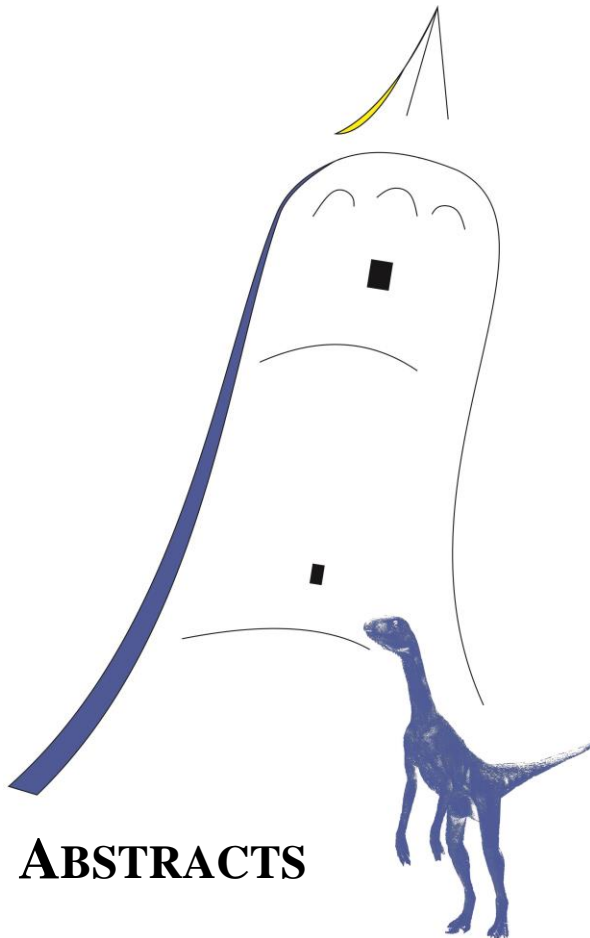


EUROPEAN ASSOCIATION OF VERTEBRATE PALAEOONTOLOGISTS



XIII ANNUAL MEETING
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Logo – Silhouette of *Silesaurus opolensis*, a genus and species of dinosauromorph from the Upper Triassic of southwest Poland. Remains of *Silesaurus* have been recovered from the ‘Keuper’ claystone at Krasiejów near Opole (Silesia, Poland), from which it takes its name. The building next to *Silesaurus* is a stylised contour of the Piast Tower, a remnant of Piast Castle, one of the oldest structures of defensive architecture in Poland. It plays a key role as symbol of the city of Opole and of Opole Voivodeship (project: Roman B. Konietzko).

Front cover – In the foreground are silhouettes of *Silesaurus opolensis*, while the background presents a view of the inside of the pavilion at Krasiejów Jurapark, with an exhibit of *in-situ* Late Triassic vertebrate remains, mostly metoposauroids. Visible through the glass wall is a portion of the quarry. The pavilion belongs to Opole University (project: Roman B. Konietzko and Dorota Konietzko-Meier; photograph by R.B. Konietzko).

Back cover – **Top:** Piast Tower - a remnant of Piast Castle, one of the oldest structures of defensive architecture in Poland. Next to the tower, the main office building of Opole Voivodeship, built between 1930 and 1934 at the former site of Piast Castle, and designed by Friedrich Lehman as seat of the local government. Inside there is a unique lift, ‘pater noster’, installed in 1932; it moves continuously - you enter and exit on the move (photograph by S. Mitrus). **Bottom:** view of the Old Town, along the street named Św. Wojciecha; in the background is the tower of the oldest church in the city, built in the tenth century, in gothic style (photograph by R. Wielki).

Book design by Dorota Konietzko-Meier.

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TABLE OF CONTENTS

Zofia Kielan-Jaworowska – an appreciation Magdalena Borsuk-Białynicka	19
---	----

ORAL PRESENTATIONS

PALEOHISTOLOGY

First insights into the bone microstructure of <i>Deinocheirus mirificus</i> Martin Kundrát and Yuong-Nam Lee	25
---	----

Histological analysis of postcranial skeletal pneumaticity in sauropods Filippo Bertozzo and P. Martin Sander	26
---	----

Histology of sauropod long bones from the Howe-Stephens Quarry (Morrison Formation, Wyoming): testing hypotheses of skeletal unity Kayleigh Wiersma and P. Martin Sander	27
--	----

Mandible histology in <i>Metoposaurus diagnosticus krasiejowensis</i> (Amphibia, Temnospondyli) from the Upper Triassic of Poland – preliminary results Kamil Gruntmejer	28
--	----

The role of metabolic rate in the evolutionary size increase of <i>Dimetrodon</i> (Sphenacodontidae) Philipp L. Knaus, Anneke H. van Heteren, Christen D. Shelton and P. Martin Sander	29
--	----

Growth and development in Pleistocene dwarfed Proboscidea Anneke H. van Heteren	
---	--

New data on cervid histology – life history and allometry Eli Amson, Torsten M. Scheyer, Christian Kolb and Marcelo R. Sánchez-Villagra	30
---	----

Modifications in molar enamel microstructure with increasing hypsodonty in Theridomyidae (Rodentia) across the ‘Grande Coupure’ Thomas Engler and Thomas Martin	31
---	----

MAMMALS

Schultz's Rule in mammals: the influence of life history on dental eruption Robert J. Asher	32
---	----

Mammal-like teeth from the Upper Triassic of Poland Marlena Świło, Grzegorz Niedźwiedzki and Tomasz Sulej	33
---	----

Comparative anatomy and systematics of Cretaceous mammal tracks of Angola Marco Marzola, Octávio Mateus, Anne S. Schulp, Louis L. Jacobs, Michael J. Polcyn, Vladimir Pervov, António Olímpio Gonçalves and Maria Luisa Morais	34
--	----

Evolution of <i>Gomphos</i> (Mammalia, Glires) in the Eocene of the Erlian Basin, Nei Mongol (China) Łucja Fostowicz-Frelik	35
---	----

Neogene mammals from northern South America (Venezuela and Colombia): implications for diversity patterns and faunal evolution in the Neotropics Juan D. Carrillo, Carlos Jaramillo and Marcelo R. Sánchez-Villagra	36
---	----

Osteology of <i>Zygodon turicensis</i> (Mammalia, Proboscidea) Jakub Březina and Martin Ivanov	37
--	----

New data on the three-tined deer (<i>Artiodactyla</i>, <i>Mammalia</i>) from the uppermost Miocene of Venta del Moro, Spain	38
Amparo Violero, Luca Bellucci, Daniel DeMiguel, Beatriz Azanza and Plinio Montoya	
Native presence of giraffes in central Europe revealed	39
Gertrud E. Rössner, Ursula B. Göhlich and Alan W. Gentry	
SPECIAL SESSION: TETRAPOD TRACKWAY DATA: ACQUISITION, STORAGE, PROCESSING AND INTERPRETATION	
Developing an ichnological data base: testing examples in EasyDB	40
Matteo Belvedere and Heinrich Mallison	
Developing an ichnological data base: theoretical considerations of user roles, demands and benefits	41
Heinrich Mallison and Matteo Belvedere	
Study of trackways as hierarchical structures and why details matter in comparative approaches	42
Michael Buchwitz and Sebastian Voigt	
<i>Paradoxichnium problematicum</i> Müller, 1959 – a principal morph of Late Permian tetrapod tracks and its palaeoecological significance	43
Sebastian Voigt, Hendrik Klein, Massimo Bernardi, Evelyn Kustatscher, Jörg W. Schneider, Hafid Saber, Lorenzo Marchetti, Paolo Mietto, Frank Scholze and Volker Faath	
Triassic archosaur footprints from Switzerland – ichnotaxonomy and biostratigraphic implications	44
Hendrik Klein, Mike Wizevich and Christian A. Meyer	
Processing and analysis with ‘Cadence Toolset’ of Late Jurassic dinosaur track data systematically acquired during ten years of excavations prior to construction of Highway A16, NW Switzerland	45
Daniel Marty, Kent A. Stevens, Scott Ernst, Géraldine Paratte, Christel Lovis, Marielle Cattin, Wolfgang A. Hug and Christian A. Meyer	
Can we discriminate between theropod and ornithopod dinosaur trackways based on footprint shape variation patterns? A geometric morphometrics approach	46
Jens Nikolaus Lallensack	
SPECIAL SESSION: PALAEOECOLOGY AND EVOLUTION OF AQUATIC REPTILES	
The evolution of crushing dentition and tooth replacement strategies in Placodontiformes (<i>Sauropterygia</i>)	47
James M. Neenan	
Microanatomy, bone histology and growth of <i>Nothosauria</i>	48
Nicole Klein, Alex Houssaye and Eva Maria Griebeler	
Ontogenetic tooth reduction and niche shifts in <i>Stenopterygius quadriscissus</i>	49
Daniel Dick	
Palaeobiogeography of Late Jurassic ichthyosaurs; a genus-level approach	50
Judith Pardo-Pérez, Nikolay Gennadievich Zverkov, Maxim Savvich Arkhangelsky and Mikhail Alekseevich Rogov	

Marine vertebrates, environment and stratigraphy of the Albian phosphorite horizon at Annopol, Poland	51
Marcin Machalski, Danuta Olszewska-Nejbert and Zofia Dubicka	
Niche differentiation in mosasaurs from the type Maastrichtian (the Netherlands/Belgium), as demonstrated by dental microwear	52
Femke M. Holwerda, Anne S. Schulp and John W.M. Jagt	
A new partial mosasaur skeleton from the Maastrichtian type section, ENCI-HeidelbergCement Group quarry, Maastricht, the Netherlands – preliminary observations	53
John W.M. Jagt, Jos Barten, Lars Barten, Dirk Cornelissen, Rudi W. Dortangs, Dirk Eysermans, Elena A. Jagt-Yazykova, Sjr Renkens and Louis Verding	
FISHES	
Mississippian chondrichthyans from Czerna near Kraków, Poland	54
Michał Ginter	
Hump-backed ginglymodian fish from the Jurassic PhuKradung Formation of Thailand	55
Uthumporn Deesri, Pratueng Jintasakul, Varavudh Suteethorn and Lionel Cavin	
A new billfish (Istiophoriformes, Istiophoridae) from the Upper Miocene of the Caribbean (Panama)	56
Carlos De Gracia, Jorge Velez-Juarbe and Carlos Jaramillo	
Mio-Pliocene elasmobranch faunas from the Urumaco sequence (southern Caribbean) and their palaeoenvironmental significance	57
Jorge B. Carrillo-Briceño, Erin Maxwell, Orangel A. Aguilera, Rodolfo Sánchez and Marcelo R. Sánchez-Villagra	
Fintasia: cutting down the ‘Scythe Myth’	58
Jeff Liston, Anthony Maltese and Laura S. Zamorano	
Osteoglossomorph palaeobiogeography – fossils refute ideas based on recent distribution	59
Niels Bonde	
NON-AMNIOTS AND SYNAPSIDS	
Mysteries in the phylogeny of early tetrapods, and their evolutionary implications	60
David Marjanović	
Organisational instability as initial phase of evolutionary change: evidence from evolution of temnospondyl amphibians	61
Mikhail A. Shishkin	
Morphological integration in the skull of Palaeozoic tetrapods	62
Celeste Pérez Ben	
Digitising the five-fingered forelimb of <i>Metoposaurus diagnosticus krasiejowensis</i> using photogrammetry	63
Elzbieta M. Teschner and Dorota Konietzko-Meier	
Early genome size increase in urodeles	64
Michel Laurin, Aurore Canoville, Mikayla Struble, Chris Organ and Vivian de Buffrénil	

Evolution of impulse locomotion in Synapsida from Early Permian to Late Cretaceous	65
Susanna B. Kümmell and Eberhard Frey	

New information on the morphology of the Zambian dicynodont <i>Syops vanhoepeni</i>	66
Leda Pičuljan, Kenneth D. Angielczyk, Christian A. Sidor, Steve Tolan, Christian F. Kammerer and Jörg Fröbisch	

PALEOGEOGRAPHY

The latest Permian-earliest Triassic microvertebrate fauna from the Vyazniki, Russia	67
Maciej Pindakiewicz, Mateusz Tałanda, Andrej Sennikov, Grzegorz Niedźwiedzki and Tomasz Sulej	

Genesis of bone accumulations in the Röt (Lower Triassic, Olenekian) of the Opole Silesia region, southern Poland	68
Monika Kowal-Linka and Adam Bodzioch	

The biodiversity of early Middle Triassic reptiles from Upper Silesia	69
Dawid Surmik	

Status quo of the <i>Europasaurus</i> Project: terrestrial vertebrates from Kimmeridgian limestones at the Langenberg Quarry (Lower Saxony, Germany)	70
Oliver Wings	

News on the Late Cretaceous Las Aguilas dinosaur graveyard, Coahuila, Mexico	71
Eberhard 'Dino' Frey, Héctor Rivera Sylva, Wolfgang Stinnesbeck, José Manuel Padilla Gutierrez, Arturo H. González González, Natalia Amezcua Torres, Anne Schulp and Valentin Vanhecke	

Never say never – new additions to the composition of the oldest latest Cretaceous continental vertebrate assemblage in Transylvania, western Romania	72
Mátyás Vremir, Ștefan Vasile, Radu Totoianu, Gareth Dyke and Zoltán Csiki-Sava	

Early Paleocene marine vertebrates from the southeast Netherlands and northeast Belgium	73
John W.M. Jagt	

Taxonomic diversity of the vertebrate assemblages from Copăceni – a new reference site for the Lower Pleistocene of the Dacian Basin, Romania	74
Ștefan Vasile, Alexandru Petculescu and Marton Venczel	

Mio-Pliocene amphibian and reptile assemblages from western Siberia – palaeobiogeographic and palaeoclimatic implications	75
Davit Vasilyan, Martin Ivanov, Jozef Klembara, Vladimir Zazhigin and Madelaine Böhme	

HISTORICAL AND METHODOLOGICAL APPROACH

Deciphering nature in the 17th century – cases relevant to vertebrate palaeontology	76
Ella Hoch	

The twentieth anniversary of the Buia Project: vertebrate palaeontology in the Lower Pleistocene of Eritrea (East Africa)	77
M. Delfino, E. Abbate, V. Balter, L. Bondioli, G. Carnevale, A. Coppa, E. Ghezzi, M. Ghinassi, Y. Libsekal, R. Macchiarelli, J.E. Martin, B. Martínez-Navarro, T. Medin, M. Papini, M. Pavia, F. Scarciglia, T. Tacail, A. Urciuoli, A. Villa, C. Zanolli and L. Rook	

The use of x-ray fluorescence in dinosaur and other vertebrate palaeontological studies Koen Stein	78
Reliability of estimating phylogenies from shape and similar multidimensional data Ceferino Varón González, Simon Whelan and Christian Peter Klingenberg	79
REPTILES	
Taxonomic affiliation of an aetosaur from Krasiejów and possible sexual dimorphism in <i>Stagonolepis</i> Mateusz Antczak	80
Manus of the aetosaur <i>Stagonolepis olenkae</i> from the lower Upper Triassic of Poland Dawid Drózd	81
The relationships of the Euparkeriidae and the rise of Archosauria Roland B. Sookias	82
New finds of dinosauromorphs and dinosauriforms from the Middle and Upper Triassic of Poland Grzegorz Niedźwiedzki	83
The speed of theropod dinosaurs: new data from trackways at Münchehagen, Germany Pernille Venø Troelsen	84
New iguanodontian dinosaur records from the North Sea Basin: palaeogeographical implications Eric Wolfgang Amadeus Mulder and René Hendricus Bartholomeus Fraaije	85
New partial skeletons of <i>Rhabdodon</i> from the upper Campanian of Provence (southern France): towards a better understanding of specific diversity Thierry Tortosa, Eric Buffetaut, Frédéric Pauvarel, Eric Turini, Yves Dutour and Gilles Cheylan	86
Species distinction in the genus <i>Protoceratops</i> Tomasz Singer	87
Ontogenetic modifications of the pelvic girdle and hindlimb revealed by a subadult specimen of <i>Protoceratops andrewsi</i> Justyna Słowiak	88
Ontogeny of the ceratopsian dinosaur <i>Bagaceratops rozhdestvenskyi</i> from the Upper Cretaceous of the Gobi Desert, Mongolia Łukasz Czepiński	89
Investigating the ancestral shell: preliminary data on new material of <i>Proterochersis</i>, the earliest fully-shelled turtle Tomasz Szczygielski	90
Palaeoecology of <i>Nidophis insularis</i> from the Upper Cretaceous of the Hațeg Basin (Romania) – another madtsoiid snake associated with a dinosaur egg nest Márton Venczel, Ștefan Vasile and Zoltán Csiki-Sava	91
Neogene snakes from Greece: giants and dwarfs in a mammal-dominated world Georgios L. Georgalis and Massimo Delfino	92

EGGSHELLS AND BIRDS

- Eggshell fragments from the Late Cretaceous of Iharkút, Hungary** 93
Edina Prondvai, Zoltán Szentesi, Attila Ósi, Gábor Botfalvai and Koen Stein
- The ‘Tuştea Puzzle’ revisited** 94
Dan Grigorescu
- Macbeth’s Nature paper: The remains of the oldest dinosaur egg and embryo, and the obstructive potential of fossil protection legislation** 95
Jeff Liston and Ai Long
- Was crocodylomorph eggshell structure always as conservative as it is in extant crocodilians?** 96
Miguel Moreno-Azanza, José Ignacio Canudo and José M. Gasca
- The specimen of *Archaeopteryx* from the Mörnsheim Formation (Upper Jurassic, lower Tithonian) of Bavaria, southern Germany** 97
Martin Kundrát, Raimund Albersdörfer, John Nudds, Benjamin P. Kear and Lü Junchang
- A new species of Pengornithidae (Aves: Enantiornithes) from the Lower Cretaceous of China suggests a specialized scansorial habitat previously unknown in Early birds** 98
Han Hu, Jingmai K. O’Connor and Zhonghe Zhou
- POSTERS**
- Middle Triassic vertebrate assemblages at the ‘Stare Gliny’ quarry in southern Poland: an environmental and systematic revision** 103
Dawid Surmik and Michał Matysik
- How many Upper Triassic bone-bearing levels are there in Upper Silesia, southern Poland?** 104
Joachim Szulc, Grzegorz Racki, Karol Jewuła and Jan Środoń
- A Late Triassic microvertebrate fauna from the Lipie Śląskie clay pit at Lisowice, Poland** 105
Grzegorz Niedźwiedzki, Jakub Kowalski, Marlena Świło, Krzysztof Owocki, Mateusz Tałanda and Tomasz Sulej
- Taphonomy of dicynodont bones from the Lipie Śląskie clay pit at Lisowice (Upper Triassic, Norian-Rhaetian; Upper Silesia, southern Poland)** 106
Adam Bodzioch, Monika Kowal-Linka, Grzegorz Niedźwiedzki and Krzysztof Owocki
- The scientific, geotouristic and economic significance of the discovery of the Triassic tetrapod Lagerstätte at Krasiejów (Opole Silesia, Poland)** 107
Robert Niedźwiedzki
- New insights into vertebrate assemblages from the lower Chañares Formation (Ladinian–earliest Carnian, Ischigualasto–Villa Unión Basin), northwest Argentina** 108
J.B. Desojo, M.D. Ezcurra, L.E. Fiorelli, A. Martinelli, J.R.A. Taborda, M.B. von Baczko, M. Hechenleitner, M. Ezpeleta, M.J. Trotteyn and S. Gouiric-Cavalli
- Late Permian footprints from the Venetian Prealps (northeast Italy): new discoveries in a largely incomplete panorama** 109
Lorenzo Marchetti, Matteo Belvedere and Paolo Mietto

Carnian tetrapod tracks from the Argana Basin (Morocco): the Dutuit Collection at the Muséum national d'Histoire naturelle, Paris Matteo Belvedere and Nour-Eddine Jalil	110
Early Jurassic dinosaur tracks from Mt. Pelmo (Italy): new insights into regional palaeogeography Matteo Belvedere, Francesco Sauro, Marco Franceschi and Paolo Mietto	111
Early sauropodomorph footprints in the Upper Triassic of East Greenland Grzegorz Niedzwiedzki, Niels Bonde, Mateusz Tałanda, Andrzej Wolniewicz, Błażej Błażejowski and Tomasz Sulej	112
Microstructure of dermal bones of vertebrates from Krasiejów Mateusz Antczak	113
Methodological approach to histological studies – how important are temnospondyl humeri for skeletochronological analyses? Elzbieta M. Teschner and Dorota Konietzko-Meier	114
A quantitative assessment of mid-diaphyseal distribution density of secondary osteons in amniotes Jessica Mitchell	115
The microanatomy of vertebral centra of <i>Tanystropheus</i> – a potential key for deciphering tanystropheid palaeobiology Dawid Surmik and Andrzej Boczarowski	116
Ontogenetic development of bone microstructure in the king penguin <i>Aptenodytes patagonicus</i> in relation to its aquatic adaptation, and palaeoecological inferences Aurore Canoville and Vivian de Buffrénil	117
Fungal activity on bones, teeth and marine invertebrates Katarzyna Górka and Andrzej Chlebicki	118
Possible endogenic organic molecules in early Middle Triassic reptile bones from Upper Silesia, Poland – results of a multiproxy study Dawid Surmik, Andrzej Boczarowski, Roman Pawlicki, Katarzyna Balin, Barbara Kremer, Mateusz Dulski and Jacek Szade	119
The first fossil record of the “White Sharks” (<i>Carcharodon carcharias</i>) from Central America and its association with other macropredatory sharks Jorge B. Carrillo-Briceño, Carlos De Gracia and Félix Rodríguez	120
The first fish remains (Sarcopterygii and Actinopterygii) from the late Ladinian–earliest Carnian (Chañares Formation) of Argentina: a wider palaeolatitudinal distribution for early mawsoniid coelacanthiforms? J.B. Desojo, S. Gouiric-Cavalli, A.G. Martinelli, L.E. Fiorelli and M.D. Ezcurra	121
Digital endocranial reconstruction of a large Triassic actinopterygian from Schesaplana, Switzerland Ashley Latimer	122
A callipurbeckiid (Ginglymodi, Semionotiformes) from the Tithonian (Upper Jurassic) of Canjuers, France Adriana López-Arbarello and Lukardis Wencker	123

First finds of micrometric-sized cartilaginous fish teeth from the Lower Cretaceous deposits of Crimea Filipp A. Trikolidi	124
Middle-Late Miocene ichthyofauna of the Taman' Peninsula (Krasnodar district, Russia) Eugenia K. Sytchevskaya	125
Neogene ichthyofauna of Tagay Bay (Olkhon Island, Lake Baikal) and Miocene expansion of the Channidae in northern Asia Eugenia K. Sytchevskaya	126
First amphibian and lizard remains from the Neogene of Urumaco, Venezuela Massimo Delfino and Marcelo R. Sánchez-Villagra	127
Two large billfish remains: do they belong to the same species? Růžena Gregorová	128
Insights into the evolutionary history of Mosasaurioidea (Squamata) using parsimony and Bayesian inference Daniel Madzia and Andrea Cau	129
The dentition of <i>Polyptychodon interruptus</i> (Plesiosauria, Pliosauridae) Daniel Madzia	130
A new basal elasmosaurid skeleton with joint pathologies from the Lower Cretaceous of Germany Sven Sachs, Jahn J. Hornung, Peter Wohlsein and Benjamin P. Kear	131
New information on dorsal vertebrae of <i>Siamotyrannus isanensis</i> (Dinosauria, Theropoda) from the Lower Cretaceous of Thailand Adun Samathi	132
A new vertebra of <i>Pararcus diepenbroeki</i> from the Vossenveld Formation at Winterswijk, the Netherlands Melanie Aranka Dominique Doring and Dennis Franciscus Adrianus Eduardus Voeten	133
Crocodylomorph diversity in the upper Maastrichtian of Serraduy (Huesca, Spain) Eduardo Puértolas-Pascual and José Ignacio Canudo	134
Endocranial morphology of <i>Maledictosuchus</i> (Thalattosuchia) from the Callovian (Middle Jurassic) of Spain Jara Parrilla-Bel, Josep Fortuny, Sergio Llacer and José Ignacio Canudo	135
Postcranial material of <i>Nothosaurus marchicus</i> from the Lower Muschelkalk (Anisian) of Winterswijk, the Netherlands, with remarks on swimming styles and taphonomy Dennis F.A.E. Voeten, Nicole Klein, Jos Lankamp, Remco Bleeker, Oliver J. Sichelschmidt, Marco Liebrand, Dennis Nieweg and P. Martin Sander	136
Small-sized spinosaurids from the lower Barremian (Lower Cretaceous) of Spain Antonio Alonso, Pablo Navarro-Lorbés, Carmen Núñez-Lahuerta and José Ignacio Canudo	137
A juvenile ctenochasmatid pterosaur from the Solnhofen Limestone Daniel Madzia, Martin Ivanov and Magdalena Łukowiak	138
<i>Megacnemus</i> – a forgotten reptile, presumably from the Triassic of Poland Tomasz Skawiński, Mateusz Tałanda and Sven Sachs	139

A partial skull of <i>Protoceratops andrewsi</i> from the Central Asiatic Expeditions in the Naturalis collections (Leiden, the Netherlands)	140
Stephan N. F. Spiekman, Dylan Bastiaans and Anne S. Schulp	
Bite marks on <i>Europasaurus</i> bones from the Langenberg Quarry near Goslar (Lower Saxony, Germany)	141
Miriam Slodownik and Oliver Wings	
A theropod vertebra from the Middle Jurassic of southern Poland	142
Tomasz Singer and Katarzyna Szczepaniak	
New data on skull anatomy of <i>Silesaurus opolensis</i>	143
Rafał Piechowski, Grzegorz Niedźwiedzki and Mateusz Tałanda	
Oxygen and strontium isotopic study of tooth enamel in <i>Tarbosaurus bataar</i> – palaeoenvironmental and palaeoecological record or diagenetic overprint?	144
Krzysztof Owocki, Grzegorz Niedźwiedzki and Barbara Kremera	
Reconstruction of a historically interesting <i>Triceratops</i> ‘?<i>brevicornus</i>’ from the Lance Formation, Wyoming, USA	145
Dylan Bastiaans, Martijn D. Guliker and Anne S. Schulp	
Morphology of the hind limb of an aetosaur from the Upper Triassic of Krasiejów	146
Szymon Górnicki	
Redescription of the braincase of <i>Efraasia minor</i> (Dinosauria, Sauropodomorpha) from the Upper Triassic of Germany, with comments on sauropodomorph phylogeny	147
Mario Bronzati, Femke Holwerda and Oliver W. M. Rauhut	
New dryosaurid-bearing beds from the Upper Jurassic of Portugal	148
Fernando Escaso, Francisco Ortega, Elisabete Malafaia, Pedro Mocho, Iván Narváez, Bruno Camilo Silva, José Miguel Gasulla and José Luis Sanz	
Re-evaluation of crocodyliform remains from the Campanian-Maastrichtian at Armuña (Segovia, Spain)	149
Iván Narváez, Christopher A. Brochu, Fernando Escaso and Francisco Ortega	
Late Cretaceous marine vertebrates in the Opole region (southern Poland)	150
Robert Niedźwiedzki	
Size-synchronised change in tyrannosauroid endoneurocranial configuration	151
Martin Kundrát, Jiří Janáček, Benjamin P. Kear and Xing Xu	
The endocast of <i>Diamantinasaurus matildae</i> (Titanosauria, Lithostrotia) from the lower Upper Cretaceous of Australia	152
Martin Kundrát, Stephen F. Poropat and David A. Elliott	
The Eurosiberian and Mediterranean regions in Europe during the Late Pleistocene, on the basis of bird occurrences	153
Carmen Núñez-Lahuerta, Victor Sauqué, Julia Galán, Antonio Alonso and Gloria Cuenca-Bescós	
Research of Pleistocene megafauna carried out at the Laboratory of Palaeobiology of Opole University	154
Klaudia Kardynał	

Preliminary report of a new mammoth find in Ellis County, north-central Texas (Proboscidea, Elephantidae, <i>Mammuthus columbi</i>) Virginia Friedman	155
Predictive models for body mass within the family Soricidae: estimating the weight of one of the smallest extinct mammals Blanca Moncunill-Solé, Xavier Jordana and Meike Köhler	156
An exceptional Middle Eocene (Lutetian) sirenian bonebed in the southern Pyrenees (Huesca, Spain): palaeobiodiversity and sedimentological analysis Ester Díaz-Berenguer, Ainara Badiola, Miguel Moreno-Azanza, Eduardo Puértolas and José Ignacio Canudo	157
Bats from some new Quaternary high-mountain localities in the Spanish Pyrenees – preliminary results Julia Galán, Víctor Sauqué, Raquel Rabal-Garcés, Carmen Núñez-Lahuerta, Gloria Cuenca-Bescós and Juan Manuel López-García	158
Post-cranial suspensory adaptations of the subfossil lemur <i>Babakotia radofilai</i> Damiano Marchi, Christopher B. Ruff, Alessio Capobianco, Katherine L. Rafferty, Michael B. Habib and Biren A. Patel	159
Early Pleistocene mammal assemblage from the Spiš Quarry near Spišská Nová Ves (Slovakia) Zuzana Krempaská and Martin Sabol	160
Morphometric analysis of the Late Pleistocene woolly rhinoceros <i>Coelodonta antiquitatis</i> (Blumenbach, 1799) from Skarszyn near Trzebnica, Poland Adam Kotowski and Krzysztof Stefaniak	161
A scavenging scenario – three pterosaur neck vertebrae with a spinosaurid tooth embedded in one of them Szymon Górnicki	162
Pencil drawings as an integral part of palaeo-reconstructions Jakub Kowalski, Kamil Gruntmejer, Piotr Janecki and Klaudia Kardynał	163
LIST OF AUTHORS	164

ZOFIA KIELAN-JAWOROWSKA – AN APPRECIATION



(Photo: Krzysztof Dubiel)

ZOFIA KIELAN-JAWOROWSKA
25 APRIL 1925-13 MARCH 2015

The present conference, the 13th Annual Meeting of the European Association of Vertebrate Palaeontologists, is dedicated to the late Professor Zofia Kielan-Jaworowska, eminent Polish scientist, in honour of her extensive contributions to the field of vertebrate palaeontology to which she devoted almost her entire life. Zofia passed away on March 13, 2015, a short time before reaching her 90th birthday. We were all taken by surprise by her death, because she still was so active and brilliant until the very end. Even in recent years (2012 and 2013), she managed to write and edit two large books including her scientific autobiography, along with a review of current knowledge of Mesozoic mammals.

Zofia was born in 1925, but after only 14 years of peaceful childhood in an independent Poland, she had to face the disastrous period of the Second World War, under extremely dangerous conditions during German occupation. As high schools had been closed by the occupiers, a clandestine educational system was organised by the Polish resistance movement – Zofia followed these courses. At the same time, she completed secret military training as a soldier of the Polish Underground Army (AK). At the risk of the firing squad if caught, together with her parents, she provided a hiding place for a Jewish person. In August 1944 she participated in the Warsaw Uprising battles against the occupiers, and eventually escaped from a prisoner transport to Germany. To her generation, such experiences were typical.

In 1945 Zofia resumed her interrupted studies, graduated in 1949 from Warsaw University, and devoted herself totally to restoring the destroyed infrastructure of Polish scientific institutions and collections as well as to research. She completed her PhD in palaeontology in 1953, was appointed a docent (lecturer) at the future Institute of Paleobiology (Polish Academy of Sciences) in 1957, and became a full professor in 1961. In the 1960s she became a member of the Polish Academy of Sciences. In 1987, she left for Norway to take a professorial position at the Paleontological Museum, University of Oslo, but she kept in permanent contact with the mother institute in Warsaw. After her return in 1995, she took on numerous academic duties, most notably the position of Editor-in-chief of *Acta Palaeontologica Polonica*. Until the very end, she unquestionably remained a central figure in Polish palaeontology.

Zofia began her professional life under the supervision of Professor Roman Kozłowski, the famous graptolite specialist. At that time, marine invertebrates were the main field of research at the Department of Paleozoology of Warsaw University. Initially, Zofia was engaged in trilobite studies (Master's degree in 1949; PhD in 1953), starting with the Devonian in Poland, then the Cambrian of Spitsbergen and later the Ordovician of Poland, Scandinavia and Czechoslovakia. About 1956, she switched from trilobites to Palaeozoic polychaete annelids, and her studies at the Zoological Station in Naples and at the British Museum (Natural History) in London resulted in a large monograph that was published in 1966. She then became known in the international scientific community as a specialist of invertebrate palaeontology.

However, her interests had for a long time revolved around vertebrate palaeontology, and in particular around the mysteries of early mammals. In this respect, she had been searching for early mammal fossils in Triassic/Jurassic karst deposits in southern Poland, but without success.

In 1961, Zofia Kielan-Jaworowska was appointed organiser and leader of the Polish-Mongolian Palaeontological Expeditions to the Gobi Desert. This proved to be a turning point in her scientific career. The eight expeditions that went to the Gobi Desert between 1963 and 1971 assembled not only a large collection of Late Cretaceous dinosaurs and other reptiles, but also mammals, notably those from Upper Cretaceous deposits. Zofia supervised the study of this material by different Polish researchers, and eventually edited the results of this immense work in ten volumes of the monograph series *Palaeontologia Polonica*. She herself had become totally committed to the study of Mesozoic mammals, exactly as she had planned at the beginning of her career, and eventually became an international authority in this field.

The Late Cretaceous mammal fossils collected by the Polish-Mongolian expeditions were unique at the time, both in number of specimens and state of preservation that surpassed that of specimens from other continents. Zofia's fifty years of research made an important contribution to the debate on several key problems of mammalian phylogeny, such as the position and evolutionary history of multituberculates; the relationships and timing of the divergence of monotremes and therians; the synapomorphic vs homoplastic character of tribosphenic molars and the zoogeographical implications of this issue, as well as functional problems related to feeding, reproduction and locomotion in early mammals.

In the 1970s, Zofia co-authored and co-edited two major volumes that summarised current knowledge of Mesozoic mammalian history and related problems. The first was entitled *Mesozoic mammals: the first two-thirds of mammalian history* (University of California Press, 1979; editors Lillegraven, Kielan-Jaworowska and Clemens). It was followed by a large comprehensive compendium, *Mammals from the age of dinosaurs: origins, evolution, and structure* (Columbia University Press, New York, 2004; editors Kielan-Jaworowska, Cifelli and Luo). The latter remains unsurpassed in its coverage of the subject and is an unmissable source of information on Mesozoic mammalogy to each vertebrate palaeontologist.

Zofia's activity extended well beyond pure research. She undertook numerous academic administrative roles, organised and/or participated in palaeontological expeditions, and took part and/or organised numerous international conferences. She was also engaged in teaching and supervising research projects. As an editor, she enforced high standards of research and scientific publications by critically revising and correcting papers, and by discussing issues, methodology and manuscript length, as well as illustration quality, with the authors. Zofia always understood the importance of popularising natural science for the education of the younger generation, and found

time for this kind of activity, publishing popular books and articles (about 60 in different languages), and organising exhibitions. Two of them, ‘Dinosaurs from the Gobi Desert’ (1968) and ‘Terrestrial Evolution’ (1985) in the centre of Warsaw, and one, an outdoor exhibit, ‘Dinosaur Valley’ at Chorzów, southern Poland. When in Norway she was engaged in modernisation of the permanent exhibition in the Paleontological Museum of Oslo University.

The achievements of Zofia Kielan-Jaworowska were recognised by numerous honours. She was elected a foreign member of the Norwegian Academy of Sciences and a member of the Academia Europaea, was awarded a doctor *honoris causa* by the University of Camerino (Italy), and appointed member of a number of Polish and international scientific societies, including an honorary member of the Society of Vertebrate Paleontology. In 1977 she was awarded a Polish State Prize for her work on Mesozoic mammals; in 1994, she received the Alfred Jurzykowski Prize of the Kościuszko Foundation in New York, in 1997 the Romer-Simpson medal by the Society of Vertebrate Paleontology, in 1998 the Walter Granger Memorial Award, and in 2005 a prize from the Polish Science Foundation, colloquially referred to as the Polish Nobel Prize.

From around 2005, Zofia’s visits to the Institute of Paleobiology in Warsaw became infrequent. She mainly remained at home, in her office and scientific library, situated in the suburban village of Konstancin near Warsaw. A number of serious accidents left her physically disabled and in pain, and it was only her steady scientific activity that helped her to keep going for so long. She continued to offer us, her colleagues, her experience and friendship, and we responded with deep estimation, gratitude and admiration for her personality and her major contributions to palaeontology.

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ORAL PRESENTATIONS

First insights into the bone microstructure of *Deinocheirus mirificus*

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The bone microstructure of *Deinocheirus mirificus*, a gigantic ornithomimosaur from the Upper Cretaceous of Mongolia was studied. Bone samples were extracted from thoracic ribs of two individuals, MPC-D 100/128 [Mongolian Paleontological Center] and the larger specimen, MPC-D 100/127. Each rib sample was cross cut at two different levels, thus providing material for four petrographic thin sections. The sections were studied using transmission and polarised light microscopy, and analysed by back scattered electron imaging. The EDAX spectra revealed that primary and replaced bone tissues showed a high amount of calcium and phosphorus. The isotropic distribution of phosphorus was also found in the marrow spongiosa. It appears that post-depositional chemical alteration in the bone tissue was low and that the high amount of phosphorus may have been derived from the original hydroxyapatite component of the bones. The rib histology shows regionalised cortex and dominant spongiosa in the medullary region. The majority of medullary rooms is coated with endosteal bone, with more active erosional edges present in specimen MPC-D 100/128. Primary osteons are embedded in a woven bone matrix, and some of the periosteal osteons open into the outer surface, a feature more frequent in specimen MPC-D 100/128. Substantial portions of the primary bone are replaced by secondary osteons at specific regions, with more redeposited Haversian systems and osteoclastic erosions present in one individual (MPC-D 100/127). Collectively, the woven bone, sub-plexiform vascularity, incomplete rest lines, intensive remodeling and rapid directional deposition reflected by rib histology suggest that *Deinocheirus* likely had high metabolic rates and rapid growth prior to reaching sexual maturity.

Histological analysis of postcranial skeletal pneumaticity in sauropods

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Sauropods were the largest animals to ever walk on our planet, ranging from small species of 5-m length to giants of >30 m length. A key adaptation for maintaining such huge dimensions was the lightening of the skeleton by invasion of the vertebrae and the girdles by bird-like air sacs as part of an avian-like respiratory system. In fact, sauropods, along with theropods and pterosaurs, show a great degree of postcranial skeletal pneumaticity (PSP). Because air sacs do not fossilise, their presence can only be inferred from osteological correlates such as PSP and pneumatic hiatuses. Evidence for PSP in the vertebrae consists of pneumatic fossae and diverticula in the neural arches, delimited by lateral laminae connecting diapophyses, zygapophyses and the vertebral centrum. These fossae are hypothesised to have hosted air sac diverticula. PSP moved gradually backwards along the skeleton during sauropod evolution, from cervicals of basal sauropodomorph to caudals and even pelvic elements in more derived neosauropods. However, an analysis at the histological level of the surface of bones where air sacs were lying can reveal more than meets the eye. To test for the presence of diverticula without obvious PSP, we analysed thin sections taken from the lateral side of the centrum of cervicothoracal vertebrae of basal sauropodomorphs and pelvic bones of neosauropods. The recognition of histological criteria suggesting the presence of air sacs, even in taxa where clear morphological features are missing, has great potential for improving our understanding of the evolution of the dinosaur respiratory system.

Histology of sauropod long bones from the Howe-Stephens Quarry (Morrison Formation, Wyoming): testing hypotheses of skeletal unity

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Sauropod bone histology has emerged as a major source of information on the life history of these giant extinct animals. It provides an insight into the growth record and ontogenetic age of an individual. Sauropod specimens from the Morrison Formation are mostly found as partially articulated skeletons or as isolated bones, as seen in, e.g., the Dinosaur National Monument quarry, which makes an assignment of specific bones to individuals difficult. In the present study, a detailed assessment of skeletal unity is provided by means of palaeohistology for several Morrison Formation sauropod partial skeletons and isolated long bones from the Howe-Stephens Quarry, Wyoming. Using histological characters such as Histological Ontogenetic Stages, growth marks, annual cyclicity, remodelling rate, and the number of generations of secondary osteons, an assignment of bones to individuals was made and compared with assignments that were made based on field observations. It is possible to assign isolated bones histologically to an existing individual, match isolated bones to comprise a new individual, and to test whether a specific bone belongs to the assigned individual. The hypothesis of skeletal unity was also tested for selected other Morrison Formation and Tendaguru specimens, and the method can also be applied here. The findings of this study thus establish a method for testing skeletal unity in fossil tetrapod skeletons.

**Mandible histology in *Metoposaurus diagnosticus krasiejowensis*
(Amphibia, Temnospondyli) from the Upper Triassic of Poland
– preliminary results**

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Recent studies have systematically augmented our knowledge of dermal bones of the Late Triassic temnospondyl amphibian *Metoposaurus diagnosticus krasiejowensis*. In fact, it has now become possible to present a detailed histological description of the skull, clavicle and interclavicle of this taxon. So far, histological data on the mandible were scant. For the present study, three well-preserved mandibles have been examined, using 68 standard thin sections.

Most of the mandibular bones reveal a homogeneous diploë structure, with the external cortex consisting of poorly vascularised, parallel-fibred bone, and Lines of Arrested Growth (LAG) and annuli present only in sculptural ridges. Dense bundles of well-mineralised Sharpey's fibres are seen in the external cortex over the entire length of the mandible. The trabecular median region is highly porous and well vascularised, showing small primary vascular canals and more numerous secondary osteons; irregular erosion spaces occur in large numbers as well. The thin and nearly avascular internal cortex consists of parallel-fibred bone. Solely the articular is not a dermal bone in origin, being formed of a thin layer of avascular cortex and a very extensive, trabecular median region. For the first time it has proved possible to describe the histology of the mandibular suture. In contrast to the cranial suture, where one type of suture predominates, the mandible reveals several types of sutural morphology, each with different mechanical properties. This may help further our understanding of mandibular biomechanics and the mode of feeding in *Metoposaurus*.

The role of metabolic rate in the evolutionary size increase of *Dimetrodon* (Sphenacodontidae)

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Dimetrodon was the dominant predator of terrestrial ecosystems of the Lower Permian of North America and Europe. Multiple species of the genus have been described spanning from the uppermost Carboniferous through the bulk of the Lower Permian. Among these forms a trend of evolutionary size increase from a body weight of 14 kg up to 250 kg has been described. Growth trajectories obtained through bone histological analysis suggests that size increased evolutionarily through the acceleration of growth rate. Here we discuss the impact of a rise in maximum metabolic rate on the evolution of size increase in *Dimetrodon*. Using μ CT, we measured the cross sectional area of the femoral nutrient canal. Scaled to femur length, it serves as a proxy for blood flow rate into the bone that indicates maximal metabolic rate of large and small species. In preliminary analysis small species show small nutrient canal radius relative to femur length similar to modern reptiles indicating low maximum metabolic rate. Larger species show larger nutrient canal cross sections after scaling. This indicates that evolutionary size increase was likely accompanied by a rise in maximum metabolic rate. In combination with morphological and bone histological data, bone micro-anatomical analysis of nutrient canal cross sectional area relative to femoral size facilitates the distinction between sympatric species of *Dimetrodon* even from isolated femora.

Growth and development in Pleistocene dwarfed Proboscidea

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Fossil insular mammalian dwarfs have variably been reported to show rapid ontogenetic development, slow development, as well as truncation of growth. These three modes of dwarfing have different implications for the life history of the animals under consideration and their morphological plasticity. The three modes of dwarfing have been recognised in different species, on different islands and by using different methodologies. It may, thus, be hypothesised that different taxa show different responses to island environments, or that environmental differences are the cause for the different dwarfing modes. Alternatively, the difference may even be a methodological artefact.

The main aim of the present study was to determine the mode of dwarfing in insular Proboscidea. Bones of Pleistocene dwarfed proboscideans from Tilos in Greece (*Elephas tiliensis*) and their normal-sized relatives (*Mammuthus primigenius*, *Elephas maximus* and *Loxodonta africana*) were thin sectioned. The sections were subsequently assessed for lines of arrested growth (LAGs), type of bone matrix and osteocyte lacunae densities, using polarised light microscopy. Preliminary histological analyses indicate that dwarfed Proboscidea had slower growth rates, at early ontogenetic stages, than large-sized ones, such as mammoths or elephants. Additionally, in the dwarfed proboscideans, remodelling started at an earlier ontogenetic stage than in the modern reference sample and bones were already heavily remodelled before adulthood was reached. LAGs are only sparsely present.

New data on cervid histology – life history and allometry

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Our knowledge of the histology of the family Cervidae (deer) has recently been augmented by work on the long bone and tooth histology of various taxa. Included in that study was the Miocene genus *Procervulus*, an early cervid that is characterised by a low growth rate. The present study adds data on cervid bone histology by describing that of another Miocene taxon, *Dicrocerus*. Along with the nature of the bony tissues, the skeletochronology of *Dicrocerus* is consistent with an intermediate growth rate, differing from the condition in *Procervulus*, and hence documenting diversity in early cervid life history.

Bone histology is now documented for various cervid taxa. Moreover, cervids are adequate (i.e., large range of body sizes, uniform lifestyles and well-resolved phylogenetic relationships) candidates to be investigated within an evolutionary (phylogenetically informed) framework the relationships of traits with body size. In order to characterise the inner organisation of long bones, parameters related to the bi-dimensional repartition of bone tissue along the cross-sectional area can be measured. While these parameters have been shown to be correlated with specific lifestyles, little attention has been paid to the influence of body size on these parameters. In effect, the gross morphology of limb bones is known to be subject to allometry, as scaling relationships between their components and body size differ from isometry. Compactness parameters appear to have isometrical relationships with body size proxies, suggesting that the inner organization of the long bones at midshaft is not significantly affected by body size.

Modifications in molar enamel microstructure with increasing hypsodonty in Theridomyidae (Rodentia) across the ‘Grande Coupure’

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The ‘Grande Coupure’ is the faunal turnover at the Eocene-Oligocene transition in Europe, where a large number of endemic European taxa were outcompeted by Asian invaders. The biostratigraphically important theridomyids (MP13–MP30) survived this event without major decline. In several lineages, theridomyids evolved independently hypsodont molars which enabled them to compensate increasing wear by more abrasive food due to the vegetation change from forests (Eocene) to drier, open habitats (Oligocene). The changes in their dentition are also reflected in modifications of the enamel microstructure. To detect these modifications that occurred along with increasing hypsodonty, the molar enamel microstructure of five theridomyid subfamilies was studied under SEM. The low-crowned and weakly hypsodont theridomyid species exhibit all the ‘*Sciurus*’-type schmelzmuster with radial enamel (RE) and thick inner layer of Hunter-Schreger bands (HSB). With increasing hypsodonty, the HSB shift from the enamel-dentin junction to the outer enamel surface. At least in two lineages, Issidoromyinae and Archaeomyini, hypsodonty evolved independently. Issidoromyinae have hypsodont molars with a thick inner layer of RE and an outer layer of HSB, whereas Archaeomyini possess a leading-trailing edge pattern, with almost completely reduced leading edge. The trailing edge is differentiated in a thick inner layer of RE and an outer layer initially formed by irregular HSB (*Protechimys*) that later turned into irregular enamel (*Archaeomys*). The changes in the molar enamel microstructure occurred together with incisor enamel changes which have previously been observed: the plesiomorphic pauciserial HSB became uniserial in the *Issidoromys* lineage and pseudo-multiserial HSB in Archaeomyini.

Schultz's Rule in mammals: the influence of life history on dental eruption

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Teeth are among the most important sources of data on mammalian evolution. The developmental and genetic causes of tooth formation, i.e., the processes behind diversity of tooth shape and size, are increasingly well understood. In contrast, diversity in patterns of dental eruption is less well documented. Mammals are notable among vertebrates in having a reduced frequency of eruption, which contributes to their increased occlusal precision between upper and lower teeth. In the early 20th century, Adolf Schultz hypothesized that mammals (particularly primates) with a 'long' life history, i.e., a longer lifespan and extended growth phase prior to sexual maturity, overlap in their eruption of anterior permanent teeth and molars. In contrast, mammals with a 'short' life history finish erupting their molars prior to complete eruption of more anterior teeth. In making this observation, Schultz outlined a hard-tissue feature that could potentially inform aspects of life history in long-extinct species. Here, I test the applicability of Schultz's Rule across a large data set of placental and marsupial mammals, sampling data on eruption and growth in over 1,500 individuals from nearly 60 genera across most major clades. Schultz was correct to note an association between 'long' life history and coincident eruption of anterior teeth and molars in some primates, but such a correlation is not necessarily found in other groups. Phylogeny plays a role in eruption patterns, both in terms of eruption sequence and the degree of overlap between dental eruption and growth itself.

Mammal-like teeth from the Upper Triassic of Poland

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Upper Triassic fossiliferous deposits at the Lipie Śląskie clay pit, Lisowice (Silesia, southern Poland), preserve a diverse assemblage of both freshwater and terrestrial small vertebrates. In addition to remains of fishes, amphibians and reptiles, the lower part of so-called grey unit has also yielded isolated mammal-like teeth that may be representatives of mammaliaforms or very primitive mammals. These finds consist of a near-complete, double-rooted right lower tooth, a ?left lower tooth and a partially preserved tooth, all possibly belonging to basal mammaliaform (genus *Hallautherium*), as well as an unidentified canine that may belong to a large specimen of Morganucodonta or Cynodontia. We consider all *Hallautherium*-like specimens to be early mammaliaform molariform teeth on the basis of the following characters: double-rooted teeth; all teeth with primary cusps a-c with additional cusps (e-d and g), long and well-separated roots with division close to the crown base; cusp b smaller than cusp c in all specimens. Double-rooted teeth and well-separated roots do not occur in early mammaliamorphs, which have an incipient or a root division that is not fully developed. These findings are significant as this is the first osteological record of mammaliaforms in the Mesozoic of Poland, as well as in the Upper Triassic deposits of the easternmost part of the Germanic Basin. They show dental morphologies that are transitional between advanced cynodonts and mammaliaforms. Teeth are similar in age to the oldest fossils of morganucodontids in the Germanic Basin.

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Comparative anatomy and systematics of Cretaceous mammal tracks of Angola

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The recent discovery of mammal tracks in the upper Aptian of Catoca (Lunda Sul, Angola) has triggered analysis of Mesozoic mammal morphotypes. About two dozen Mesozoic mammal track occurrences are known to date, often dubiously identified, mostly from Africa, a few from South and North America and Europe. Among Cretaceous mammal ichnomorphotypes, *Brasilichnium elusivum* from Brazil, *Schadipes crypticus* from Colorado and the controversial *Agadirichnus elegans* from Morocco are tetradactyl. The marsupial *Duquettichnus kooli*, from British Columbia, is the only known pentadactyl mammal ichnomorphotype from the Cretaceous. The association of features in the Catoca tracks makes them unique for the Mesozoic, such as being together mesaxonic, pentadactyl, plantigrade, wider than longer, relatively large in size (length 2.7 cm, width 3.0 cm), with short, straight and distally rounded digits, and no claw marks. In particular, the orientation of digits is autapomorphic: medial digits (II–IV) project anteriorly, while both digits I and V are more divergent and project anterolaterally.

The Angolan tracks (with digit II and III the longest, digit V shortest, and a total digit divarication of 118°) are comparable to footprint and digit proportions of *Ameghinichnus* tracks from the Hettangian (Lower Jurassic, ~200 myr) of New Jersey, and in the total digital divarication to *Ameghinichnus patagonicus* from the Callovian/Oxfordian boundary (Middle/Upper Jurassic, ~163.5 myr) of Argentina. Nevertheless, the Catoca morphotype cannot be attributed to any known Mesozoic mammal-like track morphotype and thus represents a new ichnomorphotype.

Evolution of *Gomphos* (Mammalia, Glires) in the Eocene of the Erlian Basin, Nei Mongol (China)

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The genus *Gomphos* contains relatively large (body mass *c.* 2 kg) mimotonids (basal duplicidentate Glires) that inhabited the Mongolian Plateau during the Early to Middle Eocene. Currently, we know three species of *Gomphos*; the most abundant and most widely distributed is *G. elkema* from the Bumbanian deposits of Mongolia and Nei Mongol (China). Much rarer are *G. ellae* from the Kholboldchi Formation (Mongolia) and *G. shevyrevae* from the Irдинmanhan deposits of the Erlian Basin, Nei Mongol. *Gomphos* was an important faunal element in the Bumbanian (in the Erlian Basin some of Bumbanian-equivalent deposits are even referred to as the ‘*Gomphos* beds’). It becomes considerably rarer during the Arshantan and is not known after the Irдинmanhan. New material from the Arshanto Formation the Erlian Basin comprises *G. ellae* (first record from China), which makes the Chinese record of *Gomphos* the most complete and enabled a study of dental morphology changes during the entire Bumbanian-Irдинmanhan interval. Generally, an overall simplification of the occlusal pattern is observed. For example, mesostylids, which are well-developed in *G. elkema*, become smaller in *G. ellae* and disappear in *G. shevyrevae*. Such changes parallel the trends observed among coeval Arshantan and Irдинmanhan rodents of the Gobi. Compared to lagomorphs, *Gomphos* has poorly developed unilateral hypsodonty and its mode of chewing is intermediate between typically lagomorph, mainly transverse jaw movements and propalinar, characteristic of rodents. The evidence from the dentition, skeletal morphology and size indicates that *Gomphos* is more closely related to *Anatolimys* and *Mimolagus* than to the *Mimotona* lineage.

Neogene mammals from northern South America (Venezuela and Colombia): implications for diversity patterns and faunal evolution in the Neotropics

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The Neotropical record is essential for a better understanding of diversity patterns and mammal evolution in South America. However, there is a fossil sampling bias across the continent, and little is known from the tropics, in comparison to temperate faunas. This obscures the current picture of important events such as the Great American Biotic Interchange and faunal evolution in the continent. Here we present new findings from the Urumaco sequence (Upper Miocene-Upper Pliocene) of Venezuela and from Castilletes (Middle Miocene and Lower Pliocene) of Colombia. These localities serve to characterise changes of Neotropical mammal communities during the Neogene. Middle Miocene records from Castilletes include uruguaytheriine astrapotheres (*Xenastrapotherium* and *Granastrapotherium*), leontinid notoungulates, proteroterid litopterns, glyptodonts and pampatherid cingulates. New material from Upper Miocene deposits of Urumaco provide evidence of higher diversity of giant neopiblemid rodents (*Phoberomys* and *Neopiblema*) and new post-cranial remains of native ungulates. Pliocene remains from Colombia (Ware Formation) and Venezuela (San Gregorio Formation) document the oldest records of North American mammals in the tropics represented by procyonids and camelids. Toxodonts from San Gregorio exhibit plesiomorphic features within Toxodontidae, unexpected considering their age. Other taxa include mylodontids, megatherids and megalonichid sloths and hydrochoerid rodents. Taxa of the Miocene assemblages are among the last records in the continent for several clades. Pliocene remains exhibit plesiomorphic features that are not documented in contemporaneous assemblages from higher latitudes. These findings are consistent with the role of the tropics as a cradle and museum of diversity.

Osteology of *Zygodon turicensis* (Mammalia, Proboscidea)

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Neogene proboscideans are identified mostly on the basis of teeth, the post-cranial skeleton being studied only rarely. As a consequence, little is known about ontogeny, sexual dimorphism, intraspecific variability and even interspecific differences of these mammals. *Zygodon turicensis* is a mammutid from the Middle Miocene of Europe. Permanent teeth are well known, but the data on upper tusks, deciduous premolars, mandibles and some post-cranial bones of this species have been published only occasionally. The material studied here comes from a locality known as Czujan's Sand Pit, near Mikulov (Czech Republic), and is housed in the Moravian Museum at Brno. This locality has yielded a rich assemblage of Astaracian mammals with a high number of proboscideans. Among these, *Z. turicensis* is unusually predominant. Remains studied include tusks, mandibles and appendicular skeletal elements of at least eight individuals. The bones and tusks were measured, described and compared to related species in order to obtain more information on the anatomy of, and variability within, *Z. turicensis*. Tusks were also cross-sectioned so as to assess the Schreger pattern which can be seen in cross sections of tusks of all elephantiform proboscideans and its nature enables species distinction. Tusk microstructure and post-cranial anatomy reliably differentiate *Z. turicensis* from other Neogene proboscideans. Moreover, *Z. turicensis* likely exhibits sexual dimorphism which is characterised by the absence of mandibular tusks in females. The present study provides the first comprehensive assessment of the skeletal anatomy of *Z. turicensis*.

New data on the three-tined deer (*Artiodactyla*, *Mammalia*) from the uppermost Miocene of Venta del Moro, Spain

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The vertebrate locality of Venta del Moro constitutes one of the more remarkable sources of information for the latest Miocene continental record of western Europe. Its unique cosmopolitan assemblage, dated at 6.23 Ma (Ventian, biozone MN13, local zone M3), furnishes evidence of faunal dispersal from Africa and Asia to Europe during the latest Miocene glaciations, immediately prior to the Miocene-Pliocene transition and the beginning of the Messinian Salinity Crisis. Deer remains represent 4 per cent of vertebrate fossils collected at this locality. Previous preliminary studies (based on very rare, fragmentary and incomplete material; mostly cranial appendages, lacking complete pedicles) recorded the presence of one or two deer species. Recent excavation campaigns at this key vertebrate site have provided one of the most complete collections of Late Miocene European three-tined deer, including almost complete cranial appendages, craniodental remains (isolated teeth and more or less complete mandibles and maxillae) and post-cranial elements. Here we report for the first time these new specimens of three-tined deer and outline a reconstruction of antler morphology and its ontogenetic developmental sequence, as well as a preliminary study of some interesting palaeobiological features (such as age structure and dietary adaptations). The study of deer fossils from Venta del Moro will yield a more complete picture of the adaptive radiation of crown cervids in Europe.

Native presence of giraffes in central Europe revealed

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Giraffes successfully spread across vast regions of Afro-Eurasia during the Miocene. Their excellent fossil record provides evidence of an enormous diversity, quite different from the only surviving two African genera (*Giraffa*, *Okapia*) of today. However, evidence of giraffid colonisation in central, western and northern Europe was lacking.

Recently, a re-investigation of collection material from Austria and Germany has resulted in the discovery of fossil giraffid remains previously misinterpreted as belonging to other large-sized ruminants. In fact, the fossils document not only a central European invasion of giraffes contemporaneous with the horse *Hippotherium* at the beginning of the Late Miocene, but also their persistence over several million years.

This evidence has high impact on current understanding of the evolutionary history of giraffes comprising so far unknown taxa and their competitive ecological relationship with palaeomerycids (similarly sized extinct ruminant artiodactyls). Scarcity of uppermost Miocene and Pliocene deposits obscures the entire spatiotemporal range of giraffes and their time of disappearance in central Europe. However, generally there is no reason to judge as impossible a western European distribution and persistence into the Pliocene, as recorded from southern and eastern Europe.

Developing an ichnological data base: testing examples in EasyDB

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A modern ichnological data base should have a flexible structure to allow modification and changes, especially regarding the interpretation of taxonomy and trackmaker. Using the structure of EasyDB we present some samples of track entries, based on biped and quadruped dinosaurs and modern birds. The main item, constituting the fundamental base for all the information added, is the label of the single track – either an official museum ID or field label are accepted. To this object (the ID) are directly linked a range of data (e.g., 3D model, photos, diagnosis/description, line drawings, measurements). The ID of the single track is then connected to a series of hierarchical POOLS, based on non-modifiable information, which will group described trackways (as a series of ID), Level (as a series of trackways), Tracksite (series of Levels or Trackways), Megatracksite, Locality, Country and Continent. Other features of the tracks (e.g., posture, size and preservation), their interpretation (ichnotaxonomy and trackmaker) and geological setting (e.g., group, formation, member/unit, sediment, age, palaeoenvironment and palaeogeography) are added as TAGS. Tags can be linked to different pools, and above all, can be modified after the first entry. Each modification of the tags will be recorded and has to be justified with a reference to be accepted. The example provided wishes to illustrate the commonest palaeo- and neo-ichnological cases in order to create a solid background for the development and release of the data base.

Developing an ichnological data base: theoretical considerations of user roles, demands and benefits

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An online data base for ichnological data, including photographs and 3D models, will face different demands on data structure, user interface and usability, depending of the user type accessing it. We discuss various user roles: a scientist providing data (data provider), a scientist wanting to access and download data (data recipient), a scientist wanting to analyse data from within the database (data user), a curator managing the program (data administrator), a student helper or scientist entering data (data manager) and a computer specialist managing the software itself as well as storage capacities (IT administrator), and discuss how overall usability for data providers and users can be optimised. The greatest discrepancy exists between data users and data administrators/managers/IT administrators: whereas the former are best served by a host of analytical tools inbuilt into the database, the latter will prefer a simple data and program structure. We make suggestions how these differences can be accommodated, involving a universal, rigid data acquisition standard combined with a matching standardised data output.

Study of trackways as hierarchical structures and why details matter in comparative approaches

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Palaeosurfaces may feature several trackways left by distinct individuals. Each trackway includes one or several step cycles which in turn consist of a series of three successive imprints or imprint pairs, sometimes accompanied by further features, such as tail drag marks. Based on a detailed documentation of trackways in the field or laboratory, data stored in a trackway data base may include original data (photographs, digital surface reliefs) and different types of first-order interpretations, e.g., outline drawings, landmark co-ordinates, angle and length measurements. Considering the last-named, trackway averages often work well as criteria for various purposes, including ichnotaxonomic classification, trackmaker assignment and comparison of locomotion patterns. Nonetheless, individual step cycle and imprint data can yield considerable additional information on trackmaker biology and/or the palaeoenvironment and its preservation conditions: for a trackway sample from the Lower Permian of the Thuringian Forest assigned to basal amniote and non-amniote trackmakers it is demonstrated how patterns of along-track variation - as indicated by variance, homogeneity and completeness measures - can contribute to the discrimination of ichnotaxa, producers and their locomotion styles.

***Paradoxichnium problematicum* Müller, 1959 – a principal morph of Late Permian tetrapod tracks and its palaeoecological significance**

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Late Permian tetrapod footprints are poorly known and almost all of our scant knowledge is based on just two occurrences, namely the Arenaria di Val Gardena (= Gröden Formation) of the southern Alps, northern Italy, and the Ikakern Formation of the High Atlas Mountains, south-central Morocco. Both of these tetrapod ichnofaunas are attributed to the Lopingian, although the total stratigraphic range covered by the footprint-bearing strata of the Arenaria di Val Gardena and Ikakern Formation is still under discussion. Differences in the taxonomic composition of the Italian and Moroccan ichnofaunas are referred to presumably different palaeoenvironments. The red beds of the Ikakern Formation are interpreted to represent an alluvio-fluvial inland basin, whereas the succession of the Arenaria di Val Gardena is dominated by coastal lowland deposits. A recent revision of the Val Gardena tetrapod ichnofauna has revealed that tracks previously assigned to *Herpetichnium acrodactylum* and *Tridactylchnium leonardii* actually match the ichnotaxonomic characters of *Paradoxichnium problematicum*. The latter was introduced for a single true trackway (at least three consecutive manus-pes imprint couples) from epicontinental marginal-marine deposits of the Late Permian Zechstein of eastern Thuringia, central Germany. New examples of this tetrapod ichnotaxon have recently been recovered from coastal red beds of the Zechstein in southwest Germany and from the lagoonal palaeoenvironment of the Arenaria di Val Gardena-Bellerophon transition in Veneto, northeast Italy. All hitherto known records of *Paradoxichnium problematicum* come from coastal deposits along the Tethys Ocean (Italy) and the Zechstein Sea of the southern Permian Basin (Germany). There is no indication of this tetrapod ichnotaxon from the supposedly contemporaneous, well-exposed and ichnofossil-rich Ikakern Formation of Morocco. These data suggest that the distribution of *Paradoxichnium problematicum* is facies controlled and the potential trackmakers (basal Archosauromorpha, e.g., *Protorosaurus* von Meyer, 1830) may have preferred a marginal-marine habitat.

Triassic archosaur footprints from Switzerland – ichnotaxonomy and biostratigraphic implications

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Footprints of Triassic archosaurs are abundant in the western Swiss Alps (Lac d'Emosson) and are also known from the eastern part (Glarus). They occur on extended surfaces of the Vieux Emosson Formation of the Aiguilles Rouges Massif, in a 5- to 20-m-thick sandstone-siltstone sequence. Depositional environments were shallow streams and floodplains with playa lakes draining into the southern part of the Germanic Basin. Previously, footprints from this unit have been attributed to both basal archosaurs and dinosaurs on the basis of their variable shape and preservation with pentadactyl-tridactyl pes imprints. Ichnotaxonomically, pentadactyl morphotypes have been assigned to different chirotheriids (e.g., *Isochirotherium*, *Brachychirotherium*), the tridactyl forms to various dinosaur ichnotaxa based on Ellenberger's classification.

Recent discoveries of new track surfaces in the Emosson area allow a re-evaluation of their ichnotaxonomy due to a detailed study of their preservation and extramorphological variation. As a result, all Emosson footprints represent chirotheriids and purported 'dinosaur tracks' are simply incomplete variations. They are referred to the ichnotaxa *Chirotherium barthii*, ?*Chirotherium sickleri*, *Isochirotherium herculis*, *Isochirotherium* isp. and Chirotheriidae indet. During a detailed re-investigation of footprints in the Röti Dolomite of the Glarus Alps, these could be identified as *Chirotherium barthii*.

Assemblages from the Swiss Alps document a typical 'Buntsandstein' ichnofauna known from different localities in the Germanic Basin, and are similar to other occurrences from Pangaea. Biostratigraphically, *Chirotherium barthii* demarcates the *Chirotherium barthii* biochron and together with other chirotheriid ichnotaxa supports a Middle Triassic (Anisian) date for both the Vieux Emosson Formation and the Röti Dolomite.

Processing and analysis with ‘Cadence Toolset’ of Late Jurassic dinosaur track data systematically acquired during ten years of excavations prior to construction of Highway A16, NW Switzerland

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Excavations along Highway A16 by the Palaeontology A16 from 2002-2011 recorded 59 ichnoassemblages (>17,000 m²) comprising nearly 14,000 tracks (including 254 sauropod and 409 tridactyl trackways), providing systematic documentation (field measurements, sitemaps, (ortho) photographs, 3D-laser scans), plus the preservation of 700 track-bearing slabs and 200 casts with a total surface of >700-800 m². The track data are currently in the processing (standardisation, cross-checking) and analysis phase (2012-2018), whereas vectorising of sitemaps (global track positions) and assembling of trackway parameter measurements (relative track positions) in a data base are important tasks, constituting the two major, non-relational data sets. Since 2012 an ichnological data base and software toolset called ‘Cadence’ has been developed and used to extract and integrate information from the sitemaps with the trackway parameter measurements to create an extensive trackway data base for statistical data-mining and analyses. ‘Cadence’ introduces to ichnology the explicit association of uncertainty estimates with all quantitative data, entered through an interactive 3D-graphical interface. Uncertainty estimation helps control the propagation of error within computations, and permits sophisticated, multivariate statistical analyses between and within individual trackways based on the internal integrity of relative and global measurements. ‘Cadence’ permits exploration of potential relationships with a minimum of *a priori* conventional assumptions about the trackmakers (such as of hip height, gleno-acetabular distance, gauge, gait), and may provide more defensible conclusions about trackmaker size, identity, locomotion, and even social behaviour and interactions. This approach builds from a purely geometrical description of the data by avoiding pitfalls such as the subjective interpretation of a smooth ‘trackway path’ and by introducing ‘curvature’, a geometrical curved trackway path that will necessarily be described in terms of uncertainty and with minimal biological interpretation. The Cadence Toolset is applicable to other data sets in the animal kingdom and collaborations (e.g., of 3D-track morphometric variation, substrate properties and mechanics).

Can we discriminate between theropod and ornithopod dinosaur trackways based on footprint shape variation patterns? A geometric morphometrics approach

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Footprint shape is determined by three factors, namely the anatomy of the trackmaker's foot, foot kinematics and substrate. Variations in the two last-named can lead to significant shape differences, even within a single trackway. A good understanding of intra-trackway shape variability is crucial for the interpretation of fossil footprints. Here I test landmark analysis of footprint outlines as a method for detecting variability location. Footprint outlines were derived from photogrammetric 3D-models of tracks from the Lower Cretaceous Münchehagen tracksite (Lower Saxony, Germany). Three exceptionally long and well-preserved tridactyl trackways were analysed, produced by a large-sized theropod (T3), a medium-sized theropod (T2), and a medium-sized ornithopod (I1). All three trackways were preserved on the same bedding plane, suggesting similar sedimentary conditions. In the theropod trackways, most of the variation is concentrated in the lateral hypex and the heel, suggesting that any measurements relying on these points should be used with caution. A more anterior position of the heel generally co-occurs with a more posterior position of the lateral hypex in both theropod trackways, as indicated by principal component analysis. Shape variability in the ornithopod trackway is different, being distributed more evenly along the outline. This study indicates that theropod and ornithopod trackways can be differentiated based on footprint variation patterns. Mean shapes are shown to be valuable for the size-independent assessment and comparison of footprint shapes because the influence of intra-trackway variability is minimised.

The evolution of crushing dentition and tooth replacement strategies in Placodontiformes (Sauropterygia)

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Placodontiformes represent a clade of Triassic sauropterygians that inhabited nearshore marine settings in the western and eastern Tethys. The clade consists of Palatodonta, a taxon known from only one juvenile specimen that exhibits a double row of pointed teeth in the upper jaw, and the durophagous and often heavily armoured Placodontia. Until recently, little was known about the evolution of the highly specialised crushing dentition seen in placodonts, and about their method of tooth replacement. The present work aims to shed light on this issue with the use of cranial micro-computed tomographic (μ CT) scans of Palatodonta and all species of Placodontia.

The flattened, slab-like crushing teeth seen in all placodonts have the unusual feature of being found on the palatine bone, as well as the usual marginal elements. By studying the anatomy of Palatodonta, the condition appears to have first evolved for a non-durophagous diet and was only later adapted for this in Placodontia. In addition, analysis of tooth replacement patterns in Placodontia shows a unique and highly specialised method that allowed constant feeding, despite regular functional tooth loss. Patterns follow a phylogenetic trend, with plesiomorphic taxa replacing teeth with no discernible pattern and more derived, armoured taxa replacing teeth diagonally across the palate and/or in highly modular, unilateral functional groups.

Analysis of this comprehensive μ CT data set of placodontiform crania has revealed, for the first time, their unique method of tooth replacement and previously unknown evolutionary origins of their highly derived dentition.

Microanatomy, bone histology and growth of Nothosauria

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Nothosaurs are a successful group of Middle Triassic marine reptiles (Sauropterygia) that invaded the shallow epicontinental seas of the Tethys Ocean. Hundreds of isolated nothosaur bones can be found in Muschelkalk sediments of the Germanic Basin (central Europe), providing a decent data base for bone histological studies. These nothosaurs demonstrate parallel-fibred bone tissue which is dominated by longitudinal and radial vascular canals and sometimes primary osteons. The cortex is regularly stratified by growth marks. The growth pattern follows standard growth models used for extant reptiles. Nothosaur bone tissue is similar to that described for *Simosaurus* although – based on bone tissue organisation and vascularisation – the growth rate is lower in nothosaurs. Contrary to the uniform bone tissue and growth pattern, microanatomy changes in nothosaurs from the lower to upper Muschelkalk. The small *Nothosaurus marchicus* from the lower Muschelkalk has a triangular humeral cross section with a small to moderate medullary cavity. The triangular form of the cross section resembling an airfoil, as well as the dorsoventrally flattened overall morphology of the humerus, indicate an active use of the forelimbs during swimming. This is retained and intensified throughout nothosaur evolution. However, some large forms from the upper Muschelkalk reduced their cortex to few millimetres as was already described in 2013 by Krahl and co-workers, whereas other taxa retained a more 'normal' ratio between cortex and medullary cavity. These differences in microanatomy point to different swimming styles in nothosaurs (function signal) and may indicate the use of different habitats (developmental plasticity) or, alternatively, may constitute a phylogenetic signal.

Ontogenetic tooth reduction and niche shifts in *Stenopterygius quadriscissus*

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Here I present preliminary results of an ongoing study that assesses previously hypothesised ontogenetic tooth reduction in the ichthyosaur *Stenopterygius quadriscissus* (early Toarcian, Germany). Results demonstrate a clear negative allometric scaling of the dentition, resulting in a shift of masticatory functional morphology through ontogeny. I will discuss how this reduction in dentition correlates with a significant shift in stomach contents, implying an ontogenetic niche shift. The present study demonstrates how the application of contemporary ecological concepts, such as the ontogenetic niche, to palaeontological questions can allow for high-resolution reconstructions of the life history and behaviour of extinct species for which there are no extant analogues.

Palaeobiogeography of Late Jurassic ichthyosaurs; a genus-level approach

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During the Late Jurassic, important palaeogeographic events occurred in Eurasia, North America and Gondwana. Continental rift, subduction and orogeny produced different levels of marine inundation of terrestrial systems, with rising sea level. Shallow epicontinental seaways started to separate North America from Eurasia, Gondwana, and also between segments of Gondwana itself. Tethys, the east-west seaway, expanded and at times covered large parts of the continental interior of Eurasia. The aperture of new seaways such as the Greenland-Norwegian seaway and the Mezen-Pechora strait system in the northern hemisphere; the Hispanic Corridor, between North and South America; and the Trans-Erythrean seaway (or South Africa/Rocas Verdes seaway) in the southern hemisphere allowed for intermittent interchange of invertebrate and marine vertebrate faunas.

During the past five years, the ichthyosaur fossil record has provided a way to describe new species so as to complement diagnoses of species that for a long time had been either synonymised or considered invalid. These taxonomic studies allow us now to understand the paleo-distribution of the ichthyosaurs around the world better as the relationships between the realms of the northern-southern hemisphere and boreal regions. The present report is a generic-level analysis of the dispersal routes of ichthyosaurs during the Late Jurassic compared with one of its top predators, *Pliosaurus*, and the palaeogeographic significance of high-latitude species such as *Arthropterygius* spp., *Undorosaurus* spp., *Cryptopterygius* spp, *Janusaurus* and non-ubiquitous ichthyosaurs.

Marine vertebrates, environment and stratigraphy of the Albian phosphorite horizon at Annopol, Poland

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A mid-Cretaceous (uppermost lower Albian-lower Turonian) condensed, phosphorite-bearing marine succession is exposed near Annopol, central Poland. The Albian phosphorite horizon is the most fossiliferous unit of this succession. Its stratigraphy is based on ammonites and foraminifera, whereas the environmental interpretations rely on micropalaeontological, petrographical, mineralogical and geochemical data, including the Rare Earth Elements (REE) signatures of bones and teeth. Vertebrates are represented by bony fish, lamniform sharks, chimaeroids, protostegid turtles, platypterygiine and ophthalmosaurine ichthyosaurs, pliosaurid and elasmosaurid plesiosaurs, as well as rare pterosaurs. The Annopol vertebrate fauna is of intermediate biogeographical position between the better-resolved, classical assemblages from the Anglo-Paris Basin and central Russia. Most of the vertebrate material from the phosphorite horizon is of late Albian age. Isolated skeletal elements predominate, although partial disarticulated skeletons of sharks and ichthyosaurs also occur. The phosphorite horizon is a typical *Konzentrat-Lagerstätte*, characterised by the mass occurrence of largely disarticulated skeletal elements. Three factors were most important for its formation: 1) mass occurrence of marine vertebrates, including apex predators, in the original ecosystem (attracted by favourable trophic conditions in an upwelling zone); 2) concentration of vertebrate remains (and phosphatic nodules) in conditions of low or intermitently negative (erosion) sedimentation rate; 3) enhancement of fossil preservation by early diagenetic phosphatisation after burial.

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Niche differentiation in mosasaurs from the type Maastrichtian (the Netherlands/Belgium), as demonstrated by dental microwear

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During the Late Cretaceous, mosasaurs were successful marine reptiles, achieving a worldwide distribution and occupying a wide array of ecological niches. Recent research has aided in identifying the feeding guilds of the various mosasaur taxa. In the type area of the Maastrichtian Stage (southeast Netherlands, northeast Belgium), five species are currently known; *Carinodens belgicus*, *Prognathodon sectorius*, *Prognathodon saturator*, *Plioplatecarpus marshi* and *Mosasaurus hoffmannii*. Here we present a semi-quantitative dental microwear analysis of these taxa. Our pilot study employed SEM imaging and 2D-microwear analysis. This method is slightly outdated and less accurate in comparison to 3D-microwear texture analysis; however, 2D-analysis is faster, cheaper and easily accomplished. Moreover, 2D-microwear analysis suffices to distinguish between different feeding methods. However, inter-observer bias risk is greater in the use of 2D-microwear analysis; therefore employing a single observer is recommended. The soft, non-indurated nature of the biocalcarerites from the study area rule out the possibility of microwear having been caused by taphonomic processes. Microwear indicative of feeding on hard-shelled prey items has been observed in *Carinodens*, *Prognathodon saturator* and, to some degree, in *Mosasaurus*. *Prognathodon sectorius* must have fed on softer prey. Interestingly, *Plioplatecarpus*, often considered to have been largely piscivorous, displays coarse microwear. A preliminary comparison of the stratigraphic range of this genus and its possible food items (invertebrates and vertebrates alike) in the same strata, suggests that *Plioplatecarpus* might have preyed on belemnoid and ammonoid squid, cartilaginous fish (sharks, rays) and bony fish with thick scales and/or dermal plates.

**A new partial mosasaur skeleton from the Maastrichtian type section,
ENCI-HeidelbergCement Group quarry, Maastricht, the Netherlands
– preliminary observations**

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During the first collecting trip of 2015, organised by the Nederlandse Geologische Vereniging/afdeling Limburg, at the ENCI quarry, two of us (JB and LB) recovered several dissociated dorsal and caudal vertebrae of a mosasaurid, plus a single element of the hind limbs, from a level low in the Nekum Member/high in the Emael Member (Maastricht Formation, upper Maastrichtian, *Belemnitella junior* cephalopod Zone). At a lower level, within the Emael Member (Lava Horizon), additional material was collected; it appeared that it all belonged to a single individual that was disturbed by quarrying activities some time ago. Subsequently, in a first reconnaissance dig, seven dorsal vertebrae were found in anatomical position, as well as quite a number of elements of the posterior paddle, mostly metacarpals. Even a fragment of the pubis is represented in this lot. Bone quality is very good, and most fractures appear to be recent. Two weeks later, more posterodorsal and caudal vertebrae were recovered, as well as a single rib fragment with shark tooth marks and a single, large shark vertebra, suggesting scavenging to have occurred and concomitant loss of elements of the mosasaur skeleton.

Based on characters of dorsal and caudal vertebrae, this new specimen (nicknamed ‘Lars’) can be assigned to the mosasaurine *Mosasaurus hoffmanni*. Excavation at the site, now protected, is expected to continue during the summer of 2015, the prime goals being to remove the overburden first and get rid of thick brown mud and cobbles and boulders of varying sizes (originating from fluvial deposits that piped down into the chalk via dissolution pipes). In view of the fact that hind limbs are associated, which is quite rare in the study area, we hope there will be more of the skeleton (estimated length c. 10 metres), including the anterior portion, with skull, present at the site.

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Mississippian chondrichthyans from Czerna near Kraków, Poland

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Outcrops of Mississippian carbonates are rare in Poland, particularly in comparison to Belgium or the British Isles, and our current knowledge of Tournaisian and Viséan faunas (amongst them also chondrichthyans) from the former territory is relatively poor. Only recently has the first extensive description of a rich assemblage of pelagic sharks from the upper Viséan at Todowa Grząba (western Holy Cross Mountains) been published. Here I present the results of a study of a much smaller sample from another region in southern Poland, i.e., the Krzeszowice area, northwest of Kraków, where Mississippian limestones used to crop out in the valleys of small rivers near the village of Czerna. These strata are currently exploited in a huge quarry at Czatkowice, between Czerna and Krzeszowice.

Vertebrate microfossils from sample Cz-1, as byproducts of the search for conodonts, and collected from one of the degraded outcrops at Czerna, were given to me on loan by Jerzy Dzik at the beginning of the 1990s. This assemblage contains 27 chondrichthyan teeth, amongst them asymmetrical teeth of *Thrinacodus*, two types of *Denaëa*, one unusual multicuspid cladodont tooth and only three crushing euselachian teeth. In addition, there are ten chondrichthyan scales and numerous actinopterygian microfossils such as scales, teeth, vertebrae and other bone fragments. The ichthyoliths usually are slightly broken which indicates that they were deposited in a moderately energetic environment. The taxonomic content is definitely different from that which is characteristic of the carbonate platforms (i.e., usually rich in various euselachian and euchondrocephalan dental elements) and appears to be relatively similar to the pelagic assemblage from Todowa Grząba, despite certain differences at the specific level.

Hump-backed ginglymodian fish from the Jurassic PhuKradung Formation of Thailand

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So far, the Thai ginglymodian fish record from the Jurassic and Cretaceous Khorat Plateau comprises the lepisosteiforms *Isanichthys* and *Thaiichthys*, which have been found at two localities exposing the PhuKradung Formation, namely Phu Nam Jun and Phu Noi. Non-lepisosteiform ginglymodians, gathered in the Semionotiformes in some phylogenies, are still poorly known in Thailand and most of the potential candidates correspond to insufficiently preserved specimens. Here, we describe a new ‘semionotiform’ fish on the basis of a single specimen preserved as an impression on a slab of sandstone from the Phu Kradung deposit of Ban Tha Rue, Wang Nam Kheaw District, Nakhornratchasima Province. This species is characterised by a new combination of morphological features such as: skull bones smooth, lacking ornamentation; long frontal, ratio of frontal by parietal length *c.* 2.5; ratio of skull length to orbit length *c.* 5; a hump back consisting of a small number of dorsal scales with their extremity forming posterior spines; scales of the ventral edge with posterior spine. In order to address the relationships of this new species, we performed a cladistic analysis with a new set of 103 characters built on a critical combination of characters defined previously (between 2010 and 2014) by Grande, Cavin, López-Arbarello, Gibson and Deesri *et al.* In the strict consensus tree, the Ginglymodi is a fairly well-supported node but, contrary to the tree obtained by López-Arbarello, the Semionotiformes do not appear to be monophyletic in our analysis. The new species is located in a large polytomy together with eight other non-lepisosteiform ginglymodians. In the 50% majority-rule tree, the new Thai species is located in a pectinated position between a more basal clade including *Lophionotus* + ‘*Lepidotes*’ *microrhis* and a more derived clade including *Neosemionotus* + more derived ginglymodian.

These preliminary results indicate that the new species likely is a rather basal ginglymodian, in contrast to previously described species from Thailand, and, more generally, that this part of the phylogenetic tree of the ginglymodians is not yet resolved. The Thai fossil record of ginglymodians appears to be diversified and of great potential for better understanding the phylogeny of ginglymodians and indeed the evolutionary history of the whole clade.

A new billfish (Istiophoriformes, Istiophoridae) from the Upper Miocene of the Caribbean (Panama)

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Billfishes (Istiophoriformes) represent a large radiation of predatory bony fishes including eleven extant species, some with a worldwide distribution and large-distance movements. The fossil record of the order representatives extends ranges from the Upper Eocene to the Pleistocene, comprising six species. Here, we report a well-preserved billfish from the Upper Miocene (upper Tortonian-lower Messinian) Chagres Formation, in central Panamá. The fossil consists of a near-complete, 2.6-m skeleton with 18 articulated vertebrae and associated fins. The billfish belongs to the genus *Makaira* and is characterised by a wide and slightly stout cranium, 13 caudal vertebrae and 11 precaudal vertebrae with developed facets for rib articulation and expanded lateral apophyses. Additional characters include large nutrient canals in the rostrum, similar to the extinct *Makaira panamensis* and the sailfish *Istiophorus platypterus*, and a moderate vomer similar to extant species of the genera *Istiophorus* and *Kajikia*. Billfishes diversification started during the Early Miocene with a subsequent Pleistocene radiation of small-sized species concomitant with the extinction of several lineages. Ongoing research will attempt to produce a phylogeny for the whole clade, inclusive of all fossil taxa.

Mio-Pliocene elasmobranch faunas from the Urumaco sequence (southern Caribbean) and their palaeoenvironmental significance

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The Urumaco stratigraphic sequence is composed of seven geological units, with a variety of palaeoenvironments that include terrestrial, riverine, lacustrine and marine facies. A diversity of fossils associated with terrestrial and marine facies corroborate the presumption of an estuary, much influenced by a complex hydrographic system that flowed from western Amazonia up to the Proto-Caribbean Sea during the Miocene. A wide range of fossils have been described from the stratigraphic sequence, having the most diverse vertebrate fauna from the Neogene of the southern Caribbean, which include: marine, estuarine and freshwater fishes, freshwater and marine turtles and crocodylians, and terrestrial and aquatic/semi-aquatic mammals. Here the elasmobranch faunal assemblages of Middle Miocene-Lower Pliocene section of the Urumaco sequence (Socorro, Urumaco and Codore formations) are described for the first time. Based on new fossil findings, we show a palaeodiversity of at least 24 taxa, which includes dental elements of the following genera: †*Carcharocles*, †*Hemipristis*, †*Paragaleus*, †*Galeocerdo*, †*Rhizoprionodon*, †*Carcharhinus*, †*Negaprion*, †*Sphyrna*, †*Rhynchobatus*, †*Dasyatis*, †*Aetobatus*, †*Myliobatis* and †*Rhinoptera*, as well as abundant and well-preserved rostra of *Pristis*. Using the habitat preference of the living representatives as reference, we hypothesise that the fossil chondrichthyan assemblages from the Urumaco sequence are evidence of tropical coastal shallow waters and estuarine habits. The new data increase the scarce palaeodiversity and palaeoecological knowledge of Neogene chondrichthyans from the Caribbean and Tropical America in the framework of regional geological and oceanographic events.

Fintasia: cutting down the ‘Scythe Myth’

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Pachycormids occupy a key position within Actinopterygii as part of the Holostei-Teleostei Transition, although their precise placement in this hierarchy has long been disputed. New discoveries in the Toarcian of Scotland, and in the Kimmeridgian and Turonian of North America have expanded our global knowledge of the diversity, distribution and success of pachycormids, continuing the recent ‘Pachycormid Renaissance’. A supposedly core characteristic repeated throughout the literature describes a ‘scythe-like pectoral fin’ as a synapomorphy of the group, although a cursory review of pectoral fins across the fifteen recognised pachycormid genera suggests a much broader range of form. Their unusually long pectoral fins, in contrast to an otherwise generally reduced skeletal ossification, appear to have developed to counteract buoyancy problems in a group of bony fishes lacking a gas bladder. Over 90 pachycormid specimens were assessed using morphometrics and principle component analysis to analyse a variety of pectoral fin characteristics including aspect ratio, proportional fin length/body position, supporting recent analyses that show two distinct (‘toothless’ and ‘tusked’) diverging tribes of pachycormids. In addition to showing that the ubiquitously stated ‘scythe-like’ pectoral fin is not a pachycormid synapomorphy, three distinct pachycormid pectoral fin structural morphotypes were revealed. This range of morphotypes is consistent with the widely observed disparity in niche demonstrated by these animals throughout the Jurassic and Cretaceous, the pectoral fins revealing adaptations from agile and swift, medium-sized predator, to large and slow-cruising suspension feeder, with the associated large differences required in cruising speeds and lifting surfaces to facilitate these lifestyles.

Osteoglossomorph palaeobiogeography – fossils refute ideas based on recent distribution

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Phylogenetic analyses in 2008 of the many marine Eocene osteoglossiforms have refuted the hypothesis put forward by zoogeographers to consider this group as a prime example of ‘primary freshwater fishes’, with a ‘Gondwanan’ distribution at present. The distribution of these marine species (*c.* 10 in number) all over the osteoglossiform tree made it much simpler to assume that the main trunk was marine, and that extant osteoglossiform groups were survivors among the few groups that invaded freshwater. Earlier I predicted that the ‘missing’ Cretaceous marine members would be found in the Pacific Realm. Confirmation came in 2009 with the find (together with Alvarado Ortega) of three small, primitive relatives from the marine ‘mid-Cretaceous’ at Tlayua, Mexico (presented in 2010 at the Mesozoic Fish meeting, Saltillo), the implication being that all Osteoglossomorpha, inclusive also of the primitive hiodontid lineage (today two species in North America) were invasions from marine into freshwater. In 2010 Alvarado Ortega identified a marine Paleocene fish from Chiapas as a ‘hiodontid’ (pers. comm.), and another one from Tlayua also seems very ‘hiodontid-like’ (pers. obs.). A fragmentary premaxilla from the marine Fish Clay (lowermost Danian) in Denmark appears osteoglossid-like (Danekræ book, 2008). In 2012, Louis Taverne described a supposed pantodontid (usually grouped near the osteoglossid-arapaimid clade) from the marine ‘mid-Cretaceous’ in Lebanon. The entire osteoglossomorph ‘order’ (hiodontids plus osteoglossiforms) thus appears to have originated in the sea with a few groups invading freshwater – and this includes also some primitive freshwater forms from the Lower Cretaceous of China, and the Late Cretaceous-Eocene freshwater phareodontids. The conclusion is that modern hiodontids, mormyroids, notopteroids, and even osteoglossids and arapaimids, represent independent invasions into freshwater settings – they are not ‘primary freshwater fishes’!

Mysteries in the phylogeny of early tetrapods, and their evolutionary implications

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‘Nothing makes sense in biology except in the light of evolution’, and ‘nothing makes sense in evolution without a phylogeny’ – a robust phylogeny is necessary to test hypotheses about the evolution of individual characters as well as evolutionary trends. The current ‘textbook’ tetrapod phylogeny has largely been taken for granted by recent research into such problems, but parts of it are shakier than they seem. Some widely held evolutionary hypotheses may therefore be without foundation. Based on an improved data set for phylogenetic analysis, new characters and new fossils, I present open questions and their implications for such problems as terrestrialisation. *Ichthyostega* appears to be less crownward than *Acanthostega* and may represent a very early origin of a seal-/mudskipper-like lifestyle independent of terrestrial tetrapods. Anthracosauria (Embolomeri) may lie more rootward than Temnospondyli, possibly even outside a clade that likely plesiomorphically had amphibious adults; temnospondyl phylogeny remains confusing. ‘Lepospondyli’ is most likely closer to Amniota than is Seymouriamorpha; Diadectomorpha and Amniota appear to be sister groups as usually thought, but the latter may plesiomorphically have a temporal fenestra, and its early phylogeny is not quite clear. Adelospondyli likely belongs together with Colosteidae rather than ‘Lepospondyli’; Aïstopoda apparently belongs far down on the tetrapod stem and contains another separate origin of terrestriality. ‘Microsauria’, and especially ‘Nectridea’, need to be revisited in detail; Lissamphibia and Albanerpetidae currently appear closer to the ‘lepospondyl’ clades *Scincosaurus*, *Lysorophia*, *Batropetes* and *Carrolla* than to the amphibamid temnospondyls.

Organisational instability as initial phase of evolutionary change: evidence from evolution of temnospondyl amphibians

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Transformation of a physical system from one state of matter to another proceeds through a *phase transition* that results from a critical increase of the system's fluctuations in range. The same holds true for transformation of an organism system towards a new body plan. Any evolutionary event, induced by irreparable disturbance of the normal developmental pathway, starts with a replacement of the adaptive norm by a variety of aberrations and then goes on as selective stabilisation of the most viable of these. Hence, *new evolutionary change starts as depletion of organisational stability and continues as its restoration*. Accessed at different scales, the initial (unstable) phase of this process is detectable as a grade of phenomena ranging from rapid *increase in individual variability* (at speciation level) to *disorderliness of the group body plan* termed 'archaic diversity'. Empirically, this course of starting events is implied *per se* in such generalisations as the loss of transitional forms from the fossil record, 'punctuated equilibrium', 'non-coherent evolution' and, primarily, 'quantum evolution'. So-called 'senile'(terminal) variability revealed by some lineages approaching their extinction manifests in fact the very onset of the search for a new body plan, whatever is its final success. Evidence of such a mode of initial diversification is provided by the evolution of temnospondyl amphibians across the Permian-Triassic boundary, i.e. on their way from the Palaeozoic structural pattern to the new ('stereospondyl') one. Both the Permian trimerorhachoid relicts (Dinosauridae) and some pioneer Scythian families demonstrate, at species or generic level, chimerical combinations of characters that normally distinguish high-rank taxa or major evolutionary grades.

Morphological integration in the skull of Palaeozoic tetrapods

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Morphological integration is the cohesion among traits that results from developmental and/or functional coupling. It is a key factor for understanding evolutionary processes, as it can constrain or facilitate the evolution of complex phenotypes.

Herein, the patterns of morphological integration of the skull table of the dissorophoid temnospondyls *Apateon pedestris* and *Micromelerpeton credneri*, and the seymouriamorph *Discosauriscus austriacus* are analysed and compared. Two hypotheses on the integration patterns were tested in each taxon: firstly, based on the shared developmental origin demonstrated in extant mammals, a higher integration between frontals and postparietals and between parietals and tabulars is expected, and secondly, given that postparietals and tabulars form at the latest ossification stages in *Apateon*, they are expected to be more integrated to each other than to parietals and frontals.

A similar degree of total integration between taxa was retrieved, but the patterns of pair-wise integration between elements differed. The correlations between frontals and postparietals in *Discosauriscus* and between postparietals and tabulars in temnospondyls were the highest observed. This agrees with the first and second hypotheses, respectively. However, both hypotheses were rejected for all groups after statistical tests.

It is expected that the inclusion of more fossil taxa and further studies will shed light on the origins of cranial integration and its role in the evolutionary history of the skull.

Digitising the five-fingered forelimb of *Metoposaurus diagnosticus krasiejowensis* using photogrammetry

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Metoposaurus diagnosticus krasiejowensis is a temnospondyl amphibian from the Upper Triassic of Krasiejów, southwest Poland. The material studied includes a humerus articulated with an ulna and radius, as well as an articulated manus. For better visualisation and archiving this unique specimen, computer-based photogrammetry was used. Photogrammetry is employed to determine the geometric properties of objects from photographic images. This method, which only has become viable since mid-2012, extracts 3D-data from 2D-photography. Unlike any scanning technique, photogrammetry is scale independent. There is no limitation in size and surface, i.e., ‘If you can see it, you can capture it’. This method probably offers the best colour information capture. Finally, suitable results are achieved relatively fast and cheaply. Digitalisation of the fossils in a three-dimensional view has been conducted using the software Agisoft Photoscan, and both 3D-Models were merged with PolyWorks. Using the models along with the specimens, details of the manus could be described. The manus contains five metacarpals, yet only four digits. The phalanx formula is 1-1-3-3-0. Pentadactyly is an extremely rare character among Temnospondyli, having been recorded to date only for *Paracyclotosaurus davidi*. Previous assumptions of a four-digit manus within the Metoposauridae were based on completely articulated individuals of *Dutuitosaurus ouazzoui*, a close relative of *Metoposaurus*. The pentadactyly of *Metoposaurus diagnosticus krasiejowensis* is thus a unique character among Temnospondyli.

Early genome size increase in urodeles

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Urodeles have the largest genomes among extant tetrapods, varying greatly between metamorphic and neotenic species, which have the smallest and the largest genomes of the group, respectively. The evolutionary tempo and mode of genome size expansion in Urodeles are poorly documented, especially because genome size does not directly fossilise. Consequently, the ancestral state for genome size, and therefore the polarity of its evolution in Urodeles are uncertain. However, recent studies have demonstrated that osteocyte (lacunae) size is correlated with genome size. Here we present histological data on osteocyte lacuna size from one of the oldest known stem-Urodeles, *Marmorerpeton*, from the Middle Jurassic (Bathonian, 168-166 Ma), as well as on five extant urodele species. Our analysis of these taxa, coupled with previously published data, suggests that, by the Bathonian, stem-Urodeles had already evolved large genomes that are typical of extant urodeles.

Evolution of impulse locomotion in Synapsida from Early Permian to Late Cretaceous

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The gait of reptiles relies on static friction of the autopodia on the substrate, where the claws act as anchors. Kinetic friction can occur. Autopodial rotation is compensated by passively mobile digital joints. In contrast, mammals usually use impulse locomotion, where rolling resistance occurs, which mainly is warranted by sole pads rather than the claws. The foot is set and lifted without kinetic friction. The digital joints directly transfer load from the limb to the ground because of the coherence of the invoked joint surfaces. The spring effect of the zigzag configuration of the kinematic chain of the limbs and the autopodial rays is crucial for impulse locomotion. In the tendons, tension is stored when the autopodium is set and load is applied. This tension is released during propulsion.

In Synapsida from the Early Permian to the end of the Cretaceous, the reduction of the degrees of freedom in the digital middle joints and the upper ankle joint and the evolution of a near-symmetrical metapodium indicate an evolutionary replacement of autopodial rotation by a (semi)parasagittal stance and gait. In all Therapsida, including the earliest forms with a sprawling locomotion such as *Titanophoneus*, the autopodial rays show a zigzag configuration and a good digital joint guidance. Evidently, earliest Therapsida performed an incipient stage of impulse locomotion. This was improved by the gradual increase of an energy-saving parasagittal gait and a reduction in autopodial rotation. Both trends facilitated a prolonged activity phase of the animals.

New information on the morphology of the *Zambian* dicynodont *Syops vanhoepeni*

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The Upper Permian Madumabisa Mudstone (Luangwa Basin, Zambia) has yielded a rich assemblage of dicynodont therapsids. Among the 14 currently recognised dicynodont species from this assemblage is *Syops vanhoepeni*, previously known from three partially preserved skulls. This taxon was originally described as a species of *Dicynodon*, and even following its recognition as a separate genus, *Syops* was previously thought to be a dicynodontoid (i.e., the group of dicynodonts including *Dicynodon* and its closest relatives). More recent analyses have recovered *Syops* as a cryptodont, more closely related to geikiids such as *Aulacephalodon* than to dicynodontoids. However, support for this position has remained weak, due in large part to the large amount of missing data on this taxon.

Here we describe a new specimen of *Syops vanhoepeni* collected in the Luangwa Basin in 2009. The new specimen is a partial skull (broken into three parts) associated with three pieces of the lower jaw. This specimen preserves previously unknown characters of the palate, brain case, occiput and lower jaw, significantly improving our understanding of *Syops* anatomy. Important morphological details revealed by the new specimen include the strong naso-frontal crest, absence of a true labial fossa and a robust dentary shelf. Diagnostic characters of the species also include a relatively long, low snout, anteriorly projecting massive tusks, postcaniniform crest, a thick median ridge, elongate nasal bosses and a narrow intertemporal bar with postorbitals extensively overlapping the parietals. The presence of a strong naso-frontal crest further supports the placement of *Syops* within the geikiid clade.

The latest Permian-earliest Triassic microvertebrate fauna from the Vyazniki, Russia

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The Permo-Triassic section at Vyazniki provides evidence of terrestrial floras and faunas at, or close to, the Changsingian-Induan boundary. This locality has yielded numerous vertebrates, including fishes, amphibians and reptiles and has recently been studied in detail by Russian, Russian-British and Russian-Polish teams. Since the first and preliminary recognition, it has been apparent that the Vyazniki microvertebrate assemblage represents a unique fossil fauna. This assemblage includes an apparent shark, sarcopterygian and actinopterygian fish teeth, scales and bones, but also small amphibian and reptile remains. Teeth and scales predominate in assemblages. The uppermost Permian part of the section (Sokovka site in Vyazniki) has yielded previously unreported fish taxa (e.g., *Lissodus*, *Discordichtys* and ‘*Asterodus*’) and cranial and post-cranial elements of small tetrapods (e.g., *Dinocephalia*, *Bolosauridae* and *Protosauridae*). A typical latest Permian fish fauna was found in the conglomerate layer in the Fedurniki sand pit in part of the section with the postulated Permian-Triassic boundary. Probably, fossils from this high-energy layer were reworked from the underlying uppermost Permian deposits which is strongly supported by the presence of numerous clasts of Upper Permian rocks in the same bed. The Lower Triassic part of section is poor in specimens and nearly totally dominated by remains of small temnospondyls (*Tupilakosaurus*). The absence of typical Permian taxa in the upper part of the Fedurniki section is perceptible.

Genesis of bone accumulations in the Röt (Lower Triassic, Olenekian) of the Opole Silesia region, southern Poland

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Numerous remains of reptiles and fish have been found in the uppermost Röt (Lower Triassic, Olenekian, ~247 Ma) in the vicinity of Gogolin (Opole Silesia, southern Poland). The reptile remains may be assigned to *Dactylosaurus* (Pachypleurosauria, Pachypleurosauridae), *Nothosaurus* (Eusauropterygia, Nothosauroida, Nothosauria, Nothosauridea) and unidentified taxa. The disarticulated vertebrate skeletal parts are accumulated at least in two levels. The lower level comprises thin-bedded limestone layers, mostly calcitised dolomites. Up to 3-cm-long vertebrate skeletal parts are accumulated in 1-cm-thick grey limestone laminae, which contain Fe oxyhydroxide-rich remnants of wrinkled microbial mats, small bioclasts (ostracods, foraminifera, bivalves and gastropods), coprolites, peloids, intraclasts, non-carbonate detrital grains and primarily sulphate nodules diagenetically replaced with chalcedony. The limestone laminae constitute intercalations within distinctly orange-coloured dedolomite layers which are up to several centimetres thick. Moreover, ostracod-dominated bioclastic limestones and marl laminae occur at this level. The upper level comprises marly limestones with bioclastic laminae. The vertebrate remains are accumulated in a 2-cm-thick rusty-coloured marl lamina. It contains smaller bones, mostly vertebrae and long bones up to 1-1.5 cm in length, and also minute fish scales and teeth. Desiccation cracks were found at the bottom of the overlying bed. The above-mentioned features and constituents suggest that the sediments of both levels were deposited on the tidal flat and/or in the surpratidal ponds. It is worth emphasising that Gogolin is likely the second or third site with Röt deposits (within the Germanic Basin) where remains of *Dactylosaurus* have been found, and the richest one.

The biodiversity of early Middle Triassic reptiles from Upper Silesia

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Middle Triassic vertebrate remains from Upper Silesia and the easterly margin of the Upper Silesian Coal Basin have been known at least since the early nineteenth century. In spite of this, the current state of knowledge of early marine and semi-aquatic reptile diversity from Lower/Middle Triassic boundary levels in these areas is still very poor. The most important goal of this project is to develop comprehensive systematics and a stratigraphic succession of reptiles from the Polish Middle Triassic, as well as an understanding of their mutual ecological and biogeographical relationships. Fieldwork, including palaeontological excavations at Żyglin and Jaworzno, have been complemented by a revision of specimens from historic collections at Polish and German museums. The newly described material includes remains of nothosaurs, pistosaurs, pachypleurosaurs, placodonts and other marine reptiles, including enigmatic taxa such as *Hemilopas* and *Saurophargis*. Analysis of the ecophenotype succession of reptiles throughout this relatively extended time interval (lowest Anisian-uppermost Ladinian) and the large geographical area will shed light on the palaeobiogeography and temporal and spatial distribution of marine reptile taxa in the Polish part of the European Basin during the Middle Triassic.

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Status quo of the *Europasaurus* Project: terrestrial vertebrates from Kimmeridgian limestones at the Langenberg Quarry (Lower Saxony, Germany)

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The Langenberg Quarry near Goslar is a classic outcrop of Upper Jurassic marine strata in northern Germany. In Jurassic times, the area was surrounded by large palaeo-islands. One island was the habitat of terrestrial vertebrates and plants which became deposited in the shallow-marine basin. The quarry is best known for abundant remains of the dwarfed sauropod dinosaur *Europasaurus*, but has also yielded theropod and stegosaurian dinosaur teeth, articulated pterosaur remains, the atoposaurid crocodyliform *Theriosuchus* and a paramacellodid lizard. The lack of new *in-situ* dinosaur finds still limits taphonomic studies to material which has been recovered without documentation after blasting operations. However, photogrammetric documentation now allows 3D-reconstruction of all bones within the prepared blocks. Microvertebrate assemblages recovered by extensive screenwashing are dominated by teeth of fish, marine and atoposaurid crocodyliforms. Recently, the first evidence of Mesozoic mammals in Germany has been discovered: a complete m1 with ornamented enamel indicating a plagiulacid multituberculate with affinities to *Proalbionbaatar* from contemporaneous deposits at Guimarota (Portugal). Natural dinosaur track casts discovered stratigraphically only five metres above the *Europasaurus*-bearing layer are the earliest evidence of emergence in the Langenberg section, indicating a sea level fall. The two largest, best-preserved natural track casts are assigned to theropod dinosaurs. Their length is 46 and 47 cm, respectively. With a calculated hip height of 180-190 cm and a body length of 7-8 m, the trackmaker was larger than any animal known from the dwarfed island fauna, indicating a faunal interchange ≤ 35.000 years after the *Europasaurus* bone accumulation.

News on the Late Cretaceous Las Aguilas dinosaur graveyard, Coahuila, Mexico

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The latest excavation campaign in Upper Campanian strata at the locality Las Aguilas, 40 km west of Saltillo, Mexico, has not only yielded a partial skeleton of a medium-sized hadrosaur, but also articulated skeletal remains of an ornithomimosaur. This theropod was discovered by a private palaeontologist close to our site and includes cranial elements that allowed for a secure identification. A new site with macro-, meso- and microfossils was discovered by one of us (N.A. Torres) during geological survey. Bones of several hadrosaur individuals of different size classes are abundant, but we also recovered teeth of a tyrannosaurid theropod, a pelvic fragment of a lambeosaurine hadrosaurid, longbone fragments and a phalanx of dromaeosaurid theropods, remains of a small bird, four different species of turtles, vertebrae of small eusuchian crocodylians that were not longer than one metre and two small plesiosaur phalanges. The plesiosaur phalanges represent the first occurrence of the group in the Upper Campanian of Las Aguilas. The presence of saltwater intolerant turtles suggests that the plesiosaurs either migrated into the freshwater zone of the delta, or were washed in by tides or storms. Geological investigations have revealed that the dinosaur remains result from 13 distinct layers, which were deposited in a rapidly oscillating deltaic system. The abundance of bone material in association with dinosaur tracks and plant remains makes this site unique; it allows for a detailed reconstruction of the palaeoecology during the Late Campanian of the southernmost area of the North American continent. The latest activity at Las Aguilas was the 3D scan of numerous well preserved footprints of deinonychids, coelurosaurs and hadrosaurs.

Never say never – new additions to the composition of the oldest latest Cretaceous continental vertebrate assemblage in Transylvania, western Romania

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Transylvanian (western Romania) latest Cretaceous vertebrate assemblages have been considered restricted in age to the Maastrichtian for many years. Only recently, with the discovery of a new transitional succession³ from Campanian marine to Maastrichtian continental beds, has the presence of latest Campanian continental vertebrates been documented in this area. In 2012 and subsequently in 2014, we reported on the palaeontological content and age constraints of the Petrești-Arini section, in the southwestern Transylvanian Basin. This section comprises a continuous exposure across both the Campanian/Maastrichtian boundary and the marine Bozeș Formation/continental Sebeș Formation boundary, through a transitional brackish succession, and has yielded vertebrate remains from several levels, including one that was dated confidently using nannoplankton as latest Campanian. Based on the available Petrești fossil record, a less diverse vertebrate assemblage was identified pre-dating the classic ‘Hațeg Island’ assemblages of the later Maastrichtian. The Petrești succession is an extremely endangered outcrop because of ongoing hydrotechnical works to concrete the river banks; however, these works progress slowly, and prospecting and excavations are still possible. Recent prospecting has revealed the presence of a vertebrate-rich lens hosted by a peculiar concretion-bearing facies in the brackish part of the local succession. A preliminary survey of this lens material has documented a microvertebrate assemblage with fish, amphibians, lizards, crocodyliforms, dinosaurs and multituberculate mammals, besides a macrovertebrate assemblage made up of various dinosaurs, pterosaurs and turtles. The Petrești lens thus significantly expands our knowledge regarding the oldest vertebrate assemblage of the ‘Hațeg Island’.

Early Paleocene marine vertebrates from the southeast Netherlands and northeast Belgium

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Over recent years, fairly diverse assemblages of sharks, rays, chimaeroids, bony fish and crocodiles have been recovered from lower-middle Danian strata (Geulhem Member, Houthem Formation), at Vroenhoven (Belgium) and Geulhem (southern Limburg, the Netherlands). Taxa recognised so far include paleospinacids (*Synechodus faxensis*), hexanchids (*Notidanodon* sp.), heterodontids (*Heterodontus lerichei*), carchariids (*Carcharias gracilis*, *C.* sp., *Striatolamia cederstroemi*), odontaspidids (*Odontaspis speyeri*), otodontids (*Cretalamna appendiculata* formae *lata* and *pachyrhiza*), triakids (*Palaeogaleus* sp.), mobulids (*Eomobula* sp.) and dasyatids (*Dasyatis* sp., *Hypolophodon sylvestris*). Of note is the predominance of medium- to large-sized teeth of *Cretalamna*; however, a certain collection bias cannot be ruled out.

Faunas match assemblages recorded from elsewhere, documenting a severe impact across the Cretaceous-Paleogene (K/Pg) boundary, with ‘open-water’ predators, e.g., Anacoracidae and Cretoxyrhinidae, and durophagous forms such as Sclerorhynchidae and Rhombodontidae having been hit hard. During the early Paleocene these were replaced by other groups with broadly similar ecological requirements. Bony fish include sparids (isolated teeth) and *Ostracion* (dermal plates). Top predators in the early Paleocene included marine crocodiles, such as *Thoracosaurus*, that successfully replaced the latest Cretaceous mosasaurid reptiles, with records from Denmark, Sweden, Poland and New Jersey. Similar to invertebrate assemblages, these vertebrate faunas display clear links to the Danish type Danian, but also to the Mons Basin (southern Belgium), and even further south, to North Africa (Morocco).

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Taxonomic diversity of the vertebrate assemblages from Copăceni – a new reference site for the Lower Pleistocene of the Dacian Basin, Romania

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The Lower Pleistocene ‘Copăceni Beds’, a stratigraphic unit of uncertain rank, comprise a sequence of fluvio-lacustrine silts, fine-grained sands and coquina layers that crop out along the banks of the River Argeș, 20 km south of Bucharest. A survey of the river banks during lowstand intervals has led to the discovery of numerous large mammal fossil remains, including proboscideans (*Mammuthus meridionalis*), rhinocerotids (*Stephanorhinus ?etruscus*), bovids (*Leptobos vallisarni*) and cervids (*Praemegaceros pliotarandoides*). The presence of carnivores is so far only documented by the presence of a single coprolite, similar to those described for the hyaenid *Crocuta crocuta*.

Several layers were tentatively screenwashed to test for the presence of microvertebrates. Although only small amounts of sediment were screenwashed so far, a fairly large number of microvertebrate remains were found. The small mammal assemblage is quite diverse, and includes rodents (*Castoridae* indet., *Allactaga*, *Mimomys savini*, *Lagurodon arankae* and *Allophaiomys pliocaenicus*) and insectivores (*Desmana ?radulescui*). Ectothermic vertebrates are also present, including a rich and diverse fish assemblage (*Carassius*, *Squalius*, *Tinca*, *Rutilus*, *Scardinius*, *Esox* and *Silurus*), but also anurans (*Rana*, *Bufo*), caudates (*?Triturus*) and snakes (*Natrix tessellata*).

Mammal biostratigraphy dates the vertebrate assemblage from Copăceni towards the end of the Early Pleistocene (about 1.1-1.0 Ma). Although research at Copăceni has only started recently, the palaeobiodiversity recorded from this area is quite high, placing it among the richer and most diverse Lower Pleistocene vertebrate assemblages from the Dacian Basin, second only to those known from the Tetoiu Formation.

Mio-Pliocene amphibian and reptile assemblages from western Siberia – palaeobiogeographic and palaeoclimatic implications

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Amphibian and reptile faunas from about 40 localities exposing strata of Middle Miocene to earliest Pleistocene age in western Siberia have been studied. These localities are situated directly to the east of the Ural Mountains, in the territory of southern Russia and northern Kazakhstan. The stratigraphy of the area is based on palaeomagnetic studies and biochronology of rapidly evolving small mammals.

Our studies have revealed an unexpectedly rich herpetofauna, of ten amphibian families (Hynobiidae, Cryptobranchidae, Proteidae, Salamandridae, Bombinatoridae, Palaeobatrachidae, Pelobatidae, Hylidae, Bufonidae and Ranidae) and seven reptile families (Emydidae, Gekkonidae, Lacertidae, Anguidae, Colubridae, Viperidae and Elapidae). These assemblages contribute to our understanding of the evolution and biogeography of cool-temperate amphibians and reptiles of Eurasia. The palaeobiogeographic analysis shows a predominance of elements with a European origin, such as Palaeobatrachidae, *Hyla savignyi*, *Bombina bombina*, *Ophisaurus*, *Bavariboa* etc. Forms with Asiatic affinities are few, e.g. *Salamandrella*, *Tylototriton*, *Bufo viridis* and *Alsophylax*. Our results suggest an Asiatic origin for *Salamandrella*, *Mioproteus*, the *Bufo viridis* species group and *Rana* which have (wide) spatial and temporal distribution in the Late Paleogene and Neogene of Europe. From the start of the Early Pliocene onwards, faunal diversity (1-3 taxa per locality) diminished, most probably due to a gradual climatic cooling.

Paleoprecipitation values for some of the localities have been estimated based on bio-climatic analysis of the herpetofauna. The humidity signals we compare and discuss with those existing humidity proxies from Eastern Paratethys and Central Europe. The comparison revealed also significantly higher humidity in comparison to the recent-day humidity values.

Deciphering nature in the 17th century – cases relevant to vertebrate palaeontology

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In Medieval beliefs, objects that – in a modern sense – are fossils were associated with crafts or omens. Well-known in an age of frequent poisoning cases were, among others, the tongue stones and their magical property of neutralising poison added secretly to served wine. Such beliefs intrigued rational *medici* of the Renaissance, and their studies of objects and processes in nature prepared the ground for palaeontology. Steno, or Nicolaus Stenonius (1638-1686), during his residence at the inspiring court of Grand Duke Ferdinando II of Toscana (where he had arrived in 1666), contributed to the interpretation of tongue stones as fossil shark teeth and of natural sedimentation as expressed in the principle of superposition.

Being a student of Medicine, Stenonius, following Danish tradition, had left Copenhagen for supplementary studies in Europe and started in Amsterdam in 1660. When he left, Denmark was at war with Sweden, and Copenhagen was under siege. During the early decades of the century, Denmark-Norway had prospered as a strong and wealthy double-monarchy under a king who supported the advancement of science. In the mid-1600s, disastrous wars contributed to the decline and impoverishment of the kingdom. Steno in Toscana had learned from others during his growth as a researcher. Here will be reviewed ideas from his Nordic background that were conducive to the scientific interpretation of fossils.

The twentieth anniversary of the Buia Project: vertebrate palaeontology in the Lower Pleistocene of Eritrea (East Africa)

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Started in late 1994 as research focused mainly on geological survey and regional geology, thanks to collaboration between the Asmara Department of Mines (Eritrea) and the University of Florence (Italy), the Buia Project soon allowed the recovery of abundant Early Pleistocene vertebrates associated to archaeological artifacts in an area located about 20 km south of the village of Buia (Northern Danakil Depression). In late 1995, a human cranium and other dental and post-cranial remains were retrieved in the Wadi Aalad area, in a layer dated through different approaches and falling within the Jaramillo Subchron (C1r.1n), at approximately 1.0 Ma. Exactly 15 years later, other human remains were found at Mulhuli Amo, a different locality chronologically equivalent to Wadi Aalad. Field work carried out in the last 20 years has led to the identification of three taxa of fish (*Clarias* sp., cichlids, barbine minnows), four reptiles (*Crocodylus niloticus*, *Pelusios* cf. *sinuatus*, *Varanus niloticus*, *Python* gr. *sebae*), three birds (*Anhinga* sp., Rallidae indet., *Burhinus* sp.), and 20 mammals (worth mentioning are: *Theropithecus* cf. *osvaldi*, *Elephas recki*, *Ceratotherium simum*, *Equus* cf. *grevyi*, *Hippopotamus gorgops*, *Kolpochoerus olduvaiensis*, *Kolpochoerus majus*, *Bos buiaensis*, *Tragelaphus* cf. *spekei*, *Kobus* cf. *ellipsiprymnus* and cf. *Thryonomys* sp.). For taphonomic reasons, small vertebrates are underrepresented and so far amphibians are still missing despite the fact that most likely they were originally present in the fluvial and fluvio-deltaic environment that is documented by the whole fauna and sedimentological proxies. Current research is aimed at reconstructing trophic chains and palaeoecological scenarios through stable isotope analyses.

The use of x-ray fluorescence in dinosaur and other vertebrate palaeontological studies

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X-ray fluorescence (XRF) spectrometry is a non-destructive method which allows rapid identification and mapping of elemental distributions in a wide variety of samples. The recent acquisition of a Bruker Tornado M4 XRF spectrometer in our lab allowed characterisation of element distributions in dinosaur bone and eggshell specimens from different localities. Results of XRF scans may be used to identify small fragments of thin eggshell, which would otherwise be difficult to characterise with classical microscopy or even scanning electron microscopy methods. The calcium of the eggshell and phosphor of remnants of the membrane are usually clearly distinguishable from the surrounding matrix. In bones, calcium and phosphor are generally well preserved, but the vascular spaces, osteocyte lacunae and other cavities of dinosaur bone function as a sponge for diagenetic elements such as iron, strontium, yttrium but also uranium and other Rare Earth Elements (REE). Clive Trueman and other scientists have already demonstrated that REE can be a powerful tool for taphonomic investigations. The unique patterns of REE and other trace element concentrations of fossils and fossil sites also harbour the possibility for application of XRF to identify and provide a chemical fingerprint of fossil localities. Such fingerprints may be used to target illegal fossil trade and potentially help resolve legal issues surrounding fossils of a questionable status. Nonetheless, proper comparative standards need to be established using classical acid solution and/or other mass spectrometry methods before an extensive data base of fossil locality trace element fingerprints can be compiled.

Reliability of estimating phylogenies from shape and similar multidimensional data

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In recent years, shape and other multidimensional quantitative traits have been used in phylogenetics. However, there is no consensus about the reliability of the phylogenies built using these traits. Empirical studies have yielded different results in this regard. Here, we simulate the evolution of four taxa under a Brownian motion model in a multidimensional space with varying dimensionality and different sets of branch lengths. In addition, two more sets of simulations with different degrees of integration among variables are tested using modified Brownian motion models. For each simulation the lengths of all three possible unrooted trees are computed using squared-change parsimony. Simulations are replicated and the percentage of correct phylogenetic reconstructions is used as a measure of phylogenetic accuracy. The results suggest a positive effect of the dimensionality and the length of the central branch. With low dimensionality, the phylogenetic accuracy is poor and problems of long-branch attraction appear. If more quantitative variables are used, convergence is unlikely. However, the integration among variables has a negative effect because it causes most of the variation to be concentrated in just a few dimensions. Reducing its effect implies knowing the pattern of interdependence among variables during the evolutionary process, which is difficult or impossible and requires large sample sizes. There are just very few favourable and restricted situations in which quantitative multidimensional data can be used to build phylogenies with accurate results. The effect of integration, really widespread, makes this technique not advisable.

Taxonomic affiliation of an aetosaur from Krasiejów and possible sexual dimorphism in *Stagonolepis*

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An aetosaur from Upper Triassic strata at Krasiejów (southwest Poland) was first described by Tomasz Sulej in 2010 as a new species, *Stagonolepis olenkae*. However, newly collected material suggests that its taxonomic affiliation is not as clear as initially assumed. New specimens from the Krasiejów site show typical features of both *Stagonolepis robertsoni* (Walker, 1961) and *S. olenkae*. However, distinct features from both species are also present. In addition, post-cranial remains of an aetosaur from Krasiejów were described in 2007 by Spencer Lucas and co-workers as *S. robertsoni*. Some of the newly recognised features are reminiscent of expressions of sexual dimorphism displayed in e.g. ankylosaurid dinosaurs.

Manus of the aetosaur *Stagonolepis olenkae* from the lower Upper Triassic of Poland

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Aetosauria is a clade of Late Triassic, heavily armoured omnivorous pseudosuchians. Although widely distributed and studied for over a century, the anatomy of their manus remains poorly known, having been restored solely in *Stagonolepis robertsoni* by Walker (in 1961) and in *Longosuchus meadei* by Sawin (in 1947). New material of three semi-articulated manus, associated with forearm bones (ZPAL AbIII 2407, 3049 and 3050) of *Stagonolepis olenkae* from Krasiejów in Upper Silesia has enabled restoration of its structure in that species. The specimens were cleaned mechanically and bones were partially separated. The probable phalangeal formula in *S. olenkae* is 2-3-4-5-3, the same as in *S. robertsoni*. Metacarpals are well fitted to each other and they partially overlap. The carpus consists of four carpal bones positioned in two rows. The first row consists of radiale fused with intermedium and ulnare; the second row comprises two distal carpals. Fusion of radiale and intermedium has already been observed in *S. robertsoni*, *L. meadei* and *Aetosaurus ferratus*, which suggests that this feature is typical of all aetosaurs. In *L. meadei* the same number of carpal bones were recognised, but they were differently positioned. The whole manus was covered by osteoderms of varying shapes, ranging from subrectangular in the area of metacarpals to more rounded in the area of carpals and distal phalanges. *Stagonolepis olenkae* is the first aetosaur with osteoderms covering manus known to date.

The relationships of the Euparkeriidae and the rise of Archosauria

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Euparkeria capensis has long been considered to come close to the ancestral archosaur in its morphology, and is the sister taxon to crown Archosauria in many phylogenetic analyses, although it has also been placed further down the archosaur stem and also within the crown. Several other taxa have been assigned to the family Euparkeriidae, but recent work has found only one of these, *Halazhaisuchus qiaoensis* from the Anisian of China, to form a clade with *Euparkeria*. However, no phylogenetic analyses to date have included more than one putative euparkeriid excluding *Euparkeria capensis*. For the first time, a phylogenetic analysis including all putative euparkeriid taxa is conducted, using a large matrix of stem and crown archosaurs, analysed with both maximum parsimony and Bayesian phylogenetic methods. Using both analytical methods, the putative Russian euparkeriid *Dorosuchus neoetus* is found to be the sister taxon to Archosauria+Phytosauria, whilst *Euparkeria capensis* forms a euparkeriid clade with *Halazhaisuchus qiaoensis* and the Polish taxon *Osmolskina czatkowicensis*, one node further from the crown than *Dorosuchus neoetus*. *Osmolskina* and *Halazhaisuchus* are found to be sister taxa. Support for the euparkeriid clade recovered is, however, low, and uncertainty regarding assignment of the material of *Osmolskina* and *Dorosuchus* mean that conclusions regarding euparkeriid monophyly and phylogenetic position must remain tentative. However, the broad phylogenetic position of putative euparkeriids close to the base of Archosauria is confirmed, and the euparkeriid Bauplan can be looked upon as the antecedent of the cursorial, upright locomotion which underlay the rise of crown Archosauria.

New finds of dinosauromorphs and dinosauriforms from the Middle and Upper Triassic of Poland

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New discoveries of early dinosauromorphs and dinosauriforms from the Middle-Upper Triassic of Africa, North and South America and Europe demonstrate that these groups were not a rare faunal element and constituted contemporaries of basal archosaurs and early dinosaurs during this time. Numerous isolated bones (both cranial and post-cranial elements) of several basal dinosauromorphs and dinosauriforms have been collected from the Middle and Upper Triassic of Poland. This disarticulated material represents a minimum of four taxa. Phylogenetic analyses place all new fossils within Dinosauromorpha and, in part, in Dinosauriformes, and between the basal dinosauriform and the derived clade consisting of Silesauridae and Dinosauria. In addition, the phylogenetic position of some elements inside the Lagerpetidae is supported by some synapomorphies (e.g. femoral head hook-shaped in medial and lateral view, an enlarged posteromedial tuber of the proximal end of the femur). Numerous elements resemble bones of members of the Silesauridae, but some features observed in this material were previously unrecognised amongst silesaurids. These include conical teeth with serration or a dentary bone without beak. A few limb bone remains of large silesaurid-like dinosauriforms were also found. These new data suggest that a higher number of early dinosauriform clades branched off in the Middle and Late Triassic than previously assumed.

The speed of theropod dinosaurs: new data from trackways at Münchehagen, Germany

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Berriasian sandstones (Bückeberg Formation) in Lower Saxony, northern Germany, have been providing dinosaur tracks in the two last centuries. In Münchehagen, about 50 km west of Hannover, the actively worked Wesling Quarry, which is adjacent to the Dinosaurier-Park Münchehagen with a section of just 5.62 m thick, contains at least six track-bearing strata. Most tracks are reasonably well preserved in fine-grained quartz sandstones (thickness: 0.1-1 m), but one horizon (Lower Level, lithological unit (LU) 7) yields excellently preserved trackways in a silty mudstone layer. The present study provides an examination and description of two trackways (T2 and T3) using photogrammetry, as well as a calculation of speed, identification of ichnotaxon, and an explanation as to why footprints change along the trackways. T2 (medium-sized theropod) and T3 (large theropod) demonstrate slow gaits with maximum speeds of 12 km/h and 6.5 km/h, respectively. By comparison with previous studies the tracks of these two dinosaurs probably belong to the same ichnogenus, *Megalosauripus*. Trackway configuration changed due to several parameters, i.e., degree of preservation, locomotion of the trackmaker, potential errors of measurement and distinguishing actual footprints from surrounding sediment. T2 showed crossover gait possibly caused by slippery sediment or the consequence of wide gauge and foot posture. The velocity of T2 increased with increasing stride length; however, this did not apply to T3, probably due to settlement of foothold. Along the trackways T2 increased its speed slightly (nearly status quo) and T3 showed a definite decrease indicating a clear difference between the behavior of these two dinosaurs.

New iguanodontian dinosaur records from the North Sea Basin: palaeogeographical implications

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In 2001, an iguanodontian caudal vertebra was first described from the North Sea Basin. Here, we present new records of iguanodontian skeletal remains, i.e., the distal part of a left tibia and two caudal vertebrae. These bones were trawled near the Klaverbank (or Cleaver Bank). This is a shoal, situated near the border between the Dutch and British parts of the North Sea continental shelf, at a depth of 30-40 metres, at 160 km northwest of Den Helder, the Netherlands. Our attribution of the fragmentary tibia to an iguanodontian is based on the preserved fibular facet and a direct comparison with the type material of *Mantellisaurus atherfieldensis* in the collections of the Natural History Museum (London). The caudals show a close similarity to the earlier record. It is concluded that these fossils originated from the Weald Basin. From the Triassic to the Late Cretaceous, this basin was a major topographic feature in the area that is now southern England and northern France. Its uplift during the Late Cretaceous marked the formation of the Weald-Artois Anticline. Its subsequent erosion, in combination with post-Cretaceous palaeogeography, facilitated transport of these fossils in a northerly direction.

New partial skeletons of *Rhabdodon* from the upper Campanian of Provence (southern France): towards a better understanding of specific diversity

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In the present study we note a new discovery which provides strong evidence that the specific diversity of *Rhabdodon* tends to be higher than commonly admitted. At least three fragmentary skeletons of juvenile specimens (representing two ontogenetic stages) have been excavated by one of us (FP), jointly with the Muséum d'Histoire Naturelle d'Aix-en-Provence. These discoveries provide interesting additional evidence concerning the anatomy of *Rhabdodon*. Indeed, they include some articulated parts of skeletons (paired upper and lower jaws, a virtually complete hindlimb and a pes) and most appendicular elements. The most striking features are the gracile nature of the bones (never observed in such a condition before) and important anatomic distinctions compared with other small individuals excavated at other localities in Provence. The characteristics of the jaws, the scapulocoracoids and the pelvis do not allow a direct attribution (even taking into account the juvenile condition) to *Rhabdodon priscus* from the La Nerthe Tunnel. They also present a complex combination of similarities and differences with specimens from Vitrolles-Couperigne (Bouches-du-Rhône), La Boucharde (Bouches-du-Rhône), Fox-Amphoux (Var), the Saint-Chinian area (Hérault) and from Aude. Indirectly, this discovery also documents the presence of a distinct rhabdodontid in Provence, because the size of the largest juvenile exceeds that of most of the elements found the area. The presence of a dwarf adult was identified in 2012, as a result of a preliminary osteological study on one of these small isolated bones from the area of the motorway A8 (Var). At this time, it cannot be decided whether these juveniles are young *Rhabdodon septimanicus*.

Species distinction in the genus *Protoceratops*

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The genus *Protoceratops* is one of the better-known dinosaurs, but there is a problem with the type of the first species to have been described, *Protoceratops andrewsi*. ZPAL MgD - II/3, a nearly complete specimen housed in the Institute of Paleobiology, Polish Academy of Sciences, exhibits better preserved skull and is similar to type and lectotype of *P. andrewsi*. A re-examination of autapomorphies for the genus and the family Protoceratopsidae is called for. Two species of *Protoceratops* are currently distinguished, but two additional ones are to be considered. In 1975, *Protoceratops kozłowskii* was described as a new species; on the basis of this, the genus *Breviceratops* was erected, which has subsequently been synonymised with *Bagaceratops*. However, material from Russia is not conspecific with specimens housed in Polish collections, and juvenile specimens of *Protoceratops kozłowskii* and *Bagaceratops* differ. I found another specimen in collection Institute of Paleobiology, which might turn out to be conspecific with *Protoceratops kozłowskii*, and this will yield more data on this species. Comparison specimen ZPAL MgD – II/3 and similar to him from this which was recognized as lectotype of species *Protoceratops andrewsi* by Brown and Schlaikjer in 1940 and conspecific with him, it implies erection of the new species for those others specimens.

Ontogenetic modifications of the pelvic girdle and hindlimb revealed by a subadult specimen of *Protoceratops andrewsi*

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A near-complete, articulated skeleton (ZPAL Mg D-II/3) of a subadult specimen of the ceratopsian dinosaur *Protoceratops andrewsi* from the Djadokhta Formation of the Gobi Desert, Mongolia, provides new data on post-cranial variability. A reconstruction of the pelvis shows the dorsal margin of the ilium typical of *P. andrewsi* in its erect pose and straight, long and slender ischium with expanded distal end. However, the pubis differs in shape in comparison with adult *P. andrewsi* in that the postpubis is oriented backwards, not downwards and then backwards, which means that there is no obturator notch; in addition, the shape of the prepubis is different. The right femur with a very large fourth trochanter is poorly preserved. Articulated tibia and fibula are long and slender, but both proximal and distal ends are poorly preserved. Most probably they were broken prior to final burial of the specimen. The pes lacks the tarsus; the metatarsus is compact, long and slender. The finger formula is typical of Ceratopsia (2, 3, 4, 5, 0), although the unguals are pointed, not rounded. It appears that anatomical modifications in *P. andrewsi* processed up to its subadult ontogenetic stage.

Ontogeny of the ceratopsian dinosaur *Bagaceratops rozhdestvenskyi* from the Upper Cretaceous of the Gobi Desert, Mongolia

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Bagaceratops rozhdestvenskyi is a medium-sized neoceratopsian dinosaur from the Upper Cretaceous Baruun Goyot Formation of the Gobi Desert, Mongolia, which is closely related to *Protoceratops*. Several well-preserved skulls demonstrate a wide range of variation in overall morphology, shape, size and proportions of the skull, frill and nasal horn core, details of maxillary teeth morphology; possibly also the presence of fenestration of the frill and the absence of premaxillary teeth. This variation was interpreted by earlier authors as either ontogenetic, sexual, intraspecific or interspecific. I have examined a set of skulls in the collection of the Institute of Paleobiology, Warsaw, Poland, that contain individuals of different ontogenetic stages, and have tried to do away with *post-mortem* deformation. The variability observed most likely is of ontogenetic and intraspecific nature. A few allegedly distinct species described during the last 12 years from near-contemporary sediments of the Gobi Desert may appear to be conspecific. This may result in significant reduction of the number of coeval species of ceratopsian dinosaurs in the Mongolian Cretaceous.

Investigating the ancestral shell: preliminary data on new material of *Proterochersis*, the earliest fully-shelled turtle

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The origin and composition of the turtle shell has consistently been studied by both palaeontologists and neontologists, with most of the research focused on homologies and morphogenesis of costals, neurals and (lately) the nuchal bone. The generally poorly visible shell sutures in pre-Jurassic turtles have resulted in poor understanding of the initial layout and number of shell bones. The aim of the present study is to fill this gap by examination of the shell structure in the oldest fully-shelled turtle, the Norian *Proterochersis* from Germany and Poland. This taxon is of critical significance to the understanding of turtle phylogeny, not only for stratigraphic reasons, but also because of its controversial position in the phylogenetic tree of turtles (i.e., either as the basalmost pleurodire, or a stem turtle). The new material from Poland and some historical German specimens have enabled identification of new shell characters. An osseous contact between the sacral vertebra and carapace exists, and all ten pairs of thoracic ribs contribute to the shell, the first pair not being reduced, roughly parallel to the second and forming costal plates. These characters are unique to *Proterochersis* and may represent the ancestral condition of the turtle shell; therefore they should be considered in future work on the origin and early evolution of the turtle bauplan. An updated scenario of early shell evolution may be provided. The presence of well-developed, costal plate-bearing first thoracic ribs in *Proterochersis* may have implications for the recently resurrected hypothesis of a turtle-*Eunotosaurus* affinity.

Palaeoecology of *Nidophis insularis* from the Upper Cretaceous of the Hațeg Basin (Romania) – another madtsoiid snake associated with a dinosaur egg nest

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Discovered in a megaloolithid dinosaur egg nest, *Nidophis insularis* is, next to *Sanajeh indicus*, the second Late Cretaceous madtsoiid snake to have been found in such an association. This raises the question if, as proposed for its Indian relative, *Nidophis* also preyed on dinosaur hatchlings or eggs. The taphonomy of the Tuștea nesting site, where *Nidophis* was found, and the partially articulated preservation state of the type specimen show that little or no transport occurred at this site, which confirms that the holotype individual actually died next to the egg nest, rather than having been transported into the nest subsequently.

Skeletochronology (using growth rings on vertebral apophyses) was employed to estimate the age at death of the type individual, while its length was approximated using linear regressions between vertebral parameters and body length for extant snakes. The *Nidophis* individual found at Tuștea was shown to be an adult that approached its maximum body length of around 1 m.

The small size of *Nidophis* surely allowed it to prey on amphibians, lizards, multituberculates or squamate eggs, but it made it very difficult or impossible to swallow dinosaur hatchlings, larger vertebrates known from the same site (i.e., adult dinosaurs, turtles, pterosaurs), or the thick-shelled megaloolithid eggs it was found next to.

One of the anterior vertebrae from the holotype individual also shows an unhealed bite mark, left by a pointy-toothed predator, showing that *Nidophis* was preyed upon or scavenged by a theropod or a crocodyliform.

Neogene snakes from Greece: giants and dwarfs in a mammal-dominated world

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A number of Neogene fossil localities are known from Greece, including classic sites such as Pikermi and Samos, where systematic excavations have been conducted since the nineteenth century. Large mammals have always been the main focus of these excavations, rendering other groups, such as snakes, poorly studied or totally ignored. Nevertheless, fossil snakes appear to be ubiquitous at many localities, but they frequently consist of isolated vertebrae, thus preventing identification to species level. Only two extinct species have been named to date from these localities: *Python euboicus*, a proportionally large pythonid from the Lower Miocene of Euboea Island, and *Laophis crotaloides*, a gigantic viperid from the Lower Pliocene of northern Greece, both described in the nineteenth century. Unfortunately, the holotypes of both taxa are lost, and frustratingly, whereas no additional material has ever been found of the former, a large preloacal vertebra has only recently been attributed to *L. crotaloides*. Previously undescribed material ranging in age from Early Miocene to Late Pleistocene of more than 50 different localities throughout Greece, reveals a rich diversity of taxa consisting of typhlopids, pythonids, colubrids *sensu lato*, elapids, viperids and several indeterminate forms. The biogeographic importance of the Greek localities, the large number of endemic fossil mammals, and the relatively rich extant snake fauna, make it highly likely that a thorough review of existing collections and new field work, will shed new light on the palaeobiogeography, palaeoecology, systematics and evolution of European snakes.

Eggshell fragments from the Late Cretaceous of Iharkút, Hungary

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Thousands of eggshell fragments have been recovered from the 50 kg of coarse-grained fraction (1-5 mm) of tonnes of sediment that have been screenwashed over 15 years of excavation at the Santonian (Late Cretaceous) Iharkút vertebrate locality in Hungary. To reveal the identity of the egg-laying taxa, all eggshell fragments were categorised into different morphotypes based on stereomicroscopic study. Relative abundances of the different morphotypes were quantified by their total mass. Fine structural characteristics were investigated under scanning electron microscope (SEM), and as thin sections under polarised light microscope (PLM). Structural features were quantified on SEM and PLM images. Element composition and distribution were explored with an X-Ray Fluorescence Spectrometer (XRF). Preliminary results confirmed the presence of at least three distinct eggshell morphotypes and a further three are under investigation. The most abundant (83 per cent) is 157-201 µm thick, shows variably spaced tiny nodes and larger crater-like surface ornamentation, and its two-layered microstructure comprising a mammillary layer with tightly packed, small cones and a prismatic layer with thin columns suggests a dinosaurian origin. The second most abundant type (15 per cent) has ramotuberculate ornamentation, is 208-293 µm thick, and exhibits wedge-shaped units characteristic of crocodylian eggshells. The third type (1 per cent) is ~260 µm thick, has a smooth outer surface and a three-layered microstructure with distinct aggregates of mammillae, narrow and straight prisms, and a thin external layer – similar to the eggshells of *Troodon*. Despite their fragmentary nature, these eggshells represent clear evidence of the presence of dinosaurian and crocodylian nesting sites near the ancient fluvial system of Iharkút.

The 'Tuştea Puzzle' revisited

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Since 2003, when the intimate association of megaloolithid eggs, generally assigned to sauropod dinosaurs and hadrosauroid neonates, found in the early 1990s in Transylvania, Romania, was referred to as the 'Tuştea Puzzle', no convincing explanation was advanced. Contrary, new data on the geographic and stratigraphic occurrences of the spheroolithid eggs, currently associated with hadrosaurs, together with recent cladistic analysis sustain the paraphyly of the megaloolithids and confirm the assumption that, at least some megaloolithid oospecies were laid by hadrosaurs. Collateral evidences in this regard are offered by the quantitative discrepancy amongst Latest Cretaceous megaloolithid oospecies, which consistently surpass the known sauropod species at the time and by the exceptional rarity of the spheroolithid eggs and eggshells in Europe, in contrast with the abundance of hadrosauroid skeletal remains. The facts from Tuştea are reviewed and new data confirming the autochthony of the hatchlings within the incubation site are presented. In conclusion, the basal phylogenetic position of the hadrosauroid *Telmatosaurus transsylvanicus* to whom the hatchlings from Tuştea belong, is regarded as influential factor in explaining a certain homoplasy amongst megaloolithids and spheroolithids, favored by similar conditions of incubation.

Macbeth's Nature paper: The remains of the oldest dinosaur egg and embryo, and the obstructive potential of fossil protection legislation

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Fossil protection legislation exists for many reasons, most obviously to restrict irresponsible collection of fossil material, preserving natural science heritage from the unregulated ravages of museums, commercial dealers, private collectors, tourists and academics. Invariably, the enforcement of such legislation is under-resourced when it comes to policing sites, the lower resource requirement of customs monitoring being preferred by authorities. In China, as elsewhere, an involved administration has explicitly been in place for vertebrate fossils since 1982, which has to be engaged with in order for material to leave the country legally for study and eventual return. Unfortunately, although such paperwork appears to have had some impact on the illegal fossil trade (the quantity of Chinese fossil material available at Tucson, Arizona, has greatly declined), it has also had two less desirable consequences for academic research: encouraging academic theft (to circumvent the paperwork); discouraging international collaboration by legitimate domestic research departments (to avoid the paperwork). A turgid bureaucracy may not only act as an incentive for less scrupulous foreign researchers to simply remove material without going through the required administrative process, but may also deter legitimate domestic academic departments from pursuing international partnerships in order to maximise the research potential of their fossil material. In both scenarios, science loses: research is compromised by either being underdeveloped, or by the illicit export of the material, in contravention of the 1970 UNESCO Convention, tainting the resulting outcomes. A case study of the oldest remains of a dinosaur egg is presented to illustrate this problem.

Was crocodylomorph eggshell structure always as conservative as it is in extant crocodilians?

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Crocodyloid eggshell is considered to be the most conservative amongst amniotes. Known since the Late Jurassic, all fossil eggshells attributed to crocodylomorphs have been included in the oofamily Krokolithidae. This contrasts with the high diversity observed within the crocodylomorph lineage during the Cretaceous. This incongruence raises a fundamental question in palaeology: is the crocodylomorph eggshell structure so conservative, or are there variations in this structure that have been misidentified in the fossil record? The lack of fossil embryos or gravid female specimens results in a scenario where only eggs and eggshell fragments identical to the recent crocodylomorph eggs can be attributed to this group. Taking the fact into account that all modern crocodylomorphs are restricted to a single lineage, our view of the evolution of the crocodylomorph eggshell may be biased.

We have re-examined eggshells from the Barremian of northern Spain, previously attributed to chelonians, and eggshells from the Berriasian of England, previously recorded as dinosaurian-spherulitic eggshells. The eggshells studied here are characterised by medium thickness for crocodylomorph standards, with mushroom-shaped or inverted cone shell units with blocky extinction and a smooth or slightly undulating outer surface. These eggshells present highly variable pore opening density, with pores of irregular size and shape. This variation here is interpreted as evidence of degradation of the eggshell during embryonic development. We identify them as closely related to, but not included in, the Krokolithidae. They may represent eggshells of non-eusuchian crocodylomorphs, which are abundant in the microvertebrate fossil sites where these eggshells are found.

The specimen of *Archaeopteryx* from the Mörnsheim Formation (Upper Jurassic, lower Tithonian) of Bavaria, southern Germany

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The 148-million-year-old fossils of *Archaeopteryx* are widely regarded as representing the oldest known species of bird. Since 1861 only ten reported specimens of *Archaeopteryx* have defined the morphological characters of these ‘Urvögel’. All of these fossils stem from the flaggy limestones (plattenkalks) of the Solnhofen Formation, whereas the remaining eighth (or Daiting specimen) of *Archaeopteryx* was allegedly discovered in massive-bedded limestones of the Mörnsheim Formation. XRF data obtained from the latter specimen show that its encasing matrix contains relatively large amounts of SiO₂ with trace elements Zn and Ni. XRF-based bivariate plots of Al₂O₃:SiO₃/CaO:SiO₂ and Zn:CaO/Ni:CaO illustrate cluster proximity of the Daiting specimen index to those from the Mörnsheim Formation samples. XRD analyses of the Daiting specimen and Mörnsheim Formation limestone samples also indicate that much of the SiO₂ is present as quartz, in contrast to the Solnhofen Formation in which most of the silica is present in clay minerals. Collectively, these geochemical results support the hypothesis that the Daiting specimen did indeed originate from the Mörnsheim Formation (i.e., from above the ‘Hangende Krumme Lage’) and that the eighth specimen is thus the youngest known Bavarian archaeopterygid. New osteological structures revealed by the Daiting specimen have also significantly refined the phylogenetic scoring of *Archaeopteryx*, and are critical for the vigorous debate over whether it is still an iconic early bird or simply one of many divergent offshoots from the theropod evolutionary tree. Our analyses robustly constrain *Archaeopteryx* + the Daiting specimen towards the base of the avialan stem.

A new species of Pengornithidae (Aves: Enantiornithes) from the Lower Cretaceous of China suggests a specialized scansorial habitat previously unknown in Early birds

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We describe a new enantiornithine bird *Parapengornis eurycaudatus* gen. et sp. nov. from the Lower Cretaceous Jiufotang Formation of Liaoning, China. Although morphologically similar to previously described pengornithids *Pengornis houi*, *Pengornis* IVPP V18632, and *Eopengornis martini*, morphological differences indicate it represents a new taxon of the Pengornithidae. Based on new information from this specimen we reassign IVPP V18632 to *Parapengornis* sp. The well preserved pygostyle of the new specimen elucidates the morphology of this element for the clade, which is unique in pengornithids among Mesozoic birds. Similarities with modern scansores such as woodpeckers may indicate a specialized vertical climbing and clinging behavior that has not previously been inferred for early birds. The new specimen preserves a pair of fully pennaceous rachis-dominated feathers like those in the holotype of *Eopengornis martini*; together with the unique morphology of the pygostyle, this discovery lends evidence to early hypotheses that rachis-dominated feathers may have had a functional significance. This discovery adds to the diversity of ecological niches occupied by enantiornithines and if correct reveals a remarkable amount of locomotive differentiation among basal members of Enantiornithes.

POSTERS

Middle Triassic vertebrate assemblages at the ‘Stare Gliny’ quarry in southern Poland: an environmental and systematic revision

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The ‘Stare Gliny’ quarry near Olkusz (southern Poland) exposes a 35-m-thick sequence of Middle Triassic carbonates which onlap tectonically tilted and heavily karstified Middle Devonian dolomites. Two accumulations of vertebrate remains have been recognised within the cover deposits. These differ with respect to taxonomic composition, preservational, matrix and stratigraphic position within this Middle Triassic succession. The older assemblage is probably late Pelsonian in age and occurs within dolomitic mudstones and dolocretes representing low-energy lagoons and tidal flats. The bones are prevalingly disarticulated to mm-sized fragments and sometimes weathered. More complete elements (ribs, vertebrae, limb bones) are sporadic and seem to belong to the small prolacertiform *Macrocnemus*. The younger assemblage was discovered already in the late 1950s, but until now no detailed study was undertaken. The remains were found within claystones and dolomitic breccias that fill a decametre-long palaeocave. Our reassessment of the collection has revealed that the fauna comprises mainly basal terrestrial archosauromorphs, with a subordinate contribution of other reptiles and marine fishes. Despite common disarticulation, the bone material is excellently preserved and includes limb bones, vertebrae, jaws and braincase fragments. This accumulation represents an admixture of terrestrial vertebrates which likely inhabited the palaeocave and marine remains which were washed into the hole during high-energy events.

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How many Upper Triassic bone-bearing levels are there in Upper Silesia, southern Poland?

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At least three widely separated, bone-rich intervals in the Upper Triassic succession of Upper Silesia, ranging in age from Carnian to Rhaetian (i.e., an interval of 30 myr), have been presented in papers by the Warsaw research group, led mostly by Jerzy Dzik and/or Grzegorz Niedźwiedzki. Their stratigraphic arguments are reviewed for selected vertebrate localities, in particular for the well-known Keuper sites at Krasiejów and Lisowice-Lipie Śląskie, in order to show that age assignments provided previously are still inadequately documented and questionable. This unreliability is exemplified by evolving stratigraphic correlations of the fragmentary Silesian sections (10-18 m thick) with informal subsurface units from central-western Poland and with the German standard succession, not yet corroborated by comparison with the composite reference succession of the Upper Silesian Keuper, including the new Woźniki K1 and Patoka 1 well profiles (c. 260 m thick). Based on a multidisciplinary stratigraphic study covering consistent litho-, bio-, climato- and chemostratigraphic premises, scoped on the complete regional reference section, only two levels of bone-enriched deposits in the Patoka Marly Mudstone-Sandstone Member (=Steinmergelkeuper) of the Grabowa Formation, not differing much in age (*Classopollis meyeriana* Palynozone; probably IVb Subzone), are recognised: the Krasiejów bone breccia level (of early Norian age) and the more widely distributed Lisowice bone-bearing level (also at Woźniki, Poręba and Zawiercie-Marciszów; middle Norian). In consequence of the principal uncertainties and controversies in Upper Triassic terrestrial stratigraphy, this is still a somewhat preliminary inference.

A Late Triassic microvertebrate fauna from the Lipie Śląskie clay pit at Lisowice, Poland

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We report on the first microvertebrate assemblage from the Keuper of Silesia. Upper Middle-Upper Triassic fossiliferous layers in this region preserve unique assemblages of small vertebrates that originate from different freshwater and terrestrial environments. Late Triassic small vertebrate faunas document aspects of a critical evolutionary transition in the history of terrestrial ecosystems (e.g., origin of lepidosaurs, pterosaurs and mammals). Microvertebrate fossils from the Lipie Śląskie clay pit at Lisowice are compared to the much better-known macrovertebrate diversity from this site and to diverse Late Triassic microvertebrate faunas from North America and Europe. The Lisowice microvertebrate assemblage consists of sharks, actinopterygian fish, small temnospondyls, possibly early anurans, sphenodontids, small predatory archosauriforms (possibly pseudosuchians, early suchians or dinosaurs), early pterosaurs and mammaliaforms. Some of these were not previously recorded either from this site or from the Upper Triassic of Poland. We also found a great number of forms that still elude precise identification and differ substantially from both identified and unidentifiable taxa from other Late Triassic microvertebrate faunas. The Lisowice assemblage provides a glimpse of Late Triassic diversity of small vertebrates, which are usually poorly known from terrestrial deposits of the Germanic Basin. The new diverse microfauna from Lisowice demonstrates the value of screenwashing of bone-bearing and fossiliferous horizons in the Upper Triassic of Poland. Future studies will need to include screenwashing for other Upper Triassic sites (i.e., Miedary, Woźniki, Krasiejów, Poręba), with a spectacular vertebrate record.

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Taphonomy of dicynodont bones from the Lipie Śląskie clay pit at Lisowice (Upper Triassic, Norian-Rhaetian; Upper Silesia, southern Poland)

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Eighteen dicynodont bones (Reptilia, Therapsida), collected from six bone-bearing horizons, were examined in order to decipher their taphonomic histories. The examined remains have been subdivided into two main groups. The first group comprises bones with strongly abraded cortex, or none at all. Internal voids are filled with dark grey silt accompanied by larger quartz grains (the first generation of infillings), as well as pyrite and spar (the second generation). The infillings occurring in more external voids (mainly secondary osteons) are frequently truncated, which suggests that the remains may have been redeposited to the final burial site when their pore spaces were already filled and cemented.

Bones belonging to the second group show fewer effects of abrasion and reveal a specific succession of void infillings. Dark grey silt with dispersed pyrite, yellowish fibrous calcite, dolomite (in some cases), spar drusy mosaics and sulphates (mostly barite) occupy marrow cavities, inter-trabecular spaces and erosional rooms. Occasionally, strontianite has been detected in cracks. When fibrous calcite is present on the external bone surface, it grows on the abraded bone tissue and/or truncated silt infillings occupying osteons. This suggests that fibrous calcite (and later generations of diagenetic minerals) crystallised in the final depositional site.

The above-mentioned features provide evidence of the fact that each of the two groups of examined bones had been primarily buried in different environments, and subsequently were exhumed and abraded during redeposition at the final place of burial.

The scientific, geotouristic and economic significance of the discovery of the Triassic tetrapod Lagerstätte at Krasiejów (Opole Silesia, Poland)

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Excavations at the Krasiejów clay pit started in 1905. The Upper Triassic clays were mined for the local brickyard and between 1974 and 2002 for the cement mill at Strzelce Opolskie. The bone beds were first exposed around 1980; however, palaeontological excavations and preparations of skeletons did not start until 1993. Mass accumulations of well-preserved tetrapod skeletons, mainly the labyrinthodont *Metoposaurus*, the rarer labyrinthodont *Cyclotosaurus*, herbivorous reptiles such as the aetosaur *Stagonolepis* and the dinosauriform *Silesasaurus*, as well as predatory reptiles such as the rauisuchian *Polonosuchus* and the archosaur *Paleorhinus* have been recorded from Krasiejów. Remains of other groups of reptiles and fish occur sporadically. Invertebrates (mainly bivalves) and floral remains are abundant. Almost all tetrapod skeletons occur in two 0.5-m-thick horizons exposed only in the northern part of the clay pit. The lower horizon comprises mostly freshwater tetrapods, while the upper one yields mainly terrestrial fauna. Seven new taxa of vertebrates and seven taxa of invertebrates have been erected on the basis of fossils from Krasiejów. Since 2000, one monograph, 37 papers in peer-reviewed scientific journals (29 in JCR), 4 doctoral theses and 20 master theses have been based on palaeontological and geological investigations of deposits at Krasiejów.

The discovery of the graveyard of large Triassic vertebrates at Krasiejów has been an impulse to the economic development of the Krasiejów region because it is a major geotouristic attraction in Poland. Two palaeontological museums (2005, 2006), the largest dinopark in Poland (2010) and the Evolution Park (2014) were opened in the village. Only several thousands of tourists *per annum* visited the palaeontological excavations during the first years of the 21st century, whereas after the opening of the dinopark the turnout was 210,000 visitors in 2013 and 250,000 in 2014.

New insights into vertebrate assemblages from the lower Chañares Formation (Ladinian–earliest Carnian, Ischigualasto–Villa Unión Basin), northwest Argentina

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The Triassic witnessed the origin or early evolutionary radiation of multiple amniote clades, such as lepidosauromorphs, rhynchosaurs, archosaurs, turtles and mammaliaforms. The major diversification of these lineages started during the Middle Triassic and the continental outcrops of the Chañares Formation (northwest Argentina) are among the best that document this event worldwide. Recent fieldworks in the lowermost levels of the Chañares Formation at the type and three new localities (Brazo del Puma, El Torcido and Campo Córdoba) yielded unknown vertebrate groups and considerably improved the knowledge of other clades from this unit. We report for the first time the presence of lobe-finned fishes (Sarcopterygii, Actinistia), being represented by a fragment of skull roof. Among amniotes, several non-hyperodapedontine rhynchosaurid, doswelliid archosauriform and dicynodont partial skeletons were collected within the first five metres of the formation. The absence of proterochampsids and dinosauromorphs in the first 5 metres of the Chañares Formation suggests a different faunal association to that previously known from the upper levels of the lower member of the unit (e.g., the Chañares type locality). The study of the lowermost levels of the Chañares Formation bridges a crucial gap between the well-known early Middle Triassic assemblages of southern Pangaea (e.g., the Manda beds of Tanzania and the Yerrapalli Formation of India) and the younger type Chañares fauna and the *Dinodontosaurus* Assemblage Zone of southern Brazil. This more comprehensive knowledge of the faunal associations of Pangaea will shed light on the flourishing of archosaurs during the Late Triassic and subsequently later in the Mesozoic.

Late Permian footprints from the Venetian Prealps (northeast Italy): new discoveries in a largely incomplete panorama

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The Late Permian (Lopingian) was a key period for the evolution of terrestrial vertebrates, which reached a remarkable diversity and behavioural complexity prior to the end-Permian mass extinction. However, few Lopingian tetrapod footprint sites are known to date. Specifically, these are from Italy, Germany and Morocco. At present, the sole ichnogenus found in Germany is *Paradoxichnium*, while the Moroccan ichnoassociation includes *Pachypes*, *Hyloidichnus*, *Erpetopus*, *Amphisauropus* and *Dromopus*. The Italian ichnoassociation is more diverse and complete, although a comprehensive revision based on the most recent developments in ichnology is missing. Specifically, the role of optimal preservation and extramorphologies was not properly taken into account. The study of unpublished material from a lesser-known site in the Venetian Prealps (Recoaro-Valli del Pasubio area, Veneto, northeast Italy), provides an opportunity to reconstruct a relatively diverse ichnofauna comparable to that of the classic localities of the Dolomites. Preliminary results indicate the occurrence of cf. *Dromopus*, *Merifontichnus*, *Pachypes*, *Paradoxichnium* and *Rhynchosauroides*; these footprints are attributed to diapsid and captorhinomorph reptiles, pareiasaurid parareptiles and basal archosauromorphs. Although the study is preliminary, by using a correct ichnotaxonomy and the most recent methods and approaches, it does allow a reconstruction of the faunal and palaeoecological meaning of these footprints – a most important task since very few Lopingian sites are known across the world.

Carnian tetrapod tracks from the Argana Basin (Morocco): the Dutuit Collection at the Muséum national d'Histoire naturelle, Paris

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The Late Triassic (Carnian) is a key period for our understanding of tetrapod faunal changes and radiation in the later Mesozoic. Morocco represents one of the few accessible places with a subequatorial palaeolatitude and formerly situated almost at the centre of Pangea, between Laurentia, Gondwana and Eurasia, a key hinge area that could yield insights into how life developed both north and south and help understand faunal mobility and interactions between these three major provinces.

Here we present Late Triassic (Carnian) ichnological material collected from the T5 unit (Irohalène Member) of the Timezgadiwine Formation in the 1960s/early 1970s by Jean-Michel Dutuit in the Irohalène Valley (Argana Basin, High Atlas), in the TiziMaachou Massif. The tracks are preserved in different layers, with lithologies ranging from very fine sandstone to mudstone. This material is now housed at the Muséum national d'Histoire naturelle, Paris. The collection consists of 37 tracks preserved both as ipo- and epi-reliefs. Preservation varies, and different morphotypes can be identified, referable both to chiroteriids (cf. *Brachychirotherium*) and dinosauriforms (cf. *Parachirotherium*, cf. *Grallator*). This ichnofauna resembles the Middle/Late Triassic associations of both North America and Europe; further studies need to reveal how strong this affinity is, thereby increasing the palaeogeographical and biological relevance of the North African margin of Gondwana.

Early Jurassic dinosaur tracks from Mt. Pelmo (Italy): new insights into regional palaeogeography

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Dinosaur footprints from the Lower Jurassic of northeast Italy are well known and, since the first discoveries in the early 1990s, many sites have been described. Tracks are found in the peritidal limestones of the Calcari Grigi Group, deposited on the Trento carbonate platform, now cropping out in the Southern Alps. In 2011, a group of speleologists discovered a new tracksite in the Calcari Grigi exposed almost at the top of Mt. Pelmo (Dolomites), 3,037 m above sea level. In the autumn of 2014, a short campaign to the site revealed c. 20 possible footprints, generally poorly preserved. However, it proved possible to recognise some tridactyl footprints with features (i.e., elongated digit III and narrow interdigital angle) that can be referred to *Grallator* and some possible quadruped tracks whose configuration resembles that of *Lavinipes*.

The tracks occur in a portion of the Calcari Grigi generally dated as Hettangian-Sinemurian. The Pelmo site is most easterly ever found on the Trento Platform and the single one which is located north of the Valsugana Fault, a major tectonic feature that is characterised by compressive kinematics during the Neogene, but emplaced on a former ENE-WSW trending synsedimentary extensional fault system that controlled deposition of the Trento Platform sediments during the Early Jurassic. Despite the generally poor preservation, the discovery of the Pelmo tracks expands the documented area of movement of Early Jurassic terrestrial vertebrates and may provide new important data to the refinement of palaeogeographical reconstructions of the area.

Early sauropodomorph footprints in the Upper Triassic of East Greenland

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Hunting early sauropodomorphs, inclusive of their footprints, was executed in the East Greenland Upper Triassic by the F. Jenkins Harvard expeditions (1988-2002), a Danish expedition in 2012, and one in 2014 by a Polish-Danish team. Only cursorily, rounded, ‘elephantine-like’ footprints of a quadrupedal animal were described in 1995 by the Harvard team and referred to prosauropods (i.e., the commonest dinosaurs in the skeletal record of the Fleming Fjord Formation), while tridactyl theropod footprints were recorded in detail in 1999. During the Polish-Danish expedition several other surfaces with tridactyl footprints comparable to the ‘raceway’ in the Jenkins report of 1995 were discovered, and numerous large (about 30–50 cm long), oval-shaped structures similar to earliest Jurassic sauropodomorph tracks were found at two localities in the lower-middle part of the Malmros Klint Member at MacKnight Bjerg (west of Carlsberg Fjord). The most intriguing are very narrow trackways of oval-shaped prints from two animals of different size that walked parallel – possibly the earliest evidence of gregarious behaviour in sauropodomorphs. Similar tracks, also organised in a narrow-gauge trackway, and indicative of a large quadruped animal with pes much larger than manus, have been described from the Upper Triassic (*Eosauropus* from Europe, South Africa and North America). In all newly discovered specimens, the pedal imprints are oval and elongate, possess a long axis and lack distal claw impressions. The Malmros Klint Member specimens are very similar to the Early Jurassic sauropodomorph footprint *Parabrontopodus*, because both are large in size and organised in a narrow-gauge trackway. Further study of these large, oval-shaped tracks could provide new data on the morphology of the manus and pes of Late Triassic sauropodomorphs and on size and ecological behaviour of these dinosaurs.

Microstructure of dermal bones of vertebrates from Krasiejów

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New finds from the Triassic at Krasiejów still provide novel data on the taxonomy, histology, anatomy, evolution and ecology of these vertebrate faunas. So far, among many methods, Scanning Electron Microscopy (SEM) was not used in a wide range, except for the description of dipnoan tooth plates. Most informative in SEM analyses can be distinctly sculptured dermal bones, scales and osteoderms. Analysis of micro- and nanostructures of dermal bones might be used as a taxonomic tool which was proved on the example of modern lungfishes (Dipnoi, e.g., different patterns of ornamentation in scales of several species of the genus *Labeo*).

Comparison of microstructures of dermal bones can be an effective taxonomic tool in those cases for which it is impossible to make any other analysis or when results are uncertain. Although SEM analysis might be helpful when material is fragmentary and/or disarticulated, which precludes detailed, reliable descriptions. Good examples are fish scales and Temnospondyli remains from Krasiejów, i.e., *Cyclotosaurus* and *Metoposaurus*. Single bones of both species can differ slightly or do not reveal any macroscopic differences. All bones are ornamented in the same way, so disarticulated fragments of similar size are often impossible to differentiate and assign to either one of these species. Micromorphology of dermal bones can also reflect ecological adaptations, as well as ontogenetic and pathological changes. For example, cracks and changes in growth ring distribution and loss of lepidonts (microdenticles on the circuli) might result from changes in water chemistry (pollution).

Methodological approach to histological studies – how important are temnospondyl humeri for skeletochronological analyses?

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Until recently, not many histological studies were performed on temnospondyl amphibian bones. Analyses of the postcranial skeleton are usually based on femora, not on humeri. The morphological characters of these two bones differ greatly. The metoposaurid humerus is a tetrahedral bone with a twist between the distal and proximal end and a rather short mid-shaft region. In an earlier study, three humeri have been analysed; they showed a wide histological variety. This might either be the result of different ontogenetic stages, or the sectional plane was not exactly along mid-shaft, or skeletochronological information was just not preserved in these bones. Since histology is a destructive method and postcranial material of fossil Temnospondyli is rare, the aim of the present study was to test the importance of the metoposaurid humeri for skeletochronological purposes. The sixteen humeri of *Metoposaurus diagnosticus krasiejowensis* analysed originate from middle-upper Carnian beds at Krasiejów, southwest Poland. The bones were first scanned (high-resolution micro-computed tomography), after which the position of the mid-shaft was determined using the software VG Studio MAX. Finally, thin sections were made. This has shown that metoposaurid humeri can be used for histological analyses, provided that, in order to avoid loss of data, the sectional plane cuts exactly through the mid-shaft region.

A quantitative assessment of mid-diaphyseal distribution density of secondary osteons in amniotes

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Much has come to light about Haversian bone through anthropological studies, but this bone tissue type is not well studied in other taxa, even though it is very common in birds, mammals and dinosaurs. This preliminary comparative study aims to explore how Haversian bone is distributed around the mid-diaphysis in different species. It is observed in many cases of long bones that secondary osteon formation begins at the innermost cortex and extends outwards. In addition, secondary osteons are formed primarily when damage occurs to bone as a means of repair. In areas of higher loading, near muscle attachments, for example, the general observation is that remodelling is more active, thus more Haversian tissue occurs. To test these ideas in a comparative manner, cross sections at midshaft of the long bones of around 40 species of mammals, birds and dinosaurs are examined and the interspecific variability of Haversian bone distribution is assessed. A biomechanical signal is tested based on muscle attachment sites and known loading regimes. Possible influence on Haversian bone characterised by phylogeny and habitat (aquatic, arboreal, terrestrial) is also considered. This analysis will provide a comprehensive understanding of Haversian bone in a much broader view than before, and potentially lend support to the idea of Haversian tissue as a mechanical adaptation.

The microanatomy of vertebral centra of *Tanystropheus* – a potential key for deciphering tanystropheid palaeobiology

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Tanystropheus is a large terrestrial prolacertiform that inhabited intertidal environments of land massifs, surrounding the epicontinental sea of European Basin. Remains of *Tanystropheus antiquus* have been found in shallow-water marine sediments of Poland, Germany and the Netherlands. As with all prolacertiformes, *Tanystropheus* is characterised by a long neck, but in this case the neck was extraordinarily long in proportion to total body length which gave it a rather grotesque look. It is still a mystery why in *Tanystropheus* elongation of cervical spines occurred by lengthening of the vertebral centra, rather than by increase of the number of vertebrae. We have examined several vertebral centra of *Tanystropheus antiquus* from the Polish Muschelkalk using non-destructive, high-resolution X-ray computed microtomography as well as traditional thin sections of bone, investigated under light microscopy and ESEM. We have demonstrated a thickening of the cortical bone of vertebral centra and the presence of numerous trabeculae outstretched between the walls of the centrum. Additionally, the internal part of the vertebra seems to be empty. The wall thickening of cervical vertebrae and the occurrence of trabeculae probably allowed the strengthening of the vertebrae. Vertebral centra with very long and low neural spines have elongated cervical ribs arranged along the ventro-lateral edges of vertebrae. These features provide rigidity of the vertebral column, while suppressing the flexibility of the neck. The lack of mobility in the vertical plane of the neck in *Tanystropheus* as well as the ability for broad movements in the horizontal plane suggests gathering. It means that the animal hunted for slow-moving victims and did not perform sudden movements.

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Ontogenetic development of bone microstructure in the king penguin *Aptenodytes patagonicus* in relation to its aquatic adaptation, and palaeoecological inferences

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Birds colonised various ecological niches during their evolutionary history. Besides the acquisition of flight, several lineages independently adapted to the aquatic environment and developed swimming and diving capabilities. Over the past years an increasing number of papers have focused on the diversity of long bone microstructure in aquatic birds in the light of their diverse locomotor strategies. Some studies have attempted to reconstruct the locomotor pattern of fossil taxa from their bone microstructure, without referring to a comparative set of modern taxa. These works have often drawn ecological deductions from one or two limb bones of a single specimen. However, the ecological signal contained in bone microstructure is known to vary between skeletal elements. Bone microstructure can also be affected by other factors (besides lifestyles), which have often been overlooked in palaeoecological inferences (e.g., gender, individual age, reproductive status, food supply etc.). Studies on intra-specific variability, as well as on bone microstructural development during ontogeny, are rare in the field of comparative bone histology, although such works are essential for the choice of standard parameters for bone description and structural analyses and, in a later stage, for drawing rigorous palaeobiological inferences.

In the present study, we have sampled all major long bones of several hatching, juvenile and adult specimens of the king penguin, *Aptenodytes patagonicus*, in order to assess the extent and causes of limb bone microstructural variability during ontogeny. This work focuses on three main questions: i) intraspecific variability; ii) inter skeletal-element variability and identification of the bones most affected by aquatic adaptation; iii) the evolution of bone histology, compactness and mineral density during ontogeny in relation to the change in locomotion (between juvenile period and adulthood). Physiological factors that could affect bone microstructure are also considered. This work is intended to constitute a comparative basis for the histological study of extinct sphenisciforms (and, to some extent, other diving birds), and thus provide a better framework for palaeobiological and palaeoecological inferences.

Fungal activity on bones, teeth and marine invertebrates

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Fungi are implicated in *post-mortem* decomposition of bodies. Fungal metabolic acids change tissue structure and can destroy even fossilized bones and teeth; traces which are created on (or inside) fossils can be useful for palaeoenvironmental analysis.

Fungi are commonly viewed as microborers (e.g., the ichnogenera *Mycelites*, *Mycobystrovia*, *Abeliella*) or endolithic fungi in shells (*Dodgella*, *Conchyliastrum*, *Saccomorpha* and *Polyactinia*). In bones and teeth, both mineral and organic matrices can be dissolved and therefore characteristic tunnels can be formed. Borings are filled with a micritic carbonate fluorapatite phase, which is rich in fluorine. The degree of microboring is connected with the sedimentation rate and availability of phosphate, which may be indicative of the volume of environmental productivity. Except for tunneling, fungi can cause damage on the surface of bones and teeth. Metabolic acids, produced by epilithic lichens which are integrated in fungal classification, dissolve fossils and form new markings. These traces used to be known as creation of vegetal roots. However, their shapes are different and covered with calcium oxalate. Two types of lichen corrosion pattern on fossil bones and teeth were associated with lichen genera, i.e., Type 1 - linear marks (*Sarcogyne orbicularis*, *Verrucaria* sp., *Buelia* aff. *punctiformis*) and Type 2 - subrounded holes (*Aspicilia* aff. *aquatica*). The presence of lichens suggests (at least one) period of time of fossil exhumation. Lichens penetrate marine coastal limestone and incorporate endolithic cyanobacteria of the genus *Hyella*, and fungi have also been isolated from corals. Fungi and algae are always present in healthy corals. Black bands in the interior of the coral skeleton are associated with the presence of endolithic fungi. Specific boring traces found in the fossil record are described as trace fossils (ichnofossils).

Possible endogenic organic molecules in early Middle Triassic reptile bones from Upper Silesia, Poland – results of a multiproxy study

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Bone samples of Middle Triassic reptiles (nothosaurs and prolacertiforms) have been analysed in terms of preservation of organic matter residues. Preliminary morphological studies (light microscopy and ESEM) have revealed the occurrence of vessel-like and bone cell-like structures in the cortical part of bone in several samples. Powdered bone fragments and extracted vessel- and cell-like structures have been investigated using multiple spectroscopic methods (XPS, FTIR, Raman) and high-resolution Time of Flight Secondary Ion Mass Spectrometry (ToF-SIMS). Infrared spectroscopy has revealed the presence of various amide bands, which we interpret as an effect of collagen breakdown, as well as amino acid side chains and lipids. Photoemission spectroscopy has indicated binding energy of nitrogen characteristic of amine and amide groups. Additionally, the ToF-SIMS analysis of fossil bones has indicated an abundance of amino acid residues: proline, lysine and their hydroxylated forms, compounds characteristic of animal collagens. The results of investigation on fossil material have been compared with data from similar studies on >12 year-old bones of the recent marine iguana of the Galápagos Island that died under similar environmental conditions. Proteinaceous and lipid organics must have been preserved within the fossilised vessels and bone cells were in the process of rapid early diagenetic iron oxide mineralisation. Ferruginous mineralisation protected organics against biological and physical degradation. Additional factors such as bone structure, thickness and geochemical properties of sediment may have played a role in the preservation of original organic matter even in oxidizing conditions in nearshore environments.

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The first fossil record of the “White Sharks” (*Carcharodon carcharias*) from Central America and its association with other macropredatory sharks

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The *Carcharodon carcharias* is the largest living predatory fish, with a total length exceeding 6 meters. This shark appears during the early Pliocene, and currently has a cosmopolitan distribution, inhabiting mainly in coastal and offshore temperate environments, although some individuals have been referred to tropical waters. From North and South America its Pliocene fossils have been recorded from Mexico and USA, and the Pacific coast of Peru and Chile. For the Caribbean region, dubious records of *Carcharodon carcharias* have been referred to the early-middle Miocene of Cuba and late Miocene of Panama, suggesting for both an erroneous taxonomic identification. Here based on an upper anterior tooth of *Carcharodon carcharias*, we report the first fossil record for this taxon from Central America (Punta Burica, Panama gulf of Chiriquí). The specimen was collected in a conglomerate (shallow water facies) of the upper section of the Burica Formation (late Pliocene-Pleistocene) together with isolated teeth of *Carcharhinus plumbeus*, *Carcharhinus* spp., and *Galeocerdo cuvier*. Another locality (Calabazo creek) from the same Burica Formation included a few specimens of *Carcharhinus limbatus*, *Negaprion brevirostris*, and *Rhizoprionodon* cf. *longurio*. Using “tooth enamel height” and allometric models previously performed to estimate the total length in *Carcharodon carcharias* we inferred for our specimen a body size close to 4 meters long, corresponding with an adult. This co-occurrence of *Carcharodon carcharias* and other large sharks as *Galeocerdo cuvier*, suggests that these marine large predators could have frequented the same environment without ecological exclusion.

The first fish remains (Sarcopterygii and Actinopterygii) from the late Ladinian–earliest Carnian (Chañares Formation) of Argentina: a wider palaeolatitudinal distribution for early mawsoniid coelacanthiforms?

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The amniote fossil record of the late Ladinian–earliest Carnian Chañares Formation is among the richest worldwide for the Middle Triassic. However, non-amniote osteichthyan remains were unknown from this highly fossiliferous unit, until they were collected during recent fieldwork. A specimen sampled from the lower member (~7 metres above the base), and probably late Ladinian in age, belongs to a fragment of dermal bone assignable to a coelacanthiform mawsoniid (Sarcopterygii, Actinistia) based on its ornamentation. Remains collected from the upper member (4 metres below the top; early Carnian) of the unit are represented by patches of scales that resemble those of some pseudobeaconiid perleidiforms (Actinopterygii). The record of a putative mawsoniid in the Middle Triassic of South America is of particular interest because it represents the first evidence of the group in southern palaeolatitudes during the early evolution of the clade. The oldest unambiguous mawsoniids come from the Middle Triassic of Europe and have subsequently been recorded from North America during the Late Triassic. The specimen described here indicates a wider palaeolatitudinal distribution for mawsoniids than previously recognised, spanning from a palaeolatitude of 20°N in the Northern Hemisphere to 45°S in southwestern Pangaea. This distribution indicates the presence of the group in tropical to temperate/semi-arid palaeoclimates in the north and south, respectively, and suggests a relatively broad climatic tolerance for early members of the clade. Accordingly, the probably broad geographic distribution of early mawsoniids matches the biogeographic history observed in multiple Middle Triassic vertebrates.

Digital endocranial reconstruction of a large Triassic actinopterygian from Schesaplana, Switzerland

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Braincases preserved in articulation and in three dimensions are relatively rare for fishes, and when preserved, they are usually laterally compressed and obscured by lateral dermal elements. This partial skull of an actinopterygian preserved in three dimensions comes from the Kössen Formation (Late Triassic) of Schesaplana, Switzerland. The specimen includes the neurocranium and associated dermal bones with some warping. This fish is a large basal teleost. This preservation enabled digital reconstruction of internal features including the endocranial cast and nerve canals.

A callipurbeckiid (Ginglymodi, Semionotiformes) from the Tithonian (Upper Jurassic) of Canjuers, France

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Ginglymodian fishes are abundant and diverse in Upper Jurassic limestones of Germany, but rarer in coeval sequences in France. Only a single ginglymodian is so far known from the Tithonian at Canjuers. Identified as *Lepidotes* sp., this excellently preserved specimen (MNHN CNJ89; collections of the Muséum national d'Histoire naturelle, Paris) has been studied anatomically and cladistically. This has revealed that it represents a new species of the family Callipurbeckiidae, which is the sister group of the Semionotidae within the Semionotiformes. The incorporation of the new taxon and a re-evaluation of morphological characters (i.e., more accurate definitions, addition of new character states and new characters) have produced changes in the topology compared with previous phylogenetic studies of Ginglymodi. In the new topology, macrosemiids are outside Semionotiformes and constitute the sister group to all other ginglymodians.

According to previous studies, MNHN CNJ89 is an allochthonous element at Canjuers; the new taxon inhabited the epicontinental seas that covered most of Europe connecting the Tethys with the North Atlantic during the Tithonian. One specimen among fishes at the Natural History Museum, London, referred to *Callipurbeckia minor*, actually represents the new callipurbeckiid taxon. This specimen belongs to the old fossil collection from the Middle Purbeck Beds at Swanage and probably is of earliest Cretaceous age. Therefore, the minimum biochron for the new taxon ranges from the early Tithonian to the Early Cretaceous.

First finds of micrometric-sized cartilaginous fish teeth from the Lower Cretaceous deposits of Crimea

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The micrometric-sized cartilaginous fish teeth from the Cretaceous deposits of Crimea were previously unknown. The Lower Cretaceous strata there are characterised by quite different lithologies, with both terrigenous and carbonate facies being represented. Several sections were sampled for micrometric-sized vertebrate remains; at two, situated on the right side of the River Belbek valley, some teeth and placoid scales of cartilaginous fishes were discovered, plus several indeterminate teeth of teleosts and cartilaginous fishes. The base of the section at 'Kabanij log' shows intercalations of densely and weakly cemented quartz sandstones with carbonate cement (Berriasian, *occitanica* Zone), which grades upwards into intercalations of sandstones and oolitic limestone. The upper part comprises oolitic limestone. In the lower part teeth and placoid scales of Orectolobiformes were found, while the middle and upper parts yielded some indeterminate teleost and elasmobranch debris. The sequence exposed at 'Sbrosovy log' comprises Valanginian limestones, the upper part eroded by Hauterivian clay deposition, with numerous organic remains such as foraminifera, belemnites, brachiopods, crinoids and aptychi. Based on *Lamellaptychus angulicostatus* these strata are dated as late Hauterivian. A total of 15 shark teeth and three placoid scales were found (*Sphenodus* sp., Pseudonotidanidae gen. et sp. indet.). *Dorsetoscyllium* aff. *terraefullonicum* is a carpet shark; important is the association of teeth and placoid scales of this form which was previously known only from a few localities in the Bathonian of Great Britain. A lateral tooth of Pseudonotidanidae gen. et sp. indet. is very unusual because of the fact that the symphysis part is presented by two reasonably large cusplets, the first one of which is slightly shorter in height of the main vertices. Assignment is based on structural features of the root, with a quite wide base. An anterior tooth was also collected; this has broken lateral vertices. Teeth of *Sphenodus* sp. far outnumber other material at 'Sbrosovy log', but specimens preserving the root are very rare. The entire Berriasian-Hauterivian association of cartilaginous fish teeth from the Lower Cretaceous of Crimea is new for the whole of Russia. Future collecting is possible and will permit detailed analysis of the palaeogeographic and stratigraphic distribution of these relatively rare forms.

Middle-Late Miocene ichthyofauna of the Taman' Peninsula (Krasnodar district, Russia)

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The Neogene fossil record of Taman' Peninsula has much improved our knowledge of the Middle-Late Miocene ichthyofauna in the eastern Paratethys, and provided the most informative data on fish assemblages of the Meothian. Evidence from this ichthyofauna shows that, within the Konkian-Meothian interval, the regional marine basin underwent repeated environmental changes related to temperature, salinity and degree of isolation. The earlier Chokrakian-Karaganian assemblages are poorly known and dominated by clupeids. The Konkian fauna includes Clupeidae and the endemic Callionymidae, a group inhabiting warm coastal bottom waters and now known to be commonest in the Western Pacific. The early-middle Sarmatian assemblage is dominated by pelagic Clupeinae (*Clupeonella* sp. nov.) and Alosinae (*Alosa* sp. nov.), along with boreal Gadidae (*Micromesistius* sp. nov.). This composition indicates a moderately warm marine basin that was connected with the Central Paratethys. The impoverished community of the upper Sarmatian shows a predominance of Clupeinae (*Clupeonella* sp.), while marine taxa are absent, which suggests a semi-closed brackish water basin. The late Meothian demonstrates a marked increase in diversity, embracing clupeids, gadiforms (Merlucciidae: *Merluccius maeoticus*) and numerous perciforms (Sciaenidae: *Carnevalella tmutarakanica*; Carangidae: *Lichia* sp.; Sparidae: *Sparus diatomacea*, *Diplodus* sp.; Moronidae: *Morone vogdti*, *Dicentrarchus* sp., *Lepidopus* sp.; Scombridae: 'Scomber' *spuria*). The bulk of this assemblage, composed of endemic and largely marine acanthopterygians, points to an open basin (with salinity comparable to that of the modern Black Sea) interconnected with the Mediterranean and Central Paratethys. A new change towards the condition of a freshened, closed water body, with a reduced fish fauna (only *Alosa* sp. recorded so far), occurred in the late Meothian.

Neogene ichthyofauna of Tagay Bay (Olkhon Island, Lake Baikal) and Miocene expansion of the Channidae in northern Asia

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Neogene strata exposed in Tagay Bay (Olkhon Island of Lake Baikal) contain a diverse fauna of vertebrates (fishes, birds, turtles and mammals) and molluscs. The locality has been the subject of regular study since the end of the last century. Starting from 2011, the work has been continued by a joint team of three institutions (i.e., of zoology, palaeontology and geology) of the Russian Academy of Sciences and researchers from the city of Irkutsk. Examination of the Early-Middle Miocene ichthyofauna of the Tagay section has revealed an assemblage containing Esocidae (*Esox* sp.), diverse Cyprinidae (*Palaeorutilus* sp., *Palaeotinca* sp., *Palaeocarassius* sp., Leuciscinae gen. indet.), Percidae (*Leobergia* sp.) and Channidae (*Channa* sp.). Channid remains associated with pharyngeal teeth of *Palaeotinca* sp. and numerous fin spines of ancient carp, *Palaeocarassius* sp., indicate a plant-filled water basin with an oxygen deficiency. Along with that, the presence of the Channidae points to subtropical or, in any case, quite warm climate. The occurrence of channids, basically uncommon in northern Asia, is of primary interest. Their first discovery in Neogene strata of the region (*Channa tverdislovi*) was made by the author in 1989 in the Zayssan Formation of eastern Kazakhstan, dated as MN 4b. Subsequently, the group has been identified by me at Mynsualmaz in western Kazakhstan (of Burdigalian age) and the Aya Cave in the Baikal region. The latter find, together with that from Olkhon Island, marks an episode of the most northerly expansion of the Channidae in Asia. This event, traceable also in the coeval fossil record of Europe, seems to correspond to the Miocene climatic optimum.

First amphibian and lizard remains from the Neogene of Urumaco, Venezuela

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Neogene localities in the Urumaco Basin have so far yielded a large number of marine and continental vertebrates encompassing several major clades, with amphibians absent until now. Most of the continental taxa retrieved are of large size, some being ‘giants’, such as the crocodylians *Gryposuchus* and *Purussaurus*, the turtle *Stupendemys* and the rodent *Phoberomys*. Prospecction in the Urumaco Basin carried out in November 2013 yielded two continental vertebrates of relatively small size, i.e., an amphibian and a lizard, here preliminarily referred to an indeterminate pipid frog and a teiid lizard.

The amphibian fossil comes from the locality of Corralito (Upper Member of the Urumaco Formation; Upper Miocene) and consists of a fused sacral vertebra and urostyle (25 mm long). Both elements are incomplete, but the following characters are visible: laminar and anteroposteriorly expanded sacral diapophyses, sagittal sacral ridge merging posteriorly with the crista dorsalis of the urostyle, relatively small canalis coccygeus of the urostyle. The lizard remain was collected from the Vergel Member of the San Gregorio Formation (Lower Pliocene) and consists of an incomplete right dentary (37 mm long) corresponding to the first 11 tooth positions, plus the anterior wall of the 12th position. No teeth are preserved, but the last ones were very much enlarged. The Meckel canal is entirely open and broad.

These latest finds and ongoing work demonstrate the potential of the San Gregorio Formation for documenting microvertebrates at a major phase of the Great American Biotic Interchange.

Two large billfish remains: do they belong to the same species?

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The Pucking locality in Upper Austria (Lower Miocene of Paratethys) has yielded a very rich fish assemblage consisting of about 15 taxa, some of which are particularly abundant, namely pipefish (*Syngnathus*), hake (*Merluccius*), herring (Clupeidae) and mackerel (Scombridae). In addition, there are records of representatives of bigeye (Priacanthidae), hatchetfish (*Argyropelecus*), needlefish (Belonidae), lanternfish (Myctophidae), jacks and pompanos (both Carangidae), breams and porgies (both Sparidae), boarfish (Caproidae), ponyfish (Leignathoidae) and sunfish (*Austromola angerhoferi*). The entire Pucking assemblage thus represents an almost unique and highly important record of the Lower Miocene fish fauna in the Paratethys. Two large fish remains from the Pucking locality have been newly identified as billfish, i.e., a set of incomplete prolonged jaws (rostrum) possessing villiform teeth (collections of the Naturhistorisches Museum Wien) and a slab with the abdominal part of the vertebral column with seven vertebrae and a dorsal fin held at the Landesmuseum Linz. These are the first records of billfish from the ‘Egerian’ of Europe. An interesting question is whether both sets of remains belong to the same taxon, or not. Whilst identification of the rostrum as a billfish is clear, that of the slab with vertebrae and part of a dorsal fin is more difficult.

The Pucking specimen is stratigraphic ally younger than extinct billfish families (Palaeorhynchidae, Blochiidae and Xiphiorhynchidae), except for two questionable specimens of *Aglyptorhynchus*, which is why its proper identification would really help us understand the evolution of this interesting group.

Insights into the evolutionary history of Mosasauroida (Squamata) using parsimony and Bayesian inference

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Mosasauroida is a species-rich clade of mostly marine, small to gigantic squamates with an evolutionary history recorded exclusively in Upper Cretaceous strata. Although the most distinguishable mosasauroid lineages, such as tylosaurines, plioplatecarpines and derived mosasaurines, have already been adequately recognised decades ago, their interrelationships (and especially origins) remain unsettled and largely depend of taxon and character sampling. We have revised the definitions of 150 morphological characters and scored them for 51 mosasauroid taxa. Compound characters were atomised, while neomorphic and transformational features were considered as distinct characters and not as alternative states of a single character, to avoid *a priori* assumptions on character transformations.

The resultant data set was analysed under both parsimony and Bayesian inference, the latter integrating morphological and stratigraphical data, to infer topology and timing of cladogenesis of particular mosasauroid subclades simultaneously. Both methods reconstruct monophyletic Tylosaurinae, Plioplatecarpinae and Mosasaurini (*Mosasaurus*, *Plotosaurus*). The inferred topologies also support a clade formed by *Yaguarasaurus*, *Tethysaurus*, *Russellosaurus* and *Pannoniasaurus*. In contrast, *Prognathodon* is polyphyletic and the position and inclusiveness of the Halisaurinae is problematic. Many nodes, especially those near the base of the Mosasauridae, are extremely weakly supported, which might be due to the fragmentary nature of many taxa, as well as to homoplasy. Thus, an analysis with implied weighting was performed as well, to test the effect of down-weighting homoplastic characters on relationships. Alternative Bayesian analyses have shown that higher-level relationships are particularly biased by outgroup selection among ‘aigialosaur’-grade forms.

The dentition of *Polyptychodon interruptus* (Plesiosauria, Pliosauridae)

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Pliosaurid plesiosaurs were significant components of Mesozoic marine ecosystems and dominant predators, especially during the Middle and Late Jurassic. The subfamily Brachaucheninae comprises the only macropredatory pliosaurids that persisted to the early Late Cretaceous. All other pliosaurids became extinct prior to the end of the Jurassic. However, our knowledge of brachauchenine origins, interrelationships, palaeoecology and palaeobiogeography is rather poor. *Polyptychodon* is a brachauchenine with the widest geographical distribution. Material ascribed to this taxon comes from numerous localities across Europe (i.e., the Czech Republic, England, Germany, Italy, France, Poland, Russia and Ukraine), Asia (Japan) and North and South America (USA, Argentina). These referrals, however, likely stem from the general absence of diagnostic pliosaurids in Cretaceous strata and, thus, rely merely on tradition rather than actual relationships. Material of *Polyptychodon* from the Albian/Cenomanian Cambridge Greensand of eastern England consists of isolated teeth in various states of preservation. A review of the history of these finds and direct examination of 104 isolated teeth of *Polyptychodon interruptus* at the Sedgwick Museum of Earth Sciences, Cambridge, has resulted in a better understanding of the diagnostic nature of the dentition. Considering these new data, the fragmentary nature of the material and its problematic provenance, *P. interruptus* is here regarded a *nomen dubium* and referred to as Brachaucheninae indet. It is suggested that Cretaceous pliosaurids were more diversified than usually assumed, which might have an impact on further studies of rich assemblages of isolated pliosaurid teeth (e.g., those from Annapol, Poland).

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A new basal elasmosaurid skeleton with joint pathologies from the Lower Cretaceous of Germany

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The family Elasmosauridae constitutes one of the most iconic plesiosaurian clades. Their conservative body plan represents the popular model for Plesiosauria, and is characterised by a distinctive osteological morphology especially adapted for hyper-elongation of the neck. Here we report on a new basal elasmosaurid from the Lower Cretaceous (upper Hauterivian) of Lower Saxony, northern Germany. The fossil comprises skeletal components from an osteologically old individual: most of the cranium and partial mandible, the atlas-axis complex, cervical and caudal vertebrae, ribs, an ilium and paddle elements. The specimen displays a number of primitive elasmosaurid traits including five premaxillary teeth and amphicoelous cranial cervical centra that bear short lateral longitudinal ridges, but lack ventral notches on the articular faces. The dentaries are unusual in having extremely procumbent alveoli in the symphyseal region. The mandible also forms a prominent wedge-shaped ventral platform. Interestingly, the articular surfaces of the basioccipital and atlas centrum show changes suggestive of a degenerative or chronic inflammatory joint disease. Irregular exostotic outgrowths adjacent to the articular surface are present similar to an osteophytic growth. These lesions may have caused impaired joint function and pain, perhaps contributing to the death of the individual.

New information on dorsal vertebrae of *Siamotyrannus isanensis* (Dinosauria, Theropoda) from the Lower Cretaceous of Thailand

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Siamotyrannus isanensis is a large-bodied theropod from the Lower Cretaceous Sao Khua Formation of northeastern Thailand. It was named in 1996 by Buffetaut et al., who concluded it to be a basal member of the Tyrannosauridae. It has subsequently been held to be assignable to the Metriacanthosauridae by Rauhut (in 2003) and Carrano et al. (in 2012), and suggested to be a carcharodontosaurian by Brusatte and Sereno (in 2008). In the original publication, the dorsal vertebrae of *Siamotyrannus* were only cursorily described, in spite of the importance of these elements in the phylogenetic analysis of the taxon. The objective of the present study is to describe the morphology of these vertebrae in detail.

The dorsal vertebrae of *Siamotyrannus* could be anterior to mid-dorsals, as based on the laminae on the dorsal series. The characters are: dorsal vertebrae with long and backward diapophyses; long and stalk-like parapophyses; hourglass-shaped and amphiplatyan centra; many fossae and laminae on transverse processes; hyposphene lamina is possibly parallel and sheet-like; no pleurocoel or pneumatic foramen on the centra.

A preliminary phylogenetic analysis, including dorsal vertebrae, pelvis and tail elements, suggested a 'basal' coelurosaur position with 324 most parsimonious trees, each of 1,031 steps from 351 characters of 61 dinosaur taxa, CI = 0.419 and RI = 0.69. The revision of the pelvic girdle, sacral and caudal vertebrae is still in process. In combination with new data on dorsal vertebrae, the proper phylogenetic position of this taxon is expected to be well understood in future.

A new vertebra of *Pararcus diepenbroeki* from the Vossenveld Formation at Winterswijk, the Netherlands

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The stratigraphically oldest specimen of *Pararcus diepenbroeki* (Sauropterygia, Placodontia) is described from Layer 14 of the Vossenveld Formation at Winterswijk, eastern Netherlands, and compared to younger material from the same locality. The first completely fused vertebra of the species represents an adult specimen and has an intermediate size with respect to previously published *Pararcus* vertebrae. Based on the slanting angle of the ventrolateral projections, the vertebra is interpreted to have originated from the dorsal domain. In addition to overall agreement in morphology and size that warrant identification as *Pararcus diepenbroeki*, the newly described vertebra deviates from other *Pararcus* vertebrae in the presence of a longer, ossified, neural spine and a strongly constricted, less pachyostotic and ovaloid vertebral centrum. General size agreement with previously described vertebrae suggests this novel condition to relate mainly to a different anatomical position and a varied ossification pattern along the axial skeleton. Based on this specimen, we propose to extend the diagnosis for *Pararcus diepenbroeki* slightly.

Crocodylomorph diversity in the upper Maastrichtian of Serraduy (Huesca, Spain)

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The vertebrate sites of Serraduy (Huesca, Spain), located in the Tremp Basin (Pyrenees, northeast Spain), form part of the Arén and Tremp formations that have been dated as late Maastrichtian in age. New sites, yielding dinosaurs, chelonians and crocodylomorphs have recently been discovered. The importance of the present study is that it may assist us in gauging biodiversity of Crocodylomorpha just prior to extinction at the K/Pg boundary.

The most notable remains include a complete skull of the eusuchian *Allodaposuchus subjuniperus* which has been published recently. Other remains recovered comprise several isolated teeth of two morphotypes. The first is characterised by slender conical teeth with well-marked basiapical longitudinal ridges and mesiodistal carinae slightly more marked than the ridges. These teeth are very similar to those of *Thoracosaurus*, a marine eusuchian crocodylomorph typical of the Upper Cretaceous/Paleocene. Moreover, the fact that the teeth were recovered from the transitional facies of the Arén Formation appears to substantiate this assignment.

Teeth assigned to the second morphotype were collected from the continental facies of the Tremp Formation. They are distinguished by a more robust conical shape with near-smooth enamel and well-marked mesiodistal carinae. This generalist dentition is typical of some species of the genus *Allodaposuchus* which have been recorded from coeval strata in the same area. Therefore, the Serraduy area would have had at least two different eusuchians which may be assignable to *Thoracosaurus* (marine) and *Allodaposuchus* (continental).

Endocranial morphology of *Maledictosuchus* (Thalattosuchia) from the Callovian (Middle Jurassic) of Spain

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Maledictosuchus riclaensis is a metriorhynchid (Thalattosuchia), the sole archosaurian group that secondarily returned to a pelagic lifestyle. This group has numerous adaptations, such as hydrofoil-like forelimbs, a hypocercal tail or a hydrodynamic body and skull. However, they also needed physiological specialisations in order to occupy marine environments (e.g., salt glands), which are usually reflected in soft tissues that rarely fossilise. Exceptionally, such soft tissues can be found in well-preserved endocasts (such as *Cricosaurus* endocasts), in internal cavity moulds or thanks to computerized tomography (CT) scanning techniques. To date, only three thalattosuchian genera have been scanned; *Pelagosaurus*, *Metriorhynchus* and *Cricosaurus*.

The holotype of *Maledictosuchus riclaensis* (MPZ 2001/130) stems from limestone nodules in Callovian-aged deposits at Ricla (Zaragoza, Iberian Peninsula). It consists on a very well-preserved skull and three vertebrae. The skull was prepared by mechanical methods and the entire matrix covering the bone was removed, while the internal matrix remains intact.

The skull of *Maledictosuchus* was scanned at the Institut Català de Paleontologia (ICP) (Sabadell, Spain), with an industrial CT scanner, at 430 kV and 3,45 mA. The interslice space was 0,5 mm, obtaining 1,206 slices in total. The segmentation was done using the software Avizo-7.1.

A preliminary 3D reconstruction shows some internal structures such as the nasal cavity, salt glands, antorbital sinuses, olfactory bulbs and tract and the nasopharangeal ducts. Due to the density of the bone and internal matrix, the CT images of the brain region are less well defined; nevertheless, the endocranial cavity and different sinuses, cavities and small canals have been recognised.

Postcranial material of *Nothosaurus marchicus* from the Lower Muschelkalk (Anisian) of Winterswijk, the Netherlands, with remarks on swimming styles and taphonomy

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Associated and articulated vertebrate remains are notoriously rare in Muschelkalk deposits. The gentle slope of the basin margins and limited water depth made large parts of the Muschelkalk Sea particularly susceptible to storm and wave activity. Skeletal material generally accumulated in thin lag deposits that originated through winnowing, which resulted in concentration of vertebrate remains but also caused disarticulation and abrasion. Since alpha taxonomy of stem-group sauropterygians is largely founded on cranial morphology, identification of isolated post-cranial elements in a mixed assemblage generally is challenging. Here, we describe associated and articulated partial skeletons from the Vossenveld Formation (Lower Muschelkalk, Anisian) at Winterswijk (the Netherlands) that can be confidently assigned to *Nothosaurus marchicus* due to the association with a diagnostic cranium. Their humeri are recognised as humeral morphotype II (*sensu* Bickelmann & Sander). The large variation in morphology and size among post-cranial elements is not reflected in presently known cranial material and provides evidence of the presence of an additional, unidentified nothosaur taxon in the assemblage, strong sexual dimorphism, or a broader size range for *N. marchicus* once more. Important morphological deviations between *N. marchicus* and the sympatric sauropterygians *Anarosaurus heterodontus* and a basal pistosauroid (cf. *Cymatosaurus*) exist in the humerus, ulna and clavicle-interclavice complex. These specific element morphologies reflect their respective swimming styles. *Anarosaurus heterodontus* and the basal pistosauroid relied on anguilliform swimming, whereas *N. marchicus* also employed its forelimbs in a more paraxial swimming style. Furthermore, we describe taphonomic observations that relate to predation, scavenging and the disgorgement of skeletal remains.

Small-sized spinosaurids from the lower Barremian (Lower Cretaceous) of Spain

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Spinosaurids account for a large amount of theropod remains (mainly isolated teeth) at localities exposing Lower Cretaceous strata in the Iberian Peninsula. A good example is the La Cantalera-1 site, in the Blesa Formation (Teruel, Spain), where isolated theropod teeth are frequent. The aim of the present report is to compare spinosaurid teeth from La Cantalera-1 with the known record from Spain. Seventeen teeth have been studied by using qualitative and quantitative features, including multivariate statistical analysis. Two different morphotypes have been recognised at the La Cantalera-1 site: Baryonychinae indet. and Spinosaurinae? indet. Teeth of the former, with similar morphology, have been described from other Lower Cretaceous sites in Spain, stemming from baryonychines close to *Baryonyx*. Teeth tentatively attributed to Spinosaurinae? indet. (of spinosaurines close to *Spinosaurus*) could constitute new evidence of the occurrence of spinosaurines in the Lower Cretaceous of the Iberian Peninsula, the record of this group in the area being patchy. The La Cantalera-1 record, when compared to other Lower Cretaceous sites, reflects conditions of the depositional area, i.e., a marshy environment with periodic droughts resulting in a non-permanent body of water, which represents an ecosystem unable to sustain large-sized organisms.

A juvenile ctenochasmatid pterosaur from the Solnhofen Limestone

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The Upper Jurassic Solnhofen Limestone of southern Germany has yielded numerous species of pterosaurs known from specimens that represent various ontogenetic stages. Many specimens of these species have been distributed across the world and, in some cases, forgotten about. Here we report on a juvenile pterosaur that was obtained from a private collector between 1919 and 1925, and briefly described in a local Czech journal, in 1925, as *Pterodactylus elegans*. The specimen is almost complete and well preserved. Several parts of its limb bones were lost, but their imprints remain and are visible reasonably well, thus allowing some examination of these structures. Although sketchily mentioned in a few papers since its original description, the specimen has never been studied or photographed in detail. Due to its small size (skull length <30 mm), inferring its phylogenetic affiliations is problematic. Rather long, slightly curved, anterolaterally projecting teeth that are well developed in the anteriormost part of the jaws suggest a ctenochasmatid nature. The cluster analysis using the UPGMA algorithm (Euclidean distance measure) and *k*-means clustering (*k* = 3), implementing morphometric data of juvenile ctenochasmatids from the Solnhofen area, suggest closest resemblance to *Aurorazhdarcho micronyx*. However, attribution to *Ctenochasma elegans* cannot be ruled out either. Irrespective of its systematic position, the specimen represents one of the smallest ctenochasmatid pterosaurs from the Solnhofen area known, and thus provides invaluable data on the ontogeny of Late Jurassic archaeoptero-dactyloid pterosaurs.

***Megacnemus* – a forgotten reptile, presumably from the Triassic of Poland**

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Protorosaurs were important components of many Permian and Triassic ecosystems. Some of the known protorosaurian taxa have been established on the basis of fragmentary material. One of these is *Megacnemus grandis* von Huene, 1954, of which only a single complete, yet distorted propodial – originally interpreted as a femur – is known. Although exact locality data are missing, von Huene (1954) pointed out that the specimen had most probably been found in the Middle Triassic deposits near Gogolin (southwest Poland). Since its initial description the genus *Megacnemus* has received very little attention. Our attempt is to redescribe the type specimen and assess the phylogenetic position of the taxon. The protorosaurian affinities of *Megacnemus* proposed by von Huene (1954) have been accepted in later publications; however, the bone differs from femora of most ‘traditional’ protorosaurs, such as *Protorosaurus*, *Macrocnemus* and tanystropheids, by its robustness and the lack of a sigmoidally curved shaft (however, the latter might have been affected by the distortion of the bone). Yet, *Megacnemus* does share some traits with the humeri and femora of *Dinocephalosaurus* from the Middle Triassic of China, and the humeri of *Macrocnemus* from the Middle Triassic of Italy, Switzerland and China. These are large expansions of the proximal and distal ends, as well as a strongly concave postaxial margin and a near-straight preaxial margin of the shaft. Despite these similarities, the bone of *Megacnemus* is much longer and has less rounded margins of the proximal and distal ends. However, should the similarities between *Megacnemus*, *Macrocnemus* and *Dinocephalosaurus* indeed be indicators of true affinity between those taxa, then this would be another case for a link between closely related Triassic protorosaurs from localities in Europe and China.

A partial skull of *Protoceratops andrewsi* from the Central Asiatic Expeditions in the Naturalis collections (Leiden, the Netherlands)

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The recent transfer of the palaeontological collections of the former Geologisch Museum of Delft University to Naturalis Biodiversity Center (Leiden) has led to the rediscovery of the skull and mandible of the ceratopsian dinosaur *Protoceratops*. The specimen originates from Campanian aeolian sandstone deposits of the Flaming Cliffs in Mongolia, having been discovered and excavated in 1923 during the Central Asiatic Expeditions. Between 1940 and 1957, it was acquired by Delft University. Most of the right lateral side of the skull and mandible are preserved including the jugal, quadrate, quadratojugal, maxillary (with seven teeth preserved), angular and dentary. Most of the dorsal and the anteriormost part of the skull are not preserved. Several dentary teeth are also present but are largely covered by the maxillary teeth. Additional preparation has revealed several new structures on the posterior and ventral parts of the skull which show remarkable conservation but cannot be determined with certainty because of taphonomic distortion. Based on the size of the skull, the curvature of the dentary, the number of maxillary teeth and the form of the angular depression, the specimen is interpreted as a juvenile *P. andrewsi*.

Bite marks on *Europasaurus* bones from the Langenberg Quarry near Goslar (Lower Saxony, Germany)

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The finding of the Late Jurassic dwarfed sauropod *Europasaurus holgeri* at the Langenberg Quarry was one of the major dinosaur discoveries in recent years. The taphonomy of *Europasaurus* is also unique, because there are at least 20 individuals representing different ontogenetic stages which all have been embedded in the same layer of marine limestone. Almost all of the bones represent disarticulated skeletons, but are excellently preserved with very few signs of weathering or strong abrasion. A survey of predator marks on about 1,500 prepared bones (*c.* 90 per cent *Europasaurus*; additional material mainly from marine turtles and crocodylians) has now been started. Preliminary results show that the bones lack unambiguous evidence of terrestrial predation or scavenging (i.e., by theropod dinosaurs); but bite marks of smaller scavengers are common. Several bones exhibit identical pattern: four parallel notches at intervals of approximately 1 mm and with variable length. These feeding marks are tentatively assigned to small crocodylians or, less likely, sharks. Bones and teeth of the atoposaurid *Theriosuchus* were found in the same layer. Especially larger bones (i.e., pectoral girdle) exhibit several of these bite marks, but they appear on long bones, vertebrae and ribs as well. Several other marks were found which clearly are not preparation marks. Given the complete preservation of fragile bones, abrasion is considered very unlikely, but cannot be excluded completely, because larger intraclasts are embedded among the bones in the matrix, indicating high-energy transport. A detailed comparison of our finds with Recent and Mesozoic bite marks will be presented at the meeting.

A theropod vertebra from the Middle Jurassic of southern Poland

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Body fossils of vertebrates (especially terrestrial) are very rare in Jurassic and Cretaceous rocks in Poland. Here we record a single vertebra found in association with invertebrates in the (limonitic) Baliński oolite ('storm beds') of Callovian age at Chrzanów. This specimen measures 10 mm in length and 15 mm in height. In proportions and deep fossae it is closely similar to posterior dorsal (presacral) vertebrae of *Allosaurus fragilis*. However, body size of the present animal is estimated to have been about 1 m in length based on size of vertebra. This theropod probably was a juvenile specimen or a dwarfed form ('island effect') reflecting major reduction of land areas across Europe during the Middle Jurassic. More bones are needed to obtain a better picture of dinosaurs in Poland during this interval.

New data on skull anatomy of *Silesaurus opolensis*

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Silesaurus opolensis from the Upper Triassic of Poland is one of the oldest representatives of the Silesauridae, a group of small to medium-sized omnivorous dinosauriforms of controversial relationships with dinosaurs. All silesaurids are known from incomplete, usually highly disarticulated material except for *S. opolensis*. Thus, detailed information on its anatomy is crucial in understanding the mode of life, relationships and evolution of the whole group.

Here we present somenewly identified characters of the skull of *S. opolensis*. The new skull reconstruction proposed differs in a number of aspects from previous works by Dzik and Sulej. The skull was shorter and more robust and with probably highly reduced maxillary fenestra. The jugal is strong and high and in broad contact with the quadratojugal, which is quite unusual for an early ornithodiran. The teeth are irregularly distributed and oriented laterally with distinct traces of extensive wear. The dentary shows two distinct rows of resorption pits. These rather suggest a diet of hard objects (hard plant elements or shelled food). Another important change is the reconstruction of the sclerotic ring. It has about 12 large elements. The braincase displays unusual variation in many aspects, such as the posterior surface of supraoccipital, the opening for the median Eustachian canal and the shape of basiptyergoid process. We discuss implications of these features for the mode of life of *S. opolensis* and its close relatives. Understanding of cranial morphology of this non-crown dinosaurian ancestor is important for resolving controversial questions of homology concerning general skull organisation or braincase features in early dinosaurs, as well as for improving estimates of the phylogeny and formation of bird-lineage characters in basal forms.

Oxygen and strontium isotopic study of tooth enamel in *Tarbosaurus bataar* – palaeoenvironmental and palaeoecological record or diagenetic overprint?

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The Nemegt Formation in the Gobi Desert (southern Mongolia) is famous for its diverse terrestrial vertebrate fauna from the end of the Cretaceous. It is characterized by a fairly homogeneous state of preservation of bones and a high degree of articulation of dinosaur skeletons. So far, only in a single paper have carbon and oxygen isotopic signatures from vertebrate remains collected from the Upper Cretaceous formations of Mongolia have been discussed, focusing, however, on the Djadokhta Formation.

Tooth enamel is resistant to most diagenetic processes; therefore, geochemical analysis of enamel has become a powerful tool for reconstructions of the individual history of life and investigations of seasonal habitat use, dietary habits, migration and physiology in both recent and fossil terrestrial vertebrates. Recent studies have shown that sequential sampling for dual isotope analyses (oxygen and strontium) has potential for revealing patterns of seasonal movement of land mammals. However, this new method has not been applied to dinosaurs or any other extinct animal groups older than Neogene. Here we present results of a multi-isotopic study (Sr and O isotopes) from serial sampling of tooth enamel of four (partially) articulated specimens of *Tarbosaurus bataar*, from the type locality at Nemegt, and discuss the reliability of the palaeoenvironmental and palaeoecological signatures in consideration of possible diagenetic overprint.

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Reconstruction of a historically interesting *Triceratops* ‘?*brevicornus*’ from the Lance Formation, Wyoming, USA

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Here we report on reconstruction efforts of an incomplete skull of a historically interesting ornithischian dinosaur, *Triceratops* ‘?*brevicornus*’, from the Lance Formation, near Lightning Creek, Converse County, Wyoming. The specimen most likely represents the better parts of YPM VP 001832, a skull recovered during the Yale-Hatcher 1891 Cretaceous Expeditions. Most of the diagnostic elements are absent, i.e., most of the skull base, including the majority of the condylar region, sub-orbitals up to the nasal bone anteriorly and lower jaws.

Following recovery, the skull remained in the possession of the Yale Peabody Museum up to 1956, before it embarked on its trip to the Delft University Museum in the Netherlands. In return, the Yale Peabody Museum was to receive a collection of fossils from the Dutch colony of Timor. Hampered by illness of the leading staff member of the local museum, damage incurred because of unsuitable conditions during transport. Because of insufficient reference material, subsequent repair and restoration work on the skull has been inaccurate.

Due to the recent merger of multiple collections with the Dutch national museum, Naturalis Biodiversity Center, new reconstruction efforts have been undertaken to restore the specimen. Various sources of information, including locality data and ontogenetic markers (e.g., dense vascular network, closed frontoparietal fontanelles, parietal thinning, flattened epoccipitals and number of tooth positions) are employed. By subsequently comparing these to the dimensions and characteristics of known specimens, together with the removal of post-depositional deformation, and the use of 3D-scanning and printing, a modern approach to reconstruction will be carried out.

Morphology of the hind limb of an aetosaur from the Upper Triassic of Krasiejów

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Aetosaurs were quadrupedal, armoured, possibly omnivorous, pseudosuchian archosaurs from the Upper Triassic. These terrestrial archosaurs had a worldwide distribution; they are characterised by an upturned premaxilla, and dorsal dermal armour. In some taxa, spines and ventral armour are also present.

At Krasiejów in southwest Poland plenty of well-preserved elements of skeleton of aetosaurs are known, belonging to the genus *Stagonolepis*. The first description of a post-cranial skeleton classified the individual as pertaining to *S. robertsoni*. Subsequently recovered cranial material was described as a new species, *Stagonolepis olenkae*.

Here I present a description of a post-cranial skeleton of *Stagonolepis* from Krasiejów, which includes an incomplete right hindfoot. The main purpose is to categorise bones (naming, identifying characteristics, measurements), followed by a comparison with other aetosaurs and interpretations of features described in terms of taxonomy, evolution and palaeoecology.

Redescription of the braincase of *Efraasia minor* (Dinosauria, Sauropodomorpha) from the Upper Triassic of Germany, with comments on sauropodomorph phylogeny

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The braincase is an important source of phylogenetic information for many archosaur groups. However, it plays a secondary role in phylogenetic studies of sauropodomorph dinosaurs. Based on a redescription of the braincase of *Efraasia minor*, a basal sauropodomorph from the Upper Triassic (Norian) Löwenstein Formation, Germany, we have conducted a new phylogenetic analysis adding new characters related to this complex structure. The results of the new analysis do not dramatically change the general results of previous phylogenetic studies of the group, although some of the new braincase characters show an interesting distribution pattern with regard to the phylogenetic arrangement of the classic ‘prosauropods’. ‘Prosauropoda’ was erected in the pre-cladistic era and some initial studies on the phylogeny of Sauropodomorpha still depicted it as monophyletic, but this condition has been rejected in most of the recent studies. In our analyses, the distribution of braincase characters such as the morphology of the basal tubera, the presence of a subdivided metotic foramen and the relative size of the parabasisphenoid, show that ‘prosauropods’ share a condition that is unique for and distinct of Sauropoda, and most basal members of the lineage such as *Saturnalia tupiniquim* and *Eoraptor lunensis* from the Upper Triassic (Carnian) of South America. Despite this interesting pattern concerning most of the braincase characters, constrained analyses shows that the paraphyletic status of ‘prosauropods’ in relation to sauropods is still a much stronger arrangement to explain the evolutionary history of the group.

New dryosaurid-bearing beds from the Upper Jurassic of Portugal

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Dryosauridae is a monophyletic clade of small, cursorial, plant-eating ornithopod dinosaurs that lived in both Gondwana and Laurasia. This wide distribution is particularly evident during the Late Jurassic with the Laurasian *Dryosaurus* and *Eousdryosaurus*, and the Gondwanan *Dysalotosaurus*. The dryosaurid record from the Upper Jurassic of Portugal is based mainly on isolated material from the Lusitanian Basin in the central-west of the country. So far, merely a partial specimen from the Porto das Barcas locality represents *Eousdryosaurus nanohallucis*. In this context, the discovery of new localities bearing new dryosaurid specimens is worthy of note. Two new localities have provided only isolated femora, whereas a third comprises a well-preserved partial skeleton of a small dryosaurid ornithopod. The former specimens come from the upper Kimmeridgian-lower Tithonian Praia da Amoreira-Porto Novo Formation and the Tithonian Freixial Formation. The most complete specimen is a partial skeleton from the Tithonian beds of the Bombarral Formation in Peniche. It comprises mainly appendicular bones (humerus, femur, tibia) of a single individual. All the femora recorded exhibit two dryosaurid synapomorphies such as the proximally placed fourth trochanter, and the scar for the M. caudi femoralis longus restricted to the medial surface of the femoral shaft insertion and widely separated from the fourth trochanter. The new evidence of these dryosaurid ornithopods indicates that these small cursorial dinosaurs were common inhabitants and played an important role within the Iberian herbivorous communities during the Late Jurassic.

Re-evaluation of crocodyliform remains from the Campanian-Maastrichtian at Armuña (Segovia, Spain)

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Crocodyliform remains from the Campanian-Maastrichtian at Cerro del Otero in Armuña (Segovia, Spain) comprise cranial and mandibular bones. Previously, a partial skull and the basicranial portion of a second individual have been assigned to *Allodaposuchus precedens*, whereas an isolated right mandibular branch has been included in the description of *Musturzabalsuchus buffetauti*.

It is difficult to establish the relationship between the jaw and cranial remains from Armuña, but a new detailed re-evaluation highlights several features that would allow associating them. All specimens studied present tooth rows that show equivalent transition in size and morphology of the alveoli, a strong similarity of the interalveolar spaces and a coincident occlusion pattern. On the basis of these features, we prefer to consider that the mandibular and cranial remains of crocodyliforms from Armuña pertain to the same taxon.

Comparisons with other taxa from the Campanian-Maastrichtian of Europe and a phylogenetic analysis reveal that all crocodyliform remains described from Armuña correspond to a basal eusuchian which is closely related to members of the European genus *Allodaposuchus*.

Late Cretaceous marine vertebrates in the Opole region (southern Poland)

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In the Opole Silesia, shallow-marine sandstones of Cenomanian and marls and marly claystones of Turonian and early Coniacian age are exposed. These deposits contain rich assemblages of foraminifera and invertebrates, mainly sponges, bivalves, brachiopods, irregular echinoids, serpulids and ammonoids.

Shark teeth, especially of the durophagous genus *Ptychodus* (*P. mammillaris* and, albeit much rarer, *P. polygyrus*, *P. latissimus* and *P. rugosus*), are the commonest vertebrate remains. In addition to isolated teeth and vertebral centra which occur throughout the Opole section, two accumulations of associated teeth belonging to two individuals (*P. mammillaris* and *P. latissimus*) have been recovered to date. Some ptychodontid specimens from Opole must have been gigantic animals. The size of a tooth of *P. latissimus* from Opole exceeds that of all teeth of an individual of the American *P. mortoni* which was interpreted by K. Shimada's research team to have belonged to an animal of at least 10 metres in length. Teeth of Lamniformes are also relatively frequent in the Opole region, while teeth of hybodonts, Synechodontiformes and Hexanchiformes occur sporadically.

Numerous isolated teeth of Pycnodontiformes have also been recovered from the Cenomanian deposits. However, remains of teleost fish (Actinopterygii) generally are very rare and disarticulated in the Opole Cretaceous, although a partially preserved skeleton of *Hoplopteryx lewesiensis* was described in 1898. In contrast, large quantities of teleost scales, isolated bones and teeth are accumulated inside feeding tunnels of indeterminate carnivores or detritophages (polychaetes, crabs?). This observation indicates that actinopterygians were common in the Opole Basin and that the paucity of their remains is taphonomy induced. It is surprising that, despite 150 years of palaeontological investigation, only a few marine tetrapod remains have ever been found in the Opole Cretaceous: teeth and a bone of the pliosaur *Polyptychodon interruptus* and teeth of the mosasaur *Liodon anceps* are on record.

Size-synchronised change in tyrannosauroid endoneurocranial configuration

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Tyrannosauroids were a group of latest Cretaceous apex predators. They have become famous because of their terminal, large-bodied forms such as *Tyrannosaurus* (12 m). During the Late Jurassic-Early Cretaceous, however, most tyrannosauroids were represented by much smaller-bodied taxa such as *Guanlong* (3 m) and *Dilong* (1.6 m), respectively. It therefore seems that from the mid-Cretaceous onwards different clades of tyrannosauroids underwent massive size enlargement, albeit at different rates. Indeed, the most rapid increase occurred during the last 10 to 15 million years of tyrannosauroid evolution and culminated in the colossal *Tyrannosaurus* lineage. We investigated how these size modifications were reflected in the endoneurocranium. A digital endocast of was reconstructed from CT scans of the holotype of *Dilong* (IVPP 14243; Institute of Vertebrate Paleontology and Paleoanthropology, Beijing), as well as one of the largest known specimens of *Tyrannosaurus* (FMNH PR 2081; Field Museum of Natural History, Chicago). Comparative tomographic rendering found significant proportional differences in the size of cerebral hemispheres, pontine angulation, midbrain-hindbrain juncture and floccular extension. In *Dilong* these characters are reminiscent of the conditions present in some derived maniraptorans. This palaeoneurological affinity is also supported by PCA of the Procrustes co-ordinates of the endoneurocranial landmark configuration and bivariate plots of orthogonal principal components (PC2/PC1). Contrasts with the endocasts of other tyrannosaurids and selected theropods in 2D lateral shape projections identified strong correlation in PC2 values (Pearson correlation coefficient: -0.88, $p=1.6 \times 10^{-5}$), suggesting that both length and rostro-caudal alignment of the endoneurocranium altered in accordance with increasing body size. These observations imply a size-synchronised change in brain linearisation during the evolution of gigantism in tyrannosauroids.

The endocast of *Diamantinasaurus matildae* (Titanosauria, Lithostrotia) from the lower Upper Cretaceous of Australia

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Endoneurocranial anatomy has been comparatively well studied in non-titanosaurian sauropods. Endocasts of relatively few titanosaurian taxa of Late Cretaceous age have been recorded so far; these represent mostly all major lithostrotian clades, such as the families Antarctosauridae (*Antarctosaurus*, Argentina), Nemegtosauridae (*Ampelosaurus*, Spain; *Rapetosaurus*, Madagascar) and Saltosauridae (*Bonatitan* and *Saltasaurus*, Argentina; ?*Jainosaurus*, India). Here we report on the first endocast of the titanosaurian (lithostrotian) sauropod *Diamantinasaurus matildae* Hocknull, names of all authors in full, 2009 (~95 Ma; Winton Formation) from Australia. The 3D-volume rendered endocast is reconstructed from a CT scan of the braincase (specimen AODF 836). The endoneurocranial surface shows no *post-mortem* distortion. It is partly incomplete, however, due to the absence of most of the parietal and frontal bones. Moreover, the sediment filling in this particular region has eroded away, thus causing the loss of the dorsal contours of the pre-cerebellar domain of the natural endocast. The virtual endocast of *Diamantinasaurus* is 118 mm long, relatively short and deep, has a sigmoid shape due to the pontine (49°) and cerebral (37°) flexures. The calculated endocast volume of *Diamantinasaurus* is approximately 225 cm³, which is comparable to that of *Giraffatitan* (Museum für Naturkunde, Berlin, MB.R.1919: 233 cm³). The olfactory and cerebral domains are separated by a short constriction suggesting that olfactory tracts were considerably short. The midbrain is poorly outlined and the placement of the optic lobes is obscured by a thick interstice. The hindbrain details are difficult to discern due to hypertrophy of the dorsal dural venous sinus, presence of the lateral middle dural sinus and extension of pontine dural sinus.

The Eurosiberian and Mediterranean regions in Europe during the Late Pleistocene, on the basis of bird occurrences

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Birds account for a high percentage of fossil remains in Quaternary assemblages. Because of their nature, they provide a large amount of environmental and palaeogeographical information for palaeontological sites. Despite this, they were underused in this respect until the 21st century, when analyses concerning only the presence/absence of birds at European sites have been performed. The aim of this note is to introduce a new approach to the palaeogeography and palaeoecology of Late Pleistocene bird assemblages, by not only taking into account the presence or absence of taxa, but also by using the number of identifiable specimens of each taxon. The study has focused on Late Pleistocene sites for which number of identified specimens data were available. In order to avoid statistical errors, taxa with only a single record were not taken into consideration, nor were passerine data included. The reason for that is that they are the most abundant group in ecosystems, but their small, fragile nature makes their palaeontological analysis difficult, if not impossible. Correspondence and Detrended Correspondence analysis (made with PAST software) of this table reveals two distinct groups of sites in the Late Pleistocene. One group comprises sites in northern and central Europe; the other consists of sites in the Mediterranean region. Differentiation of these groups could be due to environmental gradients – these will be analysed, so that further results may be expected.

Research of Pleistocene megafauna carried out at the Laboratory of Palaeobiology of Opole University

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Expansion of the research area and a more intensive search for Ice Age mammalian fossils have resulted in an increasing number of specimens from Opole area at southwest Poland. In addition, our knowledge of the environment these animals inhabited and of the causes of their extinction has been augmented considerably. Between 2012 and 2014, isolated bones of Pleistocene mammals, generally well preserved but mostly fragmentary, have been analysed. These specimens were recovered from Malerzowice Wielkie and from the sand pits Kuźnica Warężyńska and ‘Kotlarnia’. In the same period (2012-2014), bones of three species from the last-named locality were measured and described. This project was resumed last year, when all fossil material from the other localities was registered, described and measured. These remains can be ascribed to woolly mammoths (*Mammuthus primigenius* (Blumenbach, 1799)), woolly rhinoceros (*Coelodonta antiquitatis* (Blumenbach, 1807)), wild horse (*Equus ferus* Boddaert, 1785) and steppe bison (*Bison priscus* Bojanus, 1827). In comparison to previous research, the fauna listed here is more diverse, with remains of wild horse and steppe bison having been found here the first time. Thus, it has been rewarding not only to describe this material morphologically, but also to document a higher Pleistocene megafaunal diversity in the Opole area.

Preliminary report of a new mammoth find in Ellis County, north-central Texas (Proboscidea, Elephantidae, *Mammuthus columbi*)

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In 2014, mammoth remains were discovered in a sand and gravel pit in Ellis County, Texas. The sediments at this site are fluvial in origin; they were deposited by ancient tributaries of the Trinity River. The quarry bedrock presents shales with imprints of inoceramid bivalves corresponding to the Upper Cretaceous Taylor Group. In the gravels above the bedrock, fish teeth and vertebrae of several species (*Cretodus* sp., *Cretolamna appendiculata*, *Cretoxyrhina mantelli*, *Ptychodus whipplei*, *P. anonymus* and *P. latissimus*) confirm the age of these sediments.

The mammoth skeleton was found at a depth of 3 metres below the surface top soil. It is 75 per cent complete and fairly articulated, presents no signs of scavenging and is in excellent state of preservation. The remains were covered by fluvial fine sands. Inspection of the tusks and pelvic bones indicate that it is a subadult female. The lamellar frequency of the molar shows it to be a Columbian mammoth, *Mammuthus columbi*. The proboscidean lived during the last Ice Age or late Pleistocene in what is now north-central Texas. Of additional interest at the locality is evidence (although scant) of another family of proboscideans, Gomphotheriidae indet. The sediments that have yielded the mammoth will be dated by Optically Stimulated Luminescence. Radiocarbon dating will be run on the bones, to provide further confirmation of the age of the fossil. This is an important find for the upper Pleistocene of north-central Texas inasmuch as the skeleton is fairly complete and articulated. Additional studies will help elucidate the palaeoecological history of Texas during the Pleistocene.

Predictive models for body mass within the family Soricidae: estimating the weight of one of the smallest extinct mammals

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Body mass plays an important role in the biology, phylogeny and ontogeny of species. In view of the fact that it cannot be measured on the basis of fossil remains, allometric models between body mass and bone measurements provide an accurate solution for estimating the weight of extinct species. Historically, these models have been used for large mammals, but rarely in the field of micromammal palaeobiology. We have now performed body mass estimation models for the family Soricidae which has a wide extinct and extant distribution. Measurements of teeth, cranial and post-cranial bones (length, width and diameters) were taken on a broad sample (63 species) of extant soricid species. In all cases, regression models are significant ($p < 0.05$), whereby the femur has been judged to be better for reconstructing body mass, a fact previously observed in other orders. Teeth, those elements with a higher prevalence in the fossil record and more easily identified at species level, also show reliable results. We have tested our regression models by applying them to extinct taxa, including mainland ancestors and insular descendants, using their teeth dimensions. We have predicted the weight of some (sub)species of *Crocidura* (i.e., *C. kornfeldi*, *C. sicula esuae*, *C. sicula sicula* and *C. zimmermanni*), species of *Asoriculus* (*A. burgioi*, *A. gibberodon* and *A. similis*) and species of *Nesiotites* (*N. ponsi*, *N. meloussae* and *N. hidalgo*). We have observed that molar width is a worse body mass estimator than is molar length. Not all of the insular shrew species show the expected pattern of gigantism when their estimated body masses are compared with those of their mainland ancestors.

An exceptional Middle Eocene (Lutetian) sirenian bonebed in the southern Pyrenees (Huesca, Spain): palaeobiodiversity and sedimentological analysis

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Here we study the age, sedimentology and palaeobiodiversity of the Castejón de Sobrarbe 41 (CS41) site, a sirenian-dominated bonebed outcropping in the Ainsa Basin (Huesca, northeast Spain). It is located in the uppermost part of the Sobrarbe Formation, and has been correlated with nearby sections dated with magnetostratigraphy and benthic foraminifera, placing CS41 within the C19r chron and biozone SBZ15 (middle Lutetian, Middle Eocene). The CS41 section shows a progradation of the Sobrarbe deltaic complex, from the delta front facies, characterised by coarse-grained sandstones, to the deltaic and alluvial plain facies, dominated by fine-grained sandstones and siltstones, in which the CS41 site is located. The vertebrate fossil assemblage includes chondrichthyans, squamates, turtles, eusuchian crocodylomorphs, abundant vertebrate eggshell fragments, an isolated rodent tooth and sirenians, represented by over a hundred elements of at least six individuals attributable to a single taxon, the first sea cow with functional hindlimbs known from Europe. Other fossils comprise gastropods, infaunal bivalves and carbonaceous plant fossils. The presence of infaunal bivalves, invertebrate traces and rain splash marks suggests that the assemblage accumulated in an intertidal environment. The vertebrate remains are oriented but poorly sorted, with no signs of significant transport, suggesting that they were accumulated in a small depression during an overbank flow. CS41 is a monodominant bonebed associated with overbank settings, related to the dynamic of the tributary channels of the deltaic plain. The presence of parautochthonous remains of quadrupedal sirenians in an intertidal environment supports the hypothesis of a semi-aquatic lifestyle for stem sirenians.

Bats from some new Quaternary high-mountain localities in the Spanish Pyrenees – preliminary results

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Four new cave localities with Pleistocene sedimentary infill have recently been prospected by the Aragosaurus Group, together with the Speleological Centre of Aragón, namely Los Batanes (Biescas), Cueva de los Bucardos and Cueva de los Osos (Lecherines System) and Brecha del Rincón (Secús Range), all situated in Huesca (Spain) at altitudes ranging between 1,025 and 2,160 m.a.s.l. The present report aims to provide more data on the extant and fossil chiropteran faunas which have rarely been studied in the region.

Bat remains from Los Batanes were recovered from the first 40 cm of a sedimentary infill with numerous specimens of *Capra pyrenaica*, *Rhinolophus euryale* and *Rhinolophus ferrumequinum*; these species are common in the area today. Bat remains from Cueva de los Bucardos and Cueva de los Oso were surface collected; *Myotis myotis* was identified in the first cave, *Myotis* gr. *myotis/blythii* in the latter. Although these probably represent recent specimens, their presence is interesting as they are close to the current altitude limit of these species in Europe. Brecha del Rincón is the cave positioned highest; the majority of bat remains were recovered from the upper centimeters of the sedimentary infill, together with a fossil molar of *Ursus arctos*.

From this site, we have identified *Myotis myotis*, *Myotis* gr. *emarginatus/daubentonii/nattereri*, *Myotis* sp. and *Plecotus* sp., an assemblage suggestive of a milder climate at the time of accumulation with forest vegetation reaching higher altitudes than nowadays. An almost complete individual of *Plecotus* cf. *macrobullaris* was surface collected from an inner hall in this cave, but this probably is a recent specimen.

Post-cranial suspensory adaptations of the subfossil lemur *Babakotia radofilai*

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Palaeopropithecids, or ‘loth lemurs’, are a diverse clade of large-bodied Malagasy subfossil primates characterized by their inferred suspensory positional behaviour. The most recently discovered genus of the family is *Babakotia*. This genus has been described as more arboreal than *Mesopropithecus*, but less than *Palaeopropithecus*. For better understanding of arboreal adaptations of *Babakotia* we compared within-bone and between-bones articular and cross-sectional diaphyseal proportions of limb long bones of this specimen to suspensory hominoids, true sloths (*Choloepus* and *Bradypus*) and to present-day lemurs. Results show that *Babakotia* humeral articular to diaphyseal proportions are generally more similar to those of true sloths than to those of apes. *Babakotia* femoral proportions are likewise similar to true sloth distributions, but are also comparable to orangutans in their proximal ends (i.e., relative femoral head surface area and superoinferior breadth). Interlimb proportions show that *Babakotia*’s relative diaphyseal strengths are similar to the mean value for orangutans and in the range of true sloths. As for interlimb articular proportions, *Babakotia* overlaps with great apes for proximal articulations, but with true sloths for distal articulations. Both principal component analysis (PCA) done on the limb measurements and phylogenetic PCA, show that the limb proportions of *Babakotia* are very close to those of *Bradypus* and *Choloepus*, and very different to those of present-day lemurs (its closest living relatives). These results provide new evidence of the arboreal adaptations of *Babakotia* and further highlight similarities to both extant suspensory primates and non-primate slow arboreal climbers and hangers, i.e., true sloths.

Early Pleistocene mammal assemblage from the Spiš Quarry near Spišská Nová Ves (Slovakia)

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The Spiš Quarry (790.5 m a.s.l.), situated 12 km south of Spišská Nová Ves, represents an important site within the Spiš area, with a record of Early Pleistocene vertebrates. From a geological point of view, strata exposed comprise Middle Triassic carbonate rocks (limestone, dolomitic limestone to dolomite) with Palaeozoic and Lower Triassic rocks in its vicinity as well as with rock relicts of basal Paleogene age.

Vertebrate fossils have been found in karstic fissures filled with limestone breccia, calcareous sinter and loam. Mammals predominate, and the assemblage includes Chiroptera (*Miniopterus schreibersii*, *Myotis* ex gr. *nattereri*, *Myotis* cf. *praeivius* (cf. *gundersheimensis*) and *Vespertilio murinus*), Lipotyphla (*Beremendia* sp., cf. *Crocidura* sp., *Talpa* sp., cf. *Talpa* sp. And Erinaceidae indet.), Rodentia (cf. *Allocricetulus* sp., *Cricetus* sp., *Clethrionomys sebaldi* (cf. *kretzoi*), *Mimomys* cf. *plioaenicus*, *Pliomys* cf. *episcopalis*, *Parapodemus* sp., Sciuridae indet. and Gliridae indet.), Carnivora (*Xenocyon* cf. *lycaonoides*, *Martes* cf. *vetus* and *Mustela* sp.) and Artiodactyla (Bovidae indet.). Based of the microfossil record of the *Mimomys* cf. *plioaenicus* assemblage, the site can be preliminarily dated as Early Pleistocene (MN 17-MQ 1, i.e., 2.4-1.8 Ma). This age assignment is also validated by the occurrence of *Xenocyon* cf. *lycaonoides*. Although a detailed study of material recovered is now under way, the stratigraphical and palaeoecological importance of this extraordinary site can already be noted.

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**Morphometric analysis of the Late Pleistocene woolly rhinoceros
Coelodonta antiquitatis (Blumenbach, 1799) from Skarszyn near Trzebnica,
Poland**

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The woolly rhinoceros *Coelodonta antiquitatis* is one of the most iconic representatives of the Pleistocene megafauna. Its range extended through most of northern Eurasia, having been recorded from numerous fossils on the territory of present-day Poland. Their fossils provide a wealth of information on many morphological and biological aspects. A collection of 38 bones and 7 teeth, excavated by German palaeontologists at the end of nineteenth century at Skarszyn (Skarsine, Lower Silesia, present-day southwest Poland) and held in the collections of the University of Wrocław, was measured, compared with previous literature on the subject and analysed in the context of biogeography. The material is well preserved, but it is difficult to determine its exact age, because it was analysed in 1880s, and the site from which it comes has not been explored since then. Moreover, very little is known about the stratigraphy of Skarsine. Current work revises the Römer's original paper, entitled, 'Über den Fund eines vollständigen Skeletts von *Rhinoceros tichorhinus*', and presents unpublished measurements of woolly rhinoceros remains.

A scavenging scenario – three pterosaur neck vertebrae with a spinosaurid tooth embedded in one of them

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Here I offer a reconstruction based on three pterosaur neck vertebrae with a spinosaurid tooth embedded in one of them, as well as on a single partial skull of *Irritator* (Brazil), the incomplete neotype of *Spinosaurus aegyptiacus*. I believe spinosaurids probably were scavengers and/or opportunists on land, and wish to propose an alternative interpretation for the predation scenario published previously. In the reconstruction it is assumed that the tooth lodged in the vertebra belongs to *Irritator* because skeletal remains of that genus were recovered from the same formation which provided pterosaur vertebrae. In view of the fact that *Irritator* is the closest relative of *Spinosaurus*, it is possible that it had body proportions more closely similar to *Spinosaurus* than to other spinosaurids such as *Baryonyx* or *Suchomimus*. This means that *Irritator* was not too agile on land, similar to *Spinosaurus*, implying that it would have been difficult for it to hunt on pterosaurs.

Pencil drawings as an integral part of palaeo-reconstructions

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The study of extinct animals dates back to the early nineteenth century. Since the very beginning, attempts at reconstructions of their morphology and environment were made. When the public first took an interest in the natural history of the earth, and museums had become more popular, palaeoart became more important. Pencil and charcoal drawings, as well as paintings, captured the imagination and at the same time caused the ancient world to become more familiar to everyone. Concomitant with progress in palaeontological knowledge, the manner in which reconstructions were made, changed. A clear evolution of palaeoart is seen over the last decades, when new, often exciting finds had an impact on our concept of ancient creatures, and this is likely to be similar in future. The present exhibit links the past to current research. A series of my posters represent merely a small fraction of current knowledge, and focus only on selected groups of organisms. Reconstructions, based on modern data, were all executed in pencil in a manner that is typical of the early period of the palaeontological research. These simultaneously constitute a tribute to the pioneers of this science and cordial greetings to modern scientists.

LIST OF AUTHORS

Abbate E.	78
Aguilera O. A.	58
Albersdörfer R.	98
Alonso A.	137, 153
Amezcu Torres N.	72
Amson E.	31
Angielczyk K. D.	67
Antczak M.	81, 113
Arkhangelsky M. S.	51
Asher R. J.	33
Azanza B.	30
Badiola A.	157
Balin K.	119
Balter V.	78
Barten J.	54
Barten L.	54
Bastiaans D.	140, 145
Bellucci L.	39
Belvedere M.	41, 42, 109, 110, 111
Bergwerff L.	36
Bernardi M.	44
Bertozzo F.	26
Bleeker R.	136
Błażejowski B.	112
Boczarowski A.	116, 119
Bodzioch A.	69, 106
Böhme M.	76
Bonde N.	60, 112
Bondioli L.	78
Borsuk-Białynicka M.	19
Botfalvai G.	94
Březina J.	38
Brochu Ch. A.	149
Bronzati M.	147
Buchwitz M.	43
Buffetaut E.	87
Canoville A.	65, 117
Canudo J. I.	97, 134, 135, 137, 157
Capobianco A.	159
Carnevale G.	78
Carrillo J. D.	37
Carrillo-Briceño J. B.	58, 120
Casanovas-Vilar I.	36
Cattin M.	46
Cau A.	129
Cavin L.	56
Cheylan G.	87
Chlebicki A.	118
Coppa A.	78
Cornelissen D.	54
Csiki-Sava Z.	73, 92
Cuenca-Bescós G.	153, 158
Czepiński L.	90
de Buffrénil V.	65, 117
De Gracia C.	57, 120

Deesri U.	56
Delfino M.	78, 93, 127
DeMiguel D.	39
Desojo J.B.	108, 121
Díaz-Berenguer E.	157
Dick D.	50
Dortangs R. W.	54
Drózdź D.	82
Dubicka Z.	52
Dulski M.	119
During M. A. D.	133
Dutour Y.	87
Dyke G.	73
Elliott D. A.	152
Engler T.	32
Ernst S.	46
Escaso F.	143, 149
Eysermans D.	54
Ezcurra M.D.	108, 121
Ezpeleta M.	108
Faath V.	44
Fiorelli L.E.	108, 121
Fortuny J.	135
Fostowicz-Frelik Ł.	36
Fraaije R. H. B.	86
Franceschi M.	111
Frey E. 'Dino'	66, 72
Friedman V.	155
Fröbisch J.	67
Galán J.	153, 158
Gasca J. M.	97
Gasulla J. M.	148
Gentry A. W.	40
Georgalis G. L.	93
Ghezzeo E.	78
Ghinassi M.	78
Ginter M.	55
Göhlich U. B.	40
Gonçalves A. O.	35
González González A. H.	72
Górka K.	118
Górnicki Sz.	146, 162
Gouiric-Cavalli S.	108, 121
Gregorová R.	128
Griebeler E. M.	49
Grigorescu D.	95
Gruntmejer K.	28, 163
Guliker M.D.	145
Habib M. B.	159
Hechenleitner M.	108
Hoch E.	77
Holwerda F. M.	53, 147
Hornung J.J.	131
Houssaye A.	49
Hu H.	99
Hug W. A.	46
Ivanov M.	38, 76, 138
Jacobs L. L.	35
Jagt J.W.M.	53, 54, 74

Jagt-Yazykova E. A.	54
Jalil N.-E.	110
Janáček J.	151
Janecki P.	163
Jaramillo C.	37, 57
Jewula K.	104
Jintasakul P.	56
Jordana X.	156
Junchang L.	98
Kammerer Ch. F.	67
Kardynal K.	154, 163
Kear B. P.	98, 131, 151
Klein H.	44, 45
Klein N.	49, 136
Klembara J.	76
Klingenberg Ch.	80
Knaus Ph. L.	29
Köhler M.	156
Kolb Ch.	31
Konietzko-Meier D.	64, 114
Kotowski A.	161
Kowal-Linka M.	69, 106
Kowalski J.	105, 163
Kremer B.	119, 144
Krempaska Z.	160
Kümmell S. B.	66
Kundrát M.	25, 98, 151, 152
Kustatcher E.	44
Lallensack J.N.	47
Lankamp J.	136
Latimer A.	122
Laurin M.	65
Lee Y.-N.	25
Libsekal Y.	78
Liebrand M.	136
Liston J.	59, 96
Llacer S.	135
Long A.	96
López-Arbarello A.	123
López-García J. M.	158
Lovis Ch.	46
Łukowiak M.	138
Macchiarelli R.	78
Machalski M.	52
Madern A.	36
Madzia D.	129, 130, 138
Malafaia E.	148
Mallison H.	41, 42
Maltese A.	59
Marchetti L.	44, 109
Marchi D.	159
Marjanović D.	61
Martin J.E.	78
Martin T.	32
Martinelli A.G.	108, 121
Martínez-Navarro B.	78
Marty D.	46
Marzola M.	35
Mateus O.	35

Matysik M.	103
Maxwell E.	58
Medin T.	78
Meyer Ch. A.	45, 46
Mietto P.	44, 109, 111
Mitchell J.	115
Mocho P.	148
Moncunill-Solé B.	156
Montoya P.	39
Morais M. L.	35
Moreno-Azanza M.	97, 157
Mulder E. W. A.	86
Narváez I.	148, 149
Navarro Lorbés P.	137
Neenan J. M.	48
Niedźwiedzki G.	34, 68, 84, 105, 106, 112, 143, 144
Niedźwiedzki R.	107, 150
Nieweg D.	136
Nudds J.	98
Núñez-Lahuerta C.	137, 153, 158
O'Connor J. K.	99
Olszewska-Nejbert D.	52
Organ Ch.	65
Ortega F.	143, 149
Ósi A.	94
Owocki K.	105, 106, 144
Padilla Gutierrez J. M.	72
Papini M.	78
Paratte G.	46
Pardo-Pérez J.	51
Parrilla-Bel J.	135
Patel B. A.	159
Pauvarel F.	87
Pavia M.	78
Pawlicki R.	119
Pérez Ben C.	63
Pervov V.	35
Petculescu A.	75
Pičuljan L.	67
Piechowski R.	143
Pindakiewicz M.	68
Polcyn M. J.	35
Poropat S. F.	152
Prondvai E.	94
Puértolas-Pascual E.	134, 157
Rabal-Garcés R.	158
Racki G.	104
Rafferty K. L.	159
Rauhut O.W.M.	147
Renkens S.	54
Rivera Sylva H.	77
Rodríguez F.	120
Rogov M. A.	51
Rook L.	78
Rössner G. E.	40
Ruff Ch. B.	159
Saber H.	44
Sabol M.	160
Sachs S.	131, 139

Samathi A.	132
Sánchez R.	58
Sánchez-Villagra M. R.	31, 37, 58, 127
Sander P. M.	26, 27, 29, 136
Sanz J. L.	148
Sauqué V.	153, 158
Sauro F.	111
Scarciglia F.	78
Scheyer T. M.	31
Schneider J.W.	44
Scholze F.	44
Schulp A. S.	35, 53, 72, 140, 145
Sennikov A.	68
Shelton Ch. D.	29
Shishkin M. A.	62
Sichelschmidt O. J.	136
Sidor Ch. A.	67
Silva B. C.	148
Singer T.	88, 142
Skawiński T.	139
Slodownik M.	141
Ślowiak J.	89
Sookias R.B.	83
Spiekman S.	140
Stefaniak K.	161
Stein K.	79, 94
Stevens K. A.	46
Stinnesbeck W.	72
Struble M.	65
Sulej T.	34, 68, 105, 112
Surmik D.	70, 103, 116, 119
Suteethorn V.	56
Sytchevskaya E. K.	125, 126
Szade J.	119
Szczepaniak K.	142
Szczygielski T.	91
Szentesi Z.	94
Szulc J.	104
Środoń J.	104
Świlo M.	34, 105
Taborda J.R.A.	108
Tacail T.	78
Talanda M.	68, 105, 112, 139, 143
Teschner E. M.	64, 114
Tolan S.	67
Tortosa T.	87
Totoioanu R.	73
Trikolidi F.	124
Troelsen P. V.	85
Trotteyn M.J.	108
Turini E.	87
Urciuoli A.	78
van den Hoek Ostende L.	36
van Heteren A.H.	29, 30
Vanhecke V.	72
Varón González C.	80
Vasile Ş.	73, 75, 92
Vasilyan D.	76
Velez-Juarbe J.	57

Venczel M.	75, 92
Verding L.	54
Villa A.	78
Violero A.	39
Voeten D. F. A. E.	133, 136
Voigt S.	43, 44
von Baczko M.B.	108
Vremir M.	73
Wencker L.	123
Whelan S.	80
Wiersma K.	27
Wings O.	71, 141
Wizevich M.	45
Wohlsein P.	131
Wolniewicz	112
Xu X.	151
Zamorano L.S.	59
Zanolli C.	78
Zazhigin V.	76
Zhou Z.	99
Zverkov N. G.	51