.g. Unwin, 2003). Apart from providing valuable new information on lonchodectid anatomy, the Moon Goddess has yielded copious amounts of phylogenetic data that have helped to resolve the uncertain relationships of lonchodectids to other pterosaurs. Cladistic analysis supports the pairing of Lonchodectidae with Azhdarchoidea, a diverse clade of edentulous forms including tapejarids, tupuxuarids, chaoyangopterids and azhdarchids (Lü *et al.*, 2008) and throws new light on the evolution of tooth-loss in pterosaurs. In addition, key features of the clade Lonchodectidae + Azhdarchoidea (e.g. relatively short wing-finger, long hind limb) suggest that members of this lineage were comparatively better adapted to life in continental environments than other pterosaurs, and played a prominent role in the invasion of terrestrial habitats by pterodactyloids in the mid-Mesozoic.

Lü Junchang, Unwin, D. M., Xu Li & Zhang Xingliao 2008. A new azhdarchoid pterosaur from the Lower Cretaceous of China and its implications for pterosaur phylogeny and evolution. Naturwissenschaften DOI 10.1007/s00114-008-0397-5.

Unwin, D.M. 2003. On the phylogeny and evolutionary history of pterosaurs. In: Buffetaut, E. & Mazin, J.-M. (eds), Evolution and Palaeobiology of Pterosaurs. Geological Society, London,

Paraguay, Argentina); two extinct species of caviines (*Microcavia criolloensis*, *Galea ortodonta*). *Microcavia* inhabits today arid-semiarid microenvironments (Argentina, Bolivia and Chile) and *Galea* in open-semi-open habitats (Argentina and Brazil). Their occurrence, together with biostratigraphic and ^{14}C information, could denote the last glacial-maximum-effect.

In northern Uruguay, occur genera living today (at generic or specific level) in tropical-temperate areas: the extinct species of porcupine *Coendou* cf. *C. magnus*, the capybara *Hydrochoerus hydrochaeris* and the coypo *Myocastor coypus*, associated to caviines *Cavia* sp. and *Microcavia criolloensis*. TL and ^{14}C dates are >43.000 kyrBP. It is discussed a likely relationship with the last interglacial or interstadial, reinforced by the mammalian associated fauna. Contribution to CSIC-Project (M. Ubilla) and IGCP-518 Project (D. Bridgland).

De Iuliis, G., Bargo, M.S. & S. Vizcaíno. 2000. Variation in skull morphology and mastication in the fossil giant armadillos *Pampatherium* spp. and allied genera (Mammalia: Xenarthra: Pampatheriidae), with comments on their systematics and distribution. Journal of Vertebrate Paleontology, 20, 743-754.

Tonni, E. P., Cione, A.L. & Figini, A. 1999. Predominance of arid climates indicated by mammals in the pampas of Argentina during the late Pleistocene and Holocene. Palaeogeography, Palaeoclimatology, Palaeocology, 147, 257-281.

Ubilla, M. 2004. Mammalian biostratigraphy of Pleistocene fluvial deposith in northern Uruguay, South America. Proceedings of the Geologists´ Association, 115, 347-357.

Continental vertebrates of the late Pleistocene of Uruguay (South America): biostratigraphic, biogeographic and environmental connotations

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The late Pleistocene continental vertebrates of South America receive attention due to their taxonomic, biostratigraphic, biogeographic and environmental significance. As a consequence of fieldworks extensively performed in fluvial and paleosoil strata, as part of ongoing activities, vertebrate assemblages from northern and southern selected late Pleistocene outcrops and geographic localities of Uruguay are analysed.

The northern sediments (Sopas Formation) yield a large number of extant and extinct vertebrates (Ubilla *et al.*, 2004), predominantly mammals (ca. 40 genera, 22 families). Taphonomic analysis show that deer are predominant in the bone assemblages. A set of ^{14}C and TL ages are >43 kyrBP. Climatic and environmental adaptations of birds (Tambussi *et al.*, 2005), terrestrial and freshwater mammals (tapirs, deer, horses, proterotheriids, ground-sloths, glyptodonts, sigmodontines, otters and coypus) are discussed as well as biostratigraphic correlation and biogeographic processes.

Outcrops in southern Uruguay (Dolores Formation), with the youngest level with ^{14}C ages ca. 11.5 kyrBP, are providing an increasing diversity of mammals

Abstracts Of Presentations

17th Symposium of Palaeontological Preparation and Conservation

A preliminary investigation into the removal and remedial conservation of labels from fossil specimens

Felicity Bolton and Paolo Viscardi

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Labels associated with fossil specimens contain explicit and inherent information. Explicit information commonly reports species and locality, but collector name and other secondary data are often omitted. Inherent information such as handwriting and label style can provide information about the collector. Inherent but ambiguous information, such as undefined numbers, may relate to notebooks or locations, which can prove valuable in reconstructing a context for the specimens. It is important that these data remain with the specimen and remain in a fit state for subsequent curatorial research.

Unfortunately, labels deteriorate over time, with ink fading, adhesives failing and physical and chemical damage leading to fragmentation. In order to maintain explicit information new labels can be added, but the old labels also need to be stabilised in order to preserve inherent information. It falls to curatorial staff and conservators to preserve labels in situ or to salvage and repair those that are detaching and have deteriorated.

This study highlights the curatorial importance of retrieving information and investigates remedial conservation methods for the safe removal, repair and storage of labels from specimens – with examples of those currently being conserved for the refurbishment of the Horniman Museum Natural History Gallery.

Environmental damage to palaeontological specimens

Adrian M. Doyle and Ana Citores

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It is has long been established that inappropriate environmental conditions cause damage to palaeontological specimens but whilst there is much anecdotal evidence there are few recorded facts.

Initial research using crude one-channel dimensional displacement probes and saturated salt solutions to create various humilities, shows that so long as certain humidity thresholds are not exceeded, some specimens can return to their original dimensions: However this is time consuming for the operator and not an effective or a reliable way to gather data.

A recent purchase of mobile three-channel radio telemetric displacement transducers and a micro-climate generator are being used to help identify the relationship between environmental change and physical changes in specimens (such as cracking and splitting), in particular sub-fossil bone which is very vulnerable to fluctuating humidity.

This project is helping us understand the relationship of deterioration to inappropriate environments including the effectiveness of existing HVAC systems, irreversible damage and the stability of conservation treatments including consolidants and fillers.

The equipment will not only enable us to identify collections which are vulnerable but also those specimens on display that are also vulnerable and to feed this information into collections standards policies and recommendations.

[poster] **A new suit for the Dublin pliosaur**

Scott Moore-Fay

Palaeontology Conservation Unit, The Natural History Museum, Cromwell Road, London SW7 5BD, UK (s.moore-fay@nhm.ac.uk).

The Palaeontology Conservation Unit (NHM, London) was contracted by the National Museum of Ireland to undertake the preparation and conservation of the type skull of the *Rhomaleosaurus cramptoni.* This Jurassic Pliosaur remains to this day the largest complete pliosaur ever discovered, and is currently known from this single complete specimen. Discovered in 1848 near Kettleness Yorkshire, this specimen eventually found its way to Dublin, where it was displayed intermittently from 1922-1962. It has remained in storage ever since.

Following the skulls' arrival in London a full assessment of its condition was carried out. The skull had been set into a mixture of plaster, bricks, and pieces of sandstone. Much of the skulls' original detail was obscured by previous repairs and pyrite treatments. The skull had broken into two large pieces: the cranium and the rostrum along with numerous smaller pieces. Preparation revealed many interesting details of the original Victorian preparation and mounting.

The skulls' weight, which exceeds 60kg, made it very difficult to turn over making preparation and research difficult and potentially dangerous. To overcome this problem a two- piece epoxy supporting jacket was built up during preparation and provided support for the specimen throughout its subsequent transportation, examination and storage.

Implications of paleoenvironmental variation in the Judith River Formation (Campanian), Montana through the taphonomy of shark teeth

Yasemin Tulu[1,2]

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Taphonomic experiments on modern shark and ray teeth were conducted to determine whether it is possible to simulate transport of fossil shark teeth once shed. The results, used in conjunction with local site information: abundance of fossil chondrichthyan material, faunal assemblages, and preservation of fossil material, suggest that there is significant local variation between sites within the Judith River Formation of Montana. Two sites (Woodhawk Bonebed and Power Plant Ferry Bonebed) in close proximity (3 km) to each other from the same stratigraphic horizon in shoreface deposits were studied. The experiments show that in a dynamic environment shark and ray teeth exhibit more wear with an increase in time. This information coupled with the fact that the sites differ in their respective faunal assemblage indicates that they represent localized areas of variable energy. The high-energy paleoenvironment (Woodhawk Bonebed) has a greater abundance of species and material with a wide array of preservation, and the low energy paleoenvironment (Power Plant Ferry Bonebed) has less abundant, less speciose material and more uniform, rather pristine preservation. The Woodhawk Bonebed strongly indicates allochthonus material being mixed with autochthonous material, creating a mix of marine and estuarine fossils that has produced mixed interpretations of the geology and paleontology for the Judith River Formation.

[poster] **Late Pleistocene hystricognath rodents (Mammalia) in mid-latitudes of South America (Uruguay): insights in biogeographic and paleoenvironmental studies**

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The central-eastern areas of middle latitudes of South America are envisaged in the Pleistocene as an ecotone between the southern plains and tropical-subtropical areas (De Iuliis *et al.*, 2000). The late Pleistocene hystricognath rodents of Uruguay, associated to a diverse mammalian fauna (Ubilla, 2004), depict shifting ranges, local extinctions and climatic processes.

In southern Uruguay, arid-semiarid environments, likely related to cold climates, are suggested by: the mara *Dolichotis* cf. *D. patagonica,* living today in Argentinean southern-central arid-semiarid environments (Tonni *et al.*, 1999); the plains-viscacha *Lagostomus* sp., of humid/semiarid grasslands to desert scrubs (Bolivia,

A new albanerpetontid from the Early Cretaceous (Barremian) of southern Britain

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The extinct Albanerpetontidae Fox and Naylor, 1982 is a highly derived lissamphibian clade of small, superficially salamander-like amphibians characterized by synapomorphies including fused frontals with polygonal dorsal ornamentation, a unique craniocervical joint which superficially resembles the atlas-axis complex of mammals, strongly pleurodont, non-pedicellate teeth bearing labiolingually compressed, usually tricuspid, chisel-like crowns, and an interdigitating mandibular symphysis. An exceptionally preserved specimen from Spain (McGowan and Evans 1995) displaying soft tissue impressions shows that this species had scaly skin and eyelids, indicating a primarily or wholly terrestrial habitat preference. Throughout the clade's known temporal range, extending from the Middle Jurassic to the early Pliocene (Gardner and Böhme 2008), albanerpetontids maintained a conservative body plan and until 1995 were accommodated within a single genus, *Albanerpeton* Estes and Hoffstetter, 1976. While *Albanerpeton* has yet to be recorded from Britain, the recognition of taxonomically significant differences in the morphology of the jaws and frontals has now permitted identification of two additional genera both of which have been recorded from Britain: *Anoualerpeton* from the Middle Jurassic (late Bathonian) at Kirtlington Cement Quarry, Oxfordshire and; *Celtedens* from the Early Cretaceous (Berriasian) Purbeck Limestone Group of the Isle of Purbeck, Dorset. Subsequently, bulk screening of plant debris beds within the Early Cretaceous (Barremian) Wessex Formation of the Isle of Wight, southern England, has resulted in the recovery of a large number of isolated albanerpetontid bones representing a single species of a fourth genus. Diagnosed on the basis of a unique combination of primitive and derived characters, the new species exhibits considerable intraspecific variation in characters pertaining to the premaxilla maxilla and dentary.

Estes, R. & Hoffstetter, R. 1976. Les Urodèles du Miocène de La Grive-Saint-Alban (Isère, France). Bulletin du Muséum National d'Histoire Naturelle, 3^{e} Série, no. 398, Sciences de la Terre, 57, 297–343.

Fox, R.C. & Naylor, B.G. 1982. A reconsideration of the relationships of the fossil amphibian *Albanerpeton*. Canadian Journal of Earth Sciences, 19, 118–128.

McGowan, C.J. & Evans, S.E. 1995. Albanerpetontid amphibians from the Cretaceous of Spain. Nature, 373, 143–145.

Gardner, J.D. & Böhme, M. 2008. Review of the Albanerpetontidae (Lissamphibia), with comments on the paleoecological preferences of European Tertiary albanerpetontids. 178-218. In: Sankey, J.T. & Baszio, S. (eds) Vertebrate Microfossil Assemblages their role in paleoecology and paleobiogeography. Indiana University Press, Bloomington, 278 pp.

Blood, sweat and scars for life: the complications of comparative shark material

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Shark and ray skeletons are comprised of prismatic cartilage that is enclosed in a mineralised layer of calcium apatite tesserae. This skeletal structure gives sharks robustness and flexibility in life, but is susceptible to decay and disarticulation after death resulting in the low preservation potential of shark skeletal material. Subsequently the vast majority of fossil shark material comprises isolated teeth. Although potentially identifiable to specific level, identification of isolated shark teeth is complicated by monognathic, dignathic, sexual and ontogenetic heterodonty. Although most Post-Palaeozoic fossil sharks have living relatives, the dentitions of many modern taxa are very poorly known hampering easy comparison. It is therefore essential that comparative material of modern dentitions is available for use in untangling the palaeontological taxonomic problems. Here we investigate the different methods used to extract modern jaws and skulls and demonstrate the numerous complications of cooking, bleaching, distortion, afflictions to the olfactory organs, adhesives and safety issues.

Please note: All specimens described here were bi-products obtained from fish markets and were landed *whole* for human consumption.

Dingerkus, G., Séret, B. and Guilbert, E. 2005. Multiple prismatic calcium phosphate layers in the jaws of present-day sharks (Chondrichthyes; Selachii). Cellular and Molecular Life Sciences, 47, 38-40.

A *Triceratops* skull in Birmingham at 50 and 100: discovered 1908, transported 1958

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Thinktank, the Birmingham Science Museum, displays a skull of the horned dinosaur, *Triceratops* collected in 1908 in Montana, USA, and which arrived at the Birmingham City Museum and Art Gallery (BM&AG) in 1958. This contribution thereby marks a double anniversary, and will detail what is known about the source and collection of the specimen; how it was acquired by Birmigham Museum; its packing, transport and associated costs; and how it is currently displayed at Thinktank.

The Birmingham *Triceratops* was discovered on 9th August 1908 by a team including Barnum Brown, Peter Kaisen and C.H. Lambert for the American Museum of Natural History (AMNH) in New York. The skull was collected from the Latest Cretaceous Hell Creek Formation of Montana, although the site of recovery is now covered by the Fort Peck Reservoir. Following prolonged correspondence between Edwin H. Colbert (Curator or Reptiles and Amphibians, AMNH) and L. Bilton (Keeper, BM&AG) the skull was purchased by BM&AG for US$2000, plus the costs of transport. The skull was crated up by AMNH staff and transported on the Cunard liner *Sylvania* in 1958. Following customs clearance at Liverpool, the skull was transported to Birmingham, and the crate lifted into the Museum through a third story window. Following instructions provided by the AMNH, the skull was unpacked and mounted on a pre-prepared metal armature and became the centrepiece of Birmingham's new Evolution gallery, accompanied by many specimens from the Natural Sciences collections. In 2000, the *Triceratops* skull was transferred to Thinktank for display and it remains a central pillar of the Wild Life gallery. The *Triceratops* will feature prominently in the planned redisplay of the Natural Sciences collections, provisionally entitled 'Changing Planet'.

The foresight of the City Museum in acquiring of this specimen has made Birmingham one of the few cities in the UK to display a stunning, virtually complete and three-dimensionally preserved original skull of *Triceratops*. It remains an iconic and resonant specimen, much loved by visitors old and young alike.

The effectiveness of Synocryl 9123s during the acid preparation process

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This research looks into the chemical synocryl 9123s, formally known as Bedacryl 122x (Cray Valley) which has been used at the Natural History Museum in London as a protective resin during the acid bathing process. However, its integrity is now being questioned, and an alternative synocryl (9122x) may be replacing the older synocryl and tests are being carried out in order to justify the change.

The solvents used during this research were acetone, toluene and butanone. Various methods of microscopy (SEM, FTIR, and ZYGO) were enlisted in order to get a detailed look at how the synocryl interacts with the surface of the bone.

This research is very important as it would seem that the old synocryl 9123s has reached the end of its workable life and it has an international significance in the world of Palaeontological conservation, as poly butyl methacrylates are commonly used in acid preparation (including Acryloid B-67).

taxon for the Hateg Basin fauna are not yet completely understood.

Jianu, C.M. & Weishampel, D.B. 1999. The smallest of the largest: a new look at possible dwarfing in sauropod dinosaurs. Geologie en Mijnbouw, 78, 335-343.

Klein, N. & Sander, M. 2008. Ontogenetic stages in the long bone histology of sauropod dinosaurs. Paleobiology, 34, 248-264.

Le Loeuff, J. 2005. Romanian Late cretaceous dinosaurs: big dwarfs or small giants? Historical Biology, 17, 15-17.

Nopcsa, F. 1914. Über das Vorkommen der Dinosaurier in Siebenbürgen. Verhandlungen der Zoologisch-Botanischen Gesellschaft, 54, 12-14.

Reconstructing gaits kinematically: from sprawling to parasagittal

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The locomotion characteristic of a given vertebrate is reflected simultaneously in its osteology, arthrology, and myology. The proportions and morphology of the skeletal elements of the trunk, girdles, and limbs plus their articular surfaces comprise an articulated kinematic framework which both permits, and constrains, the animal's movements. Locomotion is achieved by the application of muscular forces to the kinematic framework, loaded by the body mass and assisted by an elastic system that stores and recovers mechanical energy. Studies of extinct vertebrate locomotion generally involve dynamical modeling (Hutchinson & Garcia, 2002; Sellers *et al.* 2004; Hutchinson *et al.* 2005). Kinematics alone is insufficient to constrain gait (Hutchinson & Gatesy, 2006). But kinematics plus specific geometric criteria associated with efficiency of locomotion can greatly reduce the space of possible gaits for a given organism (Wills, 2008). In extant vertebrates, reptilian sprawling gaits and cursorial mammalian parasagittal gaits are found by this method.

Application of the method to dinosaurs permits exploration of alternative proposals for pectoral girdle placement and mobility, the extend of antibrachium and crus pronation, and so forth. It is also particularly well suited to the complex posing of an entire skeleton with its range of motion to match trackways.

Hutchinson, J.R & Garcia, M. 2002. *Tyrannosaurus* was not a fast runner. Nature, 415, 1018–1021.

Hutchinson, J.R, Anderson, F.C., Blemker, S.S. & Delp, S.L. 2005. Analysis of hindlimb muscle moment arms in *Tyrannosaurus rex* using a three-dimensional musculoskeletal computer model: implications for stance, gait, and speed. Paleobiology, 31, 676-701.

Hutchinson, J.R. & Gatesy, S.M. 2006. Dinosaur Locomotion: beyond the bones. Nature, 440, 292-294.

Sellers, W.I., Dennis, L.A., Wang, W.J. & Crompton, R.H. 2004. Evaluating alternative gait strategies using evolutionary robotics. Journal of Anatomy, 204, 343–351.

Wills, E.D. 2008. Gait animation and analysis for biomechanically-articulated skeletons. Ph.D. dissertation, Department of Computer and Information Science, University of Oregon, Eugene, 292 pp.

plesiosaur *Rhomaleosaurus zetlandicus* from the Lower Jurassic (Toarcian) of the UK preserves an almost complete vertebral column including the tail. Notably, there is a sudden shift in the morphology of the terminal caudal vertebrae, which become increasingly compressed laterally; this shift is associated with a subtle kink in the column. This is interpreted as the first detailed osteological indication for a soft-tissue caudal fin in a plesiosaur and is incorporated into a reconstruction of this genus. The exact shape of the fin is based on unsubstantiated soft tissue evidence (Dames, 1895) so the exact outline remains speculative pending the discovery of future plesiosaur specimens preserving soft-tissue outlines. The tail fin in *Rhomaleosaurus* may have functioned as a rudder providing additional manoeuvrability for the animal when pursuing prey.

Dames, W. 1895. Die Plesiosaurier der Süddeutschen Liasformation. Abhandlungen der Königlich Preussischen Akademie der Wissenschaften zu Berlin, 1895, 1-81

Nopcsa's legacy supported: *Magyarosaurus dacus* (Sauropoda: Titanosauria) bone histology suggests dwarfism on a palaeo-island

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The dwarf status of the diminutive sauropod dinosaur *Magyarosaurus dacus* (Sauropoda: Titanosauria) from the Late Cretaceous Hateg Basin of Romania has been controversial because of the difficulty of distinguishing between juveniles and dwarfed adults in dinosaurs (Nopcsa, 1914; Jianu & Weishampel, 1999; Le Loeuff, 2005). Here we use long bone histology to prove that *M. dacus* individuals were fully grown. Even in individuals of 45% maximum size, the long bone cortex is almost completely remodelled, with interstitial laminar bone. In large sauropods this histology is only seen in senescent individuals (Klein & Sander, 2008), suggesting that *M. dacus* was growing extremely slowly at the time of its death. Possible origins of this dwarfism can only be hypothesized, but resource limitation on an island was probably the main cause. We sampled an additional large humerus (900 mm estimated length) attributed to *M. dacus* (Le Loeuff, 2005). Analogous to the smallest *M. dacus* individuals, the specimen exhibits intense secondary remodelling with some interstitial laminar bone. However, medium-sized *M. dacus* show a much denser secondary remodelling than this large individual. Based on histological and size differences, we suggest this larger specimen belongs to a different taxon than *M. dacus*. The palaeobiogeographical implications of the presence of this large

Fossil preparation skills: available information for both 'amateur' and pro.

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In the literature and other resources more information on preparation techniques is growing quickly. This is to be encouraged as there is relatively little out there. The growth in available material is helped by resources such as the www, and many in the trade have long argued for this. The growth is largely explained by initiatives such as of the SVP preparators meeting where posters, talks and other resources are now collated in a collective, publicly accessible space. Much useful detail is available already despite the fact publications number only 20 or so. A helpful list of titles of past presentations in the Preparators session is a good guide to other expertise out there. In the past there have been helpful initiatives before like the Paleotechniques volume aimed at the professional preparator as well as guide books on how to collect fossils aimed at the wider audience. Other helpful techniques can be found throughout the literature included in the 'methods' section. Presumably the general public will find it difficult to find simple guidelines towards preparing fossils. Arguably there is need for teaching resources illustrating the basics for minimal field prep, Airscribe use, Airabrasive use and minimal field preparation. Potentially, this provides huge benefits for the palaeontological community as a whole, both academic as well as 'amateur'. These theoretical benefits and examples of what kind of information out there are discussed and the audience will be invited to give feedback.

Barker, P, .1977. *Techniques of Archaeological Excavation*.

Camp, C.L. & Dallas Hanna, G. 1937. *Methods in Paleontology*.

Feldmann, R.M, Chapman, R.E. & Hannibal, J.T. 1989. *Paleotechniques*.

Leiggi, P. & May, P. 1994. *Vertebrate Paleontological Techniques (Volume One)*.

Sutton, M.Q. & Arkush, B.S. 1996. *Archaeological Laboratory Methods, An Introduction*.

http://www.vertpaleo.org/education/PreparatorsPDFs.cfm

http://www.jpaleontologicaltechniques.org/index.html

The pilot conservation of two Blaschka glass models of micro-organisms

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The talk reflects the examination and treatment of two Victorian glass models of micro- organisms made by the German glass artisans Leopold and Rudolph Blaschka. The highly aesthetic objects are part of a collection held at the Natural History Museum in London and have been chosen for pilot conservation, due to their relatively poor condition. The two models consist of glass, organic materials and occasional copper wire. Major conservation issues were identified as breakages and detachments of extremely fragile glass spines, the partially unstable glass compositions and consequent deterioration, the presence of a water-soluble coating, copper wire corrosion and inappropriate previous storage conditions. Characterisation of the original materials and their deterioration processes was carried out using a range of analytical facilities available at the museum, allowing the development of suitable treatments. These included a two-stage cleaning process, stabilisation of copper corrosion, reattachment of broken spines with Paraloid B72/Fynebond and reversible remounting of fragments using micro-tubing. A series of tests was carried out to assess the possibility of using 3D CAT and laser scanning for documentation. Recommendations are also made for future storage, conservation and research.

Anthracotherium genus have not been prone to a major revision since the earlier palaeontological discoveries (Fischer-Ooster, 1861; Kowalevsky, 1873) besides the works of Hellmund (1991) on *Elomeryx* & Hünermann (1967) and Brunet (1968) on *Microbunodon*. As a part of the new Swiss National Foundation project (n°115995) started in January 2007, the revision of the Anthracotheriidae is aiming for a better understanding of the biogeographical and palaeoecological evolution of large mammals during the Oligocene and the early Miocene in the Swiss Molasse Basin and Western Europe (N'Guyen, 2008; Scherler, in progress).

Brunet, M., 1968. Découverte d'un crâne d'Anthracotheriidae, *Microbunodon minimum* (Cuvier), à la Milloque (Lot-et-Garonne). Comptes Rendus de l'Académie des Sciences de Paris, 270, 2776-2779.

Ducrocq, S., Chaimanee, Y., Suteethorn, V. & Jaeger, J.-J. 2003. Occurence of the anthracotheriid *Brachyodus* (Artiodactyla, Mammalia) in the Early Middle Miocene of Thailand. Comptes Rendus Palevol, 2, 261-268.

Fischer-Ooster, 1861. Aufzählung der bis dahin in der Süsswassermolasse vom Bumbachgraben bei Schangnau entdeckten fossilen Thieren. Mitteilungen der Naturforschenden Gesellschaft des Kantons Bern, Naturhistoriches Museum Bern, 217-222.

Hellmund, M. 1991. Revision der europäischen Species der Gattung *Elomeryx* Marsh 1894 (Anthracotheriidae, Artiodactyla, Mammalia)–Odontologische Untersuchung. Palaeontographica, 220(A), 1-101.

Hünermann, K.A. 1967. Der Schädel von *Microbunodon minus* (Cuvier) (Artiodactyla, Anthracotheriidae) aus dem Chatt (Oligozän). Eclogae geologicae Helveticae, 60, 661-688.

Kowalevsky, W. 1873. Monographie der Gattung *Anthracotherium* Cuv. und Versuch einer natürlichen Classification der fossilen Hufthiere. Palaeontographica, 3, 347 pp.

Lihoreau, F., Barry, J., Blondel, C., Chaimanee, Y., Jaeger, J.-J. & Brunet, M. 2007. Anatomical revision of the genus *Merycopotamus* (Artiodactyla; Anthracotheriidae): its significance for Late Miocene mammal dispersal in Asia. Palaeontology, 50, 503-524.

Lihoreau, F., Blondel, C., Barry, J. & Brunet, M. 2004. A new species of the genus *Microbunodon* (Anthracotheriidae, Artiodactyla) from the Miocene of Pakistan: genus revision, phylogenetic relationships and palaeobiogeography. Zoologica Scripta, 33, 97-115.

N'Guyen, T.B. 2008. Die Anthracotherium des Oligozäns der Schweizer Molasse: Stratigraphie, Paläoökologie und Paläoklima. Unpublished Diploma Thesis, University of Fribourg: 138 pp.

Scherler, L., in progress. Large mammal evolution (Anthracotheriidae, Suidae, Tapiridae) from the Swiss Molasse during the Oligo-Miocene: biostratigraphy, biogeochemistry, palaeobiogeography and palaeoecology. PhD Thesis, University of Fribourg.

Did plesiosaurs have a caudal fin?

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Although recent reconstructions of plesiosaurs typically portray a simple tapering tail, historically they have frequently been portrayed with a vertical caudal fin. Is there any evidence for this structure in the fossil record? The existing evidence for a tail fin in plesiosaurs is reviewed but it is insufficient to reach any conclusion. However, the holotype specimen (Yorkshire Museum G503) of the large-headed

Zharkov, M.A. & Chumakov, N.M. 2001. Paleogeography and Sedimentation settings during Permian-Triassic reorganizations in biosphere. Stratigraphy and Geological Correlations, 9, 340-363. (English Translation).

When is a lamprey not a lamprey? taphonomy, anatomy, and phylogenetic significance of the Jamoytiiformes

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Exceptionally preserved, "soft-bodied" fossils of supposed vertebrates are extremely difficult to interpret with any confidence, yet they hold the potential to answer fundamental questions surrounding vertebrate origins and evolution. *Euphanerops* has recently been reviewed in detail (Janvier & Arsenault, 2007) but interpretations of *Jamoytius* remained controversial. This is because of disagreement over what anatomical characters are present, due in part, to lack of methodological rigour in interpretation. We have employed a robust analytical approach based on taphonomic analysis, topological reconstruction, careful justification of the anatomical model and comparative anatomy. Phylogenetic affinities of Jamoytiiformes are reviewed in light of recently discovered soft-bodied forms (Gess *et al.*, 2006). *Jamoytius* and *Euphanerops* are found to be sister taxa, on the stem-gnathostome lineage, rather than anaspids or petromyzontids. Revision of Jamoytiiformes and previous phylogenetic investigations also enables clarification of more general stem-gnathostome relationships and a consideration of the evolution of paired appendages.

Gess, R.W., Coates, M.I., Rubridge, B.S. 2006. A lamprey from the Devonian period of South Africa. Nature, 443, 981-984

Janvier, J. & Arsenault, M. 2007. The anatomy of *Euphanerops longaevus* Woodward, 1900, an anaspid-like jawless vertebrate from the Upper Devonian of Miguasha, Quebec, Canada. Geodiversitas, 29, 143-216

[poster] **The European Anthracotheriidae (Artiodactyla, Mammalia) from the Oligocene to the early Miocene: data from the Swiss Molasse Basin**

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The anthracotheriid family was widely spread in Eurasia, North America and Africa from the Middle Eocene to the Late Pliocene. Whereas the diverse specimens of Asia are currently well studied (Ducrocq *et al.*, 2003; Lihoreau *et al.*, 2007; Lihoreau *et al.*, 2004), the European anthracotheriids and especially the

Abstracts Of Presentations

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A *Goniopholis* skull from the Intermarine Member (Berriasian, Lower Cretaceous), Swanage (England).

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Goniopholis was a semi-aquatic 'mesosuchian' crocodilian, closely resembling modern forms. Even though known from England for over a century (Owen, 1841, 1878, 1879), the original descriptions were vague regarding stratigraphy/morphology. Other species of *Goniopholis* come from Europe, North America, Thailand and Brazil, but taxonomic problems further complicate the definition of the genus.

Fieldwork by RE recovered the skull from a distinctive laminated shale (DB bed 129b; Clements, 1993), in the Intermarine Member ("middle" Purbeck), Swanage (Dorset, England). Stratigraphical information is meaningful because previous British specimens lack precise geological origin and also confirms and improves hypothesis by Salisbury *et al.* (1999) on the provenance of the genus.

The skull is well preserved, but lost part of its three-dimensional structure. It is possible to identify features such as: nasals excluded from the naris; frontal excluded from the orbit; periorbital and perinasal ridges; presence of maxillary depressions. All features are consistent with preliminary classification as *Goniopholis simus*. In the bottom of the right maxillary fossa, the bone is eroded and roots of maxillary teeth are exposed. CT scanning was used to access internal morphological features. Information obtained is helping the revision of *Goniopholis* and other goniopholidids.

The specimen was recovered with assistance from Chris Moore and Steve Etches, prepared by Chris and Alex Moore, and CT scanned in the Royal Veterinary College London with the financial support from the Jurassic Coast Trust, England. Paul Ensom helped to interpret the stratigraphy of the outcrop. MBA receives scholarship from CNPq (Proc. 200381/2007-8), Brazil.

Clements, R.G. 1993. Type-section of the Purbeck Limestone Group, Durlston Bay, Swanage, Dorset. Proceedings of the Dorset Natural History and Archaeological Society, 114 (for 1992), 181-206.

Owen, R. 1841. Odontography. Rep. Brit. Assoc., 288, 11-69.

Owen, R. 1878. Monograph on The Fossil Reptilia of the Wealden and Purbeck Formations – Crocodilia

(*Goniopholis, Pterosuchus,* and *Suchosaurus*). Palaeontological Society Monograph, 7, 1-15.

Owen, R. 1879. Monograph of the fossil Reptilia of the Wealden and Purbeck Formations – Crocodilia (*Goniopholis, Brachydectes, Nannosuchus, Theriosuchus,* and *Neuthetes*). Palaeontological Society Monograph, 9, 1-19.

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: D.M. Unwin (Ed.), Cretaceous Fossil Vertebrates. Special Papers in Palaeontology, 60, 121-148.

[poster] **High diversity of thalattosuchian crocodylians and the niche partition in the Solnhofen Sea**

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The Solnhofen limestones of the Mörnsheim Formation (uppermost Hybonotum zone, early Tithonian, Upper Jurassic) yield a rich fauna of thalattosuchians, including at least five species: 1) *Geosaurus giganteus*, 2) *G. suevicus*, 3) *G. gracilis*, 4) *Dakosaurus maximus* and 6) *Steneosaurus priscus* (Vignaud, 1995). Niche partitioning is here hypothesised as the mechanism allowing the co-existence of these crocodylians in the same palaeoenvironment. The diverse morphology of teeth, skull and post-cranium support the specialisation towards particular diets, with little niche overlap.

The large (~4m in length) brevirostrine metriorhynchids (*G. giganteus, Dakosaurus*) were probably the top predators of the Mörnsheim environment, with laterally compressed non-procumbent serrated teeth and strong adductor musculature (von Sömmerring, 1816; Fraas, 1902). Competition between these species was prevented by further morphological differences: *Dakosaurus* was oreinirostral, with large, robust chopping/crushing teeth; *G. giganteus* was mesorostral, with blade-like slicing dentition, which occluded in a slicing scissor-like pattern, unique among thalattosuchians.

The small (~2m) longirostrine metriorhynchids (*G. suevicus, G. gracilis*), and the large (~3-4m) longirostrine teleosaurid *Steneosaurus* had procumbent dentition with piercing uncompressed and non-carinated teeth (Fraas, 1902; Broili, 1932; Vignaud, 1995), indicating a primarily piscivorous diet. *Steneosaurus* would have been a poorer swimmer restricted to ambush predation, due to its extensive body armour and lacking flippers/caudal fin. The exceptionally delicate teeth of *G. gracilis* suggest specialization towards smaller and softer prey (e.g. small crustaceans/soft-bodied molluscs). *Geosaurus suevicus*, being slightly larger and more robust than *G. gracilis*, would have been a more generalist feeder.

Broili, F. 1932. Weitere beobachtungen an *Geosaurus*. Neus Jahrbuch für Mineralogie, Geologie und Paläontologie, 68 Abteilung B, 127-148.

Fraas, E. 1902. Die Meer-Krocodilier (Thalattosuchia) des oberen Jura unter specieller berücksichtigung

& Otero, current studies) to determinate the material from Toros-Menalla (Late Miocene, Western Djurab desert). By using quantitative characters, a specific level of identification in the living and in the fossil is reached. The past numeric diversity of the genus in Toros-Menalla appears similar to the one observed today. A specific level of determination of the fossils opens new perspectives in paleobiogeography and to calibrate molecular phylogenetic trees.

Priem R, 1920. Poissons fossiles du Miocène d'Egypte (Burdigalien de Moghara, "Désert lybique"). In: Fourtau, R. (Ed.), Contribution à l'étude des vertébrés miocènes de l'Egypte. Gov Press, 8-15

Stewart K, 2001. The freshwater fish of Neogene Africa (Miocene–Pleistocene): systematics and biogeography. Fish and Fisheries, 2, 177-230.

Comparative study of Permian shark (Chondrichthyes) faunas of North and South America

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Shark remains are fairly abundant in certain Permian strata throughout the Americas. However, to date complete chondrichthyan specimens have only been found in North America. More often than not, only isolated teeth, scales and spines have been recovered, mostly from reworked sedimentary rocks. A revision of published and new materials from Brazil has shown that the following genera are common to South and North America (Johnson *et al.*, 2002; Richter, 2005; Duffin *et al.*, 1996 among others): ?*Denaea*, *Triodus*, *Xenacanthus*, *Bransonella*, *Cooleyella*, *Hybodus*, ?*Sphenacanthus*, *Bythiacanthus*, *Glikmanius* and *Protacrodus*. In some cases, occurrences in both continents are apparently severely heterochronous. Intermittent palaeogeographic links between epicontinental seaways of western Laurasia and western Gondwana through the Late Carboniferous until the Late Permian are likely to have occurred, as suggested by palaeogeographic reconstructions of marine environments (e.g. Zharkov & Chumakov, 2001). These intercontinental connections left a legacy of shark faunas that continued to evolve in the more restricted epeiric seas in both continents, whilst some taxa seem to have survived millions of years without noticeable changes in their teeth morphology. Endemic elements of these faunas are also discussed and comprise petalodonts, eugeneodontids and other genera belonging to xenacanthiformes.

Duffin, C., Richter., M. & Neis, P. 1996. Shark remains from the Late Carboniferous of the Amazon Basin, Brazil. Neues Jahrbuch für Geologie und Paläontologie Mh., Stuttgart, H.4, 232-256.

Johnson, G.D., Richter, M. & Ragogna, E.W. Global distribution of Permo-Triassic genera of xenacanthiform chondrichthyans. Society of Vertebrate Paleontology, Supplement, 22, 72A.

Richter, M. 2005. A new xenacanthid shark (Chondrichthyes) from the Teresina Formation, Permian of the Paraná Basin, southern Brazil. Revista Brasileira de Palaeontologia, 8, 140-158.

Richter, M. 2007. First record of Eugeneodontiformes (Chondrichthyes:Elasmobranchii) from the Paraná Basin, Late Permian of Brazil. In: I.S.Carvalho *et al.* (Eds.) 2007. Paleontologia: Cenários de Vida. Ed. Interciência, Rio de Janeiro, 1, 149-156.

in Chadian Late Miocene deposits (Otero *et al.*, 2008), and 2) the freshwater ariid catfish today only-known in the Niger basin but their presence was noted in Chadian Pliocene (Brunet *et al.* 2000) and from Libyan deposits (Gaudant, 1987). The results are discussed in relation with information brought by geologists.

Brunet, M., *et al.* 2002. A new hominid from the Upper Miocene of Chad, Central Africa. Nature, 418, 145–151.

Brunet, M., *et al.* 2000. Chad: discovery of a vertebrate fauna close to the Mio-Pliocene boundary. Journal of Vertebrate Paleontology, 2000, 205-209.

Brunet, M., *et al.* 1998. Tchad: découverte d'une faune de mammifères du pliocène inférieur. Cras, 326, 153-158.

Brunet, M., *et al.* 1997. Tchad: un nouveau site à hominidés pliocène. Cras, 324, 341-345.

Brunet, M., *et al.* 1995. The first australopithecine recovered west of the rift valley (Koro Toro region, Republic of Chad). Nature, 378, 273-275.

Lebatard, A.-E., *et al.* 2008. Cosmogenic nuclide dating of *Sahelanthropus tchadensis* and *Australopithecus bahrelghazali*: Mio-Pliocene hominids from chad. Proceedings of the National Academy of Sciences (USA), 105 (9), 3226-3231.

Gaudant, J., 1987. A preliminary report on the osteichthyan fish-fauna from the upper Neogene of Sahabi, Lybia. Neogene Paleontology and Geology of Sahabi, 6, 91-99.

Otero, O., Likius, A., Vignaud, P. & Brunet, M. 2008. A new *Semlikiichthys* species*, S. darsao* sp. nov. (Teleostei, Perciformes), west to the rift (Late Miocene, Toros Menalla, Chad). Palaeontology, in press.

Vignaud P., *et al.* 2002. Geology and palaeontology of the Upper Miocene Toros-Menalla fossiliferous area, Djurab Desert, Northern Chad. Nature, 418, 152-155.

Revealing the past diversity of the *Synodontis* catfish

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The extant genus *Synodontis* is represented by about 120 species distributed all over Africa except Maghreb and South Africa. Its first known occurrence is in the Burdigalien of Moghara, Egypt (Priem, 1920). Then, its fossil record is ascertained mainly by isolated bones in numerous African continental Mio-Pliocene sites in North, Central and East Africa (Stewart, 2001 and references herein; our current studies). Despite their high living diversity and a well documented fossil record, *Synodontis* remains have been tentatively attributed to only two extant species. This is explained by the lack of any osteological key for identification. Here we present the first tentative to establish characters that allow successfully to discriminate *Synodontis* fossils at a specific level. The study is driven in the Chadian basin. The bony anatomy of the eleven living *Synodontis* species has been reviewed (Pinton

von *Dacosaurus* und *Geosaurus*. Paleontographica, 49, 1–72.

Sömmerring, S.T. von. 1816. Ueber die *Lacerta gigantea* der vorwelt. *Denkschriften der Königlichen* Akademie der Wisseschaften zu Münch, 6, Classe der Mathematik und Naturwissenschaften, 37-59.

Vignaud, P. 1995. *Les Thalattosuchia, crocodiles marins du Mésozöique: Systématique, phylogénie, paléoécologie, biochronologie et implications paléogéographiques*. Unpublished Ph.D. dissertation. Université de Poitiers, Poitiers. 245 p.

Development in 'southern hemisphere' mammals

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Evidence for the common ancestry of endemic African (elephants, seacows, hyraxes, aardvarks, sengis, tenrecs and golden moles) and South American (sloths, armadillos, anteaters) mammal clades has up until recently been based almost entirely on molecular data. While anatomical features held in common by these taxa are not obvious, morphological evidence for this clade does become apparent with consideration of their development. Two particularly interesting features include a relaxed level of constraint in vertebral number and relatively late eruption of the permanent dentition. Here, I present new data on the percentage of vertebral atavisms in afrotherians and timing of dental eruption in macroscelidid specimens of known age. I optimise these characters across mammals based on recent hypotheses of the extant mammalian Tree of Life, and ask if the ontogenetic distinctiveness of Afrotheria and Xenarthra is derived or primitive relative to other placental mammals. This distinctiveness may indicate a significantly different pattern of development from that observed in non-afrotherian, non-xenarthran mammals.

[poster] **The Middle Miocene lophocetine kentriodontid delphinoid, *Liolithax* (*Lophocetus*) *pappus*: new information about its relationships and morphology**

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Liolithax pappus, a Middle Miocene (Calvert Formation) western North Atlantic odontocete has had a problematic taxonomic history. First described by Kellogg (1955) and assigned to the genus *Lophocetus* Cope, 1867, it was assigned by Barnes (1978) to the family Kentriodontidae and transferred to the genus *Liolithax* Kellogg, 1931. *Liolithax* was previously known only by isolated petrosals from the Middle Miocene Sharktooth Hill near the west coast of North America. These petrosals are very similar to the petrosal with the holotype skull of *Liolithax pappus*. Subsequently, in Baja California, Mexico, a possibly geochronologically older skull was discovered, which is definitely associated with a *Liolithax*-type petrosal (Flores-Trujillo *et al.*, 2000). This specimen indicates that *Liolithax* is a small, primitive, slender-snouted, small-toothed kentriodontine kentriodontid. In contrast, *Liolithax pappus* is a large, derived, thick-snouted, large-toothed lophocetine kentriodontid. *Liolithax* is not congeneric with the type species of *Lophocetus* (i.e. *Delphinus calvertensis* Harlan, 1842). Therefore, "*Liolithax*" *pappus* should be assigned to a new genus, but remain within the Lophocetinae. Among some Kentriodontidae, the morphology of the petrosal is relatively conservative and might not be a reliable indicator of relationships. A new specimen of "*Liolithax*" *pappus* from the Calvert Formation (CMM-V-3780) provides additional information on its cranial morphology.

Barnes, L.G. 1978. A review of *Lophocetus* and *Liolithax* and their relationships to the Delphinoid family Kentriodontidae (Cetacea: Odontoceti). Science Bulletin, Natural History Museum of Los Angeles County, 28, 1-35.

Cope, E.D. 1867. An addition to the vertebrate fauna of the Miocene period, with a synopsis of the extinct Cetacea of the United States. Proceedings of the Academy of Natural Sciences of Philadelphia, 1867, 138-156.

Flores-Trujillo, J.G., Aranda-Manteca, F.J., & Barnes, L.G. 2000. Identificación del delfín fósil del Mioceno Medio, *Liolithax kernensis* Kellogg 1931. [The identity of the fossil Middle Miocene dolphin, *Liolithax kernensis* Kellogg 1931.] Programa y Resúmenes, XXV Reunión Internacional para el Estudio de los Mamíferos Marinos, Sociedad Mexicana de Mastozoología Marina, La Paz, Baja California Sur, México, 7-11 May, 2000, p. 4.

Harlan, R. 1842. Description of a new extinct species of dolphin from Maryland. Second Bulletin of the Proceedings of the National Institution for the Promotion of Science, 195-196.

Kellogg, R. 1931. Pelagic mammals from the Temblor formation of the Kern River region, California. Proceedings of the California Academy of Sciences, Series 4, 19 , 217-397.

Kellogg, R. 1955. Three Miocene porpoises from the Calvert Cliffs, Maryland. Proceedings of the United States National Museum, 105, 101-154.

A large ostrich-like bird from the Late Palaeocene of the Paris Region

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An anterior thoracic vertebra of a large bird was recently discovered in a sand pit in the valley of the river Oise, near the city of Compiègne, about 60 km

of fossil crocodyloid eggshells, which always possess well-developed interstices and usually subcircular pore openings (e.g. *Krokolithus wilsoni*, *K. helleri*, Glen Rose Formation eggshells). These eggs are also different from previously reported crocodyloid eggs from the Bauru Group (Araçatuba Formation), associated with remains of *Mariliasuchus* (Magalhães-Ribeiro *et al.*, 2006).

The Bauru Group is the only geological unit to show two distinctive types of crocodylian eggshells, as well as dinosaurian eggs. As the Bauru Group includes no fewer than seven different mesoeucrocodylian genera, most of them notosuchians, the occurrence of two crocodyloid oospecies is expected and is a valuable source of information for palaeobiological studies, and still needs further clarification.

Magalhães-Ribeiro, C.M., Carvalho, I.S., Nava, W.R. 2006. Ovos de crocodilomorfos da Formação Araçatuba (Bacia Bauru, Cretáceo Superior), Brasil. In: V. Gallo, P.M. Brito, H.M.A. Silva, & F.J. Figueiredo (Ed.), Paleontologia de Vertebrados: grandes temas e contribuições científicas. Interciência, Rio de Janeiro, 285-292.

Mikhailov, K.E. 1991. Classification of fossil eggshells of amniotic vertebrates. Acta Palaeontologica Polonica, 36, 193-238.

Mikhailov, K.E. 1997. Fossil and recent eggshells in amniotic vertebrates: fine structure, comparative morphology and classification. Special Papers in Palaeontology, 56, 1-80.

Fishes and African palaeogeography drainage basins: first data documenting Mio-Pliocene relationships between Chad and neighbour basins

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During the Neogene, global climatic changes (notably by the Sahara desert development) and geodynamic processes (notably by the East African rifting) have strongly influenced faunal distribution in Africa by reshuffling ecological barriers. The four Miocene and Pliocene Chadian areas discovered by the Mission Paléoanthropologique Franco-Tchadienne open the only-known Neogene windows on the vertebrate fauna history in Central Africa including hominids (Brunet *et al.*, 1995, 1997, 1998, 2000, 2002; Vignaud *et al.*, 2002). They are dated 7Ma, 5.3Ma, 4Ma and 3.6Ma (Lebatard *et al.*, 2008). In that context, the Chadian freshwater fossils document the faunal exchanges between the Chad-Chari basin and the neighbour ones since the Late Miocene times. One of the peculiar features of the Chadian fossil assemblages is the richness of fossil fish which may afford to explore the paleogeography of the drainage basin. Currently, we focus on two fish taxa potentially carrying paleogeographical information: 1) the perciform fish *Semlikiichthys*, only-known in Eastern Africa before the finding of a new species of the holotype have not yet been described in their entirety, or clearly assigned to a single individual or taxon. This paper will enumerate the preserved elements, present their defining characteristics and thereby place the taxon on a firm, modern basis for inclusion in future phylogenetic, biogeographic or other studies.

Andrews, C.W. 1922, Description of a new plesiosaur from the Weald Clay of Berwick (Sussex): Quarterly Journal of the Geological Society of London, 78, 285-298.

Hawkins, T. 1834, Memoirs of Ichthyosauri and Plesiosauri, extinct monsters of the ancient earth: Relfe and Fletcher, London, 51, 1-28.

Hawkins, T. 1840, Book of the great sea-dragons, Ichthyosauri and Plesiosauri, gedolim taninim, of Moses. Extinct monsters of the ancient earth: William Pickering, London, 27, 1-30.

Owen, R. 1840, A description of a specimen of the *Plesiosaurus macrocephalus*, Conybeare, in the collection of Viscount Cole, M.P., D.C.L., F.G.S., &c.: Transactions of the Geological Society of London, 2, 515-535.

Seeley, H.G. 1892, The nature of the shoulder girdle and clavicular arch in Sauropterygia: Proceedings of the Royal Society of London, 51, 119-151.

[poster] **New crocodyloid eggs and eggshells from the Bauru Group, Upper Cretaceous of Brazil**

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The record of fossil crocodyloid eggs is scarce and poorly understood, not matching the wide diversity of crocodylomorph skeletal taxa known to date, especially regarding basal lineages. This has been partially attributed to the proportionally thin eggshell of extant crocodilians (Mikhailov, 1991, 1997).

A remarkable new association of well preserved eggshells, eggs and egg clutches is here reported from the Adamantina Formation (Bauru Group, Upper Cretaceous). The new outcrop supplied several associations of eggs distributed in a relatively small area and different horizons, and at least two egg clutches were associated with articulated remains of *Baurusuchus pachecoi*.

The new material is characterized by a particularly thin eggshell (0.15-0.25 mm), elliptical or drop-shaped pore openings (30-80 µm in length) and a tightly packed arrangement of the basic units. These features contrast with other known types

north of Paris. The accompanying vertebrate fauna, which includes fishes, turtles, crocodilians, choristoderes and mammals, indicates a Late Palaeocene (Thanetian) age. The bird vertebra is 72 mm long and comparable in size to the corresponding vertebra of an ostrich (*Struthio camelus*). It generally resembles the anterior thoracic vertebrae of living ratites, although if differs from them in various details. Two large ground birds have been known for a long time from Thanetian localities (Cernay, Berru) in the Reims area, in the eastern Paris Basin: the giant neognath *Gastornis* and the smaller palaeognath *Remiornis* (Martin, 1992; Buffetaut, 1997). The vertebra from the Oise valley is smaller and less robust than those of *Gastornis*, and its centrum is more elongate than in available specimens of *Remiornis* and differs from them in many details. The new find may thus indicate that large ratites were more diverse than previously recognised in the Late Palaeocene of Europe.

Buffetaut, E. 1997. New remains of the giant bird *Gastornis* from the Upper Palaeocene of the eastern Paris basin and the relationships between *Gastornis* and *Diatryma.* Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 3, 179-190.

Martin, L.D. 1992. The status of the Late Paleocene birds *Gastornis* and *Remiornis*. Science Series, Natural History Museum of Los Angeles County, 36, 97-108.

[poster] **An articulated specimen of *Chroniosaurus dongusensis*, and the morphology and relationships of the chroniosuchids**

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An almost complete, articulated specimen of the chroniosuchian *Chroniosaurus dongusensis* is described. Chroniosuchians are a little-known group of tetrapods found mainly in the Permo-Triassic of Russia that have been suggested to be late-surviving anthracosaurs. Detailed descriptions of the material have been limited, and few articulated specimens are known, though disarticulated material is abundant. The articulated specimen allows us to provide new anatomical information on chroniosuchids, including revised reconstructions of the skull, and for the first time to present a cladistic analysis that includes the chroniosuchians. In six of the 12 most parsimonious trees they appear as basal embolomeres, lying a node above *Silvanerpeton*, supported by specific resemblances to embolomeres in the braincase region. In the remaining six trees, they appear further crownward, above *Silvanerpeton* and embolomeres, and below seymouriamorphs and other stem amniotes, though no unambiguous synapomorphies support this node. Chroniosuchians were probably semi-terrestrial, crocodile-like tetrapods but with skull specializations that suggest a very different feeding mechanism from that of crocodiles. Their dorsal osteoderms resemble those of some crocodilians and probably allowed a limited amount of both lateral and dorso-ventral flexion of the trunk region.

3-dimensional analysis of dental complexity in tritylodontids and other high fibre plant feeders

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Tritylodontids form a moderately diverse (approximately 26 valid species, 15 genera) non-mammalian synapsid family, recorded globally and from the latest Triassic to the Early Cretaceous. The phylogenetic placement of Tritylodontidae is controversial, but likely close to the origin of Mammalia. All species share gomphodont, multi-rooted and transversely expanded 'cheek' teeth, multiple food shearing blades provided by serially repeated and numerous cusps aligned in rows, and antero-posterior jaw movement in the horizontal plane. Tritylodontids have therefore been hypothesised as high-fibre herbivores (Crompton, 1972). We apply a 3-dimensional method (Evans *et al.*, 2007) to assess and quantify crown feature complexity, or surface roughness, in tritylodontids and other extinct/extant taxa. Our analyses of 3D digital tooth models, generated by surface laser scanning, show that extant high-fibre herbivory specialists have highly complex cheek tooth morphology irrespective of the taxon-specific morphological details. The high complexity values can be related to the high number of tooth crown features, or 'tools', required to process fibrous foodstuffs such as bamboo (Jernvall *et al.*, 2008). Neither bamboo nor other grasses evolved until the Late Cretaceous. However, the dentitions of tritylodontid specimens examined were sufficiently complex to have processed plant material similarly high in fibre and/or phytolith content to bamboo.

Crompton, A.W. 1972. Postcanine occlusion in cynodonts and tritylodontids. Bulletin of the British Museum (Natural History), Geology, 21, 29-71.

Evans A.R., Wilson G.P., Fortelius M. & Jernvall J. 2007. High-level similarity of dentitions in carnivorans and rodents. Nature, 445, 78-81.

Jernvall, J., Gilbert, C.C. & Wright, P.C. 2008. Peculiar tooth homologies of the greater bamboo lemur (*Prolemur = Hapalemur simus*): When is a paracone not a paracone? In: J.G. Fleagle & C.C. Gilbert (Eds.), E. Simons: A Search for Origins. Springer, New York, pp. 335-342.

New insights on "rauisuchian" taxa (Archosauria: Crurotarsi) from Brazil

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Rauisuchian archosaurs were some of the largest terrestrial carnivores during the Middle and Late Triassic in Europe, North Africa, India, Asia, and the Americas. However, despite their worldwide distribution, rauisuchian evolutionary history is poorly understood and their taxonomy remains problematic because many taxa

[poster] **The case of the lamnid-orectolobe: where does *Palaeocarcharias* belong?**

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Palaeocarcharias stromeri is an Upper Jurassic selachian from the Solnhofen area of southern Germany and Cerin, France. Three specimens have been recovered including the near-complete holotype at Jura Museum in Eichstätt. Its fusiform body plan is reminiscent of the Orectolobid morphology though the teeth, that show linear gradient monognathic heterodonty, are high-cusped which is a morphology considered unique to the Lamniformes. Subsequently, *Palaeocarcharias* was originally placed within the Lamniformes though more recent analyses have suggested the genus be placed within the Orectolobiformes, Carcharhiniformes or a genus within Palaeocarchariformes (Duffin, 1988). This study uses character state analysis of Lamniformes, Orectolobiformes and Carcharhiniformes in order to re-assess the systematic affinities of the Genus.

Duffin, C.J. 1988. The Upper Jurassic Selachian *Palaeocarcharias* de Beaumont (1960). Zoological Society of the Linnean Society, 94, 271-286.

***Eurycleidus arcuatus*: placing a problematic historical plesiosaur taxon on a firm footing**

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Eurycleidus arcuatus (Owen, 1840) Andrews, 1922 is an historically important genus and species of plesiosaur (suborder: Plesiosauria) from the uppermost Triassic (Rhaetian) or lowermost Jurassic (Hettangian) of Street, Somerset, UK. The species *Plesiosaurus arcuatus* was erected by Richard Owen (1840) based on material collected and sold to the British Museum by Thomas Hawkins (1834, 1840). *Eurycleidus arcuatus* is of considerable importance as one of the earliest described plesiosaurs, due to its geographical location, stratigraphic position, and historical connections to Thomas Hawkins, Richard Owen, Harry Seeley (1892), Charles Andrews and others.

Eurycleidus arcuatus has a long and complicated history. The deposits from which *Eurycleidus arcuatus* was recovered are poorly known and time constrained, and there is no modern review of this complex, multiple locality. However, full details of the type locality will be presented. The description of *Plesiosaurus arcuatus* by Owen (1840) was based on a single 'pectoral' vertebra, although the holotype consists of a substantial part of the skeleton, hence, *Eurycleidus arcuatus* is a valid taxon represented by an excellent type specimen. However, the elements water) has been popular, yet appears untenable based on the absence of any skim-feeding specialisations in the azhdarchid skeleton. Claims that azhdarchids were dip-feeders (reaching down in flight to grab prey from the water) are contradicted by anatomical details, such as the stiff neck and very elongate, pointed jaw tips. A review of taphonomic and morphological data indicates that azhdarchids were strongly terrestrial, and well suited for quadrupedal foraging and a generalised diet. Azhdarchids and related taxa may have played a significant role in Cretaceous terrestrial ecosystems, and their terrestriality might explain why they survived to the end of the Maastrichtian. Witton & Naish (2008) employed extensive comparison with extant birds in order to arrive at these conclusions. However, frustratingly little has been published on avian functional morphology, and how storks, herons, pelicans and other groups procure and process prey is still chronically under-described.

Witton, M.P. & Naish, D. 2008. A reappraisal of azhdarchid pterosaur functional morphology and paleoecology. *PLoS ONE*, 3 (5): e2271. doi:10.1371/journal.pone.0002271

Sharks indicate a lagoonal environment for dinosaur remains

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Hornsleasow Quarry (SP 132 322) is a Bathonian site within the Cotswolds consisting of the Chipping Norton Limestone Formation that forms the basal layers of the Great Oolite Group. Previous sampling of the site, done soon after the quarry face had been blasted, yielded an *in situ Cetiosaurus* suggesting a significant drop in sea-level within the Bathonian. The dinosaur was recovered from a bipartite clay lens situated within a karstic hollow. Bulk sampling of the lens yielded microvertebrate material of both terrestrial and freshwater aquatic vertebrates and was subsequently interpreted as a terrestrial environment.

This study re-sampled the microvertebrate faunas of the site at Hornsleasow. The clay lens was found to contain a number of marine vertebrates as well as the previously described terrestrial and freshwater taxa. After further analysis of the site, it was concluded by this study that Hornsleasow was a lagoonal area within the Bathonian and not terrestrial as previously described.

Metcalfe, S.J., Vaughan, R.F., Benton, M.J., Cole, J., Simms, M.J. & Dartnall, D.L. 1992. A New Bathonian (Middle Jurassic) microvertebrate site, within the Chipping Norton Limestone Formation at Hornsleasow Quarry, Gloucestershire. Proceedings of the Geologists' Association, 103, 321-342

Underwood, C.J. & Ward, D.J. 2004. Neoselachian sharks and rays from the British Bathonian. Palaeontology, 47, 447-501.

were erected on fragmentary, undiagnostic remains. This is especially the case for the taxonomy of rauisuchian remains from Brazil (Santa Maria Supersecuence) described by Huene (1942). An anatomical revision of these materials confirms the rauisuchian nature and validity of *Prestosuchus chiniquensis* (diagnosable by e.g. anterior notch between the scapula and coracoid, longitudinal ridge on the dorsal surface of the ischium). "*P*". *loricatus* is also a valid species of rauisuchian, but differs in several characters from *Prestosuchus* (triangular neural spine of cervical vertebra in lateral view, accessory processes on caudal vertebrae, pit on the posterior head of the ischium), and thus represents a distinct genus. The paralectotype of *P. loricatus* is referable to *P. chiniquensis* (e.g. calcaneal tuber as height as wide and ventral surface with a depth pit), and we confirm the assignation of the paralectotype of *P. chiniquensis* to this species (*contra* Kirschlat, 2000). *Procerosuchus* is a juvenile specimen of *P. chiniquensis* and *Rhadinosuchus* is a juvenile specimen of Proterochampsidae, as was previously suggested by some authors. *Hoplitosuchus* is a *nomen dubium*, the type of which consists of unidentifiable bones, while the referred material includes remains of a rauisuchian and a dinosaur. These data confirm the presence of at least three genera (including *Rauisuchus*) of rauisuchian in the Middle Triassic of Brazil.

Huene, F.v. 1942. Die fossilen Reptilien des sudamerikanischen Gondwanalandes. Ergebnisse der Sauriergrabungen in Sudbrasilien 1928/29, Munche, 332pp.

Kischlat, E-E. 2000. Tecodôncios: A Aurora dos Arcossáurios no Triássico. In: H. Holz & L.F. De Ros (Eds.), Paleontología do Rio Grande do Sul, 273-316.

Unrestricted egg size and the evolution of obligatory parental care in birds

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Parental care in birds ranges from nest-mound monitoring in megapodes to extended periods of chick provisioning in albatrosses. Avian neonates also vary from being able to run, even fly, within a few hours of hatching ('precocial') to those emerging blind, naked, and entirely dependant on their parents ('altricial'). We document the evolution of avian developmental strategies using a recent morphology-based phylogeny (Livezey & Zusi, 2007), present correlations between strategies, egg weight and female body mass, and examine the developmental mode of the Early Cretaceous *Confuciusornis*. Sequencial loss of precocial features in hatchlings characterises the evolution of birds. Altriciality is derived within Neoaves, while a set of precocial strategies are seen in earlier lineages, including basal Neornithes and their Mesozoic counterparts (Zhou & Zhang, 2004). This evolutionary transition also encompasses an increase in relative egg size: fully altricial taxa produce significantly larger eggs compared to female body mass while those of precocial birds are smaller. Skeletal constraints on egg size, seen in Jurassic and Early Cretaceous birds (*Archaeopteryx*, *Confuciusornis*, Enantiornithes), are absent from later diverging lineages. The evolution of unrestricted egg size likely precipitated the subsequent diversification of wide-ranging reproductive strategies in living birds.

Zhou, Z. & Zhang, Z. 2004. A precocial avian embryo from the Lower Cretaceous of China. Science, 306, 654.

Livezey, B.C. & Zusi, R.L. 2007. Higher-order phylogeny of modern birds (Theropoda, Aves: Neornithes) based on comparative anatomy. II. Analysis and discussion. Zoological Journal of the Linnean Society, 149, 1-95.

Non-destructive investigation of embryo fossilised *in ovo*: absorption based versus phase contrast x-ray imaging

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Exceptionally small eggs of enigmatic origin were recovered from the Lower Cretaceous of Thailand. The detailed morphological study of the eggshell alone did not allow determining whether these eggs are from dinosaurs or from birds (Buffetaut *et al.*, 2005). In order to precise their exact taxonomic status, as well to improve our knowledge of the still debated dinosaur-bird transition, the eggs were scanned at the European Synchrotron Radiation facility using Propagation Phase Contrast computed microtomography (PPC-μCT). The relevance of using PPC-μCT on fossils has been demonstrated (Tafforeau *et al.*, 2006). In the present case, the 16 microns voxel size data revealed an exceptionally complete dinosaur embryo skeleton, preserving 300 bones fossilised *in ovo* (Fernandez *et al.*, 2007). Because these data revealed bone structures thinner than 16 microns, the eggs were further scanned using a 5 microns voxel size, thus allowing more a precise anatomical description. Although the anatomical study is still under process, the comparison of classical absorption based microtomography (μCT) and PPC-μCT reveals three degrees of density among bones, which are certainly related to the ossification pattern. The comparison of our results with that obtained by Kundrát *et al.* (2008), who compared mineralization patterns of therizinosauroid embryos with other relevant dinosaur embryos, recent crocodilians and birds, allowed to draw some preliminary conclusions about the development stage and life-style strategies of these enigmatic theropods. Moreover, we have scanned a part of the femur with a voxel size of 0.5 microns for histological purposes. This analysis reveals the cellular structure of the bone that shows both the compacta and the medullary bone partially preserved. Further histological scans and comparison with previous histological studies on dinosaur embryos (Horner *et al.*, 2001) will shed light on the phylogenetic position of these enigmatic embryos.

but few works focused recently on the large mammal remains. The review of significant Swiss Oligocene localities (e.g. Kleinblauen, Bumbach, Mümliswil-Hardberg, Aarwangen, Rochette, Rickenbach, Küttigen) and new palaeontological excavations in the Jura Molasse (Poillat, Pré Chevalier, La Beuchille), along the future Tansjurane motorway, give some light on the Swiss Oligocene large mammal evolution.

Preliminary results on the Oligocene ruminants are presented. Described for the first time in Switzerland, *Lophiomeryx mouchelini* from Poillat (Jura Molasse) points out the relationship between the populations from Central and Western Europe. The oldest known *Prodremotherium elongatum* is described at Bumbach locality (MP25). *Gelocus* cf. *laubei* from Poillat could be the youngest (MP23 ?) and the more occidental specimen of this species. Moreover, remains of the rare small *Iberomeryx minor* occurs in three localities from the Jura Molasse (La Beuchille, Pré Chevalier, Soulce). Others genera and species, such as *Bachitherium*, *Dremotherium* and *Amphitragulus*, are still in study.

This study is a part of my PhD thesis (Mennecart in progress), financed by the Swiss National Found Project n° 115995.

Engesser, B. 1990. Die Eomyidae (Rodenia, Mammalia) der Molasse der Schweiz und Savoyens. Systematik und Biostratigraphie. Mémoires suisses de Paléontologie, 112, 144 pp.

Engesser, B. & Mayo, N.A. 1987. A biozonation of the Lower Freshwater Molasse (Oligocene and Agenian) of Switzerland and Savoy on the basis of fossil mammals. Münchner Geowissenschaften Abhandlungen, 10(A), 67-84.

Engesser, B. & Mödden, C. 1997. A new version of the biozonation of the Lower Freshwater Molasse (Oligocene and Agenian) of Switzerland and Savoy on the basis of fossil Mammals. In: Aguilar, J.-P., Legendre, S. & Michaux, J. (Eds.), Actes du Congrès BiochroM'97. Mémoires et Travaux de l'École pratique des Hautes Etudes, Institut Montpellier, 21, 475-499.

Engesser, B., Mayo, N.A. & Weidmann, M. 1984. Nouveaux gisements de mammifères dans la Molasse subalpine vaudoise et fribourgeoise. Mémoires suisses de Paléontologie, 107, 39 pp.

Mennecart B. in progress The Ruminantia and Cainotheriidae (Mammalia, Artiodactyla) from Oligocene to Early Miocene of Switzerland, reassessment and new data on their phylogeny, ecology and palaeoenvironment. PhD thesis of the University of Fribourg, Geosciences section.

Mennecart, B. in progress. The Ruminantia and Cainotheriidae (Mammalia, Artiodactyla) from Oligocene to Early Miocene of Switzerland, reassessment and new data on their phylogeny, palaeoecology and palaeoenvironment. Department of Geosciences. Fribourg, University of Fribourg. PhD Thesis.

The feeding behaviour of azhdarchid pterosaurs

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Azhdarchids were globally distributed Cretaceous pterodactyloid pterosaurs, well known for the gigantic sizes achieved by some taxa (wingspans >10 m). While remaining poorly described, they have been the focus of an unreasonable amount of palaeobiological speculation. The idea that azhdarchids were aquatic skim-feeders (flying over the water surface, trawling their mandibles through the

Marine mammals through time: when less is more in the study of palaeodiversity

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The discovery of a strong influence of sedimentary rock abundance on the global Phanerozoic marine diversity record has called into question the validity of a biological interpretation of patterns in any estimate of palaeodiversity (e.g. Smith, 2001; Smith & McGowan, 2007). Surprisingly, no such bias was found in a study on the diversity of North American fossils cetaceans (Uhen & Pyenson, 2007), thus raising the question whether biasing effects may be less pronounced and potentially negligible in smaller, taxonomically better defined groups, and especially those of large marine animals.

Here I compare the European palaeodiversity records of three groups of marine mammals (cetaceans, pinnipedimorphs and sirenians) to a new database of total European Caenozoic marine sedimentary outcrop area. The new rock data fitted well with previous estimates of global sediment abundance (e.g. Ronov *et al.*, 1980). Cross-correlation analyses failed to identify a strong link between outcrop area and any of the three palaeodiversity curves. Interestingly, a comparison of the diversity records with each other revealed similar patterns in the curves of cetaceans and pinnipedimorphs. This similarity, which is also reflected in the habitat and ecology of those two groups, may indicate the presence of a genuine biological signal and validates a tentative biological interpretation of marine mammal palaeodiversity.

Ronov, A.B., Khain, V.E, Balukhovsky, A.N. & Seslavinsky, K.B. 1980. Quantitative analysis of Phanerozoic sedimentation. Sedimentary Geology, 25, 311-325.

Smith, A.B. 2001. Large-scale heterogeneity of the fossil record: implications for Phanerozoic biodiversity studies. Philosophical Transactions of the Royal Society of London B, 356, 351-367

Smith, A.B. & McGowan, A.J. 2007. The shape of the Phanerozoic marine palaeodiversity curve: how much can be predicted from the sedimentary rock record of Western Europe? Palaeontology, 50, 765-774

Uhen, M.D. & Pyenson, N.D. 2007. Diversity estimates, biases, and historiographic effects: resolving cetacean diversity in the Tertiary. Palaeontologia Electronica, 10, 1-22.

The Swiss Oligocene ruminants: preliminary results

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Numerous authors studied the lithostratigraphy and the biostratigraphy of the small mammal localities within the Molasse basin in Switzerland (Engesser *et al.*, 1984; Engesser & Mayo, 1987; Engesser, 1990; Engesser & Mödden, 1997),

Buffetaut, E., Grellet-Tinner, G., Suteethorn, V., Cuny, G., Tong, H., Kosir, A., Cavin, L., Chitsing, S., Griffiths, P.J., Tabouelle, J. & Le Loeuff, J. 2005. Minute theropod eggs and embryo from the Lower Cretaceous of Thailand and the dinosaur-bird transition. Naturwissenschaften, 92, 477-482.

Fernandez, V., Tafforeau, P & Buffetaut, E 2007. 3D imaging of enigmatic tiny eggs with embryos from the Lower Cretaceous of Thailand using phase contrast X-ray Synchrotron microtomography. 55th SVPCA Abstracts Book, 13.

Horner, J. R., Padian, K. & de Ricqles, A. 2001. Comparative osteohistology of some embryonic and perinatal archosaurs: developmental and behavioral implication for dinosaur. Paleobiology. 27, 39-58.

Kundrát, M. Cruickshank, A. R.I., Mannin, T. W. & Nudds, J. 2008. Embryos of therizinosauroid theropods from the Upper Cretaceous of China: diagnosis and analysis of ossification patterns. Acta Zoologica, 89, 231-251.

Tafforeau, P., Boistel, R., Bravin, A., Brunet, M., Chaimanee, Y., Clotens, P., Feist, M., Hoszowska, J., Jaeger, J-J., Ray, R.F., Lazzari, V., Marivaux, L., Nel, A., Nemoz, C., Thibault, X., Vignaud, P. & Zabler, S. 2006. Application of X-ray synchrotron microtomography for non-destructive 3D studies of paleontological specimens. Applied Physics A, 83, 195-202.

The biter bit: pliosaur predation on long-necked plesiosaurs

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Predation damage is common on specimens of plesiosaurs. In the Oxford Clay fauna many specimens are available, allowing statistical studies of the incidence and distribution of such marks. In most formations too few specimens are available for robust statistical analysis and only an anecdotal approach is possible. Nevertheless, the specimens available yield enough information to form hypotheses of the nature of the predators and their behaviour. Museum catalogues rarely record such phenomena, and specimens need to be examined closely bone by bone to identify such damage. It is usually found as a by-product of other research, and frequently not recorded even if identified.

This talk concentrates on three rather loosely defined deposits, the Lias, the Oxford Clay and the Kimmeridge Clay. All three contain significant faunas of marine reptiles including crocodiles, ichthyosaurs, long-necked plesiosaurs and pliosaurs.

The Lias is here used as a rather general term referring to a number of different formations covering a long time-span and including significant faunal changes. The "top predator" roles were occupied by large ichthyosaurs such as *Temnodontosaurus* and rhomaleosaurid pliosaurs. Two specimens, the first of *Rhomaleosaurus megacephalus* from the Lower Lias, possibly of Somerset, the second an as yet unnamed microclidid from the Middle Lias of Lincoln are presented. Both show evidence for an attack by a large pliosaur at the anterior end of the dorsal spine, and in the case of the Lincoln specimen evidence for torsion feeding. The skulls and necks of rhomaleosaurs were well-adapted to resist torsional forces, and the pattern of tooth marks is consistent in both cases with that of a large rhomaleosaur.

Such pliosaurs could reach a large size. *R. cramptoni* is about 7 meters long, and there is fragmentary evidence for even larger individuals. In specimens from the Oxford Clay predation damage is generally limited to the limbs and girdles. Bite marks on vertebrae are relatively rare. Although marine crocodiles and ichthyosaurs were present in the marine reptile fauna, they were not adapted to predation on large prey. The large pliosaur *Liopleurodon*, with a maximum skull length of about 1.2 meters, is the most likely candidate for most of the predation. In some cases he marks show a pattern of dentition compatible with that of *Liopleurodon*. A common predation strategy appears to have been the removal of limbs to disable the prey. Isolated limbs are relatively common in Oxford Clay deposits and many propodials, especially those of *Cryptoclidus*, bear large tooth marks at the proximal end. Some specimens, especially smaller ones, have damage which indicates that the whole body has been held in the jaws. It is probable that the predator in these cases also is *Liopleurodon,* though there is some evidence for larger pliosaurs in the formation.

Specimens from the Kimmeridge Clay, though far fewer in number, show evidence for a different pattern of predation. Bite marks on vertebrae and other elements are common and more generally distributed. The huge pliosaur *Pliosaurus* was capable of seizing a large plesiosaur by the body and quite literally biting it in half.

It is tentatively suggested that these three faunas demonstrate changes in predation behaviour in large pliosaurs. The Liassic forms employed "Shock and Awe" tactics, relying on high impact attack and rapid dismembering of prey species. Callovian forms in general disabled prey by the selective removal of limbs and grasping of the whole body in the jaws in smaller prey. The Kimmeridgian forms were larger, and could employ this strategy to deal with the largest prey. It is suggested that the trend towards enormous size, as exemplified by huge pliosaurs from Svalbard and Mexico, is an adaptation to feeding in this way.

Inside and out: a comparison of the lower jaw of two basal mammals

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Two of the first mammals, *Morganucodon* and *Kuehneotherium,*are found in Early Jurassic fissure deposits from South Wales (Kermack *et al*., 1968; Kermack *et al*., 1973) and, although the bones are fragmented, the abundance of material offers a unique opportunity to study individuals at varying stages of their growth and tooth replacement. We use high resolution CT images and 3-D reconstructions to provide new insights into the jaw and dentition of these mammals.

A complete lower jaw of *Morganucodon* is digitally reconstructed in 3-D. Internally, histological detail includes Lines of Arrested Growth (LAGs) and these are mapped on the digital reconstruction to clearly reveal the remodelling

with associated mandibular rami. Comparison with the scanty material reported from that site shows that it is identical to the mandibular fragment identified as the purportedly oldest known *Diplocynodon* (Ginsburg & Bulot, 1997; Pereda Suberbiola *et al.*, 1999). Detailed examination of this new exquisitely preserved material reveals however that this Late Paleocene eusuchian does not belong to the genus *Diplocynodon* but to the primitive eusuchian *Borealosuchus*. This record of a new species of *Borealosuchus* highlights that freshwater habitats were not exclusively occupied by alligatoroids throughout the Cretaceous-Paleocene interval in Europe and that *Borealosuchus* was not restricted to North America. *Borealosuchus* is one of the few eusuchians the fossil record of which spans the K/T boundary. This genus might have dispersed from North America through high latitude routes during the Late Cretaceous or the Paleocene. The subsequent absence of *Borealosuchus* in Europe in the Eocene, compared with the abundance of other derived eusuchians (*Diplocynodon* and *Asiatosuchus*) in comparable ecosystems, is therefore interesting in the light of crocodylian faunal turnover.

Ginsburg, L. & Bulot, C. 1997. Les *Diplocynodon* (Reptilia, Crocodylia) de l'Orléanien (Miocène inférieur à moyen) de France. Geodiversitas, 19, 107-128.

Pereda Suberbiola, X., Murelaga, X., Astibia, H. & Badiola, A. 1999. Restos fósiles del cocodrilo *Diplocynodon* (Alligatoroidea) en el Mioceno inferior de las Bardenas reales de Navarra. Revista Española de Paleontología, 16, 223-242.

[poster] The Bulgarian dinosaur: did it exist? European late Cretaceous ornithomimosaurs

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For historical and geological reasons the dinosaurian fossil record from central Europe is little known. Here we describe and interpret a portion of a left humerus from the Upper Maastrichtian of Vratsa district in north-western Bulgaria. This bone is the first known record of a dinosaur from Bulgaria; it is certainly a theropod, probably an ornithomimosaur. We discuss the fossil record of other similar fossils of theropod dinosaurs, in particular other problematic remains from the Maastrichtian of Belgium. Rare Earth Element (REE) analysis combined with strontium (Sr) isotope data demonstrate that the Bulgarian dinosaur was initially fossilised in a terrestrial environment and then later re-worked into Late Maastrichtian marine sediments.

largely in the first one-third of the group's history. Despite the appearance of new clades of medium to large herbivores and carnivores later in dinosaur history, these new originations do not correspond to significant diversification shifts. Instead, the overall geometry of the Cretaceous part of the dinosaur tree does not depart from the null hypothesis of an equal rates model of lineage branching. Further, we conclude that dinosaurs did not experience a progressive decline at the end of the Cretaceous; nor was their evolution driven directly by the KTR.

Lightening up: a new approach to understanding integumentary remains in Mesozoic sauropsids

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Regrettably conflated with issues of phylogeny and avian flight origins, data concerning feather origins based on so-called "Chinese feathered dinosaurs" continue to be the focus of acrimonious debate. The only "scientific" basis for identifying putative protofeathers in such fossils is the Prum-Brush "evo-devo" model (Prum & Brush, 2002) that is grounded in a faulty interpretation of the literature. Various *ad hoc* statements in the "birds as dinosaurs" literature concerning the original role of protofeathers, i.e. insulation, signaling (anything but flight!), do not withstand critical analysis. Considering amniote integumentary evolution *in toto*, the major problem has been providing the organism with keratinized tissues that protect the vitally important barrier against insensible water loss. There is an obvious advantage to achieving this end using a minimum of energy resources. Based on considerations of skin morphology in living lepidosaurs, a strategy for the organization of the skin in several archosaurian lineages is proposed: independent evolution of tightly overlapping imbricate scales. That such would have had a highly organized dermis reinforces arguments that have been proposed for "protofeathers" and pterosaurian "hair" being remains of dermal collagen (Feduccia *et al*., 2005). The taphonomic constraints on preserving scale impressions will be discussed.

Prum, R.O. & Brush, A.H. 2002. The evolutionary origin and diversification of feathers. Quarterly Review of Biology, 77, 261-295.

Feduccia, A., Lingham-Soliar, T. & Hinchliffe, J.R. 2005. Do feathered dinosaurs exist? Testing the hypothesis on neontological and paleontological grounds. Journal of Morphology, 266, 125-166.

New material of the alleged oldest *Diplocynodon* from the Late Paleocene of northeastern France: revision and implications for crocodylian dispersal

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New eusuchian material from the Late Paleocene of Mont Berru near Reims, northeastern France, has recently been prepared. It consists of a complete skull

of the dentary during life. A comparison is made with the reconstructed dentary of *Kuehneotherium* to illustrate differences in both external morphology and internal structure.

The pattern of tooth replacement is of interest in such basal mammals, where diphyodonty is just being established (Mills, 1971; Parrington, 1971; Gill, 1974). High resolution scans of different growth stages can now illustrate the development of replacing teeth and the shedding and resorption of the anterior premolars.

Gill, P.G. 1974. Resorption of premolars in the early mammal *Kuehneotherium praecursoris*. Archives of Oral Biology, 19, 327-328

Kermack, D.M., Kermack, K.A. & Mussett, F., 1968. The Welsh pantothere, *Kuehneotherium praecursoris*. Zoological Journal of the Linnean Society, 47, 407-423

Kermack, K.A., Mussett, F. & Rigney, H. W. 1973. The lower jaw of *Morganucodon*. Zoological Journal of the Linnean Society, 53, 87-175

Mills, J.R.E. 1971. The dentition of *Morganucodon*. Early Mammals. Zoological Journal of the Linnean Society, 50, Suppl. 1, 29-63

Parrington, F.R. 1971. On the upper Triassic mammals. Philosophical Transactions of the Royal Society of London B, 261, 231-270.

The influence of character correlations on phylogenetic analyses: a test case in the carnivoran cranium

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Character independence is a major assumption in many phylogenetic analyses using morphological data, despite the understanding that there are often strong correlations among traits (Kluge, 1989; Kangas *et al*., 2004). While phylogenetic signals have been identified in patterns of morphological integration, there has been relatively little attention paid to how observed patterns of modularity may influence or at least complicate analyses of phylogenetic relationships. Here, we extend studies assessing modularity in mammalian cranium (Goswami, 2006) with simulations and empirical data to determine: 1) Do character correlations influence discrete character distributions over evolutionary time scales; 2) Do individual modules differ in the relationship between shape disparity and phylogenetic distance? 3) Do individual modules differ in the relationship between pattern of integration and phylogenetic distance? 51 3-D landmarks were digitized from 36 species of extant and fossil carnivorans for analysis of shape and morphological integration. To quantify shape disparity, partial Procrustes distance was calculated for each pair of species for each of the six cranial modules. Cranial base shape shows the strongest phylogenetic signal of the modules. Simulations show that correlated characters are closer in PCO space than uncorrelated characters, thus demonstrating that even low levels of integration can mislead phylogenetic analyses.

Kluge, A.G. 1989. A concern for evidence and a phylogenetic hypothesis of relationships among *Epicrates* (Boidae, Serpentes). Systematic Zoology, 38, 7-25.

Kangas, A.T., Evans, A.R., Thesleff, I. & Jernvall, J. 2004. Non-independence of mammalian dental characters. Nature, 432, 211-214.

Goswami, A. 2006. Cranial modularity shifts during mammalian evolution. American Naturalist, 168, 270-280.

Preservation of nitrogen and carbon isotopes in 50Ma fossil fish from the Green River Formation, Wyoming

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Animals fractionate nitrogen and organic carbon isotopes during food digestion and preferentially excrete the lighter isotopes. Consequently their body tissues become more enriched in δ^{15}N and $\delta^{13}C_{org}$ than their food. This simple relationship between consumer and food means that the trophic level of organisms in present day and Neogene vertebrate ecosystems can be distinguished on the basis of their isotopic signature (e.g. Mingawa & Wada, 1984; Pinnegar & Polunin, 1999; Ruiz-Cooley *et al.*, 2004). However, in this study nitrogen and carbon isotopic ratios are being used to investigate the community structure and palaeoenvironmental changes within a much older fossil ecosystem. Analyses of exceptionally-preserved bones and scales of fossil fish from the Eocene Green River Formation, Wyoming, USA indicate that isotopic signatures can be used to define the trophic structure of extinct communities. Organic geochemical analyses were carried out to discover the nature of the nitrogen and organic carbon from which the bulk isotope signals were derived. Additionally, laboratory-based taphonomy experiments were carried out to investigate potential alteration of the primary isotopic signatures. When organisms become fossilised, alteration occurs from the macroscopic to the nanoscopic level. Extant fish were used to gain a better understanding of how isotope ratios may vary after death and during early diagenesis.

Mingawa, M. & Wada, E. 1984. Stepwise enrichment of ^{15}N along food chains: Further evidence and the relation between □^{15}N and animal age. Geochimica et Cosmochimica Acta, 48, 1135-1140.

Pinnegar, J.K. & Polunin, N.V.C. 1999. Differential fractionation of δ^{13}C and δ^{15}N among fish tissues: implications for the study of trophic interactions. Functional Ecology, 13, 225-231.

Ruiz-Cooley, R.I., Gendron, D., Anguiniga, S., Mesnick, S. & Carriquiry, J.D. 2004. Trophic relationships between sperm whales and jumbo squid using stable isotopes of C and N. Marine Ecology Progress Series, 277, 275-283.

Eocene in age (~50 to 43 mya). The core of the material consists of fossils acquired through the Danish 'Danekræ' fossil treasure trove legislation. Almost two-thirds of the fossils are isolated skulls preserved three-dimensionally in clay ironstone concretions; bird fossils of this age and degree of preservation are extremely rare in an international context.

A preliminary investigation has revealed the presence of at least one odontopterygid, a member of the extinct 'pseudo-toothed birds' and the first representative of this group known from Denmark. Other taxa present include remains of Lithornithidae and a new taxon possessing a massive, psittacid-like beak.

The Lillebælt Clay Formation birds are temporally placed just after the Early Eocene Climate Optimum, a period of elevated temperatures resulting from rapid greenhouse warming. Comparison of the new bird fauna with the recently revised fauna from the older (54 mya) Fur Formation of Denmark, represents a unique opportunity to investigate the effect of the prehistoric greenhouse warming within a single zoological group in a clearly delimited biogeographic area.

Dinosaurs and the Cretaceous terrestrial revolution

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The observed diversity of dinosaurs reached its highest peak during the mid and late Cretaceous, the 50 million years (myr) that preceded their extinction, and yet this explosion of dinosaur diversity may be explained largely by sampling bias. It had long been debated whether dinosaurs were part of the Cretaceous Terrestrial Revolution (KTR), from 125-80 myr ago (Ma), when flowering plants, herbivorous and social insects, squamates, birds, and mammals all underwent a rapid expansion. Although an apparent explosion of dinosaur diversity occurred in the mid Cretaceous, coinciding with the emergence of new groups (e.g. neoceratopsians, ankylosaurid ankylosaurs, hadrosaurids, and pachycephalosaurs), results from the first quantitative study of diversification applied to a new supertree of dinosaurs show that this apparent burst in dinosaurian diversity in the last 18 myr of the Cretaceous is a sampling artefact. Indeed, major diversification shifts occurred

The osteology of *Leedsichthys* (Pachycormiformes): growth, resorption and fragmentation of a problematic Jurassic giant

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Paradoxically, the osteology of what is reputed to be the largest bony fish ever, *Leedsichthys problematicus*, remains virtually unknown (Liston, 2004), nearly 120 years after it was first described by Arthur Smith Woodward (Smith Woodward, 1889). The main reason for the material being difficult to identify is that the animal grew with only limited ossification throughout most of its skeleton. As a result of this, a comparatively limited number of bones appear to be preserved, and those that have are invariably badly crushed and fragmentary. All this makes handling - never mind identification - difficult. Less than ten years after his first tentative description of a variety of bony remains, Arthur Smith Woodward retracted all his osteological identifications save for gill rakers and lepidotrichia (Leeds & Smith Woodward, 1897). Although circumstantial evidence exists to suggest that he worked further on remains found the following year by the original discoverer of the fish, Alfred Nicholson Leeds (Liston & Noè, 2004), no accounts resulting from this work were ever published.

Work was carried out in the Hunterian Museum, University of Glasgow, Scotland (home of the most complete specimen of Leedsichthys ever excavated, known as 'Big Meg'), to review the hypodigm of material there, and conduct repairs in an attempt to make the surviving elements as complete as possible for identification. Estimates of size and calculations of age were made, in order to establish possible growth rates.

Leeds, A. & Smith Woodward, A. 1897. Report on a field-trip to Peterborough. Proceedings of the Geological Association, 15, 190-192.

Liston, J. 2004. An overview of the pachycormiform *Leedsichthys*. In: G. Arratia & A. Tintori (Eds.), Mesozoic Fishes 3 - Systematics, Paleoenvironments and Biodiversity. Verlag Dr. Friedrich Pfeil, München, 379-390.

Liston, J. & Noè, L. 2004. The tail of the Jurassic fish *Leedsichthys problematicus* (Osteichthyes: Actinopterygii) collected by Alfred Nicholson Leeds - an example of the importance of historical records in palaeontology. Archives of Natural History, 31, 236-252.

Smith Woodward, A. 1889. Preliminary notes on some new and little-known British Jurassic fishes. Geological Magazine, 6, 448-455.

A new avian fauna from the early-middle Eocene Lillebælt Clay Formation of Denmark

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A number of hitherto undescribed fossil bird remains have been recovered from the Lillebælt Clay Formation of central Denmark, which is early-middle

Prey selection by theropods and the rarity of juvenile dinosaurs.

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Traditionally the rarity of juvenile dinosaurs in the fossil record has been attributed to taphonomic bias against their small and incompletely ossified bones. However, an alternative or accessory explanation that fits the known evidence of carnivorous behaviour in theropods is the preferential consumption and subsequent digestion of juveniles. Populations of extant organisms are typically structured with large numbers of juveniles and adults, but few individuals of intermediate ages as the juvenile taxa are preferentially targeted by predators, and so rarely reach sub-adulthood. Experimental and observation data show that almost all extant predators preferentially select naive and vulnerable juvenile prey. Like modern carnivores, theropods would therefore be expected to have preferentially hunted and ate juvenile animals leading to the absence of small, and especially young, dinosaurs in the fossil record. In addition, supporting evidence comes from coprolites and stomach contents of theropods which include bones attributed to juvenile prey. Furthermore, a review of the known incidences and possible ecological implications of theropod bone use, concludes that there is currently no definitive evidence supporting the regular deliberate ingestion of bone by these animals. Few examples of bone exploitation by carnivorous theropod dinosaurs are known, and this represents an apparent waste of both mineral and energetic resources that are regularly exploited by many extant amniote predators. Theropods did not need to exploit the bones of adult dinosaurs for minerals as the whole of the juvenile prey would be consumed, and the inferred strong digestion of theropods would have dissolved the juvenile bones and thus rarely left stomach contents to be preserved. The traditional view of large theropods hunting the adults of large or giant dinosaur species is therefore considered to have been a rare occurrence.

Functional interpretation of spinosaurid quadrates (Dinosauria: Theropoda) from the Mid-Cretaceous of Morocco

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The Kem-Kem region of Southeastern Morocco has supplied a large number of vertebrate fossils of Lower Cenomanian age which include a great diversity of carnivorous dinosaur taxa (Sereno *et al.*, 1996). At least six families of theropod dinosaurs have been found including the Spinosauridae represented by the genus

Spinosaurus (Russel, 1996; Dal Sasso *et al.*, 2005). Five quadrates come from this deposit and are determined to be from juvenile and adult spinosaurids. Their morphology indicates two morphotypes which may be associated with two different species of Spinosauridae.

Morphofunctional analysis of quadrate bones and their mandibular condyles has revealed that the mechanics of the lower jaw of spinosaurids was particular. The posterior parts of the mandible displaced laterally when the jaw moved downwards thanks to a helicoidal shape of the mandibular articulation of the quadrate. The spinosaurids *Spinosaurus* (Buffetaut & Ouaja, 2002) and *Baryonyx* (Charig & Milner, 1997) had a weak and short mandibular symphysis retaining some mobility between the two jaw rami. When the jaw opened, the rami moved laterally allowing the mouth and the pharynx to be widened. This jaw mechanic is present in some ornithocheiroid pterosaurs (Wellnhofer, 1980; Bennet, 2001) and living pelecanid birds which are both adapted to fish and to swallow big fishes (Bennett, 2001). Spinosaurids which were engaged in at least a partially piscivorous lifestyle (Charig & Milner, 1997; Buffetaut *et al.*, 2004) were able to consume large fish such as coelacanths and may have fed occasionally other prey such as pterosaurs and juvenile sauropods.

Bennett, S.C. 2001. The osteology and functional morphology of the late cretaceous pterosaur Pteranodon. Palaeontographica Abteilung A, 260, 1-153.

Buffetaut, E. & Ouaja, M. 2002. A new specimen of Spinosaurus (Dinosauria, Theropoda) from the Lower Cretaceous of Tunisia, with remarks on the evolutionary history of the Spinosauridae. Bulletin de la Société Geologique de France, 173, 415-421.

Buffetaut, E., Martill, D. & Escuillie, F. 2004. Pterosaurs as part a spinosaur diet. Nature, 430, 33.

Charig, A.J. & Milner A.C. 1997. Baryonyx walkeri, a fish-eating dinosaur from the Wealden of Surrey. Bulletin of the Natural History Museum of London, 53, 11-70.

Dal Sasso, C., Maganuco, S., Buffetaut, E. & Mendez, M.A. 2005. New information on the skull of the enigmatic theropod *Spinosaurus*, with remarks on its size and affinities. Journal of Vertebrate Paleontology, 25, 888-896.

Russell, D. A. 1996. Isolated dinosaur bones from the Middle Cretaceous of the Tafilalt, Morocco. Bulletin du Muséum national d'Histoire naturelle (4e série) 18, 349-402.

Sereno, P.C., Dutheil, D.B., Iarochene, M., Larsson, H.C.E., Lyon, G.H., Magwene, P.M., Sidor, C.A., Varricchio, D.J. & Wilson, J.A. 1996. Predatory dinosaurs from the Sahara and Late Cretaceous faunal differentiation. Science, 272, 986-91.

Specialization in the head of a Miocene beaked whale (Odontoceti: Ziphiidae)

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Extant ziphiids are described (Nowak, 2003) as marine, 3.3-12.8 m long cetaceans that may dive to great depths (+/- 1000 m), some remaining submerged for over an hour; they are suction feeders that take mainly cephalopods, and fish. Similarities with sperm whales (Physeteridae) were noted by whalers and comparative anatomists, such as Flower (1898) who remarked that after sperm whaling became unremunerative, sperm oil "has found a rival, possessing all the qualities

Pliocene boundary. Nature, 389, 153-158.

Leakey M.G., Feibel C.S., Bernor R.L. *et al.* 1996. Lothagam: a record of faunal change in the Late Miocene of East Africa. Journal of Vertebrate Paleontology, 16, 556-570.

Lebatard A-E., Bourlés D.L., Duringer P. *et al.* 2008. Cosmogenic nuclide dating of *Sahelanthropus tchadensis* and *Australopithecus bahrelghazali*: Mio-Pliocene hominids from Chad. Proceedings of the National Academy of Sciences USA, 105, 3226-3231.Vignaud P., Duringer P., Mackaye H.T. *et al.* 2002. Geology and palaeontology of the Upper Miocene Toros-Menalla hominid locality, Chad. Nature, 418, 152-155.

[poster] **A uniquely complete specimen of the fossil shark *Wodnika* from the Late Permian Marl slates of Durham, England**

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Wodnika has being known and collected since the 1830's from Britain and Germany but this is the only complete specimen ever found. The Marl slates were deposited on the western margin of the Zechstein Sea and contain a varied fish fauna dominated by *Palaeoniscus freieslebeni*, but *Wodnika* is one of the rarest genera in the fauna. This specimen (in conterpart) shows the complete body outline and new details of the fin shapes, parts of the dentition, better details of the whorl in the nasal area and the internal cartilage skeleton.

Wodnika is known from English localities by pieces of scales, teeth and a few fin spines and from similar age deposits in Germany (the eastern end of the Zechstein Sea) also from incomplete specimens. Schaumberg (1999) gave detailed descriptions based on the pieces in German collections and attempted a reconstruction. *Wodnika* has been assigned to Hybodontoidea by Zangerl (1981) and to Sphenacanthidae by Maisey (1982).

This new specimen will allow accurate identification of partial specimens and determine if the specimens from Britain are the same species as those from Germany. We also hope it will help to clarify the phylogenetic relationship of *Wodnika,* unclear at present because of the fragmentary nature of previous specimens.

Maisey, J.G. 1982. Studies on the Paleozoic Selachian Genus *Ctenacanthus* Agassiz: No. 2. *Bythiacanthus* St. John and Worthen, *Amelacanthus*, new genus, *Eunemacanthus* St. John and Worthen, *Sphenacanthus* Agassiz, and *Wodnika* Münster. American Museum Novitates, 2722, 1-24.

Schaumberg, G. 1999. Ergänzungen zur Revision des Euselachiers *Wodnika striatula* Münster 1843 aus dem oberpermischen Kupferschiefer und Marl-Slate. Geologica et Palaeontologica, 33, 203-217

Zangerl, R. 1981. Chondrichthyes 1, Paleozoic Elasmobranchii. In: H.P. Schultze (Ed.), Handbook of Paleoichthyology, 3A: 1-115.

The locality is also of particular interest due to the associated or partially articulated skeletons of nothosaurs and pachypleurosaurs. Most of the classical Muschelkalk bonebeds of central Europe of Anisian and Ladinian age, are younger than Winterswijk, and had yielded mainly only isolated bones of sauropterygians. Thus studying pachypleurosaurs and nothosaurs from Winterswijk will result in new and important insights into the phylogeny and evolution of these sauropterygians.

The mammal assemblages of the hominid fossiliferous area of Toros-Menalla (Late Miocene, Chad Basin): ecological structure and palaeoenvironmental implications

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Characterising the palaeoenvironmental context of the earliest hominids is a key issue for understanding their behavioural and morphological evolution, especially since the recent discoveries of Late Miocene hominids in Africa. The earliest known hominid, *Sahelanthropus tchadensis* (Brunet *et al.* 2002, 2005), was discovered in the Anthracotheriid Unit (AU) of the Toros-Menalla area (northern Chad) in association with a rich vertebrate fauna. It was biochronologically and isotopically dated to 7 Ma (Vignaud *et al.* 2002; Lebatard *et al.* 2008). The characterization of this fossil assemblage is crucial because it is the only Late Miocene faunal record from Central Africa. Moreover, it documents an important period of global climatic change (Cerling *et al.* 1997), associated with the opening of landscapes and the setting up of modern East African ecosystems (Leakey *et al.* 1996).

Here we provide a quantitative assessment of the structure of the Toros-Menalla mammal assemblages from the AU in order to investigate their palaeoenvironmental significance. First we analyse the relative abundances of taxa and their habitat preferences. The resulting taxonomic structure is used to reconstruct the diversity and the relative extent of the habitats represented. Second, the distribution of taxa within three meaningful ecovariables (locomotion, feeding preferences and body mass) is confronted to the ecological structure of modern African environments.

Brunet M., Guy, F., Pilbeam, D., Lieberman, D.E., Likius, A., Mackaye, H.T., Ponce de León, M.S., Zollikofer, C.P.E. & Vignaud, P. 2005. New material of the earliest hominid from the Upper Miocene of Chad. Nature, 434, 752-755.

Brunet M., Guy F., Pilbeam D., Mackaye H.T *et al.* 2002. A new hominid from the Upper Miocene of Chad, Central Africa. Nature, 418, 145-151.

Cerling T.E., Harris J.M., MacFadden B.J. *et al.* 1997. Global vegetation change through the Miocene/

[...], in the oil of an allied [...] species of whale, the bottlenose (*Hyperoodon*)". The physiological and morphological similarities, often regarded to indicate relationship, may reflect evolutionary convergence. Ziphiids may be descended from platanistoids, with physeterids being more stemwards (e.g. Hamilton *et al.*, 2001). A similar interpretation seems implied by Lambert (2005). Extant beaked whales are particularly vulnerable to high-intensity anthropogenic sound from sonar and airguns (Hildebrand, 2005). Experimentation in the sense organs noted for the Eocene cetaceans (Thewissen & Bajpai, 2007) continued to some extent within Odontoceti, with physeterids and, possibly later, ziphiids exploring anatomic potentialities for deep marine hunting. A ziphiid fossil from the late Miocene Gram Formation, Denmark, is analysed for features of specific adaptation. The lower jaw is, anteriorly, remarkably robust in the long, narrow, toothed lower beak, and is, posteriorly, remarkably thin-walled in the spacious, right and left receptacles probably for sound conduction. The less well-preserved upper part of the cranium, the facial and rostral bones, exhibit structures that through comparative analysis permit some interpretation of the whale's ecological preferences.

Flower, W.H., 1898. Whales, and British and Colonial whale fisheries. In: W.H. Flower, Essays on Museums and Other Subjects Connected with Natural History. MacMillan and Co., London, 185-208.

Hamilton, H., Caballero, S., Collins, A.G. & Brownell Jr, R.L., 2001. Evolution of river dolphins. Proceedings of The Royal Society of London B, 268, 549-556.

Hildebrand, J., 2005. Impacts of anthropogenic sound. In: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery & T.J. Ragen (Eds.), Marine Mammal Research : Conservation beyond Crisis. The Johns Hopkins University Press, Baltimore, 101-123.

Lambert, O., 2005. Systematics and phylogeny of the fossil beaked whales *Ziphirostrum* du Bus, 1868 and *Choneziphius* Duvernoy, 1851 (Mammalia, Cetacea, Odontoceti), from the Neogene of Antwerp (North of Belgium). Geodiversitas, 27, 443-497.

Nowak, R.M., 2003. Walker's Marine Mammals of the World. The Johns Hopkins University Press.

Thewissen, J.G.M. & Bajpai, S., 2007. Evolution of the sensory landscape in Eocene cetaceans. Abstract. Journal of Vertebrate Paleontology, 27, supplement to no 3, 157A.

Dawn horses and the North American connection

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There is a particularly dense stratigraphic record of primitive equoids (dawn horses) in the North American Early Eocene (Gingerich, 1991). The same does not hold true for Europe, where remains are usually either rare or fragmentary (Hooker, 1994). Europe is also where the endemic equoid family Palaeotheriidae evolved. The shortcoming of the European record has been partially rectified by long-term collecting at one Early Eocene site, that of Abbey Wood, UK. Here, a substantial assemblage belonging to the genus *Pliolophus* has been accumulated. In addition, the first upper dentition since the 19th century of the type species of *Hyracotherium*, *H. leporinum* Owen, 1841, has recently been found in the London

Clay near the type locality of Studd Hill, Herne Bay, Kent. These new finds begin to address the tangled taxonomic and palaeobiogeographic problems that surround North American and European dawn horses, which are largely due to extensive intraspecific variation. Coding the variable characters for cladistic analysis is not straightforward, particularly when including small as well as large assemblages. Nevertheless, the weight of evidence favours independent evolution in the two continents, following a single phase of dispersal from Europe to North America at the beginning of the Eocene.

Owen, R. 1841. Description of the fossil remains of a mammal (*Hyracotherium leporinum*) and of a bird (*Lithornis vulturinus*) from the London Clay. Transactions of the Geological Society of London, 6, 203-208.

Gingerich, P.D. 1991. Systematics and evolution of early Eocene Perissodactyla (Mammalia) in the Clarks Fork Basin, Wyoming. Contributions from the Museum of Paleontology, University of Michigan, 28, 181-213.

Hooker, J.J. 1994. The beginning of the equoid radiation. Zoological Journal of the Linnean Society, 112, 29-63.

[poster] X-ray microtomographic investigation of the quantitative increase in body mass engendered by pachyostosis within squamates

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Many tetrapods that are secondarily adapted to an aquatic life display pachyostosis. This osseous specialization, corresponding to an increase in bone volume, is considered to play the role of ballast for hydrostatic regulation of the body trim in shallow-water swimmers. The aim of this study was to quantify the increase in bone volume engendered and, considering not significant bone density variation within squamates, to evaluate the resulting increase in body mass. In order to do so, bone volume of vertebrae of two Cretaceous pachyostotic varanoid lizards - *Carentonosaurus* and a new genus that is being described - has been compared to the one of vertebrae of extant semi-aquatic, arboreal and terrestrial species of *Amblyrhynchus*, *Brookesia*, *Calumma*, *Furcifer*, *Mabuya*, *Varanus*, *Tribolonotus*, and *Tupinambis*. These volumetric data have been acquired by means of both conventional and synchrotron microtomography, imaging techniques allowing to non-destructively reconstruct the three-dimensional outer and inner structures of the samples. This study revealed an extraordinary high vertebral compactness in the pachyostotic taxa - suggesting important functional and physiological consequences - as well as some interesting patterns within extant squamates.

[poster] The Moroccan fossil fish assemblages: phyogenetic, paleoecologic and paleobiogeographic implications

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Numerous fossil fish sites are known in Morocco, dated from the Cretaceous and Eocene. The Tafilalet Basin is composed of a Cenomanian basis, the Kem Kem Beds and a Turonian level, Goulmima. The Jbel Tselfat, situated near the city of Meknes, is dated to the Cenomanian. The Ouled Abdoun Basin belongs to the Plateau of Phosphate and extends from the Maastrichtian to the Ypresian. The study of the ichthyofaunae, with the description of new material, allows us to reconstitute the paleo-environment. Presently, the Jbel Tselfat, Goulmima and the Ouled Abdoun are considered marine environments, and the Kem Kem Beds as a freshwater continental environment. Another opportunity of this biological study is the comparison between the faunae of the Moroccan sites with contemporary localities, such as Lebanon (Hakel, Hadjoula), Portugal, and Slovenia. The paleobiogeographical analysis comparison allows to establish the relationships between the biogeographical areas. Preliminary results based on the method of Cladistic Area shows a cluster which regroups the localities of the Middle East, Slovenia, England and Morocco. This cluster is clearly distinguished from a group composed by areas as Brazil, China, Equatorial Guinea and Congo.

Winterswijk (The Netherlands), an exceptional early Anisian locality in the Germanic Muschelkalk

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The locality of Winterswijk provides an unique situation, where especially well preserved body fossils of marine reptiles and terrestrial vertebrate tracks and track-ways, from the Lower Muschelkalk (early Anisian) were preserved in one facies. The quarry exposes a 40 m thick section of mud-cracked laminated carbonate mudstones interpreted as tidal flat facies dominated by algeal laminates. The deposits are covered by an extensive network of polygonal structures on the bedding planes, representing mudcrack polygons, indicating periodical drying of the surface. The highly unusual taphonomy may be explained by wind tides bringing in carcasses of marine reptiles, which then were scavenged upon after the tide went out by terrestrial reptiles that had specialized on this resource.

lifestyle. We conclude that the extreme specialization of the pinniped postcranial skeleton for swimming has placed increased importance on the cranium for feeding and reproductive specializations, resulting in a wide range of cranial morphology.

The endocranial cavity of a nonmammalian eucynodont and its bearing on the origin of the mammalian brain

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Combination of complete preparation and CT scanning of a skull of the chiniquodontid eucynodont has revealed as much of the size and general morphology of the brain as is likely to be possible in cynodonts. The resulting reconstruction is partly speculative because of the failure of much of the brain, notably the sides and base of the cerebral hemispheres, to be impressed on bony surfaces. Features that can be reasonably well inferred include a relatively large olfactory bulb, very narrow cerebral hemispheres, and a well-developed, mammalian-sized cerebellum.

There is an anomaly in that the brain of the eucynodonts was very unlike that of mammals, whilst much of the rest of the anatomy points to a mammal-like biology, with fine neuromuscular control and at least partially endothermic physiology. On the basis of this evidence, the novel view is proposed that the mammalian brain evolved in two separate stages. The first consisted of elaboration of the cerebellum in association with increasingly precise proprioception and neuromuscular control, and is found in the cynodonts. The second consisted of the expansion of the cerebral cortex, leading to the characteristic mammalian neocortex, in association with elaboration of the olfactory and auditory sensory input. The latter coincided with the entry of the ancestral mammal into its small-bodied, insectivorous, nocturnal habitat.

Of the two conflicting current accounts of the origin of the mammalian brain, this conclusion supports the 'outgroup' hypothesis that the dorso-ventral ridge (DVR) of the cerebral hemispheres of living sauropsids is not the homologue of the mammalian neocortex, rather than the 'recapitulation' hypothesis, which posits that it is.

Too many theropods? the diversity of predatory dinosaurs in the mid-Cretaceous of Morocco

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Six families of theropod dinosaurs, including two of the largest known predatory dinosaurs, *Spinosaurus* (Dal Sasso *et al.*, 2005) and *Carcharodontosaurus,* have been found in the ?early Late Cretaceous Kem Kem beds (e.g. Sereno *et al.*, 1996; Russell, 1996). By contrast, sauropods are represented by just two families and ornithopods are so far unknown, except for possible footprints. This unexpected distribution is also, supposedly, reflected in relative abundances of fossil remains. Complex niche partitioning, widespread piscivory, taphonomic bias, sampling bias and taxonomic inflation have all been suggested as explanations for the over-representation of predators. A project on the vertebrate assemblages of the Kem Kem beds aims to resolve this problem through taxonomic reassessment and both qualitative and quantitative taphonomic analyses based on museum collections and field studies. Preliminary results suggest that the super-abundance of theropods is only minimally influenced by taxonomic oversplitting and that they appear to have been a dominant component of the Kem Kem faunas.

Dal Sasso, C., Maganuco, S., Buffetaut, E. & Mendez, M.A. 2005. New information on the skull of the enigmatic theropod *Spinosaurus*, with remarks on its size and affinities. Journal of Vertebrate Paleontology, 25, 888-896

Russell, D. 1996. Isolated dinosaur bones from the middle Cretaceous of the Tafilalt, Morocco. Bulletin du Museum National d'Histoire Naturelle, 4th series, 18 section C, nos. 2-3, 349-402.

Sereno, P.C., Dutheil, D.B., Iarochene, M., Larsson, H.C.E., Lyon, G.H., Magwene, P.M., Sidor, C.A., Varricchio, D.J. & Wilson, J.A. 1996. Predatory dinosaurs from the Sahara and Late Cretaceous faunal differentiation. Science, 272, 986-91.

Vertebrate fossils from Morocco: our state of knowledge

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Since the first finds of vertebrate fossils in Morocco at the beginning of the last century, palaeontological discoveries have succeeded one another and a succession of vertebrate-bearing horizons dated from Devonian to present has been reported.

Vertebrate fossils from Morocco are of considerable importance in terms of palaeobiogeography and large-scale evolutionary studies. They can illustrate most of vertebrate history, from the Devonian "fishes" (Emsian-Famennian of Tafilalet and Erfoud regions: placoderms, actnistiens, actinopterygian, and eusteolepiform and onychodontiform sarcopterygians) to the prolific Mio-Plio-Pleistocene sequences of the Atlantic coast, which cover the last 6 millions years of vertebrate's history. They document badly known periods of vertebrate evolution and constitute real windows on the faunal succession on the North African margin of Gondwana : the oldest known North African terrestrial vertebrates (Khenifra and Argana basins, Permian); the recent discoveries on Early Jurassic (Ouarzazate province) that shed new lights on the evolution and early diversification of dinosaurs; the oldest known gondwanian mesozoic mammals (Anoual region, Berriasian); the abundant vertebrates from Kem Kem beds (Cenomanian) which constitute an important potential to understand vertebrate palaeoecology and paleobiogeography in the Late Cretaceous; the oldest known modern mammals and birds from Africa (Paleocene of Oulad Abdoun and Ouarzazate basins); and the phosphatic deposits (Oulad abdoun basin) especially famous for their well preserved and diversified vertebrate fauna which provide a good reference for understanding vertebrates evolution from Maastrichtian to the Ypresian (K/T and P/E biotic crisis, the initial radiation of Paleocene mammals and the palaeobiogeography of the southern Tethysian margin and the arabo-african platform).

An overview of these palaeofaunas is given with a particular references to the Permian and Triassic vertebrates from the Argana basin, with their palaeobiographic implications.

Considering this wealth of palaeontological data, one could expect that Morocco possesses important Museums and the most complete collections on vertebrate fossils. In fact, a large number of scientific publications held on specimens obtained from open market rather than on specimens collected throughout scientific fieldwork. Vertebrate fossils are commercially attractive and raise much private demand. Commercial dealers argue that they help peasants who make a living from selling fossils. In fact, they take advantage of them and sell fossils to the highest bidder contributing to the impoverishment of whole regions of geologic heritage. Scientists who often share the responsibility for public ignorance of fossils should provide more information to the public. They should also develop long-term scientific projects and thereby, help in preserving this priceless heritage.

***Palaeospondylus*, a jawless vertebrate from the Devonian of Scotland**

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Recent suggestions that the enigmatic Devonian vertebrate *Palaeospondylus* represented the larvae of the Devonian lungfish *Dipterus* have been repudiated by comparisons to extant larval lungfish and the discovery of *Dipterus* specimens within the size range of *Palaeospondylus*. New information provides evidence for affinity with the jawless vertebrates. For example, histological sections show that all *Palaeospondylus* elements are composed of a mineralized cartilage most similar to that recently described in *Euphanerops*, principally in the preservation of large chondrocyte cells. Also, as with *Euphanerops*, there is no prismatic cartilage preserved, making an affinity with the chondrichthyans most unlikely. Reinterpretation of the chondrocranium suggests that the posterior region is particularly informative: the first few anterior rounded vertebrae differ substantially from the more posterior, and are interpreted as unfused occipital segments. The 'cranial ribs', extending along either side of these occipital segments, are reinterpreted as elongated parachordals. This results in an elongated occipital region posterior to the otic capsules, a characteristic also seen in osteostracans such as *Norselaspis*. However, the occiput is fused in *Norselaspis*, and the lack of fusion of the occipital region in *Palaeospondylus* is more similar to the condition in Heterostraci.

Morphometric analysis of cranial morphology in pinnipeds (Mammalia, Carnivora): disparity, dimorphism, ecology and ontogeny

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Pinnipeds (seals, sea lions and walruses) are fully aquatic carnivorans (Mammalia, Carnivora) that show a wide range of feeding and reproductive strategies and have a global distribution. This study examined pinniped cranial morphology and the factors that have influenced their evolution. 3D morphometric data from 138 specimens (20 genera) were collected using a digitizer and analysed with Procrustes analysis and Principal Components Analysis. Ecological correlates of shape, ontogeny and dimorphism were examined. Data from previous studies of terrestrial carnivorans were also included for comparison.

The three pinniped families occupy distinct areas of morphospace, despite significant ecological overlap. While most species within Phocidae (seals) and Otariidae (sea lions) cluster near the mean shape for their respective family, a few species in both families converge onto Odobenidae (walrus) space. These convergences can be separated into feeding (*Erignathus*, *Hydrurga*) and reproduction-related (*Cystophora*, *Mirounga*, *Otaria*) adaptations, demonstrating that different selection pressures can produce similar morphologies. Interestingly, taxa that converge onto Odobenidae space also display longer ontogenetic trajectories. The young for these taxa cluster near the mean shape for their respective families, showing that the cranial convergences develop primarily during the juvenile growth period. Dimorphism is apparent in some of these convergent species, and those (*Cystophora*, *Otaria*) showing the most extreme cranial shape dimorphism display less body size dimorphism, possibly due to larger female body size in polar waters. Pinniped cranial disparity is comparable to that of terrestrial carnivorans, despite representing far fewer species. This remarkable discordance between taxonomic and morphological diversity indicates that pinnipeds have undergone strong selective pressures on cranial morphology, probably due to adaptations to a marine