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Schriften der GeoUnion Alfred-Wegener-Stiftung – 2012/3

Centenary Meeting of the Paläontologische Gesellschaft

Programme, Abstracts, and Field Guides

24.09. – 29.09.2012
Museum für Naturkunde Berlin

Edited by Florian Witzmann & Martin Aberhan

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Edited by Florian Witzmann & Martin Aberhan

Organisers:
Martin Aberhan, Jörg Fröbisch
Oliver Hampe, Wolfgang Kiessling
Johannes Müller, Christian Neumann
Manja Voss, Florian Witzmann

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Grußwort von Annette Schavan

Ich gratuliere allen Mitgliedern der Paläontologischen Gesellschaft zu ihrem 100-jährigen Bestehen! 100 Jahre Paläontologische Gesellschaft sind gleichzeitig auch 100 Jahre Wissenschaftsgeschichte, in der sich nicht nur die Wissenschaft und mit ihr die „Lehre vom alten Sein“ tief greifend verändert, sondern auch soziale, ökonomische und politische Zusammenhänge rasant entwickelt haben.

Es steht außer Frage, dass die Paläontologie mehr denn je für die Beantwortung der drängenden Zukunftsfragen benötigt wird: Die Erkenntnisse paläontologischer Forschung helfen uns, den großen Herausforderungen des drohenden Klimawandels und der Gefährdung der biologischen Vielfalt zu begegnen.

Um diese Herausforderungen zu meistern, müssen die weltweit besten Wissenschaftler miteinander kooperieren. Die Paläontologische Gesellschaft hat die überragende Bedeutung internationaler Kooperation schon zum Zeitpunkt ihrer Gründung erkannt. So hat sie sich dezidiert nicht als nationale Gesellschaft, sondern als Forschungsgesellschaft für den gesamten deutschsprachigen Raum verstanden. Seit hundert Jahren leistet die Paläontologische Gesellschaft mit ihrer „Paläontologischen Zeitschrift“, der Ausrichtung internationaler Fachtagungen und ihren Netzwerken einen wichtigen Beitrag zur Internationalisierung der deutschen Paläontologie und damit zum Erhalt ihrer internationalen Spitzenposition.

Zu den Voraussetzungen für paläontologische Spitzenforschung gehört es auch, die Sammlungen als Vermächtnis früherer Leistungen zu pflegen und als Grundlage künftiger Forschung zu erhalten. Deshalb fördert das Bundesministerium für Bildung und Forschung (BMBF) die sammlungsbezogene Forschung in den Museen. Gemeinsam mit den Ländern hat das BMBF Positionen zur strategischen Weiterentwicklung der Forschungsmuseen formuliert und mit einem Schwerpunkt zur „Sprache der Objekte“ weitere Fördermöglichkeiten eröffnet.

Die Paläontologische Gesellschaft trägt mit ihrer wissenschaftlichen Kompetenz dazu bei, dass Deutschland seiner umweltpolitischen Verantwortung gerecht werden kann. Auch in internationalen Wissensnetzwerken vermittelt sie diese Kompetenzen. Das ist der Schlüssel, um die Zusammenhänge von Natur und Gesellschaft zu verstehen und zu einem nachhaltigen Umgang mit den begrenzten Ressourcen zu gelangen.

Ich wünsche der Paläontologischen Gesellschaft und ihren Mitgliedern alles Gute und viel Erfolg für ihre weitere Arbeit!

Annette Schavan
Bundesministerin für Bildung und Forschung

Welcome by Annette Schavan

I congratulate the members of the Paläontologische Gesellschaft on its centennial anniversary! A century of the Paläontologische Gesellschaft is also a century of science history. During this time, not only has the science and its ‘lessons from the past‘ changed dramatically, but also its interconnections to society, economics and politics.

Palaeontology unquestionably is needed more than ever to answer urgent questions about our future: the insights from palaeontological research help us meet the great challenges of climate change and threats to biologic diversity.

To master these challenges, the best scientists worldwide must work together. The Paläontologische Gesellschaft has recognised the primacy of international cooperation since its founding, framing itself not just as a national society but as a research society for the entire German-speaking world. The Paläontologische Gesellschaft, via its journal, international meetings and its networks, has for a century contributed greatly to the internationalization of German palaeontology, and to the preservation of its high international standing.

Care for scientific collections is a fundamental requirement of top-tier research, establishes a historical legacy of prior work, and lays a foundation for future scientific endeavours. Accordingly, the Federal Ministry for Education and Research (BMBF) supports collections-based research in German museums. Together with individual German states, the BMBF has outlined a future development strategy for research museums, with a focus on ‘Sprache der Objekte’ (‘Messages from Objects’), and further opportunities for support.

The scientific competence of the Paläontologische Gesellschaft contributes to Germany’s ability to meet its environmental responsibilities. The Paläontologische Gesellschaft also provides this competence to international scientific networks. This work is essential for understanding the relationships between society and nature, and for the sustainable management of our limited natural resources.

I wish the Paläontologische Gesellschaft and its members all the best and success for the future.

Federal Minister for Education and Research

List of Symposia

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Thursday, September 27 / Lecture Hall 2

Symposium 26 (*Chair: D. Nagel*): **Tilly-Edinger Award**

Wednesday, September 26 / Emil-Fischer Lecture Hall

Schedule of Symposia

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09:10	Plenary Lecture: Neil Shubin				
09:50	**Coffee/Tea**				
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10:40					
10:55					
11:10					
11:25					S20 The Evolution of Modern African Biogeography
11:40					
11:55					
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13:45					
14:00					
14:15					
14:30				S18 Amber as a Window to Terrestrial Palaeoecosystems	
14:45					
15:00					
15:15	**Coffee/Tea**				
15:45	S26 Tilly Edinger-Award	S5 New Challenges in Micropalaeontology – Going Beyond the Standards	S9 Bridging the Gap – Cross-Discipline Research in Biology and Palaeontology	S18 Amber as a Window to Terrestrial Palaeoecosystems	
16:05					
16:20					
16:35					
16:50					
17:05					
17:20					

17:30	**Poster Session & Beer in Thaersaal**

19:30	Public Lecture: Martin Sander

* LGF Landwirtschaftlich-Gärtnerische Fakultät
MfN Museum für Naturkunde

Thursday 27th September

	Emil-Fischer Lecture Hall (Hessische Straße 1-2)	Lecture Hall 1 (LGF*)	Lecture Hall 2 (LGF*)	Lecture Hall 7 (MfN - Nordbau)
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09:30 09:50 10:05 10:20	S24 The Young Palaeontologist Award	S6 Evolution, Development, and Developmental Palaeontology – the Interplay of Ontogenetic and Deep Time	S13 The Triassic – Organismic Evolution Between Two Mass Extinctions	S8 Taphonomy – Preservation of Ecological and Biogeographic Attributes in the Sedimentary Record
10:35	**Coffee/Tea**			
11:00 11:15 11:30 11:45	S24 The Young Palaeontologist Award	S6 Evolution, Development, and Developmental Palaeontology – the Interplay of Ontogenetic and Deep Time	S13 The Triassic – Organismic Evolution Between Two Mass Extinctions	S8 Taphonomy – Preservation of Ecological and Biogeographic Attributes in the Sedimentary Record
12:00	**Lunch**			
13:20 13:35 13:50 14:05	S24 The Young Palaeontologist Award	S6 Evolution, Development, and Developmental Palaeontology – the Interplay of Ontogenetic and Deep Time	S13 The Triassic – Organismic Evolution Between Two Mass Extinctions	S8 Taphonomy – Preservation of Ecological and Biogeographic Attributes in the Sedimentary Record
14:20	**Coffee/Tea**			
15:10 15:30 15:45 16:00 16:15 16:30	S16 Biological Factors of Sauropod Gigantism	S19 More than just Wet Feet - Tetrapod Transitions from Land to Sea and Hot Spots of Marine Tetrapod Evolution	S25 Open Symposia	S21 Gymnosperm Evolution – Major Events and Mysteries
16:45	**Poster Session & Beer in Thaersaal**			
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Friday 28th September

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09:30 09:50 10:05 10:20	S14 The Early Evolution of Tetrapods and their Ecosystems	S3 Frontiers in Geobiology	S 15 Tendaguru and Beyond – Vertebrates in Jurassic Terrestrial Ecosystems	S11 The Cambrian Bioradiation of Metazoa – an Interdisciplinary Approach
10:35	**Coffee/Tea**			
11:00 11:15 11:30 11:45 12:00	S14 The Early Evolution of Tetrapods and their Ecosystems	S3 Frontiers in Geobiology	S 15 Tendaguru and Beyond – Vertebrates in Jurassic Terrestrial Ecosystems	S11 The Cambrian Bioradiation of Metazoa – an Interdisciplinary Approach
12:15	**Lunch**			
13:30 13:45 14:00 14:15 14:30	S14 The Early Evolution of Tetrapods and their Ecosystems S1 Alfred Wegener	S3 Frontiers in Geobiology S12 Climate Change and Biodiversity Patterns in the Mid-Palaeozoic (IGCP 596)	S 15 Tendaguru and Beyond S25 Open Symposia	S11 The Cambrian Bioradiation of Metazoa – an Interdisciplinary Approach
14:45	**Coffee/Tea**			
15:15 15:35 15:50 16:05 16:20 16:25 16:35 16:50	S1 The Alfred Wegener Centennial Symposium: The Idea that Changed the World – 100 Years of Continental Drift	S12 Climate Change and Biodiversity Patterns in the Mid-Palaeozoic (IGCP 596)	S25 Open Symposia	S22 The Development of Modern Vegetation Belts During the Cretaceous and Tertiary

18:30	**Conference Dinner in Tierpark Friedrichsfelde**

Programme

All symposia will be held in Museum für Naturkunde, Landwirtschaftlich-Gärtnerische Fakultät der Humboldt-Universität (Faculty of Agriculture), and Emil-Fischer Lecture Hall.

Tuesday, 25th September

Workshop 1: Molecular Clocks – Estimating Evolutionary Divergence Times
Organiser: J. Müller

Workshop 2: The Paleobiology Database: A Hands-on Tutorial on Estimating Fossil Diversity Patterns
Organiser: W. Kiessling

Workshop 3: Möglichkeiten der Forschungsförderung durch die DFG
Organiser: K. Remes, DFG

Museum für Naturkunde, Dinosaur Hall
Anniversary Event and Reception / Festakt

19:00 Admission and light snacks

19:30 Welcome

Prof. Johannes Vogel, Generaldirektor, Museum für Naturkunde Berlin

Cornelia Quennet-Thielen, Staatssekretärin, Bundesministerium für Bildung und Forschung

Nicolas Zimmer, Staatssekretär für Wirtschaft und Forschung, Berlin

Dr. Michael Wuttke, Präsident der Paläontologischen Gesellschaft

20:10 Musical performance by Unduzo (a cappella)

20:20 Flying Buffet

21:00 Special Lecture:

Simon Conway Morris:

Mass extinctions, missing links and other evolutionary myths

21:45 Musical performance by Unduzo and flying buffet continues

Wednesday, 26th September

Emil-Fischer Lecture Hall

9:00 Announcements

9:10 Shubin N.: **Fossils, genes, and the origin of novelties: examples from vertebrate appendages (Plenary Lecture)**

9:50 COFFEE / TEA

Symposium 2: Biodiversity in the Fossil Record – Going Beyond How Many Taxa
Chair: A. McGowan

10:20 Roopnarine P. D.: **Species richness, functional diversity and the selection of communities (keynote)**

10:40 Webb T.: **Combining richness, evenness and similarity to track the diversity of fish communities**

10:55 Hardy C., E. Fara, R. Laffont, J. L. Dommergues, C. Meister, P. Neige: **Deciphering the phylogenetic distribution of extinctions: a case study of Pliensbachian ammonites**

11:10 McGowan A. J.: **Occupancy-estimation techniques: turning sampling failures into useful information in palaeobiology**

11:25 Hopkins M. J.: **Environmental patterning in trilobite morphological disparity**

11:40 Wills M., M. Hughes, S. Gerber, M. Ruta: **Patterns of morphological disparity through geological and research time**

11:55 Hoffmann R., S. Zachow, F. Fusseis, D. Korn: **Quantitative morphology using x-ray computed tomography and the species concept in palaeontology: a case study from cephalopods**

12:10 LUNCH

13:30 Aberhan M., W. Kiessling: **Rebuilding biodiversity after a mass extinction: insights from molluscan benthic ecosystems across the Cretaceous-Paleogene boundary in Patagonia**

13:45 Nürnberg S., M. Aberhan: **Habitat breadth and geographical range predicting evolutionary rates in Mesozoic bivalves**

14:00 Schulze Dieckhoff T. J., S. N. Nielsen: **Evolution of ecological traits along a latitudinal transect in Chilean mollusks since the Miocene**

14:15 Renaudie J., D. B. Lazarus: **Macroevolutionary patterns in Antarctic Neogene Radiolaria**

14:30 Schneider S.: **Bivalve ecology drives biodiversity – early rudist “reefs” on Tithonian-Berriasian carbonate platforms**

14:45 Dorst S., J. Schönfeld, L. Walter: **Biodiversity of benthic foraminifera on the shelf and slope of the NE-Atlantic**

15:00 Erbajeva M., N. Alexeeva: **Biodiversity of the Late Cenozoic mammal fauna of the Baikal region in the context of global and regional events**

15:15 COFFEE / TEA

Symposium 26: Tilly-Edinger Award
Chair: D. Nagel

15:45 Introduction

15:50 Bastl K.: **Ecomorphology of the European *Hyaenodon*: apex predator or opportunistic hunter? New aspects revealing the ecological niche**

16:05 Böhmer C.: **Evolution der Wirbelsäule bei Archosauriern: Fossilien, Morphologie und *Hox* Gene**

16:20 Buchwitz M.: **Warum Chroniosuchier die Krokodile unter den reptilienartigen Amphibien sind**

16:35 Haug C.: **Evolution of functional body regions in arthropods – A combined palaeontological and neontological approach**

16:50 Hübner T. R.: **The ontogeny of *Dysalotosaurus lettowvorbecki* (Ornithischia: Ornithopoda) and implications for the evolution of ornithopod dinosaurs**

17:05 Orliac M.: **The Evolution of the brain of Artiodactyla (Mammalia)**

17:20 Schultz J. A.: **Funktionsweise prätribosphenischer Gebisstypen**

19:30 Sander M.: **Die Biologie der sauropoden Dinosaurier: Die Evolution des Gigantismus (Public Lecture)**

Lecture Hall 1

Symposium 4: Stories from the Past – Reading Biomineralized Diaries
Chairs: B. R. Schöne, T. Tütken

10:20 Surge D., J. H. Barrett: **Late Holocene marine climate archives from archaeological shells (keynote)**

10:40 Taft L., U. Wiechert, H. Zhang, S. Mischke, B. Plessen, M. Weynell, A. Winkler, F. Riedel: **Hydrologic and climatic signals across the Tibetan Plateau inferred from $\delta^{18}O$ and $\delta^{13}C$ patterns archived in shells of the gastropod *Radix* sp.: a window to the past?**

10:55 Holland H. A., B. R. Schöne, C. Lipowsky, J. Esper, E. Schömer, D. Gronenborn: **The first bivalve-based annually resolved paleoclimate archive of the central and northern North Sea spanning AD 1040 to 2010**

11:10 Beierlein L., G. Nehrke, T. Brey: **Confocal Raman microscopy and its contribution to sclerochronology**

11:25 López Correa M., P. Montagna, S. Goldstein, M. T. McCulloch, A. Freiwald, M. Taviani, J. A. Trotter, J. Raddatz: **Gorgonian and scleractinian corals record ambient seawater neodymium isotopic composition**

11:40 Waskow K., P. M. Sander: **Life stories of sauropods – Histological evidence for the ontogenetic stage of different sauropod taxa and its implications for growth, sexual maturity and longevity**

11:55 Griebeler E. M., N. Klein, P. M. Sander: **Aging, maturation and growth of sauropodomorph dinosaurs as deduced from growth curves using long bone histological data**

12:10 LUNCH

Symposium 5: New Challenges in Micropalaeontology – Going Beyond the Standards
Chair: H. Gebhardt

13:30 Frenzel P., S. Mischke, S. Fürstenberg, C. Wrozyna, P. Peng, K. Henkel, L. G. Akita, A. Schwalb: **Ostracoda as Quaternary lake level indicators on the Tibetan Plateau**

13:45 Luger P.: **Cretaceous Palaeogeography: Ostracoda versus larger Foraminifera from Northern Somalia and their relations to those of the southern Tethys**

14:00 Weinmann A. E., M. R. Langer, S. Lötters, D. Rödder: **Travelling through time: the past, present and future biogeographic range of *Amphistegina* spp.**

14:15 Wolfgring E., J. Wöger, A. Briguglio, C. Ferrandez Canadell, J. Hohenegger: **Multispiral growth in nummulitids: a three-dimensional approach**

14:30 Munnecke A., A. Delabroye, T. Servais, T. R. A. Vandenbroucke, M. Vecoli: **Systematic occurrences of malformed (teratological) acritarchs in the run-up of Early Palaeozoic $\delta^{13}C$ isotope excursions**

14:45 Lazarus D. B., J. Barron, A. Türke, P. Diver, J. Renaudie: **Diversity history of Cenozoic diatoms**

15:00 Hesemann M.: **The Foraminifera.eu Project – status and perspectives**

15:15 COFFEE / TEA

15:45 Sames B.: **The revival of late Mesozoic non-marine ostracod biostratigraphy – Breaking conceptual barriers (keynote)**

16:05 Zobel K., F. Wiese: **Taxonomy and palaeoecologic significance of Turonian calcareous dinoflagellate cysts from the Upper Cretaceous of NW Germany (Salder Formation, Upper Turonian)**

16:20 von Bargen D., J. Engelke, J. Dreßel, J. Lehmann: **Benthische Foraminiferen aus dem Unter-Apt des Münsterlandes, NW-Deutschland**

16:35 Herbig H. G., J. Pabst, J. Könen: **Agglutinating foraminifera from Mississippian (Viséan) pelagic carbonate environments of Menorca and the Cantabrian Mountains – a neglected tool to decipher deep-water environments**

16:50 Wendler I., J. E. Wendler, B. T. Huber, K. G. MacLeod: **Understanding stable isotope signals from fossil foraminifera – a Turonian Fossillagerstätte from Tanzania**

17:05 Gebhard H., S. Coric, R. Darga, A. Briguglio, B. Schenk, W. Werner, N. Andersen: **An integrated paleo-environmental analysis of a marine transgressive sequence from the northern Tethyan margin: the Lutetian to Priabonian beds of Adelholzen (Helvetic Unit, Bavaria, Germany)**

Lecture Hall 2

Symposium 7: Anomalies and Pathologies – the Other Sources of Variation
Chairs: O. Hampe, M. Voss, F. Witzmann

10:20 Keupp H.: **Paläopathologie schalentragender Cephalopoden (Palaeopathology of shell-bearing cephalopods) (keynote)**

10:40 Asbach P.: **X-ray based cross-sectional imaging in palaeontology – techniques and applications**

10:55 Wöger J., E. Wolfgring, A. Briguglio, C. Ferrandez-Canadell, J. Hohenegger: **The use of µ-CT in the investigation of teratologies and bauplan modifications in larger benthic foraminifera**

11:10 Fischer T., R. T. Becker: **Palaeopathology and autecology of uppermost Famennian ammonoids from the Maider and Tafilalt Basins (eastern Anti-Atlas, southern Morocco)**

11:25 Jattiot R., E. Fara, A. Brayard: **An asymmetric ammonite from the Toarcian of Cénaret (Lozère, France)**

11:40 Foth C., A. M. Yates, O. W. M. Rauhut, R. J. Butler: **A pathological tail in a basal sauropodomorph dinosaur from South Africa**

11:55 Voss M.: **Anomalies of the vertebral column in fossil sea cows (Mammalia, Sirenia)**

12:10 LUNCH

Symposium 9: Bridging the Gap – Cross-Discipline Research in Biology and Palaeontology
Chair: J. Hoffmann

13:30 Fechner R.: **The mechanical design of the archosaurian pelvis**

13:45 Nyakatura J. A., P. Arnold, V. R. Allen, M. S. Fischer: **Mobility in the hip of *Iguana* and implications for deducing the range of motion in early reptiles**

14:00 Witzmann F., R. R. Schoch: **Feeding behaviour of the Triassic plagiosaurid *Gerrothorax* – a case study of aquatic feeding in temnospondyls**

14:15 Ou Q., D. Shu, G. Mayer: **Cambrian lobopodians, extant onychophorans and early cephalisation in Panarthropoda**

14:30 Luo C., M. Zhu, J. Reitner: **Enigmatic Cryogenian medusoid fossils from North China: a unique bauplan with possible metazoan affinity**

14:45 Reich M., T. R. Stegemann: **Giant Mesozoic holothurian larvae?**

15:00 Klug S., J. Kriwet: **Divergence estimates of major squalomorph clades (Chondrichthyes, Neoselachii) and their impact on phylogenetic hypotheses**

15:15 COFFEE / TEA

15:45 Sanchez-Villagra M. R.: **Embryos in Deep Time – Palaeontology and the study of the evolution of vertebrate biological development (keynote)**

16:05 Voigt S., J. Kriwet, M. Schweizer, S. Hertwig: **Molecular systematics of pupfishes (Cyprinodontiformes, Cyprinodon) from northern Mexico**

16:20 Hoffmann J., C. Lüter: **Recent thecideide brachiopods – What can modern cryptic brachiopods tell us?**

16:35 Roden V. J., M. Reich: **Microstructures of modern sea pen axes – a tool for the systematics of fossil pennatulaceans (Octocorallia)**

16:50 Selden P.: **Jurassic spiders**

Lecture Hall 4

Symposium 23: Öffentlichkeitsarbeit – Vernetzung oder Abgrenzung?
Chair: K. Grimm

10:20 Leinfelder R.: **Das „Lange Jetzt", Anthropozän-Fossilien und transdisziplinäre Wissenschaften – Herausforderungen und Chancen für die paläontologische Öffentlichkeitsarbeit (keynote)**

10:40 Humberg B., R. Köjer: **Ausstellen! Chancen der interdisziplinären Konzeptentwicklung**

10:55 Mudroch A., U. Richter: **Paläontologen als Vermittler im Natur- und Geotourismus**

11:10 Radtke G.: **Erlebnis Geowissenschaften (Paläontologie) – Öffentlichkeitsarbeit der Geologischen Dienste (Beispiel Hessisches Landesamt für Umwelt und Geologie, HLUG)**

11:25 Discussion

Symposium 20: The Evolution of Modern African Biogeography
Chairs: F. Bibi, J. Müller

11:40 Lehmann T., S. C. Curran, H. M. Dunsworth, W. E. H. Harcourt-Smith, F. K. Manthi, K. P. McNulty, J. R. Scott, P. S. Ungar: **Palaeoecological context of the early Miocene African mammal transition: evidence from dental microwear of tragulids**

11:55 Rößner G. E., M. Clauss: **Neogene rise and decline of African tragulids (Artiodactyla, Ruminantia): possible selection related to digestive innovations within Ruminantia**

12:10 LUNCH

13:30 Souron A.: **Investigating the fossil record of extant African wild pigs (*Potamochoerus, Hylochoerus*, and *Phacochoerus*): a geometric morphometric approach**

13:45 Grohé C., Y. Chaimanee, C. Blondell, J. J. Jaeger: **Carnivora from the Miocene of Southern Asia and Africa: biogeographical implications**

14:00 Bibi F.: **Terrestrial African biogeography and paleoenvironments: late Miocene to Recent**

14:15 Hipsley C. A., J. Müller: **Evolutionary consequences of Cenozoic climate change on African lacertid lizards (Squamata: Lacertidae)**

14:30 Pinton A., O. Otero: **Fish Paleobiogeography: the Neogene setting of the modern ichthyofauna in Africa north of the equator**

14:45 Scholz H., M. Glaubrecht: **The Turkana Basin (N-Kenya) in the Plio-Pleistocene: cradle or sink of molluscs?**

15:00 Hoetzel S., L. Dupont, E. Schefuß: **Late Neogene vegetation change of the South West African tropics (Namibia) and the expansion of modern savannas**

Lecture Hall 7

Symposium 17: Mammalian Dentitions – Diversity, Form, and Function
Chairs: T. Martin, O. Kullmer

10:20 Fortelius M.: **Dental ecometrics and the evolution of mammal faunas (keynote)**

10:40 Kaiser T. M., E. Schulz: **Mammal molar teeth, a tribosystem of durability**

10:55 Schulz E., V. Piotrowski, M. Clauss, M. Mau, G. Merceron, T. M. Kaiser: **Variability in tooth wear indicates attritional wear – implications from feeding experiments with lagomorphs**

11:10 von Koenigswald W.: **Zahnverschleiß an Säugetierzähnen – destruktiv oder konstruktiv?**

11:25 Schwermann A., O. Kullmer, T. Martin: **Function and wear in the dentition of the common opossum (*Didelphis marsupialis*)**

11:40 Klietmann J., L. W. van den Hoek Ostende, B. Metscher, D. Nagel, M. Rummel: **Why have a dP4 ? Deciduous upper premolars in the talpid *Desmanella engesseri***

11:55 Engels S., J. Habersetzer, O. Kullmer, E. Schlosser-Sturm, J. Hurum: **A 3D-model of the complete dentition of *Darwinius masillae***

12:10 LUNCH

13:30 Stefen C., U. Witzel: **Biomechanical aspects of the incisor action of recent and fossil castorids**

13:45 Anders U., W. von Koenigswald: **How much tooth is needed to feed a mammoth? – The modification of the occlusal surface area in Elephantidae during life span**

14:00 Schwermann L.: **Mastication in *Diacodexis* and other primitive Artiodactyla**

14:15 Winkler D. E., R. Rozzi, E. Schulz: **The enigmatic bovid *Duboisia santeng* (Early-Mid. Pleistocene, Java): a multiproxy approach to its palaeoecology**

Symposium 18: Amber as a Window to Terrestrial Palaeoecosystems
Chairs: A. Schmidt, J. Heinrichs

14:30 Perrichot V.: **Mid-Cretaceous amber forests from France**

14:45 Seyfullah L. J., C. Beimforde, V. Perrichot, J. Rikkinen, A. R. Schmidt: **The what and why of amber: attempting to understand the relationship between resin production and amber deposits**

15:00 Solorzano Kraemer M. M., F. Stebner, A. S. Kraemer: **Taphonomy of the Mexican amber**

15:15 COFFEE / TEA

15:45 Rust J.: **Neuigkeiten aus der Bernsteinforschung – Neue Fundstellen, neue Methoden, offene Fragen (keynote)**

16:05 Heinrichs J., K. Feldberg, S. Dong, H. Schneider, A. R. Schmidt: **From fossils to molecules – diversification and historical biogeography of liverworts**

16:20 Hoffeins C., H. W. Hoffeins: **Dipteren im Baltischen Bernstein – eine aktuelle Übersicht**

16:35 Wagner R., M. M. Solorzano Kraemer, F. Stebner: **Psychodiden (Diptera, Nematocera) in burmesischem Bernstein**

16:50 Wedmann S., V. Makarkin, T. Weiterschan: **Fossil larvae of Berothidae (Neuroptera) from Baltic amber**

17:05 Dunlop J. A.: **Mites in amber**

17:20 Schmidt A. R., S. Jancke, E. E. Lindquist, E. Ragazzi, G. Roghi, P. C. Nascimbene, K. Schmidt, T. Wappler, D. A. Grimaldi: **Arthropods in Triassic amber**

17:30 POSTER SESSION

Thursday, 27th September

Emil-Fischer Lecture Hall

8:30 McElwain J.: **Impacts of global warming on plant biodiversity and ecosystem function: A 200 million year old case study form East Greenland (Plenary Lecture)**

Symposium 24: The Young Palaeontologist Award / Zukunftspreis

9:30 Introduction

9:35 Alberti M., F. T. Fürsich, D. K. Pandey: **The Oxfordian stable isotope record of the Kachchh Basin, western India, and its implications for palaeoclimatic, palaeogeographic, and palaeoecologic reconstructions**

9:50 Chellouche P., F. T. Fürsich, M. Mäuser: **Taphonomic and palaeoenvironmental studies of the Upper Kimmeridgian Wattendorf Plattenkalk of Upper Franconia (Southern Germany)**

10:05 Hernandez-Ballarin V., A. Oliver, P. Pelaez-Campomanes: **Dental microwear analyses in *Armantomys* (Gliridae, Rodentia) from the Madrid Basin during the Middle Miocene Climate Transition**

10:35 COFFEE / TEA

10:20 Laaß M., E. Frey, A. Kaestner, P. Vontobel, A. Hilger: **Sound localisation in small anomodonts**

11:00 Lautenschlager S., E. J. Rayfield, P. Altangerel, L. M. Witmer: **Form, function and feeding: a biomechanical model of *Erlikosaurus andrewsi* (Dinosauria: Therizinosauria) and its evolutionary implications**

11:15 Madern P. A., L. W. van den Hoek-Ostende: **Going south: drift in Miocene mammalian biodiversity hotspots**

11:30 Neubauer T. A., M. Harzhauser, A. Kroh: **Adaptive radiation in a gastropod species lineage of late Miocene Lake Pannon**

11:45 Reich S., F. P. Wesselingh, W. Renema: **Mollusc faunas as indirect indicators for palaeo-seagrass vegetation**

12:00 LUNCH

13:20 Schlüter N., F. Wiese, G. Other: **On the evolution of the Late Cretaceous sea-urchin *Micraster* – The tale of the *Micraster*-evolution**

13:35 Schmidt M., A. Kossler, A. C. G. Henderson, E. Shemang, M. Fuchs, F. Riedel: **Late Pleistocene palaeolimnology of the megalake Palaeo-Makgadikgadi (Kalahari, Botswana) inferred from diatom assemblages**

13:50 Veitschegger K., D. Nagel, F. A. Fladerer: **Late Pleistocene and Holocene mammal remains from the archaeological excavation in Lindabrunn (380 m, Lower Austria)**

14:05 Walliser E. O., J. Reitner: **New insight in the Early Carboniferous cold seeps deposits of Winterberg and Iberg (Harz Mountain): reconstruction of a hydrocarbon dependent environment**

14:20 COFFEE / TEA

Symposium 16: Biological Factors of Sauropod Gigantism
Chairs: H. Mallison, M. Sander

15:10 Christian A.: **Sauropods from head to tail – how did they work? (keynote)**

15:30 Sander P. M., C. T. Gee: **Sauropod herbivory: how nutrition played a role in gigantism (or not)**

15:45 Werner J., E. M. Griebeler: **Reproductive biology of sauropods and its possible impact on their gigantism: comparative analysis of mammalian, avian, crocodilian and sauropod reproduction**

16:00 Schmitt A., P. M. Sander, I. Ruf, P. Sereno: **Paleobiological implications of semicircular canal dimensions in Sauropoda**

16:15 Schanz T., P. M. Sander, H. Viefhaus, Y. Lins: **Quantitative interpretation of tracks using soil mechanical concepts**

16:30 Mallison H.: **Sauropodomorph locomotion and how it shaped sauropod gigantism**

18:00 **GENERAL ASSEMBLY / MITGLIEDERVERSAMMLUNG Paläontologische Gesellschaft**

Lecture Hall 1

Symposium 6:
Evolution, Development, and Developmental Paleontology – the Interplay of Ontogenetic and Deep Time
Chair: N. Fröbisch

9:30 Schoch R. R.: **Developmental evolution of early tetrapods: a diversity of life histories (keynote)**

9:50 Maas A., J. T. Haug, C. Haug, D. Waloßek**: Ontogenetic data from fossils with reference to the 'Orsten' type of preservation**

10:05 Klein C., D. Korn, H. Keupp: **Ontogenetic patterns of the Late Devonian ammonoid *Cymaclymenia* from Morocco**

10:20 Marjanović D., F. Witzmann: **Finally grown up: is this what a morphologically adult lissamphibian looks like? New data for ontogenetics and phylogenetics from an Oligocene newt (Salamandridae: Pleurodelinae)**

10:35 COFFEE / TEA

11:00 Fröbisch N. B., N. Shubin: **Patterns of variation in salamander limb skeletogenesis**

11:15 Scheyer T. M., J. M. Neenan, N. Klein, M. R. Sanchez-Villagra: **The rise of Mesozoic marine reptiles and a review of the developmental record**

11:30 Maxwell E. E., T. A. Deccechi: **Measuring phenotypic integration in the limbs of the Jurassic ichthyosaur *Stenopterygius quadriscissus***

11:45 Stein K., R. Reisz, T. Huang: **Embryonic bone and eggshell histology of prosauropods(?) from the Lower Jurassic Lufeng Formation, Yunnan, China**

12:00 LUNCH

13:20 Hayashi S., M. Burns, M. Watabe, K. Carpenter: **Differerent developmental patterns between ankylosaur and stegosaur osteoderms: implications for the behavior variations among thyreophoran dinosaurs**

13:35 Bickelmann C., P. Meier, C. Mitgutsch, M. A. G. de Bakker, M. K. Richardson, R. Jimenez, M. R. Sanchez-Villagra: **Evolution of fossoriality in mole limbs (Mammalia: Talpidae)**

13:50 Müller J., C. A. Hipsley: **Molecular divergence dating: its potentials, its uses, and its problems**

14:20 COFFEE / TEA

Symposium 19:
More than just Wet Feet – Tetrapod Transitions from Land to Sea and Hot Spots of Marine Tetrapod Evolution
Chairs: M. Voss, J. Fahlke

15:10 Berta A., S. Young, T. A. Demere, J. Gatesy: **From teeth to baleen: a major macroevolutionary transition in mysticete whales (keynote)**

15:30 Kuschel C. H., H. Preuschoft: **More than wet feet – Whole body involved! On the interaction of propulsory habits and vertebral column in aquatic mammals**

15:45 Houssaye A., P. M. Sander: **Peculiarities in ichthyosaur long bone microanatomy**

16:00 Gingerich P. D., K. Heissig, W. von Koenigswald: **Richard Dehm Collection of pakicetid astragali (Mammalia, Cetacea) from the Eocene of Pakistan**

16:15 Volpato V.: **Evidences of aquatic adaptation in *Pakicetus* (Mammalia, Archaeoceti): A hip cancellous bone perspective**

16:30 Fahlke J. M., O. Hampe: **Changes of internal cranial morphology related to first aquatic adaptations in early whale evolution**

Lecture Hall 2

Symposium 13: The Triassic – Organismic Evolution Between Two Mass Extinction Events
Chair: D. Korn

9:30 Bucher H.: **Early Triassic recovery from the end-Permian mass extinction: biotic and abiotic changes (keynote)**

9:50 Gastaldo R. A., S. L. Kamo, C. V. Looy, J. Neveling, R. Prevec, N. J. Tabor: **Constraining the End-Permian Crisis in the Karoo Basin, South Africa: new Data from the Eastern Cape Province**

10:05 Korn D., A. Ghaderi, V. Hairapetian, L. Leda: **Morphological evolution and extinction patterns of the Ammonoidea at the Permian-Triassic boundary of Iran**

10:20 Fuchs D.: **The evolution of coleoid cephalopods – what happened during the Triassic?**

10:35 COFFEE / TEA

11:00 Leda L., D. Korn, A. Ghaderi, V. Hairapetian: **Early Triassic microbialites and carbonate factory changes across the Permian-Triassic boundary near Julfa (NW Iran) and Abadeh (Central Iran)**

11:15 Hofmann R., M. Hautmann, H. Bucher: **"…and they all lived happily ever after": Palaeoecology of benthic faunas in the aftermath of the end-Permian mass extinction**

11:30 Hagdorn H.: **Slipped through the bottleneck – a Palaeozoic echinoid from the Triassic Muschelkalk**

11:45 Fischer J., S. Voigt, J. W. Schneider, F. Franeck: **The shark fauna and its nurseries from the Triassic Madygen lake (Kyrgyzstan)**

12:00 LUNCH

13:20 Abu Hamad A. M. B., A. Jasper, D. Uhl: **The record of Triassic charcoal and other evidence for palaeo-wildfires: signal for atmospheric oxygen levels, taphonomic biases or lack of fuel?**

13:35 Kustatscher E., F. M. Petti, M. Bernardi, M. Avanzini: **Diversity of plants and continental tetrapods in the Triassic of the southern Alps: palaeobotanical and ichnological evidences**

13:50 von Hillebrandt A.: **Discovery of *Psiloceras spelae* and associated microfauna in the Triassic-Jurassic Boundary Beds of the Hallstatt-Zlambach Basin (Northern Calcareous Alps)**

14:20 COFFEE / TEA

Symposium 25: Open Symposia

15:10 Reich M.: **100 Jahre Paläontologische Gesellschaft – Geschichte(n) … Von A(bel) bis Z(ittel) über J(aekel) (keynote)**

Open Symposia – Vertebrates

15:30 Ruf I., V. Volpato, G. Billet, C. de Muizon, T. Lehmann: **The inner ear of *Leptictidium auderiense* (Leptictida, Mammalia) – a key to the reconstruction of leptictid locomotion**

15:45 Sobral S., J. Müller: **A reanalysis of the Upper Triassic diapsid *Elachistosuchus huenei* by X-ray micro-computed tomography**

16:00 Solarczyk A.: **Dreidimensionale photogrammetrische Modelle von Fährten von Dinosauriern aus der Unterkreide (Berrias) von Münchehagen, Niedersachsen**

16:15 Schellhorn R.: **A remarkable carpal construction in *Prosantorhinus germanicus* (Rhinocerotidae, Mammalia) from Sandelzhausen (Bavaria, Germany)**

16:30 Schröder K. M., A. Lopez-Arbarello: **Diversity of *Aspidorhynchus* Agassiz, 1833 (Neopterygii, Aspidorhynchiformes) in the Solnhofen limestones, Germany**

Lecture Hall 7

Symposium 8: Taphonomy – Preservation of Ecological and Biogeographic Attributes in the Sedimentary Record
Chairs: J. Nebelsick, A. Tomašových, M. Zuschin

9:30 Escarguel G.: **On temporal and spatial scales of biodiversity changes: a deep-time macroecological perspective (keynote)**

9:50 Castellani C., A. Maas, J. T. Haug, D. Waloszek: **The Swedish 'Orsten'-type Lagerstätte: a Window into the Cambrian Alum Shale Ecosystem**

10:05 Tütken T.: **Exceptional geochemical preservation of 47 Myr-old vertebrate remains from the Eocene Messel Pit, Germany?**

10:20 Krause R. A., S. H. Butts, D. E. G. Briggs: **Experimental silicification of calcite and aragonite shell: toward an understanding of the microstructural controls on silica replacement**

10:35 COFFEE / TEA

11:00 Wolkenstein K.: **Fluorescent shell colour patterns in bivalves from the Middle Triassic Muschelkalk**

11:15 Neumann C.: **Predatory vs. non-predatory boreholes in fossil and recent echinoids**

11:30 Nebelsick J. H., Z. Belaustegui, J. M. de Gibert, A. Mancosu, A. Kroh: **Taphonomy and diversity of mass accumulation of clypeasteroid echinoids**

11:45 Mewis H., W. Kiessling: **Long-term stability of Pleistocene reef-coral communities from Vanuatu**

12:00 LUNCH

13:20 Millet J., W. Kiessling, M. Zuschin: **Environmental instability may support ecological stability: an example from Pleistocene reefs of the Red Sea**

13:35 Thomas J., M. Guiraud, H. Dineur, E. Fara, B. David: **Evaluating museum collections biases : potential impacts on palaeobiodiversity studies**

13:50 Zuschin M., M. Harzhauser, O. Mandic: **Taxonomic and numerical sufficiency in a lower and middle Miocene molluscan metacommunity of the Central Paratethys**

14:05 Tomašových A., D. Jablonski, S. K. Berke, A. Z. Krug, J. W. Valentine: **Decoupling between species and genus spatial range-size gradients**

14:20 COFFEE / TEA

Symposium 21: Gymnosperm Evolution – Major Events and Mysteries
Chairs: L. Kunzmann, R. Rößler, M. Krings

15:10 Bomfleur B.: **Gymnosperms of the Triassic Polar forest biome of Gondwana (keynote)**

15:30 Bauer K., E. Kustatscher, M. Krings: **Ginkgophyte leaves from the late Permian Kupferschiefer of Germany**

15:45 Rößler R.: ***Medullosa* – eine paläozoische Gymnospermengattung mit Wuchsformenvielfalt**

16:00 Gee C. T., A. Schmitt: **Cracking the mystery of conifer cone construction using micro CT – a preliminary report**

16:45 **POSTER SESSION**

Friday, 28th September

Emil-Fischer Lecture Hall

8:30 Jackson J.: **Evolution and environment in the Caribbean Neogene (Plenary Lecture)**

Symposium 14: The Early Evolution of Tetrapods and their Ecosystems
Chair: J. Fröbisch

9:30 Reisz R. R.: **The origin of high fiber herbivory and its significance in the initial diversification of amniotes (keynote)**

9:50 Le Fur S., C. F. Kammerer, J. Fröbisch: **The early evolution of terrestrial tetrapod communities**

10:05 Schultze H. P.: **The palaeoenvironment at the transition from piscine to tetrapod sarcopterygians**

10:20 Preuschoft H., B. Hohn, U. Witzel: **Biomechanics and functional preconditions for terrestrial lifestyle and their influence on the general tetrapod bauplan**

10:35 COFFEE / TEA

11:00 Lindemann F. J., E. Volohonsky: **An Early Carboniferous bonebed on Spitsbergen**

11:15 Werneburg R.: **Eryopid temnospondyls from different ecosystems of Pennsylvanian up to Upper Permian Laurasia**

11:30 Brocklehurst N., J. Fröbisch, C. F. Kammerer: **The influence of sampling on the fossil record of Paleozoic synapsids**

11:45 Spindler F.: **Die sphenacodonten Pelycosaurier Europas**

12:00 Shelton C. D., P. M. Sander: ***Ophiacodon* long bone histology: testing the Brinkman hypothesis**

12:15 LUNCH

13:30 Jansen M., R. Reisz, J. Fröbisch: **A new basal dinocephalian from the Middle Permian Mezen fauna (Russia) and its implications for the evolution of basal therapsids**

13:45 Kammerer C. F.: **The relationships of *Deuterosaurus* and phylogeny of the Dinocephalia**

14:00 Walther M., J. Fröbisch: **The quality of the fossil record of anomodonts (Tetrapoda, Synapsida)**

14:15 Fröbisch J., C. F. Kammerer, M. Jansen: **A new basal dicynodont (Synapsida, Therapsida) from the Late Permian *Cistecephalus* Assemblage Zone of South Africa**

Symposium 1:
The Alfred Wegener Centennial Symposium: The Idea that Changed the World – 100 Years of Continental Drift
Chair: C. Scotese

14:30 Rowley D. B., A. M. Forte, C. J. Rowan, S. P. Grand, N. Simmons: **The dynamics driving plate tectonics and continental drift: why a close reading of Wegener is always rewarding**

14:45 COFFEE / TEA

15:15 Scotese C. R.: **Continental Drift: the idea that changed the world (keynote)**

15:35 Şengör A. M. C., N. Lom, S. Ülgen: **Pangaean Games 2012**

15:50 Schettino A.: **The role of hot spots in the break-up of Pangaea and the opening of the Atlantic ocean**

16:05 Lawver L. A., I. W. D. Dalziel, L. M. Gahagan, I. O. Norton: **Dispersal routes of South American land mammals: paleogeographic and paleontological constraints often agree**

16:20 Maisey J. G.: **The physiographic and biogeographical relationships of northeastern Brazil during the Cretaceous**

16:35 Wright N., S. Zahirovic, R. D. Müller, M. Seton: **Towards adaptable, interactive and quantitative paleogeographic maps**

16:50 Servais T., D. A. T. Harper: **The Great Ordovician Biodiversification in the context of Lower Palaeozoic palaeo(bio)geographies**

Lecture Hall 1

Symposium 3: Frontiers in Geobiology
Chairs: J. Reitner, G. Wörheide, S. Kiel, A. Nützel

9:30 Westall F.: **Ancient life and its signatures from early-mid Archaean formations in the Pilbara, Australia and Barberton, South Africa: implications for the Curiosity rover on Mars (keynote)**

9:50 Reitner J., M. Blumenberg, J. P. Duda, C. Luo, N. Schäfer, M. Lu, M. Zhu: **New Ediacara-type organisms from black laminated microbial carbonates of the Shibantan Member of the Three Gorges Area (Dengying Formation, Hubei, China)**

10:05 Seuß B.: **Study on a fossil nautiloid – surprising insights**

10:20 Großmann M., A. Nützel: **Gastropod palaeoecology of a Permian fauna from Coleman, Texas**

10:35 COFFEE / TEA

11:00 Nützel A., A. Kaim, I. Hausmann, E. Kustatscher: **The Cassian biota – ecology and geobiology of the Triassic diversity hotspot**

11:15 Kaim A., S. Kiel: **Emergence and evolution of wood-fall communities**

11:30 Hethke M., F. T. Fürsich, B. Jiang: **Oxygen deficiency in Lake Sihetun (NE China) and its consequences – Formation of a Lower Cretaceous *fossillagerstätte***

11:45 Wiese F., M. Blumenberg: **Oligotrophic? Eutrophic? Imbalanced nutrients! Black shale formation in a shallow shelf setting during the OAE 2 (Wunstorf, Germany)**

12:00 Kiel S.: **Environmental impacts on the evolution of the deep-sea methane-seep fauna**

12:15 LUNCH

13:30 Weinkauf M., T. Moller, M. Koch, M. Kucera: **Effects of environmental change on the calcification intensity of planktonic Foraminifera: a case study from Sapropel S5**

13:45 Schäfer N., N. V. Quéric, A. Reimer, J. Reitner: **Organic compounds and conditioning films within deep rock fractures (Äspö Hard Rock Laboratory, Sweden)**

14:00 Schuster A., D. Erpenbeck, A. Pisera, G. Wörheide: **New insights into the classification of desma-bearing demosponges ('Lithistida') – A combined molecular and morphological study**

Symposium 12: Climate Change and Biodiversity Patterns in the Mid-Paleozoic (IGCP 596)
Chairs: P. Königshof, T. Suttner

14:15 Waters J. A.: **Devonian – Mississippian echinoderm community evolution and climate change**

14:30 Jansen U.: **Revision of Rhenish Lower Devonian Brachiopoda**

14:45 COFFEE / TEA

15:15 Marshall J.: **Land plants and the Late Devonian extinction events (keynote)**

15:35 Aboussalam Z. S., R. T. Becker, S. Eichholt: **Conodont dating of reefs and carbonates platforms in the Middle and Upper Devonian of the Morrocan Meseta**

15:50 Königshof P., J. Dopieralska, Z. Belka, G. Racki, N. Savage, P. Lutat, A. Sardsud: **Depositional facies settings of Late Devonian sequences in northwestern Thailand: a multidisciplinary approach**

16:05 Hartenfels S., R. T. Becker: **Conodont age and correlation of the transgressive *Gonioclymenia* and *Kalloclymenia* Limestones (Famennian, Anti-Atlas, SE Morocco)**

16:20 Valenzuela-Rios J. I.: **Biodiversity and evolution of Lochkovian and Pragian (Lower Devonian) Icriodontidae (Conodonta) from northern Spain, a reference for global studies**

16:35 Liao J. C., J. I. Valenzuela-Rios: **Givetian conodont biodiversity pattern (Middle Devonian) in the Spanish Central Pyrenees**

16:50 Shen S. Z., Y. Wang, Y. Liu, X. D. Wang, Y. J. Li: **Tempo of the end-Permian mass extinction**

Lecture Hall 2

Symposium 15: Tendaguru and Beyond – Vertebrates in Jurassic Terrestrial Ecosystems
Chairs: D. Schwarz-Wings, O. Rauhut, O. Wings

9:30 Carrano M.: **Paleoecology and biogeography of the vertebrate fauna of the Morrison Formation, Late Jurassic, western United States (keynote)**

9:50 Ezcurra M. D.: **Phylogenetic analysis of Late Triassic-Early Jurassic neotheropod dinosaurs and its early biogeographic and evolutionary history**

10:05 Rauhut O. W. M., D. Pol: **The dinosaur fauna of the Middle Jurassic Cañadón Asfalto Formation of Chubut, Argentina**

10:20 Martin T., A. O. Averianov, A. V. Lopatin: **Middle Jurassic vertebrates from Berezovsk in western Siberia (Russia)**

10:35 COFFEE / TEA

11:00 Stiegler J., J. Clark, X. Xu: **A multi-element histological analysis of the Jurassic tyrannosauroid *Guanlong wucaii***

11:15 Wings O.: **The Langenberg-Quarry in Oker – A special window into the terrestrial Late Jurassic of Northern Germany**

11:30 Lopez-Arbarello A., E. Sferco, O. W. M. Rauhut: **The freshwater coccolepids (Actinopterygii, Chondrostei) from the Jurassic of Patagonia**

11:45 Hübner T. R., C. Foth, W. D. Heinrich: **Reappraisal of the Upper Jurassic *Dysalotosaurus* locality 'Ig/WJ' at Tendaguru based on historic, taphonomic, and demographic data**

12:00 Kosch J. C. D., D. Schwarz-Wings, G. Fritsch: **Tooth replacement in Dicraeosauridae – insights from CT images of *Dicraeosaurus hansemanni***

12:15 LUNCH

13:30 Cuny G., R. Liard, U. Deesri, T. Liard, S. Khamha, V. Suteethorn: **Freshwater hybodont sharks from the Late Jurassic – Early Cretaceous of northeastern Thailand: stratigraphical and palaeobiogeographical implications**

Open Symposia – Invertebrates

13:45 Kröger B., J. A. Rasmussen: **Die „Vaginatenkalke" des Ostseeraumes – Palökologische Interpretation des Mittelordovizischen (Darriwilium) Massenvorkommens endocerider Cephalopoden**

14:00 Weiner T.: **New data on the *Annulata* Events in the Moravian Karst (Famennian, Czech Republic)**

14:15 Schneider J. W., B. Eichler: **Oldest known potamolepid freshwater sponges (Demospongiae) from the Early Permian Döhlen Basin, Germany**

14:30 Lehmann J., D. von Bargen, O. Friedrich, J. Dressel, J. Engelke: **Integrated palaeontology of the Early Aptian at the southern margin of the Lower Saxony Basin: an unusual near-shore bay deposit including OAE 1a**

14:45 COFFEE / TEA

15:20 Wilmsen M., N. Richardt: **Biofacies, depositional environment and stratigraphy of the Oberhäslich Formation (lower Upper Cenomanian, Saxonian Cretaceous Basin, Germany)**

15:35 Janussen D.: **New excellently preserved fossils from Late Cretaceous Arnager Pynt, Bornholm shed a light on the Mesozoic history of sub-class Amphidiscophora (Hexactinellida, Porifera)**

15:50 Klug C., W. Riegraf, J. Lehmann: **Soft-part preservation in heteromorph ammonites from the Cenomanian-Turonian Boundary Event (OAE 2) in the Teutoburger Wald (Germany)**

16:05 Studeny M.: **Ein Problematicum aus der Unteren Gosau-Subgruppe von Brandenberg (Tirol, Nördliche Kalkalpen, Österreich)**

16:20 Rasser M. W., J. P. Friedrich, F. Göhringer, A. K. Kern, J. Kovar-Eder, J. H. Nebelsick, A. Roth-Nebelsick: **Ein hochauflösendes Profil vom miozänen Randecker Maar: Neue Einsichten in die Entwicklung eines fossilen Kratersees**

16:35 Scholz J., M. Spencer Jones, A. Grischenko, D. E. Kharitonov: **Like a BEAGLE's second voyage: bryozoans in collections**

Lecture Hall 7

Symposium 11: The Cambrian Bioradiation of Metazoa – an Interdisciplinary Approach
Chairs: M. Steiner, B. Weber

9:30 Vannier J.: **The rise of metazoan life (keynote)**

9:50 Na Lin, W. Kiessling: **Controls on global biodiversity patterns during the Cambrian radiation**

10:05 Maletz J.: **Still in hiding? – Problems of recognizing early Radiolaria**

10:20 Sun X., C. Heubeck, M. Steiner, J. Maletz, D. Hippler: **Sedimentary environment of the Precambrian-Cambrian transition in the Meishucun area, Yunnan, south China**

10:35 COFFEE / TEA

11:00 Heubeck C., S. Evseev: **A major earthquake shook up a key Precambrian-Cambrian boundary stratigraphic section: Karatau Range, Kazakhstan**

11:15 Elicki O., M. M. Altumi, S. Gürsu, M. C. Göncüoğlu, U. Linnemann, M. Hofmann: **Cambrian successions of the east Mediterranean Gondwana: multidisciplinary study with palaeoecologic and palaeogeographic focus**

11:30 Weber B., M. Steiner, S. Evseev, C. Heubeck, G. Ergaliev: **A Meishucun-type lower Cambrian (Terreneuvian) ichnofauna from the Malyi Karatau Range (SE Kazakhstan)**

11:45 Scouflaire Q., M. Steiner, S. Evseev: **Paleoenvironmental significance of ferromanganese stromatolites in the early Cambrian of the Lesser Karatau Range, Kazakhstan**

12:00 Yang B., M. Steiner, G. Li, H. Keupp: **Terreneuvian small shelly faunas of East Yunnan (South China) and their biostratigraphic implications**

12:15 LUNCH

13:30 Forchielli A., M. Steiner, S. Hu, H. Keupp: **The Chengjiang Biota (Cambrian Stage 3) of Yunnan Province (South China): taphonomy of a Burgess Shale-type fossil lagerstätte**

13:45 Fatka O., P. Budil, R. Mikulas, V. Micka, M. Szabad, V. Vokac, L. Laibl, L. Grigar: **Evidence of predation in Cambrian trilobites from the Barrandian area (Czech Republic)**

14:00 Haug, J. T., D. E. G. Briggs, C. Haug: **Functional morphology of *Leanchoilia superlata* (Megacheira, Chelicerata sensu lato) from the Burgess Shale (middle Cambrian, British Columbia, Canada)**

14:15 Laibl L.: **Diversity of ptychopariid trilobite larvae from the Skryje-Týřovice Basin**

14:30 Steiner M., J. Maletz: **Cambrian graptolites (Pterobranchia) and the origin of colonial organization in metazoans**

14:45 COFFEE / TEA

Symposium 22: The Development of Modern Vegetation Belts During the Cretaceous and Tertiary
Chair: B. A. R. Mohr

15:15 Spicer R. A.: **Cretaceous terrestrial climates and vegetation: data, models and speculation (keynote)**

15:35 Mohr B. A. R., C. Coiffard, S. Löwe, M. Bernardes-de-Oliveira: **Early Cretaceous palaeoequatorial vegetation and adaptations to a seasonally dry climate**

15:50 Kunzmann L., B. A. R. Mohr, S. Löwe, C. Coiffard, M. Bernandes-de-Oliveira: **Gnetophytes from the late Early Cretaceous Crato flora: ecological and phytosociological aspects**

16:05 Coiffard C., B. A. R. Mohr, M. Bernandes-de-Oliviera: **Ecological and ecophysiological aspects of the Cretaceous monocotyledon evolution**

16:20 Wappler T., C. C. Labandeira, J. Rust, H. Frankenhäuser, V. Wilde: **Testing for the effects and consequences of mid Paleogene climate change on insect herbivory**

16:35 Butzmann R., T. C. Fischer, E. Rieber: **Oligocene macroflora from the inner alpine fan-delta of the Häring Formation (Rupelium) of the Duxer Köpfl in Kufstein / Lower Inn Valley (Austria)**

16:50 Kovar-Eder J., U. Knörr, P. Mazouch, A. Roth-Nebelsick: **Tracing shifts in dispersal syndromes: fruit ecology in modern vegetation and Paleogene/Neogene plant assemblages**

18:30 **CONFERENCE DINNER IN TIERPARK FRIEDRICHSFELDE**

List of Posters

Anné J.: **Calcium is for the birds: variation in bone chemistry within Avians**

Austermann G., A. Hildenbrand, F. J. Cueto Berciano, P. Bengtson: **Growth-line analysis of the Middle Cambrian brachiopod *Vandalotreta djagoran* (Kruse, 1990) from the Manuels River Formation, Conception Bay South, Newfoundland, Canada, using ImageJ and R**

Bärmann E. V., D. Erpenbeck, S. Börner, G. E. Rössner, B. Azanza, G. Wörheide: **The curious case of *Gazella arabica***

Bayramova S.: **Climate change and vegetation in the Oligocene of the south-eastern edge of the Greater Caucasus (Azerbaijan)**

Bouougri E. H., H. Porada, J. Reitner: **Paleoecology and taphonomy of the Ediacaran Nama-type assemblage: evidence from the sedimentary record of Kliphoek Member (Nama Group) in southern Namibia**

Braune C., R. Lieberei, D. Steinmacher, T. M. Kaiser: **A simple microwave extraction method for the isolation and identification of plant opal phytoliths**

Brice D., E. Pinte, B. Mistiaen: **The global Taghanic Biocrisis (Givetian) on brachiopods of the Ferques inlier area (Boulonnais-France)**

Briguglio A., E. Wolfgring, J. Wöger, C. Ferrandez Cañadell, J. Hohenegger: **Growth styles and their deviations in Larger Benthic Foraminifera evidenced by computed tomography**

Buchwitz M., S. Voigt: **First definite archosaur from the Triassic of Central Asia**

Castellani C., A. Maas, J. T. Haug, D. Waloszek: **'Orsten'-type preservation: case study of the Swedish 'Orsten' Lagerstätten**

Danto M., F. Witzmann, J. Müller: ***Solenodonsaurus janenschi* and the origin of amniotes**

de Carvalho M.: **The Devonian trilobites of Brazil: a review**

Dohrmann M., S. Vargas, D. Janussen, A. G. Collins, G. Wörheide: **Molecular paleobiology of early-branching animals: integrating DNA and fossils elucidates the evolutionary history of hexactinellid sponges**

Dreßel J., J. Engelke, D. von Bargen, J. Lehmann: **Morphologische Diversität und dynamische Umweltbedingungen am Beispiel von Ammoniten der frühen Kreide**

Dynowski J. F., J.-P. Friedrich, J. H. Nebelsick, A. Roth-Nebelsick: **Computational Fluid Dynamics as a tool to investigate the hydrodynamics of irregular sea urchin tests**

Eichholt S., R. T. Becker, S. Stichling: **Microfacies and development of the Devonian reef at Ain Jemaa (Moroccan Meseta)**

El Atfy H., D. Uhl, B. Stribrny: **An unexpected 'window' into the Mesozoic of the North Sea and adjacent areas – palynomorphs and charcoal from a sandstone pebble of Quaternary glacial deposits**

Evers S. W., O. W. M. Rauhut: **Evidence for spinosaurid affinities of *Sigilmassasaurus brevicollis* (Theropoda, Tetanurae)**

Falk D., G. Olbrich, O. Wings: **Excavation report and field documentation of a sauropod skeleton from the Jurassic of the Turpan Basin, Xinjiang, NW China**

Färber C., R. Koch, A. Munnecke: **Origin of *in situ* freshwater oncoids from a karstic spring in the Northern Franconian Alb (Bavaria, Southern Germany)**

Fischer J., M. Franz, S. Kaiser: **Oxygen and strontium isotopes from fossil bioapatite from the Middle Triassic (Anisian-Ladinian) Muschelkalk Sea**

Franeck F., J. W. Schneider, J. Fischer, I. Kogan, M. Buchwitz, F. Spindler, S. Voigt: **Microvertebrate remains from the non-marine Triassic Madygen Formation of Kyrgyzstan**

Friedrich J.-P., D. Sievers, J. H. Nebelsick: **Actuo-palaeontological 3D morphometric analysis of irregular echinoids**

Füllenbach C. S., B. R. Schöne: **Influence of environmental changes on the crystal fabrics and growth patterns in shells of the freshwater gastropod *Viviparus viviparus***

Furió M., L. W. van den Hoek Ostende: **Neogene and Quaternary Eulipotyphlan fossil assemblages in Spain – Synopsis of the last 23 Ma of Erinaceomorpha and Soricomorpha evolution in Southwestern Europe**

Gamper A., U. Struck, Q. Scouflaire, B. Weber: **Carbon and Nitrogen isotope study of the upper Ediacaran Gaojiashan Member in South China: insights in causes of the Cambrian Explosion**

Germer J., N. V. Quéric, D. J. Jackson, J. Reitner: **The biomineralisation strategy of the extant sphinctozoan coralline demosponge *Vaceletia* and its affinities to the Lower Cambrian archaeocyaths**

Harzhauser M., A. K. Kern, O. Mandic, W. E. Piller, T. A. Neubauer: **Solar cycles control ecological windows for lake bottom settlement by bivalves during the Late Miocene**

Haude R.: **Biostratinomie vollständiger Holothurien in einer unterdevonischen Echinodermen-Lagerstätte der argentinischen Präkordillere**

Haug G. T., J. T. Haug, C. Haug: **Ein Bild sagt mehr als tausend Worte – Ein Aufruf für mehr Abbildungen in wissenschaftlichen Publikationen**

Haug J. T., G. Mayer, C. Haug, D. E. G. Briggs: **A Cambrian morphotype in the Carboniferous: a long-legged, non-onychophoran lobopodian from the Mazon Creek Fauna**

Hauschke N., J. Ansorge, G. Barth, C. Brauckmann, H. Kozur, V. Wilde: **An arthropod Lagerstätte in the Norian (Upper Triassic) of Seinstedt, eastern Lower Saxony**

Heckeberg N. S., G. E. Rössner, R. J. Asher, G. Wörheide: **Diversity and phylogeny of extant and fossil cervids (Ruminantia, Artiodactyla)**

Helling S., R. T. Becker: **New proetid and phacopid trilobites from the Middle Frasnian (Upper Devonian) of the Tafilalt (Anti-Atlas, SE Morroco)**

Hennhöfer D. K., E. Pascual-Cebrian, S. Götz, S. Kiel: **Fossilized digestive systems in 23 Million year old wood-boring bivalves**

Herbig H.-G., E. Nardin, A. Müller: **Latest Devonian and Carboniferous tabulate corals from the Western Palaeotethys – Palaeodiversity, palaeogeography and facies relations of a neglected taxon**

Hethke M., M. Alberti, F. T. Fürsich, C. Liu: **A multiproxy approach to the reconstruction of relative sea-level changes in the Holocene Pearl River delta of China**

Hildenbrand A., G. Austermann, P. Bengtson: **"Small shelly fossils" of the Middle Cambrian Manuels River Formation at its type locality along Manuels River, Conception Bay South, Avalon Peninsula, Newfoundland, Canada**

Hornung J. J., A. Böhme, M. Reich: **Berriasian-Valanginian (Early Cretaceous) vertebrate faunas of northwestern Germany**

Jansen U.: **Late Silurian to earliest Middle Devonian evolution of Rhenish brachiopods**

Kaiser S. I.: **Causes and consequences of Famennian and Tournaisian biocrises revisited**

Kiel S., D. Vardeh, N. Brinkmann, T. Treude: **Bored bones: an experimental study on the microbial degradation of bones in marine environments**

Klug C., C. Naglik, K. De Baets, C. Monnet, D. Korn: **Comparing intraspecific variability of ammonoids**

Klug S., J. Kriwet: **First Miocene holomorphic stingray (Chondrichthyes, Myliobatiformes, Dasyatidae) from SE Asia**

Koch M., S. Wedmann: **47 Ma old true bugs (Insecta: Heteroptera) – do they have connections with extant ones?**

Kocsis T. Á., J. Pálfy: **Substage-level extinction rates of Early Jurassic radiolarian genera**

Kogan I., M. Licht, S. Pacholak, S. Brandt, C. Brücker, J. W. Schneider: **Caudal swimming in the Triassic fish *Saurichthys***

Könen J., M. R. Langer: **Mikro-Computer Tomographie und 3D-Rekonstruktion der planktonischen Foraminifere *Globigerinoides sacculifer***

Konwert M.: **A new teleost from the Late Jurassic Plattenkalks of Ettling (Bavaria, Germany)**

Kriwet J., A. Engelbrecht, T. Mörs, M. Reguero, C. Tambussi, R. Stepanek: **First chimeroid, batoid and shark records (Chondrichthyes: Holocephali, Elasmobranchii) from the uppermost horizons (Late Eocene, Telms 6 and 7) of the La Meseta Formation, Seymour Island, Antarctica**

Kustatscher E., J. H. A. van Konijnenburg-van Cittert, K. Bauer, R. Butzmann, B. Meller, T. C. Fischer: **A new flora from the Upper Permian of Bletterbach (Dolomites, N-Italy)**

Laaß M., N. Hauschke, V. Wilde, N. Kardjilov, H. Oosterink: **3D Reconstruction of the first xiphosuran from the Muschelkalk (Triassic) of the Netherlands based on microCT and neutron tomography**

Lautenschlager S.: **The cranial myology of *Erlikosaurus andrewsi* in three dimensions – a novel approach for digital muscle reconstructions**

Lazarus D. B., with members of the Neptune/Chronos projects, MRC network and IODP PCG: **Building a global infrastructure for 21st Century marine micropaleontology**

Löwe S., B. A. R. Mohr, C. Coiffard, M. E. C. Bernardes-de-Oliveira: **A new fossil gnetophyte from the Aptian Crato-Formation of Brazil**

Marali S., M. Wisshak, M. Lopez Correa, A. Freiwald: **Aragonitic cold-water corals as geochemical archives of ocean temperature**

Marpmann J. S., J. L. Carballido, K. Remes, P. M. Sander: **Ontogenetic changes in the skull elements of the Late Jurassic dwarf sauropod *Europasaurus holgeri***

Marty D., C. A. Meyer: **From sauropods to cycads – The Late Jurassic terrestrial record of the Swiss Jura Mountains**

Mekawy M. S.: **Encrustation and bioerosion on the giant clam (*Tridacna maxima*) shells from the Egyptian Red Sea coast**

Meller B., R. Roetzel: **Carpodeposits from a late Early Miocene estuarine environment (Korneuburg Basin, Lower Austria)**

Mette W., C. Korte, A. Elsler: **Carbon isotope fluctuations and benthic environments in the north-alpine Rhaetian**

Mey W.: **First record of the family Micropterigidae (Insecta, Lepidoptera, Homoneura) from Bitterfeld amber**

Millet J.: **A new method to compare fossil assemblages with Recent communities**

Mitchell R., N. Clark, G. J. Dyke, A. J. McGowan: **SEM and Raman spectroscopic analysis of limb bones from a small-bodied theropod (?Tetanurae) from the Kem Kem Formation, Morocco**

Nagm E., M. Wilmsen: **Taxonomy, biostratigraphy and palaeobiogeography of Late Cenomanian-Turonian (Cretaceous) ammonoids from Wadi Qena, central Eastern Desert, Egypt**

Nawrot R., D. Chattopadhyay, M. Zuschin: **The role of body size in marine invasion through the Suez Canal: implications for the fossil record**

Nose M., R. Vodrazka, L. P. Fernandez, I. Mendez-Bedia, E. Fernandez-Martinez, F. Soto: **First record of chambered hexactinellid sponges from the Palaeozoic**

Otero O., A. Pinton: **The fish fossil record and associated aquatic environments: A framework for the interpretation of African fish paleobiogeography during the Neogene**

Pascual-Cebrian E., D. Hennhöfer, P. Zell, S. Götz: **Rudist taxonomy based on grinding tomography and biomedical software**

Pinheiro F. L., C. L. Schultz: **Morphological disparity on the palates of Pterodactyloidea (Pterosauria) and its implications for the ecology of the clade**

Pint A., P. Frenzel, M. Engel, H. Brückner: **Test malformations in Holocene and Recent Foraminifera from athalassic and marginal marine environments as an indicator for extreme environmental conditions**

Plax D. P., D. V. Barbikov: **Eurypterid (Chelicerata, Eurypterida) findings in Famennian saliniferous deposits of the Devonian of the Pripyat trough (Starobin Potassium salt deposit, Belarus)**

Quéric N. V., J. Reitner: **Microdigitate Fe/Mn microbialites from the Äspö tunnel (Sweden) – A modern example of the microbial subterranean fossil *Frutexites***

Reich M., A. S. Gale, N. Schlüter, B. Thuy, F. Wiese: **Early Cretaceous bathyal holothurians from the western North Atlantic Ocean (Blake Nose, ODP Leg 171B)**

Reitner J., C. Luo, M. Zhu, M. Lu, T. He, J. P. Duda, N. Schäfer, B. Hansen, M. Blumenberg: **Cap carbonate related microbial biosignatures**

Renaudie J., D. B. Lazarus: **Advances in Antarctic Neogene radiolarian high-resolution stratigraphy**

Richter U., A. Mudroch, F. Spindler: **NaTourDidakt – Vermittlung paläobiologischer Inhalte als Dienstleistung**

Roden V. J.: **Das Hessische Landesmuseum Darmstadt – Geschichte und Neukonzeption**

Rößler R., F. Spindler, R. Noll, R. Neregato, R. Rohn-Davies: **Anatomically preserved calamitaleans from the Permian of Tocantins (Parnaíba Basin, NE Brazil) exhibit growth form diversity**

Sánchez-Beristain F., K. Simon, L. Pérez-Cruz, P. García-Barrera, J. Urrutia-Fucugauchi: **Die Verwendung der LA-ICP-MS zur geochemischen Analyse von Rudistenschalen aus der Oberkreide von Chiapas, Mexiko**

Schneider J. W., I. Kogan, J. Kriwet, J. Sell: **Finding localities of the Triassic „Lizard fish" *Saurichthys* in Germany**

Schneider S., M. Harzhauser: **The Leviathaniidae – the largest pre-Cenozoic gastropods**

Schudack M., K. Nuglisch: **Foraminiferenfauna, Sedimentologie, Geochemie und paläoozeanographische Entwicklung an der Eozän/Oligozän-Wende in der Bohrung Loburg 1/90 (Sachsen-Anhalt)**

Schwarz C.: **'Septal compass' and 'septal formula' – a new method for phylogenetic investigations of the ear region in sciuromorphs (Rodentia, Mammalia)**

Soler-Gijon R., T. Tütken, F. Witzmann: **The phosphate nodules associated to skeletons of the Triassic temnospondyl *Plagiosuchus pustuliferus* – biogenic *versus* diagenetic origin?**

Spindler F., J. Fischer: **The Second Evolution – Life reconstructions through the ages**

Suttner T. J., E. Kido: **Facies development and biodiversity of the Early to Middle Devonian shallow marine sequence of the central Carnic Alps (Austria-Italy)**

Suzuki H., R. Schmidt-Effing: **Zwei Radiolarienzonen der mittleren Kreide von Costa Rica**

Torres-Martinez M. A., F. Sour-Tovar, S. A. Quiroz-Barroso: **Stratigraphic and paleobiogeographic implications of productid brachiopods from the Carboniferous of Santiago Ixtaltepec, Oaxaca, Mexico**

Traiser C., A. Roth-Nebelsick, J. Kovar-Eder: **MORPHYLL – A data base for the acquisition of ecophysiologically relevant morphometric data of fossil leaves**

Vatter M., T. Lehmann: **Is the ear region of the modern aardvark really primitive? – A comparison of the ear region in fossil and extant Tubulidentata (Mammalia)**

Veitschegger K., J. Kriwet: **Systematic position of *Prionace glauca* (Linnaeus, 1758) inferred from CO1, with comments on the monophyly of carcharhinid sharks (Chondrichthyes, Carcharhiniformes)**

Voigt S. C., J. Kriwet, M. Schweizer, S. Hertwig: **Parallelism in cyprinodontid fishes (Teleostei, Cyprinodontiformes) from northern Mexico indicates rapid morphological evolution without genetic transformations**

Voigt S., M. Buchwitz: **Evolution of locomotion traits in basal cotylosaurs inferred from trackway data**

Voss M.: **To validate or not to validate: the re-evaluation of the *Halitherium*-species complex and its impact on sirenian systematics**

Walliser E. O., M. Rodriguez-Martinez, J. Reitner: **Palaeobiology of the rudist assemblages from the 'Red Ereño' limestone (Guernica, Basque Cantabrian Basin, N Spain)**

Walter L., S. Dorst, J. Schönfeld: **Biodiversity of benthic Foraminifera on the shelf and slope of the Celtic Sea**

Weber B., Q. Scouflaire: **A Late Ediacaran "Tube World" from China: exoskeletal macrofossils and trace fossils from the Gaojiashan section (South Shaanxi), northern Yangtze Platform**

Weinkauf M., T. Moller, M. Koch, M. Kucera: **Morphological deviations in planktonic Foraminifera as a reaction to enhanced environmental stress: opportunities and problems**

Wendler J. E., I. Wendler, T. Rose, B. T. Huber: **Using cathodoluminescence spectroscopy to distinguish biogenic from early-diagenetic calcite in Cretaceous microfossils from the Tanzanian Drilling Project**

Werneburg R., I. Kogan, J. Sell: ***Saurichthys* from the Upper Buntsandstein (Anisian) of Lower Franconia**

Wilmsen M.: **Cenomanian (Cretaceous) ammonites from the North Cantabrian Basin, northern Spain**

Winkler D. E., T. M. Kaiser: **A case study of seasonal, sexual and ontogenetic divergence in the feeding behaviour of the moose (*Alces alces* Linné, 1758)**

Wolkenstein K.: **Widespread occurrence of boron-containing organic pigments in the Jurassic red alga *Solenopora***

Yan L., B. R. Schöne: **An attempt of applying a short-lived bivalve, *Paphia textile* to reconstruct the East Asian monsoon during the mid-late Holocene**

Abstracts of Oral Presentations and Posters

In alphabetical order

(Presenters of oral presentations are underlined)

S2 – Rebuilding biodiversity after a mass extinction: insights from molluscan benthic ecosystems across the Cretaceous-Paleogene boundary in Patagonia

Aberhan M.[1]* & W. Kiessling[1]

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Environmental perturbations preserved in the fossil record offer the opportunity to assess the dynamics of ecosystem recovery over evolutionary time scales, and to obtain a perspective for the current biodiversity crisis. We studied the recovery dynamics of benthic molluscs from the Cretaceous-Paleogene (K-Pg) mass extinction in Patagonia in marginal marine and middle shelf environments to address three questions: (1) How strongly is community diversity affected by the extinction and for how long? (2) Is the loss of diversity through extinctions compensated by a gain in diversity via immigrating and newly originating taxa? (3) Do diversity trends in middle shelf habitats and marginal marine environments match?

Total diversity in the Danian is lower than in the Maastrichtian and this difference is more pronounced in marginal marine habitats. Similarly, Danian community diversity is below that of Maastrichtian assemblages in marginal marine settings but not in the middle shelf. Thus, recovery of both community and total diversity was more complete in middle shelf habitats. In both settings, the most diverse and abundant elements of post-extinction assemblages are genera that survive the K-Pg boundary. Immigrating and newly evolving genera played only subordinate roles and did not fully compensate the diversity loss at the K-Pg boundary. The progressive accumulation of post-extinction diversity levels off with time. Early during recovery, diversity tends to build up more slowly than expected by chance. In particular, the re-immigration of survivors from near-by localities was delayed. Later on, invasions (marginal marine) and origination events (middle shelf) were unusually common. The shape of the diversity trajectories mirrors that of classical accumulation curves in which the cumulative number of taxa, recorded as a function of the number of individuals collected, approaches an asymptote. This suggests that, over the studied time interval, available ecospace was filled and on-site diversity approached saturation, although at a lower level than before the extinction event. Survivors that dominated Danian assemblages were rare during the Maastrichtian, and therefore probably poor competitors. Once released from competition by the disruption of stable Maastrichtian communities their competitiveness increased. This suggests a type of incumbency, where numerically subordinate taxa rose to ecological dominance in the aftermath of a major perturbation. Because similar patterns are known from terrestrial ecosystems, this may be a general process across mass extinctions.

S12 – Conodont dating of reefs and carbonate platforms in the Middle and Upper Devonian of the Morrocan Meseta

Aboussalam Z. S.[1]*, R. T. Becker[1] & S. Eichholt[1]

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In our current DFG project we compare the Middle/Upper Devonian facies history of the southern (Moroccan Meseta) and northern (Rhenohercynian Zone)

external Variscides. It concentrates on the "Eovariscan Interval" of the western Prototethys, characterized by the initial collision of NW Gondwana and Laurussia/Armorica. The distribution of carbonate platforms and reefs in time and space forms a significant part of the research program. Fieldwork in 2011/2012 concentrated on different structural units of the western Meseta. Precise dating of the previously poorly studied reefs is achieved with the help of conodonts and few ammonoids.

The Oued Cherrat Zone contains three ca. N-S running reef belts. The northeastern Ain Khira Reef did not produce conodonts but its Givetian age is proven by *Stringocephalus*. The base of the supposed Givetian reef east of the Oued Cherrat, in the Ain Dakhla region, surprisingly yielded Lower Emsian icriodids. However, reworked Eifelian-Givetian conodonts in an Upper Devonian conglomerate with many reefal clasts west of the Oued Cherrat suggests that a Givetian reef was locally present and subsequently eroded. Further to the south, the small, isolated reef body at Ain-As-Safah yielded only Upper Givetian conodonts, followed by rich Frasnian faunas from overlying, highly condensed brachiopod and *Manticoceras* limestone. The reef complex is a large slump block that was embedded tectonically and with an angular unconformity in Lower Givetian, deeper-water nodular limestones.

In the Coastal Block a carbonate platform developed continuously from the Emsian to Givetian, with two main reefal phases interrupted by ?Eifelian neritic limestones. Conodonts from overlying dolomites suggest a final drowning in the course of the global Frasnes Events, with subsequent deposition of very condensed pelagic carbonates until the end of the Frasnian. The Ain Jemaa reef north of Oulmes experienced a similar fate slightly later, at the end of the Lower Frasnian. The change from underlying pelagic limestones with goniatites to shallow-water limestones occurred in the upper Eifelian, before the global Kacak Event.

Further to the south, in the Rehamna, extensive Givetian reefs formed near Mechra Ben Abbou. They overlie cherty neritic limestones with Lower Givetian conodonts. It has not yet been possible to date the reef extinction. The allegedly contemporaneous non-reefal facies to the east, at Foum-el-Mejez, produced lower Emsian conodonts at its base and is, therefore, older than the Rehamna reefs. True reefs are completely absent from the Jebilet region around Marrakesch. Only at the Jebel Ardouz, a thin biostrome developed in the Lower Givetian. An underlying supposed Emsian conglomerate with many reefal blocks turned out to contain Middle Frasnian conodonts. This proves local overthrusting and the local complete erosion of younger, more extensive Givetian/Frasnian reef limestones. The supposed Givetian reef at El Moussira is in fact an Upper Visean crinoidal limestone.

S13 – The record of Triassic charcoal and other evidence for palaeo-wildfires: signal for atmospheric oxygen levels, taphonomic biases or lack of fuel?

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As wildfires are today important sources of disturbance in many terrestrial ecosystems, it is of great interest to understand how different environmental parameters and fire-activity interacted during past periods of the Earth history. Fossil charcoal, intertinites, and pyrogenic polycyclic aromatic hydrocarbons (PAHs) represent the only direct evidence for the occurrence of such palaeo-wildfires. In the present contribution, a review of published data, together with new data on the occurrence of fossil charcoal for the Permian and the Triassic is presented. For a long time, it has been speculated, that an assumed lack of evidence for palaeo-wildfires during the Triassic should be explained by a large drop in atmospheric oxygen concentration following or during the end-Permian mass extinction event, preventing the occurrence of wildfires. However, evidence for palaeo-wildfires is relatively common in many middle and late Triassic strata, whereas such evidence is almost totally lacking from early Triassic sediments. The interpretation of this "charcoal gap" or depression is difficult, as many factors (e.g. atmospheric oxygen concentration, taphonomical biases, lack of sediments suitable for the preservation of macroscopic charcoal, lack of fuel, and "ignorance" of scientists) may have influenced not only the production, but also the preservation and recovery of evidence for palaeo-wildfires during this period. Thus, it is not clear whether this Early Triassic "charcoal gap" can also be seen as evidence for an assumed "wildfire gap" or not. Without any doubt further investigations on the early Triassic record of charcoal and other evidence for palaeo-wildfires will be necessary before this problem can be solved. In fact, it can be expected that the number of published records of (early) Triassic evidence for palaeo-wildfires will increase in the future as more and more scientist working on sediments of this age may become aware of the interest in fires from this time. This will certainly make it possible to give a much better picture of the temporal and regional distribution of wildfires during this period in the future.

S24 – The Oxfordian stable isotope record of the Kachchh Basin, western India, and its implications for palaeoclimatic, palaeogeographic, and palaeoecologic reconstructions

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During the Jurassic, the Kachchh Basin was situated at the mouth of the Malagasy Gulf, a southern extension of the Neotethys separating eastern (India, Madagascar) from western (Africa) Gondwana. Today, the area is characterized by well exposed Jurassic strata containing an abundant fossil fauna whose stable isotope ($\delta^{13}C$, $\delta^{18}O$) composition can be used to reconstruct the palaeoclimate. Since most stable isotope studies for the Jurassic have been carried out on fossils from Europe, the Indian material is especially valuable in differentiating global from regional events. The Jurassic has traditionally been considered to be an ice-free greenhouse world with comparatively stable climatic conditions. However, a series of studies during the last few decades challenged this view: It has been proposed, for instance, that an ice age occurred at the Callovian to Oxfordian boundary leading to a global drop in water temperatures and sea level. Interestingly, the stable isotope record and the sedimentary record of the Kachchh Basin point to rather stable conditions at this boundary with a prominent temperature minimum occurring not before the Upper Oxfordian. It is tempting to connect this regional event with the break-up of Gondwana causing the influx of polar waters along the East African coast or, alternatively, leading to enhanced upwelling currents in the northern Malagasy Gulf. Apart from palaeoclimatic and palaeogeographic reconstructions, the stable isotope compositions of fossils offer information on their palaeoecology. The results of belemnites show lower temperatures and weaker temperature fluctuations through time than those of the benthic fauna (oysters, brachiopods). This agrees well with different life habitats of both groups with belemnites spending major parts of their life in deeper water outside the Kachchh Basin and entering shallow areas only occasionally (e.g., during seasonal migrations to spawning grounds).

S17 – How much tooth is needed to feed a mammoth? – The modification of the occlusal surface area in Elephantidae during life span

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The body size of Elephantidae is continuously growing for about two-thirds of their life span. Simultaneously, the functional surface of the dentition is increasing due to the horizontal tooth exchange. Each molar is larger than the precedent one. Thus, molars are available to break down enough plant material for almost the entire life span. But in very old individuals the last molars might be worn down extremely, having only very few enamel ridges left. According to the limited number of very old individuals – and of collection biases – such dentitions are fairly rare. Most individuals do not reach such a high age, although, fully grown elephants are not endangered by predators. But badly worn teeth of senile individuals occur sometimes among the abundant fossil teeth of *Mammuthus primigenius*. The mammoth skeleton excavated in Polch near Koblenz might have reached an age, where the worn teeth might have become the limiting factor in providing the animal with sufficient energy, and thus, may have lead to starvation.

Such teeth of senile individuals raise the question how much functional tooth surface is required to support a fully grown senile mammoth? As a measure of functionality of elephant teeth the total length of the shearing edges should be investigated. However, instead of the total length of these edges the used occlusal area can be measured more easily. Tests show that both values correlate very well. The functional area on the occlusal surface can also cover parts of two successive molars.

A fully grown mammoth with a shoulder height of about three meters might have weighted three to four tons. Our analysis shows, that the total functional occlusal area in the lower jaw in a fully grown individual reaches a mean of about 260 cm^2. In senile individuals, however, the functional area can be decreased to half of this value, in extremes even to one fifth. This highly reduced functional area kept the animal alive despite its fully sized body mass. That means, that the dentition of a fully grown *Mammuthus*, as well as *Loxodonta* or *Elephas* is highly oversized, if only the minimal energy for the maintenance of the body mass is regarded. The surplus in the functional dentition is able to provide all the energy needed for other aspects of life.

S4 – Calcium is for the birds: variation in bone chemistry within Avians

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The definition of bone has always been difficult, due to the variability of bone tissue. This variation can be attributed to

the bioapatite structure, which can incorporate a wide range of chemical substitutions that affect the chemical and mineral properties of bone. Thus, understanding bone chemistry is important in the comprehension of mineral homeostasis, healing processes, and mechanical loading in modern animals, as well as potential fossilization processes and interpretation of fossil chemistry. One group of particular interest are the birds. Veterinary literature notes that bird bones have a higher percentage of calcium than the bones of other vertebrates, which results in shattering rather than fracturing in response to trauma. However, it has not been demonstrated whether this is due to elevated amounts of calcium within the apatite structure, a higher ratio of bone apatite to collagen within the skeleton or mechanical difference due to the hollow structure of bird bones. It is also unclear if this is a character for all birds since most veterinary research focuses on domestic or rehabilitated flighted birds.

In this study, I use a ThermoScientific Niton XL3t XRF Analyzer and Innov-X Delta Handheld XRF Analyzer to examine calcium chemistry of 22 species of birds to assess variation between species. Variation within an individual was tested by analyzing multiple skeletal elements from each specimen. Specimens varied in age, diet, habitat, preparation of the skeleton, health (pathologic vs. normal bone), and sex. Calcium was measured in overall parts per million (ppm) and converted into percent composition. Results were compared to calcium levels in 25 species of non-avian vertebrates to assess variation within vertebrate groups.

XRF analysis revealed significant variability in calcium content between species, between known domestic versus wild individuals, between pathologic and normal bone, and between different skeletal elements of the same individual within all vertebrate groups. This variation suggests that the skeletal system in all vertebrates can support a wide range of calcium levels, allowing the body to adjust to different mechanical and mineral homeostatic needs. Birds did not show elevated calcium content compared to other vertebrates, challenging the notion of elevated calcium levels within this group. However, further testing is necessary to test whether apatite to collagen ratios differ in birds compared to other vertebrates, or if other significant differences in bone chemistry exist.

S7 – X-ray based cross-sectional imaging in palaeontology – techniques and applications

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Cross-sectional imaging allows non-invasive analysis of palaeontological specimens. The image quality is mostly based on the density and morphology of the respective specimen and the x-ray technique that is used for imaging. Since these x-ray based techniques are broadly used in health-care, the availability of "human-scanners" is distinctly larger compared to micro-scanners (e.g., micro-computed-tomography, micro-CT).

The technique of x-ray based imaging (plain film and computed tomography) will be reviewed with special focus on the specific requirements for palaeontological imaging. Technical details will be presented in order to provide an idea which specimens are likely to be successfully scanned with "human-scanner-technique" and which specimens probably need to be scanned with advanced techniques such as micro-CT. Several examples will be presented to demonstrate the advantages but also the challenges of using a human scanner for imaging of palaeontological specimens.

Due to the broader availability of "human-x-ray-scanners" the use in palaeontology is favorable and on the rise. Technical details are important in this context since the use in humans can be distinctly different compared to palaeontological imaging.

S4 – Growth-line analysis of the Middle Cambrian brachiopod *Vandalotreta djagoran* (Kruse, 1990) from the Manuels River Formation, Conception Bay South, Newfoundland, Canada, using Image J and R

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A common method of analysing seasonal growth lines, growth rates and growth patterns in fossil shells, e.g. bivalves or brachiopods, is the time-consuming manual counting and distance measuring of the growth lines. Such manual measuring may lead to inaccuracies in determining the exact position and border of a growth line or an increment, particularly in small fossils. With the help of the platform-independent software packages Image J and R, growth lines and growth patterns in the brachiopod *Vandalotreta djagoran* (Kruse, 1990) from the Middle Cambrian Manuels River Formation at Conception Bay South, Newfoundland, Canada, were studied. Greyscale images were analysed and growth lines of the ventral valve surface automatically counted. Algorithms for analysing the spectrum produced by Image J were applied in combination with a newly developed brute-force search for the best-match growth-line seasonal cyclicity using Fourier transformations and syntheses. It is shown that this method is faster, easier to use and at least as accurate as manual measuring and analysis of growth lines and growth patterns. The project is funded by the Klaus Tschira Foundation, Heidelberg.

S5 – Benthische Foraminiferen aus dem Unter-Apt des Münsterlandes, NW-Deutschland

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Aus dem Tagesaufschluß einer Tongrube bei Ahaus-Alstätte, Münsterland, NW-Deutschland, wurde die benthische Foraminiferen-Fauna untersucht. Als Basis dienen 115 horizontiert entnommene Proben. Besonderes Augenmerk lag auf der Erfassung des Fischschiefers, der zeitlich dem Oceanic Anoxic Event 1a (OAE 1a) entspricht.

Neben feinstratigraphischen Fragestellungen wurde besonderes Augenmerk auf die Besiedelung des benthischen Lebensraumes während des OAE 1a gelegt. Dieser durch eine fein laminierte Sedimentation ausgezeichnete Bereich wurde mit 14 Proben-Horizonten bearbeitet. Neben vereinzelten Makrofossilien benthisch lebender Arten konnten in allen Horizonten benthische Foraminiferen gefunden werden. Die quantitative Erfassung der Foraminiferen-Fauna zeigt während des OAE 1a nach einem starken, andauernden Einbruch eine langsame, stark schwankende Zunahme der Besiedelungsdichte. Die Artenzusammensetzung verändert sich innerhalb des OAE 1a, darüber hinaus finden sich Verschiebungen der Dominanzstruktur der vorhandenen Arten.

Im gesamten erfassten Profil sind immer wieder Vorkommen einzelner Arten oder Gattungen zu beobachten, die nur in einem oder wenigen Horizonten mit hoher Individuenzahl auftreten oder deren sonst eher geringe Individuendichte kurzzeitig deutlich zunimmt. Diese auffälligen Unterschiede werden als Zeichen einer Veränderung mikrohabitueller Bedingungen gedeutet, d.h. Veränderungen der lokalen Lebensbedingungen führen zu einer Stärkung der Konkurrenzkraft einzelner Arten oder Artengruppen. In einzelnen Fällen liegen Erklärungen für diese Erscheinungen auf der Hand. So ist zum Beispiel das Auftreten einer sessilen Art, die der Gattung *Lituotuba* Rhumbler zugeordnet wird, stark vom Vorhandensein größerer Sandkörner als Anheftungsuntergrund im ansonsten tonigen Sediment abhängig. Andere Fälle wie das gemeinsame kurzzeitige Auftreten stark skulpturierter kalkschaliger Arten der Gattungen *Epistomina* Terquem, *Lenticulina* Lamarck und *Planularia* Defrance oder die fast vollständige Verdrängung der häufig vorkommenden Arten der Gattung *Ammobaculites* Cushman durch Arten der Gattungen *Gaudryina* D'Orbigny und *Falsogaudryinella* Bartenstein sind zur Zeit Gegenstand weiterer Untersuchungen.

Die Untersuchungen sind Teil des DFG-Projektes „Palaeobiology, morphology and diversity of macrofaunas: A case study on Early Cretaceous ammonites" und sollen der Klärung palökologischer Zusammenhänge im Rahmen dieser Studie dienen.

S3 – The curious case of *Gazella arabica*

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Gazelles form a species-rich genus of horned ruminants (Bovidae) and are arguably amongst the most iconic and endangered animals. In the taxonomic literature of the past few years, 10-23 different species are recognized, depending on the author. One of the most enigmatic members of the genus is *Gazella arabica*, the earliest gazelle known from Arabia. The type material, one male, and one female individual collected in 1825, has been the subject of many studies that tried to figure out what *G. arabica* actually is: a unique (possibly extinct) species? Or a synonym of *G. gazella* or *G. dorcas*? Especially the male, designated as the lectotype by Neumann (1906), has puzzled researchers for centuries, as no similar gazelle has ever been found. Using mitochondrial DNA of the type material, we wanted to clarify the taxonomic status of *G. arabica*. What seemed to be a simple task swiftly developed into a detective story. We found skin and skull of each supposed individual to belong to different individuals, in the case of the female even to different species. Morphometric analyses of skull dimensions verified the results from the molecular phylogenetic analysis. Finally we can conclude that *G. arabica* (as defined by the male type skin) represents a distinct gazelle lineage that is closely related to Mountain gazelles (*G. gazella*).

S26 – Ecomorphology of the European *Hyaenodon*: apex predator or opportunistic hunter? New aspects revealing the ecological niche

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New aspects of the ecomorphology of the European *Hyaenodon* include herein the dietary adaptation, the morphology

of the brain and the hearing capabilities. In order to assess the diet of these fossil predators, low magnification microwear was combined with the analysis of the microstructure of the enamel and the Hunter-Schreger-band (HSB) pattern. The European and Asian taxa were examined for the first time and show a transition from undulating to zigzag HSBs. Furthermore, microwear of *Hyaenodon* from all continents was observed for the first time. The ossiphagous tendencies of *Hyaenodon* can be confirmed: the heavy wear, the thicker enamel, the presence of zigzag HSB and the highly pitted microwear pattern indicate the procession of tough food. A surprising result is the slightly different niche of the North American species compared to the European *Hyaenodon*. *Pterodon* disappears at the Eocene-Oligocene border from Europe and findings of *Entelodon* are rare in Europe. Concluding, bone crackers were less frequent in Europe than in North America and *Hyaenodon* could have been adapted more into that niche in Europe.

The brain is important for phylogenetic and sensory implications and thus is reconstructed in fossils with endocranial casts or CT-scans of the braincase. The characteristics of the *Hyaenodon* brain are: large olfactory bulbs, large pyriform lobe, low neocortex and a moderately folded neocortex. These features are shared with the marsupial Tasmanian devil *Sarcophilus harrisii* and the giant anteater *Myrmecophaga tridactyla*. Both of the latter are Theria of known well-developed olfactory sense. The brain structure (relative size of the olfactory bulbs and the pyriform lobe) indicates that the sense of smell was relatively important in *Hyaenodon*.

The hearing apparatus is characterized by: small, but bony bulla; bulla of entotympanic origin and chambered; cochlea makes three turns; small and delicate incus; incudo-mallear joint on the incus with rather simple articulation facets. Concluding from these structures of the hearing apparatus, *Hyaenodon* shows no adaptation to low frequencies as seen in the sand cat *Felis margarita*. It most probably had a wide frequency range and if the inference of the morphological similarity of the *Hyaenodon* incus to the incus of the domestic cat is allowed, an adaptation to high frequencies is indicated. The overall picture of the European *Hyaenodon* is showing now an opportunistic hunter in rather dense vegetation.

S21 – Ginkgophyte leaves from the late Permian Kupferschiefer of Germany

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The Kupferschiefer (lower Zechstein) flora from Germany is one of the most important late Permian floras of Europe. Although this flora has been studied since the 19th century, its biodiversity, especially that of the ginkgophytes, remains incompletely understood, due in part to the fact that most foliage specimens do not yield cuticles. A safe discrimination of macromorphologically similar species is therefore difficult. All ginkgophyte foliage from the Mansfeld and Sangerhausen area was historically assigned to *Baiera digitata* because it was believed that fossil ginkgophyte leaves possess a similarly high intraspecific variability as the leaves of the extant *Ginkgo biloba*. In 1936, Florin introduced the new genus *Sphenobaiera* for Mesozoic ginkgophyte foliage from Franz-Joseph-Land, and subsequently all ginkgophyte leaves of the historical Kupferschiefer collections formerly assigned to *B. digitata* were transferred to this new genus. Thus, the two taxa *B. digitata* and *S. digitata* reported from the German Kupferschiefer in fact refer to the same species. New studies of the historical Kupferschiefer collections kept at the Martin-Luther-University at Halle-Wittenberg, the Palaeontological and Stratigraphical collection and the "Reiche Zeche" at the Technische Universität Freiberg, and the Humboldt Museum für Naturkunde at Berlin reveal that the Kupferschiefer ginkgophyte foliage is more diverse than previously recorded. Macromorphometric analyses indicate that at least three different petiolate leaf-types occurred. The first type corresponds to the original *B. digitata*. The leaves are up to 12 cm long and 8 cm wide with linear to inversely lanceolate segments. The second type, *Baiera* sp. 1, is characterized by a curved rachis, a thinner petiole and wedge-shaped or slightly broadened segments. The third type corresponds to *Esterella gracilis*, a taxon hitherto reported exclusively from the Permian of France. These leaves are irregularly branched, with narrow, linear segments that gradually taper towards the tips of the higher branching orders. Our re-analysis of the Kupferschiefer ginkgophytes demonstrates that macromorphometry is a useful tool also for palaeobotanical studies, especially if the specimens do not yield cuticles. Moreover, the Kupferschiefer ginkgophytes were not represented only by *B. digitata*, but rather also by at least two additional species. Our results contribute to a more accurate understanding of the diversity of the ginkgophytes in the early Permian, the period of time during which the radiation of this lineage of gymnosperms seems to have commenced.

S22 – Climate change and vegetation in the Oligocene of the south-eastern edge of the Greater Caucasus (Azerbaijan)

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New palynological data for Maycopean deposits (Oligocene-lower Miocene) from the Islamdagh outcrop of the south-eastern edge of the Greater Caucasus (Gobustan region) will be discussed.

Four palyno-zones that characterize the vegetation and climate in the Oligocene period are distinguished in the outcrop based on changes in the composition of the spore-pollen spectra of higher plants. Ten samples from the outcrop mentioned above have been studied using standard palynological methods.

The spore-pollen spectra of the Oligocene of the south-eastern edge of the Greater Caucasus illustrate a weak differentiation of vegetation in the Oligocene and the predominance of forests, among which are: 1) Polydominant humid subtropical coniferous and deciduous forests, the analogues of which are now common in southeast China, and on the Atlantic coast of North America; 2) Mediterranean-type forests with the participation of xerophilic elements; 3) Swamp formations along the sea and river terraces with *Taxodium*, *Nyssa*, *Glyptostrobus* and palm trees on the sandy shores.

The climatic conditions of the early Oligocene used to correspond to the wet subtropical type with tropical elements, which is evidenced by the presence of, East-Asian and tropical vegetation types (swamp cypress, redwood, *Glyptostrobus*, *Nyssa*, *Ginkgo*). In the mid-late Oligocene period (analysis of material palynozone II) the mid-annual temperature decreases, which is expressed in the appearance of moderate representatives of the vegetation (birch, pine) and of the so-called "Turgai" flora (maple, linden, hazel). Temperature decline and vegetation changes during the Late Oligocene are observed in most regions of Eurasia (Borzenkova, 1992). In Western Europe subtropical forests which are typical for the Lower Oligocene were replaced by deciduous temperate floras of "Turgai" type in the Late Oligocene. The process of vegetation turnover in our region was less dramatic. Various taxa belonging to differing geographical/ecological areas from the subtropics still remained until the Late Oligocene and elements from the temperate zone became more prominent.

S4 – Confocal Raman microscopy and its contribution to sclerochronology

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Rising global temperatures, ocean acidification and rising sea levels: just three of many changes mankind will have to deal with in the future. A precise understanding of past warm phases is essential for successfully anticipating forthcoming change and mitigating its consequences. Understanding the connections of the complex global climate system during warm phases, when climate conditions were similar to what we can expect for the future, is a major task for palaeo-climate reconstructions. Since instrumental data are restricted to the last two centuries, past climates can only be revealed by proxy data.

Fossil biogenic carbonates (e.g., molluscs, foraminifera) are key-sources of information for palaeo-climatic and palaeo-environmental reconstructions, as anatomical and/or geochemical properties of the carbonate can serve as proxies for certain environmental parameters. Confocal Raman microscopy (CRM) can play a central role in analysis and quality control of biogenic carbonate studies.

CRM can identify mineral (and organic) phase(s) in marine biogenic carbonates at high spatial resolution (300 nm), i.e. it allows to identify taphonomic changes in the carbonate structure. Furthermore, this method is ideal to detect possible contaminations, e.g., resulting from shell preparation in the laboratory (e.g., by epoxy resin or super glue). CRM is also a valuable tool to identify and visualize growth increments within accretionally precipitated carbonate skeletons of marine organisms. Commonly used dyeing techniques (like e.g., Mutvei's solution) are often inefficient when applied to fossil biogenic carbonates with low organic content. CRF can reveal shell formation processes at a very high spatial resolution, even in several million years old shell material.

Here, we demonstrate the potential of CRM supported analysis, using shells of the marine bivalve *Arctica islandica*. Its wide northern-boreal distribution, its relative abundance in the fossil record (present in the North Atlantic for at least 20 million years), its longevity (more than 400 years) and not least its high temporal resolution (seasonal and even daily information can be obtained) make it an exceptional bio-archive. Fossil shells, dated from Oligocene to Holocene, collected from the North Atlantic and the Mediterranean Sea, were analysed for their state of preservation by applying CRM. Since these shells are entirely built of aragonite (meta-stable polymorph of $CaCO_3$) it makes them an ideal object for recrystallisation studies. In addition, CRM was used to visualize growth increments in the umbonal and the ventral shell portion at different spatial resolutions (µm to mm). Results were then compared to reflected light microscopy and staining methods in the same specimens.

S19 – From teeth to baleen: a major macroevolutionary transition in mysticete whales

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Recent phylogenetic analyses using a combination of fossil, morphological and molecular evidence detail a multifaceted major ecomorphological transition from teeth to baleen and the origin of batch filter-feeding. Extant mysticetes retain both developmental and genetic evidence of their ancestral toothed heritage. Some stem toothed mysticetes (i.e. aetiocetids) provide evidence of the simultaneous occurrence of teeth and baleen and are seen as transitional forms that may have captured large prey with their teeth and also batch filter-fed on zooplankton with their baleen.

Study of the comparative anatomy of baleen especially the morphology of full baleen racks of extant minke and gray whale (e.g. plate length, width, thickness, orientation) provides hypotheses regarding details of the filtration mechanism. Preliminary study of baleen ultrastructure revealed cuticle, cortex, and medulla epithelial layers. Scanning electron micrograph (SEM) investigation showed slight variations among cells and microridges in the cortical layer of examined species. Transmission electron micrographs (TEM) of cross sections of baleen plates showed distinct species level patterns of calcified tubules. Future work will include investigation of baleen and palate vascular anatomy through barium and latex injection and high resolution X-ray computed tomography (CT) to determine the position of vessels and their relationship to baleen and other anatomical structures. In addition to baleen there were major morphological modifications that facilitated batch filter feeding such as an increased size of the oral cavity and flexibility of the mandibles. We trace on a composite phylogenetic hypothesis the sequence and timing of character transformations that led to both baleen and batch filter feeding.

S20 – Terrestrial African biogeography and paleoenvironments: late Miocene to Recent

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Sub-Saharan Africa today is largely isolated from North Africa and Eurasia by a wide arid belt made up of the Saharan and Arabian deserts. However, the mammalian fossil record indicates that faunal connectivity between Africa and Eurasia was stronger throughout most of the Neogene. At a smaller scale, eastern African environments today are mainly characterized by the Somali-Masai vegetational zone, consisting of arid to semi-arid grassland and woodland environments receiving less than 600 mm of rainfall per year. Abundant fossil and paleoclimatic evidence indicates, however, that eastern Africa was significantly wetter and more forested throughout most of the Neogene and at least up through the Pliocene. The development of tropical and subtropical aridity therefore appears to have played a major role in the shaping of modern African biogeography. I here review and investigate aspects of the mammalian fossil record of African and Arabian sites from the late Miocene to the Pleistocene, with an emphasis on tracing the development of aridification and its impact on paleoenvironments and faunal compositions.

The Miocene fossil record of the Arabian Peninsula offers an important window onto the early development of the Arabian desert, and to the nature of interchange between Africa and Asia. In the United Arab Emirates, the Miocene Shuwaihat Formation documents the presence of desert conditions by at least 8 Ma or older. At the same sites, the overlying Baynunah Formation is fluvial in origin and contains the remains of a diverse, mainly African, fossil fauna. The sparse Arabian terrestrial fossil record suggests that arid conditions had been in place by the late Miocene, but that alternating climatic changes intermittently permitted extension of African faunal elements north-eastwards into the Arabian Peninsula and to the doorstep of the Asian mainland.

I also take a closer look at the paleoenvironmental record in eastern Africa. The paleoclimatic record indicates an average trend of decreasing temperatures globally since the mid-Miocene, and increasing aridification and climatic variability in Africa, especially after 3 Ma. I ask: How prevalent are arid environments in eastern Africa at different times since the early Pliocene? I use the large and diverse fossil record of Bovidae (antelopes and relatives), herbivorous mammals which have been shown to be excellent paleoenvironmental indicators, to investigate the heterogeneity of paleoenvironments represented by fossil sites of the last 5 Ma in eastern Africa (Malawi, Tanzania, Kenya, Ethiopia). Correspondence analysis clearly reveals an overall aridification trend, with the proportion of relatively arid sites approximating modern eastern African conditions increasing especially after 2 Ma. There is also tentative evidence that during the Pliocene and Pleistocene, sites to the southern extent of eastern Africa (Tanzania, Malawi) may have been consistently drier than those to the north (Kenya, Ethiopia).

S6 – Evolution of fossoriality in mole limbs (Mammalia: Talpidae)

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Talpidae comprises moles, shrew moles, and desmans. Since their origin in the Late Eocene, they have occupied different habitats, such as terrestrial, semi-aquatic, semi-fossorial, and strictly fossorial. Strictly fossorial moles exhibit several ecomorphological specializations in their skeleton and transformations associated with changes from a terrestrial to a fossorial lifestyle, e.g. in the limbs, occurred gradually across phylogeny. We present several collaborative studies which combine paleontological and developmental data to decipher the origin and evolution of these ecomorphological specializations.

First, the humerus of fossorial moles displays a highly-derived morphology, associated with rotation, with broadened muscle attachment sites and distinct articulations. Since bone compactness is likely to exhibit a strong ecological signal, it was studied in skeletal humeri of 19 recent and extinct talpid taxa. Results show that the transition zone from the medullary cavity to the cortical compacta is significantly higher in fossorial than in non-fossorial taxa, and, the ratio describing the elliptic shape of the medullary cavity is significantly smaller.

Furthermore, based on histological sections, 3D reconstructions of cartilaginous tissue of the humerus of the strictly fossorial Iberian mole, *Talpa occidentalis*, show that several derived features are already present in 21-23 days old embryos; a case of developmental penetrance.

At last, besides the development of an additional digit-like bone in mole autopods, fossorial moles have enlarged their hands compared to the feet, thus gaining better digging capabilities. In terms of heterochrony, we analysed the expression of *Sox9*, which is an early marker of chondrification. Results show that it is advanced in the hands compared to the feet in *T. occidentalis*. In contrast, *Sox9* expression is synchronous in the sister-taxon shrew, *Cryptotis parva*, and the mouse. This transcriptional heterochrony accounts for earlier reported pattern heterochrony and later differences in size, and is another finding of developmental penetrance in mole limbs.

S26 - Evolution der Wirbelsäule bei Archosauriern: Fossilien, Morphologie und *Hox*-Gene

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Evo-Devo hat das Verständnis für evolutive Prozesse in den letzten 25 Jahren maßgebend revolutioniert. Eine der bedeutendsten Entdeckungen war die einer evolutionär hoch konservierten Gruppe von Genen: der *Hox*-Gene. Sie sind entscheidend an der antero-posterioren Differenzierung der Körperachse und der Entwicklung von Segmentalstrukturen aller bisher untersuchten Metazoa beteiligt. Bei den Vertebraten wird die zentrale Funktion dieser Gene in der Wirbelsäule sichtbar. Der tief in der Evolution verankerte Zusammenhang zwischen *Hox*-Genen und der Morphologie des Axialskeletts brachte die Hypothese auf, dass ein spezifisches Gen-Expressionsmuster (*Hox*-Code) für die verschiedenen Wirbelformen innerhalb der Wirbelsäule verantwortlich ist. Somit spielen diese Gene eine entscheidende Rolle in der Evolution der spezifischen axialen Variation.

In diesem Zusammenhang stechen die sauropodomorphen Dinosaurier als einzigartige Gruppe von Tieren besonders heraus. Sie weisen nicht nur höchst komplexe, sondern auch sehr unterschiedliche Wirbelmorphologien auf und ihre Wirbelanzahl variiert deutlich. Bis dato ist die genaue Art und das Muster dieser Variation bei den Sauropodomorpha nicht verstanden. Da für die Analyse dieser fossilen Gruppe von Archosauriern keine direkten genetischen Informationen zur Verfügung stehen, ist die Wirbelmorphologie der einzige Schlüssel, um diese faszinierende Fragestellung zu lösen. Erstmals wird hier eine Korrelation zwischen dem Grad der Formänderung zwischen nachfolgenden Wirbeln und der Anzahl von aktiven *Hox*-Genen in der entsprechenden Axialregion bei rezenten Archosauria identifiziert. Hierfür wurde zuerst der *Hox*-Code für die Entstehung der präsakralen Wirbelsäule in dieser Gruppe ermittelt. Die verfügbare genetische Information wurde mit In-situ-Hybridisierungsexperimenten beim Nilkrokodil vervollständigt. Anschließend wurde der direkte Zusammenhang zwischen *Hox*-Gen-Expression und Wirbelmorphologie bei Huhn und Krokodil mittels qualitativer, morphologischer und quantitativer, morphometrischer Studien analysiert. Nachdem morphologische Ähnlichkeit kausal mit *Hox*-Gen-Expression in Verbindung steht, wird es möglich, die Wirbelformänderung als Proxy für das genetische Expressionsmuster zu nutzen. Auf Basis der quantifizierbaren Änderungen in der Morphologie der Wirbel wurde der *Hox*-Code für ausgestorbene Archosauria rekonstruiert. Die beobachtete Variation der morphologischen Regionen in der Wirbelsäule von sauropodomorphen Dinosauriern resultiert aus einer spezifischen Änderung der *Hox*-Gen-Aktivität. Diese Ergebnisse zeigen, dass die morphologische Disparität innerhalb der Wirbelsäule genutzt werden kann, um die zugrundeliegende genetische Information zu rekonstruieren.

Die Integration von Fossilien, Morphologie und Genen in der Evolutionsforschung hat in den letzten zwei Jahrzehnten zunehmend an Bedeutung gewonnen. Meist ist dieser Ansatz

darauf begrenzt, die phänotypischen Veränderungen während der Evolution indirekt durch den Vergleich mit Prozessen der individuellen Entwicklung eines Organismus zu interpretieren. Hier wird erstmals die direkte Korrelation zwischen Gen-Expression und morphologischer Variation analysiert und die genetische Basis für Evolution in einer ausgestorbenen Linie zurückverfolgt. Somit sind die Analysen nicht nur von größter Wichtigkeit für das Verständnis der evolutiven Geschichte der Sauropodomorpha und ihrer außergewöhnlichen Morphologie, sondern sie repräsentieren auch eine bedeutende Fallstudie zur direkten Anwendbarkeit der Prinzipien der Entwicklungsbiologie auf die Paläontologie.

S21 – Gymnosperms of the Triassic Polar forest biome of Gondwana

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The evolution of land plants is characterized by a probably unparalleled diversification of gymnosperms during the Triassic. The high seed-plant diversity especially in southern Gondwana is particularly interesting, given that these floras flourished under warm-temperate climatic conditions in palaeolatitudes well within the polar circle, unlike any forest biome today. The abundance of compression floras and the occurrence of permineralized peat deposits from Antarctica continue to yield a wealth of information about the biology and ecology of this Triassic polar forest biome.

The most prominent plant fossils from the Triassic of Gondwana are leaves of the Corystospermales, which consist of simple to up to tripinnate fern-like fronds with a characteristic basal bifurcation (*Dicroidium*). The most commonly associated reproductive organs include the cupulate structure *Umkomasia* and the pollen organ *Pteruchus*; all are known in remarkable anatomical detail from the Antarctic permineralized peat. Antarctic *Dicroidium* plants have been reconstructed as tall, *Ginkgo*-like trees that formed the dominant constituents of riparian forest communities.

Conifers are almost exclusively represented by the common association of voltzialean leaves (*Heidiphyllum*), seed cones (*Telemachus*), and more rarely pollen cones (e.g., *Switzianthus*). The permineralized peat has also yielded anatomically preserved stems and leaves (*Notophytum*) as well as seed cones (*Parasciadopitys*). Although initially assigned to three different conifer families, new evidence shows that all these organs belong to a single group of voltzialean conifers. These conifers were medium-sized trees that were abundant in flood-basin areas with high water tables, forming the dominant element of low-diverse conifer swamps and forested bogs.

A variety of other gymnosperms occurred in more locally restricted environments. For example, the recently described matatiellaceaen peltasperms are represented by foliage (*Dejerseya*, *Pachydermophyllum*, *?Linguifolium*) and ovuliferous (*Matatiella*, *Andersonia*) and pollen organs (*Townrovia*). Matatiellaceae are interpreted as early-successional shrubs to small trees that were especially successful in colonizing stressed wetland environments in the high-latitude regions of Gondwana. A further seed-fern group, the Petriellales, appears unusual in many respects; these plants were probably small, perennial shrubs known so far only from the Gondwanan Triassic. They had slender stems, fan-shaped leaves with characteristic anastomoses (*Rochipteris*), pinnately arranged synangiate organs (*Kannaskoppianthus*), and multi-ovulate cupules (*Petriellaea*) reminiscent of the Jurassic Caytoniales.

In addition, cycads, Ginkgoales, and various other gymnosperm fossils with obscure botanical affinities have been described from the Triassic of Gondwana. Even though some of the Triassic gymnosperm groups are today known in remarkable detail, the continuing descriptions of enigmatic seed-plant fossils from Triassic deposits worldwide demonstrate that we still have only just begun to unravel the diversity of gymnosperms in the Early Mesozoic greenhouse world.

S8 – Paleoecology and taphonomy of the Ediacaran Nama-type assemblage: evidence from the sedimentary record of Kliphoek Member (Nama Group) in southern Namibia

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The Ediacaran marks in the earth's history, a period of extensive development of the first metazoan biota that colonized a wide variety of marine environments ranging from coastal to deep sea settings. Detailed studies based on preservation style and depositional setting of Ediacara fossils-bearing deposits provide significant insight into the paleoecology and life style of these communities. The Nama assemblage constitutes a distinct Ediacara community dominated by underground Vendobionts. In the northern part of Witputs sub-basin (Southern Nambia) and along a N-S transect, combined taphonomic signatures and sedimentological studies of fossiliferous Kliphoek Member (Nama Group) allow constraining the paleoecological setting of *Pteridinium*-

Ernietta-Nemiana assemblage. The Kliphoek Member is a transgressive succession made up of mixed siliciclastic-carbonate deposits. The lower part of the member is dominated by thick-bedded sandstone associations, indicating a braided-fluvial setting in the north that grade southward to wave and storm-dominated foreshore and shoreface environment. The upper part, which encompasses most of the fossiliferous horizons, is made up of mixed siliciclastic-carbonate succession indicating a wave and storm-dominated inner-shelf setting. Several monospecific fossiliferous layers have been identified and are made either by *Pteridinium*, *Ernietta* or *Nemiana*, whereas *Rangea* is rare. The *Pteridinium* and *Ernietta* are preserved both *in situ* and as winnowed assemblage along the transition area from shoreface to inner shelf and in the upper part of inner shelf setting, whereas *Nemiana* is preserved in life-position within the heterolithic facies of distal inner shelf setting. The autochthonous assemblages made up of *Pteridinium* and *Ernietta* occur as single or superimposed growth generation and correlate with quiet-water conditions prevailing during relatively prolonged inter-storm periods. The taphonomic signatures of the winnowed *Pteridinium-Ernietta* assemblages are consistent with physical reworking during high-energy events. Such storm events may cause i) sudden burial of *in-situ* monospecific community, ii) erosion and *in-situ* redeposition of the reworked biota in the proximal inner shelf setting, iii) or in rare case, some elements are transported and redeposited within the distal inner shelf area. The palaeoecological model emphasizes an underground vendobionts community that lived on a fine-grained sandy substrate in a stressed shoreface-inner shelf environment. It formed an infaunal biota engulfed in loose sediment and with vertical upward growth. Growth and distribution of Vendobionts communities appear controlled by palaeoenvironmental factors such us inherited sea floor topography, physical conditions, water depth, nature of substrate and sediment supply. According to their in situ three-dimensional mouldic preservation and their ability to be transported far from their biotope without major deformation, most of the bag-shaped fossils were completely filled in situ by sediment before their final burial.

S17 – A simple microwave extraction method for the isolation and identification of plant opal phytoliths

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Silicon (Si) is the second most abundant element in the earth's crust after oxygen (28 % vs. 47 %). In nature Si exists mostly as silicon dioxide and is available to plants as silicic acid. Large accumulations of Si are found in the Poaceae and Cyperaceae plant families, which have Si contents of > 4 %.

In plant tissues, opal phytoliths form as silicic acid that polymerises to silica gel and finally is deposited in intracellular or extracellular spaces. The amorphous structure ($SiO_2 \bullet nH_2O$) of opal phytoliths results from a biological and physical process that is not yet well understood.

Two principal methods have been developed to extract opal phytoliths: the dry ashing method and the wet oxidation method.

The dry ashing method utilises high temperatures. Plant material is placed in porcelain crucibles in a muffle furnace and heated to 400-800 °C for 2-6 h. Several authors have reported modifications of the structure and surface of opal phytoliths after dry ashing, including changes of the refractive index, shrinkage and warping. The dry ashing method largely changes the physical properties of opal phytoliths.

The wet oxidation method uses a cocktail of different mineral acids to digest the plant material. For example, Schulze's solution is a combination of concentrated nitric acid and potassium chlorate or sodium chlorate, which is added to a boiling water bath for ca. 5 h to break down plant tissues.

Both the dry ashing and wet oxidation methods are widely used for the preparation of reference phytolith collections used for the reconstruction of past environments. These reference phytolith collections are used in palaeo- and archaeobiology to identify and classify plant remains in extant soils.

The use of phytoliths in plant cell physiology research is becoming increasingly popular and the traditional extraction methods are compared and discussed on their different potential by many authors.

To understand the structure, chemical composition and qualitative characteristics of opal phytoliths in detail, morphologically intact phytoliths are needed. Therefore, opal phytoliths must be kept in their original or equivalent solution to preserve their amorphous ($SiO_2 \bullet nH_2O$) molecular structure.

We present a new extraction method, which has high potential to support qualitative analyses of the unaltered properties of single opal phytoliths. Fresh leaf material was heated in distilled water in a kitchen microwave oven for 3-4 hours, stirred and then strained through a plankton sieve (50-µm mesh). After purification, the plant tissue matrix was successfully degraded.

Our new native extraction method does not use acidic chemicals or high temperatures to break down plant tissues. The focus of this research is to separate the plant tissue into small groups of cells and single silicified cells (opal phytoliths). Using our method, the opal phytoliths remain in solution during the whole procedure, which preserves their molecular structure.

S12 – The global Taghanic biocrisis (Givetian) on brachiopods of the Ferques inlier area (Boulonnais-France)

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The Taghanic biocrisis is one of the most important crises of the Devonian stage commonly recognized. Many causes such as eustatic sea-level changes and major global warming have been discussed by different authors.

In the Ardennes the impact of Taghanic biocrisis can be recognised by different fossil groups, such as tabulate corals and ostracods. In Ferques (Boulonnais, N. France), the western prolongation of the Ardennes (Namur Synclinorium), the Taghanic biocrisis are evident in the middle-upper Givetian corresponding to Couderousse- and Bastien members (middle and upper members of the Blacourt Formation).

The Couderousse Member nearly belongs to the Middle-Upper *varcus* Zones. It has yielded the conodont *Polygnathus denisbriceae* Bultynck, 1979, found in the Ardenne (Namur Synclinorium), in the lower part (the base except) of the lower member of the Fromelennes Formation. Between the Couderousse- and Bastien Members faults occur. Above this level, the *subterminus* conodont Zone is recognized in this Bastien Member.

Most authors consider that IIa, the first cycle T-R cycle of Depophase II, was initiated at the base of the middle *varcus* Zone.

Brachiopods are absent from the last fifteen meters of the calcareous Griset Member (lower member of the Blacourt Formation), whereas stromatoporoids and corals (very abundant below in the Griset Member) are absent in the last two meters.

Sediments of the Couderousse Member are composed of bioclastic crinoidal, pyrite-rich limestones (partly nodular) alternating with calcareous claystones.

The lower beds of Couderousse Member are very rich in large shells of brachiopods showing a significant biodiversity: 14 species occur such as spiriferids, atrypids, terebratulids (stringocephalids) suggesting a high-energy environments (Taghanic Onlap). The upper part of the Couderousse Member corresponds to the post Event, as a period of a lower-energy environment, which is characterized by biotic stress and the extinction (Taghanic biocrisis) of 10 species of which *Stringocephalus* is one.

The lower part of the Bastien Member contains bioclastic crinoidal limestones, poor in fossils, yielding only 4 species of brachiopods, fragment of valves, small crinoid ossicles and omphalid gastropods which disappear at the top, which corresponds to another crisis of the polyphased Taghanic Biocrisis.

Some stromatoporoids are present just at the bottom (faulted zone) of the Bastian Member.

As in the Moulin Boreux section in the Ardennes opportunist tabulate corals, scolioporids exclusively, appear in the upper part of the Bastien Member in two beds, one at the base with *Scoliopora* cf. *denticulata* and *Aulopora serpens* and few meters higher with the same species associated with *Roemeria infundibulifera*, reacting to environmental stress.

S7 – Growth styles and their deviations in Larger Benthic Foraminifera evidenced by computed tomography

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X-ray computed tomography is a method of investigation which releases precise measurements of bi- and three-dimensional parameters. Therefore, the use of such instruments is particularly interesting on those taxa characterized by complex morphology and bauplan as larger benthic foraminifera (LBF). The segmentation of the chambers in these taxa revealed interesting results concerning ontogeny, growth and bauplan modification through life time.

It has been found that the volume of the chambers (lumina) in LBF increases following an exponential to logistic function to accommodate cell growth. In details, such sequence of volumes can be very different in apparently similar taxa. In tests characterized by an Archimedean spiral the sequence of volume is rather linear – often leading to some bauplan modifications to accommodate exponential cell growth – , whereas in test with geometric spirals the volume growth follows an exponential function. However, the volume data seem to oscillate constantly around the exponential growth. Oscillations have been found on several individuals of *Cycloclypeus carpenteri* and on more specimens of *Palaeonummulites venosus* and they do correlate with calendar cycles such as monthly or semester cycles; other cycles found on the volumes seems to reflect the rain profile during the year according to locality where the specimens have been collected. The data obtained after segmentation of fossil specimens provide the same spectrum of results. Some taxa, with strict growth geometries, seem to possess a step-wise volume sequence. Other fossil taxa increase the number of their active chambers to accommodate cell growth. Nevertheless, in all investigated specimens growth cycles are evident. Their recognition and correlation with biological evidences and/or with ecological parameters

will be most important to assess evolutionary and environmental variations in the fossil record.

S14 – The influence of sampling on the fossil record of Paleozoic synapsids

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Synapsida dominated the terrestrial realm between the late Pennsylvanian and the Triassic. Their early evolution includes some of the first amniotes to evolve large size, herbivory and macro-carnivory. However, little research has been done either on the changes in diversity occurring in synapsids during this early period in their evolution, nor on the potential effects of anthropogenic sampling bias on their record. Here an assessment is made of synapsid diversity, both at the species and genus level, between the Carboniferous (Moscovian) and the Middle Permian (Capitanian). A raw, taxic diversity (richness) estimate is generated, and two separate methods are used to correct for sampling bias. A recently published modification of the residual diversity method is applied to remove the effect of anthropogenic sampling bias, and a supertree is generated using the matrix representation with parsimony method to infer ghost lineages and obtain a phylogenetic diversity estimate.

Evidence of significant anthropogenic sampling bias may be found in a strong positive correlation between the number of amniote-bearing collections and the taxic diversity of synapsids. The patchiness of the geographic distribution of fossils also highlights the gaps in our knowledge. These facts call into question interpretations of the Permian terrestrial record that have not been corrected for sampling.

The sampling-corrected diversity curves indicate a significant extinction in Synapsida across the Kungurian/Roadian boundary, in which the Edaphosauridae and Ophiacodontidae die out and the Sphenacodontidae experience a large decrease in diversity. However the extinction does not affect all synapsid groups; Therapsida and Caseidae increase in diversity across the boundary. Whilst the uncorrected diversity curve indicates a recovery from the extinction during the remainder of the Roadian, the sampling-corrected diversity curves indicate that diversity remains low. It is concluded that this extinction marks the turnover between the 'pelycosaur'-dominated fauna of the early Permian and the therapsid-dominated fauna of the late Permian.

S26 – Warum Chroniosuchier die Krokodile unter den reptilienartigen Amphibien sind

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Hautknochenplatten (Osteoderme) treten sowohl bei urtümlichen Landwirbeltieren als auch innerhalb der Amnioten in verschiedenen Gruppen konvergent auf. Häufig liegen Reihen von Rückenplatten vor, die in ihrer Anordnung mit den Segmenten der Wirbelsäule korrespondieren, so zum Beispiel bei Vertretern der Dissorophiden, Plagiosaurier, Chroniosuchier, Pareiasaurier, Placodontier und Archosauromorphen.

Lediglich bei manchen Archosauriern der Krokodil-Linie und den Chroniosuchiern, einer Gruppe urtümlicher Amnioten-Verwandter des Perms und der Trias, sind benachbarte Osteoderme durch komplexe Gelenke miteinander verbunden. Morphologische und knochenhistologische Vergleiche, deren Ergebnisse hier vorgestellt werden, legen nahe, dass Chroniosuchier-Rückenpanzer in ihrer Tragefunktion denen der Krokodile glichen und dass ihre Evolution gleichermaßen durch eine zunehmende Flexibilisierung geprägt war. Dieser Trend ist wahrscheinlich auf die Erfordernisse eines semi-aquatischen Lebensstils, besonders die Fähigkeit zum Undulationsschwimmen, zurückzuführen.

Dass Wirken unterschiedlicher Selektionsfaktoren zeigt sich deutlich im morphologisch stark abgeleiteten Osteodermsystem des mittel- bis spättriassischen Chroniosuchiers *Madygenerpeton pustulatus*: Anders als bei gleich alten Formen hat sich gegenüber den permischen Vertretern der Gruppe der Knochenpanzer noch verbreitert und die Flexibilisierung geschieht nicht durch Reduktion, sondern durch Umgestaltung der Gelenke zwischen benachbarten Osteodermen.

Während Vergleiche ausgestorbener Tiergruppen mit Krokodilen meistens auf die Gebissstruktur, Ernährungsweise und die oft ans Wasser gebundene Lebensweise abzielen, so verweist die hier vorgestellte Studie zusätzlich auf Analogien in der Evolution der Hautknochenplattensysteme. Demnach sind Krokodile in mancherlei Hinsicht Chroniosuchier-Nachahmer.

S13 – First definite archosaur from the Triassic of Central Asia

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Alexander G. Sharov described *Longisquama insignis* and *Sharovipteryx mirabilis* from the Triassic Madygen Formation of Kyrgyzstan, Central Asia, as members of the Archosauria, an assignment that has been questioned in several following studies and despite the high publicity of these reptiles their systematic position within Diapsida has not yet been resolved with certainty. No further fossils referable to archosaurs were reported from Madygen until 2007 when the "Chroniosuchid Locality", type locality of the chroniosuchian reptiliomorph *Madygenerpeton pustulatus*, was discovered within fluvial deposits. Probable archosaur remains from this locality are often disarticulated and include cranial elements and teeth as well as postcranial bones.

Here we introduce an almost complete less than 25 cm long hind limb with a crurotarsan ankle and an associated pelvis which signify the presence of pseudosuchian archosaurs in the Madygen Formation. Even though the pelvis has an appearance somewhat reminiscent of basal archosauriforms due to the short and robust rather than long and slender ischium and pubis, it displays several features that suggest an affinity to poposauroid "rauisuchians": ilium with an anterior process which is longer than the posterior process and with an anterodorsally inclined crest dorsal to the supraacetabular rim; distal end of the pubis is anteroposteriorly expanded relative to the shaft and features a long distal margin that accounts for more than one third of the shaft length; distal portion of the pubis is mediolaterally compressed and thinner than the anterior portion; distal portion of the ischium is expanded relative to its shaft.

If our preliminary assignment is confirmed by a more thorough study of the hind limb morphology, the new small archosaur from Central Asia might turn out to be part of the Early to Middle Triassic radiation of the Poposauroidea which also yielded the Chinese forms *Qianosuchus*, *Lotosaurus* and *Xilousuchus*.

S22 – Oligocene macroflora from the inner alpine fandelta of the Häring Formation (Rupelium) of the Duxer Köpfl near Kufstein / Lower Inn Valley (Austria)

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Currently fossil floras from Bad Häring and Duxer Köpfl are the only known macrofloras of an inner alpine fan delta in a Lower Oligocene "piggy-back-basin", from which data for a regional paleoecological and paleoclimatic reconstruction may be gathered. Compared to the collections from Bad Häring the number of fossils from the Duxer Köpfl is lower. These fossils contribute to our understanding of the Lower Oligocene floras of the Western Paratethys realm. The Duxer Köpfl site is located at the Lower Valley of the Inn River, close to Kufstein, at an altitude of 900 m above sea level. Sedimentological and biostratigraphic studies indicate an early Rupelium age (NP 23-24). Paleogene transgression and sedimentation starts with a basal conglomerate (Lengerer Member) above Triassic strata, and interfingers with bituminous marls and a 60 cm thick bed of anthracitic coal of the Bergpeterl Member from where the plant imprints derived. The flora of the Duxer Köpfl comprises laurophyllous evergreen elements, as well as several deciduous genera, such as *Comptonia*, *Fraxinus*, *Cedrelospermum* and *Ulmus*. The following taxa have been distinguished: *Pseudotsuga maegdefrauii* sp. nov. with winged seed, *Pinus palaeostrobus*, *Tetraclinis brachyodon*, *Rhodomyrtophyllum reticulosum*, *Cedrelospermum flichei*, *Myrica longifolia*, *Myrica lignitum*, *Comptonia schrankii*, *Engelhardia orsbergensis*, *Platanus neptuni*, *Ulmus fischeri*, samaras of *Fraxinus* sp., *Daphnogene cinnamomifolia*, f. *lanceolata*, *Laurophyllum pseudoprinceps*, *Dryophyllum callicomifolium*, *Eotrigonobalanus furcinervis*, *Leguminosites*, a stigma of *Nymphaea haeringiana* comb. nov. and rhizomes of *Nymphaea arethusae*. Fossil material previously assigned to two genera *Palaeolobium* or *Anoectomeria* is emended to *Nymphaea haeringiana* sp. nov. The taxa of the Duxer Köpfl flora are also found in floral communities of similar age (lower to middle Rupelium or Kiscellium) of the central and southern Paratethys: Slovenia (Sotzka, Novi Dol), Hungary (floral community Kiscell), Romania (Cornești-Aghireș) and Bulgaria (Rhodopes). There is also similarity with Early Oligocene mediterranean floras of southeast France (Manosque, Cereste, Dauphine), Italy (Santa Giustina, Sassello), Spain (Bagnasco, Cervera) and the Balearic Islands (Peguera, Izarra). Characteristic for such floras are the genera *Tetraclinis*, *Ziziphus*, *Dryophyllum*, *Eotrigonobalanus*, *Myrica*, *Engelhardia*, *Comptonia*, *Daphnogene*, *Cedrelospermum*, and rarely *Rhodomyrtophyllum* and *Platanus neptuni*. The vegetation consists of partly evergreen, nanophyllous forests, which are comparable to Chinese or North American "Mixed Mesophytic Forests" and indicate dry seasons.

S15 – Paleoecology and biogeography of the vertebrate fauna of the Morrison Formation, Late Jurassic, western United States

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The Morrison Formation remains the most richly sampled Late Jurassic terrestrial ecosystem in the world, having provided a wealth of fossil material documenting all major vertebrate clades. These fossils frequently derive from bonebed deposits, but even these vary in nature from catastrophic death assemblages to attritional microfossil accumulations. The result is a diversity of taphonomic and paleoecological perspectives on this geographically widespread formation.

Paleoecologically, Morrison vertebrate faunas show broad compositional similarities to those of most well-sampled post-Triassic terrestrial deposits, in which aquatic and semi-aquatic taxa tend to dominate in both diversities and sampled abundances. Dinosaurs represent from 25-35% of taxa by either measure; mammals can be quite diverse but are almost always rare; crocodylians and turtles tend to be less diverse but more common than either group. These latter groups may have represented important ecological links between terrestrial and aquatic systems throughout much of the Mesozoic, although the two systems are often treated as distinct.

The paleobiogeography of the Morrison Formation reveals intraformational variations within an otherwise broadly characteristic vertebrate fauna that may relate to regional climatic and environmental variations. Comparisons with coeval faunas elsewhere also show varying degrees and types of similarities, but few of these can yet be tied explicitly (or exclusively) to the breakup of Pangaea. These suggest that global paleobiogeographic patterns may have a complex relationship with organismal phylogenetic histories, large-scale climatic and physiographic influences, and regional extinctions.

Substantial improvements in the sampling of other Late Jurassic formations will be required to better appreciate these patterns on a global scale, and to diminish the disproportionate importance that the Morrison Formation has held. In addition, the present necessity of utilizing particular sampling units (such as formations) must eventually yield to site-by-site analysis if the true complexities of the Late Jurassic world are to be more fully analyzed and understood.

S12 – The Devonian trilobites of Brazil: a review

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The vast Brazilian territory has four large intracratonic basins, each containing a considerable thickness of Palaeozoic sediments: the Amazon, Solimões (formerly Upper Amazon), Parnaíba, and Paraná basins. The Amazon and Solimões basins are located in Northern Brazil, the Parnaíba Basin is North/Northeastern, and the Paraná Basin is in the Southeast/South. Devonian trilobites are documented in three basins (to exclude Solimões) and include representatives of the families Homalonotidae, Dalmanitidae and Calmoniidae. The Calmoniidae is considered to be endemic to the marine cold-water, southern hemisphere Malvinokaffric Realm. The other families are more cosmopolitan, although some endemism is evident at genus or species level among their representatives from Brazil. The systematic and biogeographical relationships of the Lower and Middle Devonian (Pragian-Givetian) trilobite assemblages from these three basins are reviewed, based on the literature and original research. A table summarizing the distribution of trilobites in the Devonian of Brazil is presented, and some biogeographical considerations are discussed. Despite being partly contemporaneous, the trilobites within each of the Brazilian intracratonic basins show some endemism and have different biogeographical affinities.

S8 – 'Orsten'-type preservation: case study of the Swedish 'Orsten' Lagerstätten

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The Cambrian Alum Shale succession of Scandinavia is dominated by blackish mudstone and shale deposits. This condensed succession encloses, in its youngest series, numerous early diagenetically-formed limestone concretions locally called 'Orsten'. Etching such 'Orsten' nodules from different times yielded a set of assemblages of three-dimensionally preserved, secondarily phosphatized, 0.1 to 2 mm long microfossils, mainly arthropods. Of these arthropods, virtually all body parts, e.g. eyes, appendages, and surface details, such as mouth and anus, setae, pores and sensilla, are present in their original topology. Internal structures are rarely preserved and their interpretation is often more equivocal. 'Orsten'-type fossils result from an early incrustation and/or impregnation of the cuticle in the case of arthropods, by calcium phosphate. Usually the epicuticle layer was replaced by phosphate, but also additional thin coatings of phosphate may occur. Again, the surface may be partially covered with microcrystals of pyrite and calcite leaving small ridges after etching. Subsequent embedding in a fine limestone matrix, the future limestone nodule, prevented the fossils from any compaction and deformation. The nodules were probably formed a few metres below the water-sediment interface and grew by cement filling of the host-sediment porosity before compaction of the shales. Replication and authigenic mineralization of soft parts is assumed to have been the result of a complex interaction be-

tween abiotic and biotic factors acting at the microscale level, in which microbial activity of bacteria may have played a key role. In the case of the Swedish 'Orsten', the presence and influence of bacteria could not be demonstrated so far and remain unclear. Size limitation and overall rareness of the 'Orsten' microfossils suggests that they did not form under widespread phosphate-rich conditions. Etching residues include a high amount of fecal pellets. Organisms preserved in 'Orsten'-type preservation were phosphatised during an early diagenetic stage before extensive decay occurred, owing to the high local phosphorus levels of the accumulated fecal pellets (high bitumen content of shales and nodules). Slight variation in community structure between the rock samples suggest that phosphatisation of the dead carcasses probably did not occur in situ. The 'Orsten' assemblages represent a thanatocoenosis (i.e., a death assemblage) with possibly a mixture of autochthonous and allochthonous organisms, yet owing to the overall good quality of preservation transportation did not play a major role in the observed community composition. We review the current knowledge about the alum shales, 'Orsten' preservation and taphonomic aspects and discuss it against our observation on the large material at hand.

S8 – The Swedish 'Orsten'-type Lagerstätte: a window into the Cambrian alum shale ecosystem

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The late Cambrian Alum Shale Formation of Scandinavia consists of a condensed succession of dark, organic-rich, finely laminated shales with intercalated beds and limestone concretions. These shales were deposited possibly across a broad, poorly oxygenated, sediment-starved and sulphur-rich epicontinental sea of shallow depth. The shale deposits are highly fossiliferous and have yielded mostly polymerid and agnostoid euarthropods. With the discovery of the 'Orsten'-type fossils etched from the limestone nodules our view of the benthic faunal communities of the Alum Shale Sea have changed tremendously. The 'Orsten' nodules yielded, in addition to numerous conodonts, diversified exceptionally 3D-preserved assemblages of 0.1 to 2 mm sized secondarily phosphatized arthropods. Assignable fossil taxa comprise lobopods, pentastomids, chelicerates, and crustaceans. Many of these were originally representatives of the so-called meiofauna, a size-defined community of tiny animals living, temporarily or not, on and within a nutrient-rich flocculent bottom layer. Recent re-investigations of the large material of 'Orsten' fossils revealed the presence of much more complex and diversified biocommunities than known so far, not least because the focus was almost exclusively on arthropods. New faunal elements comprise four sponge taxa including three hexactinellids and one possible stem sponge taxon. The material includes also a few small shelly fossils identified as hyoliths, tomotiids (*Lapworthella* sp.?), putative monoplacophoran molluscs, and organo-phosphatic shells of linguliform brachiopods, which are quite common but mostly occur as fragments making their precise identification difficult. Along these new faunistic elements, also various fragments of unknown affinities occur throughout the Alum Shale succession. These problematica consist of ornamented plates, sclerites and tube- to cone-like structures, known mostly only by a few specimens, representing an additional faunistic pool of more than 15 taxa. Also non-animal material could be identified in the form of cyanobacteria. Additionally, fragments of previously unknown cuticle-bearing animal taxa round up the search for new material, such as new crustacean larvae and a set of, at least, four worm-shaped forms. Apparently the Alum Shale biota was highly diversified and reached, at least, a comparable species richness as that of the other major Cambrian Lagerstätten. With the new finds and the discovery of meio- and macrofaunal components, the 'Orsten'-type assemblages from the nodules provide a reliable and complete view of the original ecosystem of the Alum Shale sea in the late Cambrian period. The presence of rich benthic faunas suggests that the water of the Alum Shale Sea was not anoxic and that the bottom may have been firm enough to allow colonization also by sessile organisms, but restricted spatially and temporarily. The complexity of the Alum Shale biota indicates that much of the structure of modern marine ecosystems with hierarchical level of the food web was already established by the Cambrian.

S24 – Taphonomic and palaeoenvironmental studies of the Upper Kimmeridgian Wattendorf Plattenkalk of Upper Franconia (Southern Germany)

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Plattenkalks represent one of the most celebrated types of fossil Lagerstätten, exhibiting a unique quality of fossil preservation. This preservation requires special environmental conditions, which are often obscured by the lack of sedimentary structures in the respective strata. To unlock

the palaeoenvironmental data hidden in these sedimentary bodies, an array of taphonomical, palaeoecological and geochemical analyses can be utilised. The Wattendorf Plattenkalk, the oldest of the Solnhofen-type plattenkalks of Southern Germany, allows qualitative as well as quantitative taphonomic investigations, because every bedding plane of the 20 cm thick plattenkalk-unit has been equally thoroughly searched for fossils over a time span of nine years. For performing quantitative taphonomic analyses, hierarchically arranged, comparable taphonomic features have to be processed. Taphonomic features utilized were bending of the spinal column, dissociation of articulated extremities from the trunk and overall skeletal articulation. By clustering combinations of these different biostratinomic features in fossil fishes, primarily of the genus *Tharsis*, per layer four different taphofacies were established.

By this method, four distinct taphofacies could be deduced (taphofacies A to D). These taphofacies indicate four energy regimes represented in the depositional environment of the Wattendorf Plattenkalk. The transition from taphofacies A to taphofacies D seems to mark a development from only slight environmental disturbance to conditions of higher disturbance affecting the fish carcasses.

With regard to qualitative taphonomy, the Wattendorf Plattenkalk has yielded three distinct modes of soft tissue preservation. In some fish fossils, phosphatization of connective tissues can be observed. Besides this phosphatic permineralization, there is also evidence of primary preservation of soft tissues through pyritization. These tissues eventually have been hydratized to goethite, similar to the preservation of soft tissues exhibited by some fossils from the Early Cretaceous Crato Formation of Brazil. The third type of soft tissue preservation is impregnation of internal voids in bones left by osteocytes and blood vessels, by iron minerals.

Palaeoecological data obtained from a nearby coral patch-reef, as well as $\delta^{18}O$-data from brachiopod shells point at sea-surface palaeo-temperatures of around 23°C.

A combination of these results allows the reconstruction of a depositional environment that exhibited stable environmental conditions at the beginning of the plattenkalk deposition. Towards the end, in contrast, conditions started to fluctuate strongly. These strong perturbations were induced by bottom-water currents and mixing of the water body, perhaps initiated by strong storms in a restricted basin with subtropical to tropical water temperatures.

S16 – Sauropods from head to tail – how did they work?

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Sauropod dinosaurs were the largest terrestrial animals ever, reaching body masses up to at least 80 metric tons thereby surpassing the largest non-sauropod vertebrates by an order of magnitude. The extreme body size of sauropods has fascinated scientists of different disciplines, and a variety of arguments has been put forward in order to explain sauropod gigantism. Apparently, extrinsic causes like the oxygen level or resource availability are not suitable for explaining sauropod gigantism, because no evidence can be found for especially favorable conditions in the Mesozoic. Therefore, the explanation for sauropod gigantism has to be found in their biology. However, no explanation that focuses on a single trait is convincing.

During the recent years, not least through the efforts of the DFG-funded Research Unit 533, it has become evident that sauropod gigantism resulted from a specific combination of characters, so that different constraints limiting the body size in other lineages of terrestrial vertebrates were circumvented. Some of these characters like the lack of mastication and egg-laying are plesiomorphic (due to phylogenetic heritage), others can be regarded as a cascade of key innovations, like a high metabolic rate, an avian-style respiratory system and the long neck. The unique bauplan of sauropods with the usually extremely long neck allowed exploiting resources efficiently, so that a very large body could be supplied with sufficient energy even with a comparatively high metabolic rate.

S22 – Ecological and ecophysiological aspects of the Cretaceous monocotyledon evolution

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The lower Cretaceous angiosperm macrofossil record already includes the three major groups of angiosperms i.e. ANITA (*Pluricarpellatia*, *Scutifolium*), Magnoliids (e.g. *Archaeanthus*, *Endressinia*, *Araripia*) and Eudicots (*Sapindopsis*). However, monocots, which constitute about one-fourth of the living angiosperms, are very scarce in Lower Cretaceous strata. These remains are partly equivocal, especially the pollen and several leaf taxa. An exception are charcoalified flowers with *in-situ* pollens that belong most likely to the Araceae, and possibly the dispersed leaf *Acaciaephyllum* and a few additional fossils. The monocot fossil record remains meager at least until the Turonian with the appearance of Arecaceae and Pandanaceae.

This stratigraphic distribution of fossils may erronously lead to the conclusion that monocots diversified mostly during the Late Cretaceous. However, monocots were already ecologically diverse during the early Cretaceous, but trees, especially palms, were still missing and these are besides aquatics most prone to fossilisation.

Therefore the Cretaceous fossil record seems to mirror, besides the true diversification pattern, a taphonomic bias. New fossils from the low latitudes, a region that had been clearly underrepresented, is beginning to shed new light on early monocot evolution. These new taxa are anatomically preserved and thus allow interpretations on their ecology and habitat.

Plenary – Mass extinctions, missing links and other evolutionary myths

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Good heavens! Your speaker doesn't believe in giant impacts, massive volcanism, stupendous tsunamis, bits of dismembered dinosaur flying through the air? He denies missing links? No *Acanthostega*, *Archaeopteryx*, *Ardipithecus*? Of course not. By evolutionary myths I mean areas of received wisdom that are over-due for scrutiny, demolishing comfort zones and perhaps revitalizing the discipline. Mass extinctions? Of course they happen. But what is their real significance? Missing links? All in favour, but maybe their real importance lies in a different direction? And there are plenty more evolutionary myths; those of randomness, deep homology "well, it will do". And then there is the big one, mind and consciousness. Plenty to talk about.

S15 – Freshwater hybodont sharks from the Late Jurassic – Early Cretaceous of northeastern Thailand: stratigraphical and palaeobiogeographical implications

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The discovery of a new site in Kalasin Province, Phu Noi, has significantly increased our knowledge of the hybodont sharks from the Phu Kradung Formation, which now include the following taxa: *Hybodus* sp., aff. *Hybodus* sp., *Acrodus* nov. sp., *Jiaodontus* sp., *Lonchidion* sp. A and B and *Heteroptychodus* cf. H. *kokutensis*, as well as dorsal finspines and two morphotypes of dermal denticles. This represents the youngest occurrence of the genus *Acrodus*, and together with the presence of *Jaiodontus* and of dermal denticles of an unusual morphotype restricted to the Jurassic of southern Thailand, it suggests a Late Jurassic age for most of the Phu Kradung Formation, whereas the presence of *Heteroptychodus* suggests an Early Cretaceous age for the top of the Formation. As it is the oldest occurrence of the latter genus, it also suggests a Thai origin for *Heteroptychodus*, which may have replaced *Acrodus* in the Thai freshwater palaeoecosystems. However, the age of the Phu Kradung Formation is still uncertain, with contradictory signals coming from palynology and detrital zircon thermochronology, which suggest a Cretaceous age, whereas the vertebrate fossils are more in favour of a Jurassic age. From a palaeobiogeographical point of view, the shark assemblages from the Phu Kradung Formation appear to share both European, with *Acrodus* nov. sp. and *Lonchidion* sp. A, and Asian, with *Jaiodontus* sp., affinities. Except perhaps for *Heteroptychodus* at that time, there are no endemic hybodont genera in Thailand, contrary to what has been observed later in the Early Cretaceous, when the level of endemicity at genus level is much higher with two endemic genera, *Isanodus* and *Mukdahanodus*, in the Barremian Sao Khua Formation, and two genera, *Acrorhizodus* and *Khoratodus*, in the Aptian Khok Kruat Formation. During the Early Cretaceous, *Heteroptychodus* expanded its geographical distribution from Thailand to Japan, Kyrgyzstan, South China and Mongolia.

S14 – *Solenodonsaurus janenschi* and the origin of amniotes

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Solenodonsaurus janenschi Broili, 1924, is a basal tetrapod that is only known from the Late Carboniferous (Westphalian D) Gaskohle of Nýřany, Czech Republic. This taxon has played an important role during the last century in discussions about the origin of amniotes, and its phylogenetic position has been controversial. Furthermore, previous studies did not ascertain if the differently sized skeletons ascribed to *S. janenschi* represent a partial growth series or different taxa. In the present study, all the known specimens of *S. janenschi* are redescribed and

the phylogenetic position reevaluated. A broad, vertical groove at the base of the maxillary teeth is regarded as an autapomorphic character, which is present in both the large and small specimens of S. janenschi. Other characteristic features, which are not unique to *S. janenschi*, are: an extension of the lacrimal that forms the anteroventral margin of the orbit; a long posterior extension of the jugal; long, curved ribs without uncinate processes; spool-shaped vertebrae, and small, wedge-like intercentra. The small specimen shows juvenile characters in the skull (neurocranium unossified), the vertebral column (poorly ossified centra) and the humerus (undifferentiated morphology). The new morphological characters of *S. janenschi* based on our examination were added to the data matrix of Ruta, Coates and Quicke. The phylogenetic analysis suggests that *S. janenschi* is not a basal amniote, but lies on the amniote stem and turns out to be the sister taxon of the Lepospondyli. Shared characters with Lepospondyli include the shape of the vertebrae, nonswollen neural arches, and the absence of an intertemporal. However, the mode of vertebral ontogeny differs between *S. janenschi* and lepospondyls and is more plesiomorphic in the former: whereas the vertebral centra ossified concomitantly with the neural arches in lepospondyls, their ossification was delayed with respect to the neural arches in *S. janenschi*. On the basis of the morphological results, some implications concerning life-style and palaeobiology of *S. janenschi* can be drawn. A rather long humerus with a slender shaft argues for a predominantly terrestrial mode of life. The curved, slender ribs, as well as the comparatively small skull, suggest costal ventilation of the lungs similar to that in amniotes, rather than buccal pumping. The squamosal of *S. janenschi* bears a flat, curved crest that extends along the margin of the shallow squamosal embayment. The morphology of this embayment in which an ossified dorsal margin is absent, renders the presence of a tympanum unlikely.

S3 – Molecular paleobiology of early-branching animals: integrating DNA and fossils elucidates the evolutionary history of hexactinellid sponges

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Reconciliation of palaeontological and molecular phylogenetic evidence holds great promise for a better understanding of the temporal succession of cladogenesis and character evolution, especially for taxa with a fragmentary fossil record and uncertain classification. In zoology, studies of this kind have largely been restricted to Bilateria. Hexactinellids (glass sponges) readily lend themselves to test such an approach for early-branching (non-bilaterian) animals: they have a long and rich fossil record, but for certain taxa palaeontological evidence is still scarce or ambiguous. Furthermore, there is a lack of consensus for taxonomic interpretations, and discrepancies exist between neontological and palaeontological classification systems. Using conservative fossil calibration constraints and the largest molecular phylogenetic dataset assembled for this group, we infer divergence times of crown-group Hexactinellida in a Bayesian relaxed molecular clock framework. With some notable exceptions, our results are largely congruent with interpretations of the hexactinellid fossil record, but also indicate long periods of undocumented evolution for several groups. However, new findings successively close these gaps in the fossil record. For example, new findings of *Hyalonema* spp. from the Coniacian extend the Late Cretaceous record of this taxon from c. 80 MY (Late Campanian) to c. 88 MY (Coniacian) (D. Janussen, oral presentation, this conference). This study illustrates the potential of an integrated molecular/palaeobiological approach to reconstructing the evolution of challenging groups of organisms.

S2 – Biodiversity of benthic foraminifera on the shelf and slope of the NE-Atlantic

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The diversity and distribution of benthic foraminiferal species on the shelf and slope of the northeastern Atlantic was assessed from 40 publications going back to 1913. A precondition for any biodiversity determination is a standardised taxonomy. Therefore, we compiled a synonymy matrix from published species lists. Foraminiferal occurrence and abundance data as well as supplementary, hydrographical and sedimentological parameters were also included. Because of the different geomorphological,

physical and hydrographic conditions in the study region, it was subdivided in six areas (A-F) according to their species inventory. The investigation of 2837 stations revealed a total number of 1087 species, with a synonymy rate of 25 % among them. The high degree of synonymy primarily arose from different taxonomic concepts, and methods of sampling and preparation among the authors. In addition, the data availability and completeness have been identified as main obstacles for a sound diversity analysis. Quantitative analyses of living benthic foraminifera revealed an inter-regional diversity pattern. All six areas were characterized by an increase of diversity, expressed by the Fisher-α-index, from the shelf to the slope. The areas also depict increasing species richness from N to S. Furthermore, two mid-slope diversity maxima were found in the study area, one on the Basque continental margin and the other to the West of Ireland. The determination of latitude and depth distribution of six common species exhibits an irregular, "oak-leaf like" distribution pattern for the shelf areas. At the time being, it is difficult to judge whether this pattern reflects the real distribution or if it is inferred by the inhomogeneous sample coverage. However, available data display similar distribution patterns of all six species on the continental slope, despite of different modes of life as well as food and substrate preferences. This infers that these species have the same ecohabitat on both, shelf and slope. A comparison of the different areas with reference to their faunal assemblages displayed close linkages despite of different hydrographical, sedimentological and geomorphological boundary conditions.

S25 – Morphologische Diversität und dynamische Umweltbedingungen am Beispiel von Ammoniten der frühen Kreide

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Diese Arbeit ist eingebunden in das DFG-Projekt „Palaeobiology, morphology and diversity of macrofaunas: A case study on Early Cretaceous ammonites", innerhalb dessen die Palökologie eines abgeschnürten Teils der Niedersächsischen Bucht in der frühen Kreide anhand von Ablagerungen nahe Ahaus-Alstätte in Westfalen rekonstruiert wird. Mit Hilfe von sedimentologischen, geochemischen und paläontologischen Untersuchungen sollen die Bedingungen des Ablagerungsraumes bestimmt werden.

Der temporäre Abbau in einer neuen Tongrube durch die "Entsorgungsgesellschaft Münsterland" bietet aufgrund der sehr guten Erhaltung von benthischen sowie planktischen Foraminiferen und kalkigem Nannoplankton die besten Voraussetzungen für eine Rekonstruktion. Neben den sehr gut erhaltenen Mikro- und Nannofossilien führen die Schichten auch eine Vielzahl sehr gut erhaltener Invertebraten, darunter sind Ammoniten der Gattung *Deshayesites* am häufigsten.

Da Mikrofossilien auf dynamische Umweltbedingungen mit Veränderungen in Morphologie und Diversität reagieren, liegt der Schluss nahe, dass solche Veränderungen auch an den Makrofossilien zu erkennen sind. Um diese Hypothese zu stützen ist es notwendig die folgenden Fragen mit Hilfe der zu erhebenden Daten zu beantworten:

1) Welches sind die morphologischen Eigenschaften der Ammoniten?

2) Besteht die Möglichkeit anhand dieser Eigenschaften statistisch belegte Gruppen zu bilden?

3) Wie ist die Diversität der vorliegenden Ammoniten?

4) Welche ökologischen Bedingungen haben geherrscht?

Die erforderlichen Untersuchungen zur Beantwortung der Fragen nach Morphologie und Diversität erfolgen zunächst auf klassische Weise mit Schieblehre und Maßband. Für weitere und detailliertere Untersuchungen beziehungsweise zur Untersuchung von Werten, die mit der Schieblehre nicht erfassbar sind, wird ein 3D-Laserscanner zur Verfügung stehen.

Ob die vermessenen Individuen aufgrund ihrer morphologischen Eigenschaften in Gruppen zusammenfassen lassen, kann mittels verschiedener statistischer Verfahren untersucht werden. So bildet beispielsweise die Clusteranalyse eine Möglichkeit zur Gruppierung der Ammoniten aufgrund ihrer Ähnlichkeiten.

Im Anschluss lassen sich die Ergebnisse der Ammonitenuntersuchung in die palökologischen Untersuchungen der Sedimentologie, Geochemie und Biostratigraphie des Profils integrieren, so dass die Umweltbedingungen dieser Ammonitenassoziation bestimmt werden können.

In weiteren Studien lässt sich dann eventuell klären, ob neben den Mikrofossilien auch Makrofossilien, wie Ammoniten, besser als Proxies für Umweltbedingungen genutzt werden können.

S18 – Mites in amber

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Mites (Acari) are relatively rare as fossils, and their small size coupled with a complex higher systematics have hindered extensive study. Current research usually recognises two major clades – Parasitiformes and Acariformes – whereby some authors even question whether mites are monophyletic. Irrespective of this, the two lin-

eages have very different fossil records. Parasitiformes (i.e. predatory mites and ticks) are represented by only 15 fossil species, known from the Cretaceous onwards. Acariformes (all other mites) are represented by 290 fossil species, including numerous living taxa found as subfossils, with records going back to the Devonian. In both cases the bulk of the dataset derives from inclusions in amber. Recent advances in the study of mites in amber are summarised, including the first formal records of groups such as Uropodina and Labidostomatida. Computed micro tomography is likely to be a key methodology in future, and an example of its application to a tiny, phoretic mite belonging to the Astigmata clade is presented.

S9 – Computational Fluid Dynamics as a tool to investigate the hydrodynamics of irregular sea urchin tests

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Irregular sea urchins are well known from recent as well as fossil settings. Many of these echinoids, which are either in- or epifaunal, have a characteristic flattened test. Studies investigating the hydrodynamics of these sand dollars have indicated that their flat morphologies prevent the sea urchins from being lifted off the sea floor when flow velocities increase. Some species of irregular echinoids, including *Mellita quinquiesperforata* (Leske, 1778), show typical slit like openings. These lunules might additionally contribute to a decrease in lift by reducing the pressure gradient between upper and lower surface of the test. Other sand dollars, like *Dendraster excentricus* (Eschscholtz, 1831), are known to form large clusters on the sea floor. This echinoid is unique in its feeding behaviour when experiencing special flow velocities: it uprights itself parallel to the current with the anterior part of the test buried in the sand to capture plankton particles passing the oral surface. The presented study investigates the hydrodynamic properties of the recent sand dollars *Mellita quinquiesperforata* and *Dendraster excentricus* using Computational Fluid Dynamics (CFD). For the analyses, 3D surface models of both echinoids were created with the NextEngine™ laser scanner and transferred into the CFD software package CFX of the ANSYS Academic Research Release 13. The results of this study can contribute to our understanding of the palaeoecology of irregular sea urchins as well as to the formation of mass accumulations of sand dollars which also commonly occur in the fossil record.

S12 – Microfacies and development of the Devonian reef at Ain Jemaa (Moroccan Meseta)

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The Middle and Upper Devonian (Givetian-Frasnian) is distinguished globally by a maximum development of large reef complexes. They show a highly variable palaeoecology, with different main reef builders (stromatoporoids, tabulate and rugose corals, calcareous algae, bryozoans) in different regions. They can be developed as large bioherms, consisting of an initial bank facies growing into differentiated reef, slope and platform realms, as in the eastern Rhenish Slate Mountains, as smaller-scale atolls sitting on volcanic buildups, as biostromes, as in the Eifel area, or as mudmounds. Based on their rather southern palaeolatitudinal position on the shelf of Gondwana, outside the central tropical belt, the poorly investigated reefal limestones of the Moroccan Meseta are of particular importance for Palaeozoic reef studies in a palaeoclimatic context. A facies comparison of reefs of the southern (Hercynian Morocco) and northern (Rhenohercynian Zone) external Variscides, across the at least 3000 km wide western Prototethys, is conducted in the frame of a current DFG project.

In the western Moroccan Meseta, large Givetian carbonate platforms extended from the Atlantic Ocean (Coastal Block) to the Oulmes area. At first focus lies on the reefal complex of Ain Jemaa, at the eastern end of this belt. The reef is represented by 130 m of massive limestones, which comprise the time interval from the Lower Givetian to the upper part of the Lower Frasnian (*Palmatholepis transitans* Zone). Detailed studies (bed-by-bed) of micro- and macrofacies allow to reconstruct the reef building processes and to establish ca. twenty different microfacies types/subtypes.

Above upper Eifelian nodular limestones (“griotte”), the initial phase of the reefal complex is composed of massive crinoidal limestones with only a few brachiopods, followed by a well-bedded biostrome facies with tabulate corals (alveolitids and favositids) and laminar stromatoporoids (e.g. brachiopod-stromatopore floatstones). Rugose corals are relatively rare and there was some influx of open-water organisms (conodonts, gastropods). Subsequently, a low-relief bioherm developed, with a continuing crinoidal content. There was a slight zonation with fore reef (reef breccias), reef core (with large bulbous stromatoporoids) and back reef facies sets (e.g., *Amphipora*-*Stachyodes* and *Thamnopora*-rich floatstones). The main reef builders are the tabulate corals and bulbous and branching stromatoporoids; rugose corals remained uncommon.

Crinoidal limestones mark the top of the reefal complex and indicate, together with the onset of rich conodont faunas, an increasing open marine influence, followed by the final rapid reef extinction by drowning. The overlying Middle and Upper Frasnian consist of dark-grey (hypoxic) basinal marls and shales with some trilobites, goniatites, and dacryoconarids.

S25 – An unexpected 'window' into the Mesozoic of the North Sea and adjacent areas – palynomorphs and charcoal from a sandstone pebble of Quaternary glacial deposits

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Many parts of Northern and Central Europe are dominated by glacial sediments deposited during Quaternary glaciations. These sediments do not only provide a wealth of information about the glaciation history but, especially in the case of very coarse-grained sediments (e.g. moraines, eskers), these sediments may also provide information about the geology of the source region from which the clastic components are derived. In rare cases, such coarse glacial deposits, but also 'coarse-grained' fluvial sediments such as conglomerates, may act as small palaeontological 'windows' revealing new and/or additional information about much older palaeobiota/sediments otherwise not preserved or (easily) accessible.

We provide an overview of the fossil content (palynomorphs and charcoal) from a pebble of calcareous sandstone from the bottom of the North Sea, which comes from Quaternary glacial deposits located ca. 80 km SW of the Dogger Bank (in a graben called "Silver Pit"). This pebble provides an unexpected 'window' into the Mesozoic (Late Jurassic), adding support to previous palaeoenvironmental and palaeoclimatic interpretations for this period in the region of the North Sea and adjacent areas.

The taxonomic composition of the palynoflora points to a Late Jurassic (or Late Jurassic/Early Cretaceous) age of the sandstone. The probably coniferous charcoal is interpreted as direct evidence of a wildfire occurring during this period in the source area of the sediments of this particular sandstone. This finding, together with already published data on Mesozoic deposits, allows concluding that wildfires were obviously widespread during this period in the area of the modern day North Sea and adjacent areas.

S11 – Cambrian successions of the east Mediterranean Gondwana: multidisciplinary study with palaeoecologic and palaeogeographic focus

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The global evolutionary changeover in the Ediacaran-Cambrian interval has lasted approximately until early Cambrian Series 3 and was significantly triggered by changing environmental conditions and biological innovations. At Cambrian Series 2–3 transition, most of eco-space in the shallow-marine and in the continental-to-marine transitional zones was already occupied by metazoans, indicating their potential for and speed of adaption. Several Perigondwanan regions have been investigated in the eastern Mediterranean by combined palaeontological, ichnological, sedimentological, heavy-mineral, and geochronological methods, to get data for stratigraphy, palaeo-environmental characterization and palaeo-ecological conclusions.

An extensive number of trilobites, brachiopods and hyolites from carbonate successions of Turkey, Jordan, and Israel indicate shallow-shelf fully-marine habitats, temporary influenced by storms. Related microfauna is sessil-epibenthic, suspension/deposit feeding (poriferids, echinoderms, chancelloriids, helcionellids, hyolithelminths, bradoriids, problematica). The fauna indicates typical low-latitude habitats around the *Ovatoryctocara granulata* biostratigraphic level with palaeogeographic relations to Morocco, Spain, Iran, and Australia.

Trace fossils have been found from siliciclastic equivalent strata. In Jordan, they are of moderate diversity and coeval to skeletal fossils and indicate environments related to tidal-bar complexes and deltaic areas. Ichno-assemblages from Egypt and Libya are of distinctly less diversity and interpreted as more proximal, but, coeval to Jordan. They indicate short transgressive pulses into fluvial environments. So, a biostratigraphic correlation is possible from the Middle East to central-north Africa. Somewhat younger, unusual arthropod trace fossil assemblages discovered upsection (Jordan) represent marginal-continental habitats.

Heavy minerals from the Middle East are of Ediacaran age and indicate a domination of local sources, but some material derived from the Saharan Metacraton, too. Comparable rocks in central-north Africa have similar geo-

chronological age. Their provenance region is the Trans-Saharan Belt, but some relation to the West-African Craton is significant. So, the Middle East region and the central-north Africa region have been situated in distant areas on the same shelf during the Cambrian.

Central-north Africa represents rather proximal, fluvial conditions in the Cambrian. In the Middle East a short-lived sub-equatorial carbonate platform, overlain by deltaic and subsequent fluvial siliciclastics has developed.

Summarizing, palaeontological data, sedimentary patterns, and data from heavy minerals indicate that no deposition has taken place in the working area during the Fortunean at least. If the first sediments are stage 2 and/or stage 3 in age is hard to stress because of their continental nature. A short marine phase and incursions around stages 2-3 boundary led to immediate installation of complex ecosystems in the shallow marine realm, but also to colonization of the continental transitional zone. Metazoa of this age have been able to colonize such "non-marine" habitats quickly, which indicates their ability to extended ecospace utilization due to progressed bio-innovations and palaeo-ecological adaptions. Marginal-continental environments must *have provided significant advantages for living already in the mid-Cambrian. Reduced ecologic pressure compared to the well populated shallow marine realm with its already complex trophic relations may be a plausible conclusion.*

S17 – A 3D-model of the dentition of *Darwinius masillae*

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Darwinius masillae from the Eocene of Messel represents one of the most complete skeletons of a Paleogene primate. The juvenile individual with deciduous and partial permanent dentition is preserved on two slabs of artifical matrix. While the skeleton has been largely compressed, flattened or deformed by taphonomic processes, the teeth maintained their original shape due to their hardness. This makes the teeth in particular valuable for comparative investigations concerning the classification of the fossil and functional morphology of the teeth itself. A previous study based on µCT-scanning showed that some of the teeth are entirely hidden due to the fact that they were not erupted during lifetime or because of the process of fossilization. All erupted teeth are only visible from lateral view; their occlusal surfaces are hidden by bone, artifical matrix or their antagonists. Since the occlusal surfaces of the teeth are most significant, it was the aim of this study to reconstruct all of them virtually by µCT-scanning. Due to the size proportions of the plate vs. teeth, the resolution and signal-to-noise-ratio of the accomplished µCT-scans was relatively low, although a special ROI-CT algorithm (for huge sample volumes vs. small details) was applied. Therefore we developed a new method to further increase the quality of the 3D surfaces of all preserved teeth by combining meticulous voxel based procedures with vector based procedures. High quality models were prepared of all 45 preserved teeth of *Darwinius masillae* strictly correlating to the shape of the original morphologies. This was evaluated and confirmed by an overlay of stl and voxel models as the third step of data analyses. The dental arches of the extant species *Aotes trivirgatus* and *Lemur mongoz* represent inconspicuous mean shapes suited to start with a reconstruction of the dental arch of *Darwinius masillae* without prior phylogenetic implications. Furthermore a simulation of the masticatory movement within the power stroke was performed by the OFA-software (Occlusal Fingerprint Analyser) with antagonistic molars to gain insight into the mode of dental operation in the lifetime of *Darwinius*. The aim of which is a precise alignment of the dentition compared to dislocated positions in the fossil specimen.

S2 – Biodiversity of the Late Cenozoic mammal fauna of the Baikal region in the context of global and regional events

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The Baikalian region includes the territories of Prebaikalia and Transbaikalia, located west and east of Lake Baikal. At least until the Miocene, both areas were joined. The former terrestrial connections between Europe and Asia and with North America served as migration pathways for mammalian dispersion. Neogene faunas were rather abundant and diverse and included both European and American elements, but the Central Asian forms were dominant. Gradual cooling in northern latitudes and intensive orogenic processes during the Pleistocene led to prominent environmental changes in Eurasia. Pliocene savanna-like forest-steppes gradually became reduced. They were replaced by boreal forest, grassland and steppes which expanded widely and open landscapes became dominant. The genus *Equus* appeared for the first time and replaced *Hipparion*. The Pliocene small mammal taxa completely disappeared and were replaced by the Pleistocene genera *Cromeromys, Spermophilus, Clethrionomys, Borsodia,*

Prolagurus, *Lagurodon* and *Eolagurus*. Further progressive cooling of the climate during the Late Pleistocene resulted in the formation of open landscapes with the so called mammoth or tundra-steppe fauna in Prebaikalia, whereas the Transbaikal area was inhabited by a fauna in which Central Asian species were dominant.

S8 – On temporal and spatial scales of biodiversity changes: a deep-time macroecological perspective

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One hundred years ago, Alfred Wegener's great idea about continental drift largely relied on fossil-based paleobiogeographical evidences. Today, the understanding of the geographical distribution of extant species on Earth – historical biogeography – still largely depends on paleontological data. On the other hand, the ongoing, human-driven loss of diversity more recently called for a better, historical and functional understanding of the spatiotemporal variations of diversity on Earth – macroecology. Because space and time are practically distinct, but functionally related dimensions of ecological systems, such approach calls for a spatially-integrated study of biodiversity dynamics at an evolutionary timescale – a deep-time macroecology. Indeed, the biosphere is a complex adaptive system whose study cannot be arbitrarily reduced to any single spatial- and/or temporal-scale level of resolution without a loss of content. Patterns and processes of diversity changes may fundamentally differ from one spatiotemporal scale to another, calling for a proper integration of fossil and extant data into standardized analytical frameworks. From this perspective, estimates of the quality and reliability of the paleontological data, on the one hand, and improvement of the power and robustness of the analytical tools, on the other hand, clearly constitute two major, complementary research axes for the years to come.

In this talk I briefly review some recent examples of deep-time macroecological studies and related methodological developments. Based on these first results, I identify further research axes, especially concerning the reliability of fossil data at hand.

S25 – Evidence for spinosaurid affinities of *Sigilmassasaurus brevicollis* (Theropoda, Tetanurae)

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The enigmatic theropod dinosaur *Sigilmassasaurus brevicollis* has been described on the basis of isolated vertebrae found in "middle" Cretaceous strata of Morocco. The remains strongly resemble those found and described as "*Spinosaurus* B" by Ernst Stromer in the first half of the twentieth century in Egypt. The erection of the genus *Sigilmassasaurus* recognizes the "*Spinosaurus* B"-morphotype as being sufficiently different from *Spinosaurus* sp. to justify a distinct genus. Unfortunately, the Egyptian material was destroyed in during World War II and the holotype of *Sigilmassasaurus* is a single vertebra to which other, similar elements have been referred. However, the original diagnosis of *Sigilmassasaurus* is problematic, and figures in the original description were simplified to line drawings that complicate comparative analyses of new material. The validity of *Sigilmassasaurus* as a distinct taxon has been questioned by several authors ever since its initial description. Some authors have suggested that *Sigilmassasaurus* is a junior synonym of *Carcharodontosaurus*. However, no *Sigilmassasaurus* vertebral material has ever been found in unambiguous association with *Carcharodontosaurus* skull material. To investigate the taxonomic affinities of *Sigilmassasaurus*, unpublished material housed in the Bayerische Staatssammlung für Paläontologie und Geologie in Munich was examined. Features that characterize *Sigilmassasaurus* have been found and compared to taxa of the major theropod and specifically tetanuran groups, with an emphasis on carcharodontosaurs and spinosaurs.

The material examined includes anterior, middle, and posterior cervical vertebrae as well as transitional 'cervicodorsal' and anterior dorsal vertebrae. The material in question can be assigned to *Sigilmassasaurus* on the basis of shared characters that are also found on the holotype and in the descriptions of Stromer's "*Spinosaurus* B". These include a centrum considerably wider than high, the presence of a pronounced rim around the anterior articular facet, and an anterior median tuberosity on the condyle of the centrum. Some characters also found on the vertebrae clearly distinguish the *Sigilmassasaurus* material from carcharodontosaurs, arguing against the synonymy of *Sigilmassasaurus* with *Carcharodontosaurus*. These features include internal pneumatic structures of the camerate type that could be revealed computer tomographic (CT) scanning of *Sigilmassasaurus* vertebrae. Some characters that suggest a position of *Sigilmassasaurus* outside of Carcharodontosauridae furthermore suggest megalosaurid, and specifically spinosaurid, affinities such as the low height/width ratio of the articular facets, the prominent keel in posterior cervicals, the strongly

elongate transverse processes, and the elongate middle cervical centra. If *Sigilmassasaurus* indeed is a valid spinosaurid taxon, as suggested here, the diversity of this clade in the Cretaceous of northern Africa was higher than previously recognized.

S15 – Phylogenetic analysis of Late Triassic – Early Jurassic neotheropod dinosaurs and their early biogeographic and evolutionary history

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New discoveries and studies have improved our knowledge of early neotheropod dinosaurs in the last decade. However, updated and comprehensive phylogenetic analyses of Late Triassic and Early Jurassic theropods are currently lacking. In order to assess the phylogenetic relationships of these taxa, a data matrix composed of 39 terminals and 633 informative characters was compiled. In the most parsimonious trees recovered by the analysis, *Liliensternus*, *Procompsognathus*, *Lophostropheus*, *Gojirasaurus* and BP/1/5278 were recovered within a polytomy at the base of Coelophysoidea. The latter taxa were the sister-taxa of a clade composed of a "*Syntarsus*" *kayentakatae* + *Kayentavenator* clade and a group including *Segisaurus*, *Coelophysis bauri*, *Coelophysis rhodesiensis*, *Camposaurus*, and an unnamed Mexican coelophysoid. The position of *Kayentavenator elysiae* indicates that it should be considered a junior synonym of "*Syntarsus*" *kayentakatae*. The placement of BP/1/5278 does not agree with its proposed identification as a juvenile specimen of *Dracovenator*, and it may instead represent a distinct form of basal coelophysoid. After *a posteriori* pruning of wildcard taxa, *Liliensternus* was placed as the most basal coelophysoid, *Lophostropheus* as the most basal member of Coelophysinae, and *Coelophysis bauri* as the sister-taxon of a clade composed of *Camposaurus*, *Segisaurus* and *Coelophysis rhodesiensis*. Outside Coelophysoidea, *Zupaysaurus* was found as the sister-taxon of a group including Dilophosauridae and Averostra. Dilophosauridae was composed of *Dracovenator*, *Cryolophosaurus* and *Dilophosaurus wetherilli*. Within Averostra, *Sarcosaurus woodi* was recovered as a basal ceratosaur, probably representing the oldest member of the clade. Optimization of femoral length under a linear maximum parsimony criterion revealed a reduction of body size in Coelophysoidea and an overall increase in the lineage leading to Averostra. However, a conspicuous increase in body size is not documented during the Early Jurassic, contra to some prominent hypotheses of "ecological release" for theropods following the Triassic-Jurassic extinction. The reconstructed body size evolution fits better a Browning Model (equivalent to a General Random Walk) rather than a Browning Model with trend. Thus, based on the available sample, the divergence in body size between coelophysoids and the clade including other neotheropods seems to have been mostly driven by passive events. The results also indicate that basal coelophysoids (i.e. those outside the "*Syntarsus*" + *Coelophysis* clade) are currently the most abundantly sampled late Norian–Rhaetian theropods. However, following the Triassic–Jurassic extinction event, theropod assemblages are composed of derived coelophysoids, dilophosaurids and basal averostrans. Biogeographic analyses indicate that the Late Triassic neotheropod assemblages possessed a strong paleolatitudinal structure, but acquired a cosmopolitan distribution during the Early Jurassic. Accordingly, the Triassic-Jurassic boundary mass extinction appears to have had a deep impact on the early biogeographic and evolutionary history of Theropoda, resulting in a shift of the taxonomic content and biogeographical pattern of the group.

S25 – Origin of *in situ* freshwater oncoids from a karstic spring in the Northern Franconian Alb (Bavaria, Southern Germany)

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A so far unknown occurrence of freshwater oncoids has been investigated in Walkersbrunn (Gräfenberg) on the south-western margin of the Northern Franconian Alb (Bavaria, Southern Germany). The oncoids are formed at a slope over the short distance of only 12 m in the course of a small karstic spring, which rises in the Opalinuston Formation (Lower Aalenian, Middle Jurassic). Hydrochemical, microfacies, and isotope analyses have been performed in order to distinguish between abiogenic and biogenic processes in the formation of the oncoids. The oncoids consist of calcareous tufa, a well-known phenomenon in the Franconian Alb, which is built up mostly by massive Upper Jurassic limestones and dolomites. Since the Upper Cretaceous the rocks have suffered a strong karstification, which is caused by waters enriched in pedogenic carbon dioxide dissociating into aggressive carbonic acid. Thus the calcareous material in the subsurface is corroded and dissolved, whereby the percolating waters get supersaturated with respect to calcium carbonate. At water-impermeable rocks (aquicludes) the waters rise as karstic springs, where the precipitation of calcium carbonate is rapidly enabled due to the strong increase of temperature and decrease of pCO_2.

Biogenic assimilation processes by water plants, e.g., mosses are commonly considered crucial for the formation of calcareous tufa. In contrast, our results show that for the

formation of the oncoids in Walkersbrunn, abiogenic removal of carbon dioxide plays also an important role. CO_2 removal is due to turbulences, which occur at numerous wooden branches along the slope. These branches act as nuclei of the oncoids around which the calcareous mantle is formed by laminated cortices. These cortices show a seasonal alternation with (i) bright sparitic layers, formed in spring and summer months mostly by the cyanobacteria *Schizothrix* sp., and (ii) dark micritic layers, which result from the abiogenic precipitation of calcium carbonate in the winter months. The sparitic layers are commonly thicker than the micritic layers, and show a depletion of $\delta^{13}C$. This depletion is probably caused by *Schizothrix* sp., which preferentially incorporates ^{12}C into its cells during photosynthesis. Contrary to the common definition, the oncoids lack a regular overturning due to low current velocities, and grow most of the time *in situ*.

S19 – Changes of internal cranial morphology related to first aquatic adaptations in early whale evolution

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Whales evolved from terrestrial artiodactyls. The transition from life on land to life in the water took place throughout the Eocene, and Eocene archaeocete whales show various degrees of aquatic adaptations. Modern cetaceans have strongly modified nasal structures with reduced turbinates, and lack paranasal sinuses, whereas the sense of smell is well-developed, and pneumatization can be extensive in the skulls of modern artiodactyls.

In order to resolve how and when turbinates and sinuses were reduced in cetacean evolution, and how these modifications relate to other aquatic adaptations, we analyzed the internal cranial morphology of an early Eocene semi-aquatic protocetid archaeocete (*Artiocetus clavis*) and an early Oligocene anthracotheriid artiodactyl (*Bothriodon americanus*) using computed tomography (CT) and digital surface reconstruction. Results were compared to those of existing studies of middle Eocene remingtonocetid and late Eocene basilosaurid archaeocetes.

Early and middle Eocene semi-aquatic archaeocetes that had already acquired aquatic hearing mechanisms and showed changes in the limbs and vertebral column suitable for aquatic locomotion still had large nasal turbinates and paranasal sinuses. Frontal sinuses were slightly more strongly reduced than maxillary sinuses, compared with the plesiomorphic state in basal artiodactyls. However, basilosaurid archaeocetes that were already fully aquatic still had frontal sinuses. The olfactory region of the brain was elongated, and the presence of a cribiform plate and turbinates indicates that olfaction was retained in archaeocete whales. Reduction of the turbinates, if there was any, was restricted to the anterior portion of the maxilloturbinate.

We conclude that the reduction of nasal turbinates and paranasal sinuses occurred relatively slowly and relatively late in cetacean evolution, after morphological developments related to hearing, feeding, and locomotion in the water.

S15 – Excavation report and field documentation of a sauropod skeleton from the Jurassic of the Turpan Basin, Xinjiang, NW China

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From April 9 to April 30, 2012, a paleontological excavation of the Sino-German Paleontological Cooperation Project took place near the city of Shanshan (Turpan Basin, Xinjiang). It was organized and administrated by the Chinese Jilin University and the Paleontological Museum of Shenyang.

The local desert outcrops of lacustrine and fluvial sediments from the Middle and Late Jurassic are partly very rich in vertebrate fossils. The site “Boneanza”, containing a very large sauropod skeleton (nicknamed “Karl der Große”), was discovered by Achim Schwermann, Ben Thuy, and Oliver Wings in 2009. The approximately 4 m thick geological profile of the vertically inclined layers belongs to the Qigu-Formation. It consists mainly of reddish-brown, partly mottled grey-green mudstones to siltstones in layers that are a few dm thick. Calcretes indicate pedogenic overprint in the reddish sediments.

The excavation team consisted of up to 30 Chinese part-time assistants as well as five Europeans. For protection against weathering and fossil thieves, the site was reburied in 2009, so fieldwork began with the removal of several metric tons of covering sediment. The site was then enlarged to a length of approx. 15 m and deepened up to 2 m with a hydraulic chisel hammer (P95 18 hp Powerpack + Breaker) and an electric chisel hammer (Hilti TE 706 AVR). The specimen may be displayed *in situ* to visitors; negotiations with potential sponsors are currently underway. Hence, most bones were just exposed and only parts of dorsal ribs were excavated to reach underlying bones.

Several sauropod bones were discovered in the approximately 60 cm thick bone layer; the taxonomic assignment of these remains will be discussed elsewhere. The exposed, articulated axial skeleton consists of the two most

posterior cervical vertebrae (length of 2nd last vertebra: 1.06 m), all 12 dorsal vertebrae (total length: 4.5 m) with five fused sacral vertebrae and the first two caudal vertebrae. Articulated cervical ribs indicate that more cervical vertebrae may be found nearby. Several pelvic girdle elements (one ilium, both pubes, one ischium) were preserved close to the articulated left hindleg (femur length: 1.65 m, tibia and fibula, one metatarsal). Other finds include three teeth of theropods (cf. *Sinraptor*), partly articulated xinjiangchelyid turtle shells, semionotid fish remains, bivalves with shell preservation, and several gastroliths, which appear concentrated near the femur.

Documentation of the excavation consists of drawings and sketches, measurements, photos, photogrammetry, and a geological profile. Time lapse videos provided a cheap and quick way to document the excavation progress. A GoPro-HERO outdoor digital camera was programmed to automatically take pictures in 2 s intervals. The photos were merged into a movie (30 pic/s) using Adobe Lightroom 4.0 and LR Timelapse on a PC. The resulting time lapse shows one minute realtime in one second movietime.

S11 – Evidence of predation in Cambrian trilobites from the Barrandian area (Czech Republic)

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Reports of predation on trilobites are generally rare, although trilobites were abundant and diverse invertebrates in many Palaeozoic marine ecosystems. In the present contribution we discuss two types of bite marks in exoskeletons of Cambrian trilobites:

(1) large assymetrical rounded and/or more or less W-shaped healed injuries on lateral and posterolateral sides of articulated exoskeletons of large paradoxidid trilobites and (2) the 'lateral bite mark' which typically occurs in a restricted position on the left and/or right side of the thorax and in some cases also on the posterior cephalic margin of conocoryphid and ptychopariid trilobites. Trilobite specimens revealing the healed injuries and 'lateral bite marks' used in this study were collected from the 'middle' Cambrian Jince and Buchava formations of the Barrandian area.

The healed injuries are interpreted as failed predatory attacks, while the 'lateral bite marks' represent results of predatory attacks on the postero-lateral side of trilobites in their living position. The agents responsible for the healed injuries as well as for the 'lateral bite marks' are unknown.

S9 – The mechanical design of the archosaurian pelvis

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Based on the orientation of the pubis, archosaurs can be roughly separated into two groups: propubic archosaurs with an anteroventrally directed pubis and opisthopubic archosaurs with a posteroventrally directed pubis. If one assumes that shape and structure of a bone represent a response to its mechanical loading, differences in the orientation of the pubis in archosaurs have to be induced by changes in the functional role of the associated muscles. How these changes in the functional role look in detail is yet not understood. This is mainly due to the fact that in the past, studies on the function of the muscles attached to the archosaurian pelvis focussed on their biological role. In extant archosaurs, the biological role of the muscles attached to the pelvis comprises locomotion, ventilation, and trunk stabilization. Since these roles represent important aspects in the biology of an organism, the reconstruction of those aspects in extinct archosaurs will considerably increase our understanding of the biology of this group. The reconstruction of the biological role of muscles in extinct animals strongly depends on the precision of the reconstructed muscle arrangement. For several reasons, however, the reconstruction of the arrangement of muscles attached to the pelvis of extinct archosaurs is not trivial. In contrast, the functional role of muscles can be reconstructed by means of biomechanics.

Biomechanics is the most rigorous part of functional morphology and based on the strict assumption that universal constraints, set by physical rules, are present. These general rules act on all organisms at any time. In recent years, biomechanics has become a major tool to elucidate form-function relationships in extant and extinct organisms. In order to gain insights into the functional role of muscles attached to the pelvis of archosaurs, the mechanical loading of the pelvis of extant archosaurs was studied using finite element analysis (FEA). For this purpose, specimens of *Crocodylus niloticus* Laurenti, 1768, *Gallus gallus* Linnaeus, 1758, and *Rhea americana* Linnaeus, 1758 were dissected. Finite element models were generated of the

pelvis of *Crocodylus niloticus* and *Gallus gallus*. Muscular data are based on own dissections and published data.

The findings of this study reveal major differences in the mechanical loading of the pelvis of crocodiles and birds. Thereby, the arrangement of the abdominal hypaxial muscles has major impact on the mechanical loading of the pubis. Applying these findings, extinct archosaurs demonstrate that the requirement of trunk stabilization has major impact on the orientation of the pubis.

S7 – Palaeopathology and autecology of uppermost Famennian ammonoids from the Maider and Tafilalt Basins (eastern Anti-Atlas, southern Morocco)

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The failed predation on ammonoids, as evidenced by repaired shell injuries, provides important clues to reconstruct the life style (autoecology) of individual morphological and taxonomic groups. For example, taxa living closely above the sea-floor were more prone to benthic predators than forms that lived in the open water column. Shell injuries can also shed light on changes in predation on ammonoids with time, especially across major extinction events. This aspect has not yet been covered by any previous study. We analysed shell and steinkern injuries from three localities (Bou Tlidat, Lambidia, Tazoult Nehra) of southern Morocco that yielded rich uppermost Famennian (Wocklumian, UD VI) faunas. Our statistical data and previous results for the lower Tournaisian of the same region throw some light on the abundance and diversity of marine predators at the time of the Hangenberg Crisis, close to the Devonian-Carboniferous boundary. For example, and due to the lack of mineralized skeletons, most marine arthropods, apart from trilobites, leave a very poor fossil record.

The paleopathological abnormalities are classified according to the forma-types and quantified. A normalisation approach takes the state of preservation of each fossil into account and correlates the completeness of the animal with the anomaly rate. Almost all injuries of pre-Hangenberg ammonoids were probably caused by pincer-bearing crustaceans. Whereas punctiform injuries were possibly inflicted by thoracopods, slit-shaped anomalies were most likely caused by decapods. Injuries of the apertural edge occur rarely (forma *verticata*). Several ammonoids were injured by bites (forma *mordata*). The origin of this type of anomaly may lie in archaic chondrichthyans.

The Hangenberg Crisis marked a major turning point for marine life. More than 90 % of all ammonoid genera became extinct. Only representatives of the Prionoceratidae became opportunistic and re-radiated fast. Hitherto, extinction-survival patterns of the predator fauna (especially the crustaceans) are unknown. The comparison of pre- and post-Hangenberg shell anomaly rates do not show any significant variations. This leaves two interpretations: (1) the Hangenberg Crisis did not lead to a significant predator extinction, or (2) crustaceans, the assumed main injury inflictors, were similarly opportunistic as their prey spectrum and recovered quickly after the crisis.

Furthermore, 17 pre-Hangenberg ammonoid genera were measured morphometrically and sorted into different ecomorphotypes according to their shell forms, ornament, and suture complexity. The autecological analysis were correlated with the variable anomaly rates. As expected, the healed injury rates of assumed megaplanktonic (e.g., kosmoclymeniids) and eunektonic (e.g., Tornoceratacea) ecotypes are lower than those of supposed migronektonic (e.g., sporadoceratids) or demersal (e.g., wocklumeriids) ammonoids.

S4 – Oxygen and strontium isotopes from fossil bioapatite from the Middle Triassic (Anisian-Ladinian) Muschelkalk Sea

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The late Illyrian transgression from Tethyan waters into the Central European Basin led to the Upper Muschelkalk Sea, a shallow epicontinental sea that was interconnected with the Tethys via rather narrow gates and was surrounded by source areas. Favourable biostratigraphic control is provided by ceratite and conodont zonations of high resolution. Therefore, the Upper Muschelkalk represents a good example to evaluate ecological changes of shallow epicontinental seas and discuss possible control mechanisms.

Biologically precipitated apatite represents a valuable geochemical archive, from which it is possible to obtain palaeoenvironmental information. When unaltered its oxygen isotope composition ($\delta^{18}O_p$) reflects that of the ambient water ($\delta^{18}O_w$) and its temperature at the time of apatite formation. The here presented preliminary data set obtained from fossil bioapatite of fish teeth (Chondrichthyes, Actinopterygii), semiaquatic amphibian teeth, brachiopods and conodonts from the Germanic Basin (Baden-Wuerttemberg, Franconia, Thuringia) as well as the Tethyan realm is Middle Triassic Upper Muschelkalk (Upper Anisian–Lower Ladinian) in age. The data set

contains 62 $\delta^{18}O_p$ values and 21 $^{87}Sr/^{86}Sr$ ratios. The $\delta^{18}O_p$ values from the Germanic Basin are in a range of 16-20 ‰ VSMOW, while the values measured from time-equivalent Tethyan samples vary between 18.6-22.4 ‰ VSMOW. The $^{87}Sr/^{86}Sr$ ratios of 0.7078-0.7083 are notably higher than the proposed seawater ratio of around 0.7075, and are in good agreement with published $^{87}Sr/^{86}Sr$ data derived from brachiopods of the Germanic Basin.

Altogether, the $\delta^{18}O_p$ values of fish teeth from the German sites are on average depleted in ^{18}O by 2 ‰ relative to the fully marine Tethyan signature. The data set displays a slight trend of increasing brackish conditions from South Germany to Thuringia. Samples from locations closer to the Vindelician-Bohemian source area have lower $\delta^{18}O_p$ values than samples from more distal locations. In summary, our data set points to significant fresh water input from surrounding sources responsible for lowered salinities of the Upper Muschelkalk Sea.

Moreover, distinct differences in the oxygen isotope values from coeval beds exist between conodonts and fish teeth. Differences between conodonts, brachiopods and fish tooth enameloid probably are the result of different habitats of the former organisms. The partly distinct discrepancy of up to 3 ‰ between tooth enameloid, tooth crown bulk samples and complete teeth, however, hint to diagenetic alteration of the less resistant osteo- and orthodentine of the teeth compared to the hypercrystalline tooth enameloid layer.

S13 – The shark fauna and its nurseries from the Triassic Madygen lake (Kyrgyzstan)

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The ichthyofauna of the Middle to Late Triassic (Ladinian–Carnian) fluvio-lacustrine Madygen Formation in SW-Kyrgyzstan, Central Asia, is known to be dominated by actinopterygians and sarcopterygians. Recent finds of tooth crowns, dermal denticles and egg capsules, however, are evidence of at least two contemporaneous taxa of oviparous sharks. Thus, Madygen represents one of only few selachian occurrences in Triassic freshwater deposits of Asia.

The hybodontid *Lonchidion ferganensis* is represented by over 100 juvenile teeth of about 1 mm mesiodistal length forming three distinguishable morphotypes of a heterodont dentition. A singular adult tooth of nearly double the size of the juvenile ones demonstrates to a certain degree ontogenetic heterodonty. The heterodont crushing-grinding type dentition indicates durophagy on benthic invertebrates, which is in accordance with the pelecypod-rich mudstones as the main tooth-bearing strata. Other remains assigned to *Lonchidion* are hybodontid rake-like dermal denticles. Furthermore, *L. ferganensis* is regarded as the producer of the up to 12 cm long egg capsule *Palaeoxyris alterna*. The latter is characterized by a distinct three-fold division into fusiform body gradually tapering in a short pointed beak and a long slender pedicle marked by parallel ribs. The capsule is composed of six helicoidally clockwise twisted bands with alternating breadth pattern and an accompanying flange-like structure. The co-occurrence of *Lonchidion* teeth and *Palaeoxyris* egg capsules clearly supports the assignment of *Palaeoxyris* capsules to hybodontid sharks.

A second capsule type, *Fayolia sharovi*, reached a total length of 7 cm and is characterized by a fusiform body that is composed of two broad helicoidally clockwise twisted bands. The band margins are paralleled by a distinct scar line overlapped by a broad flange accompanying both bands. Since xenacanthiform sharks are generally regarded as the most probable producers of *Fayolia*, the occurrence of *Fayolia* type capsules implies the presence of a yet unknown xenacanthid shark in the Madygen fauna. Other indication of its presence are slender, pointed dermal denticles of xenacanthid affinity.

Low tooth enameloid $\delta^{18}O_p$ values of around 10 ‰ and high $^{87}Sr/^{86}Sr$ ratios of around 0.7098 reflect tooth formation under freshwater conditions in the Madygen environment. Considering the mass occurrence of juvenile teeth and egg capsules in the study area we propose that hybodontid/xenacanthid sharks recurrently occupied littoral zones of the Madygen lake for spawning. The small number of full-grown individuals points to habitat partitioning of juveniles and adults wherefore the study site is interpreted as a shark nursery. The occurrence of different oviparous shark species also indicates some degree of temporal partitioning. Therefore, the oviposition strategies (habitat shift, site fidelity) inferred from the Madygen sharks are remarkably similar to those of modern relatives suggesting that the reproductive patterns seen in extant sharks originated well before the Cenozoic.

S11 – The Chengjiang Biota (Cambrian Stage 3) of Yunnan Province (South China): taphonomy of a Burgess Shale-type fossil Lagerstätte

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The preservation of highly volatile tissues and soft parts is exceptional in the Earth history, but provides

a huge amount of information on early metazoan bauplans. Deposits where these soft-bodied fossils occur are named fossil conservation Lagerstätten. The conservation deposit of Chengjiang represents one of the oldest fossil deposits conserving both metazoan stem- and crown-group bauplans right after the most rapid diversification event of metazoa ("Cambrian bioradiation event"). Although extensive studies on the systematic taxonomy of this Lagerstätte have been carried out, the major mechanisms of preservation of this exceptional soft-tissued fossil Lagerstätte remained controversial so far. Weathering plays a pivotal role in the taphonomy of the Chengjiang Biota, but an overview on its taphonomic pathways using material with little or no weathering influence is still missing. This work aims at presenting an updated model based on the study of both unweathered and weathered Chengjiang-type fossil material. Energy dispersive X-ray (EDX) analyses and elemental mapping of fresh fossil material from a variety of facies settings indicate pyrite crystals to be located only surrounding the fossils. Instead of this particular type of preservation, carbon can be detected in almost all metazoan clades present in this fossil deposit. The Chengjiang fossil Lagerstätte is commonly considered as a typical Burgess Shale-type deposit. However, the systematic and detailed study of various fossil groups, such as brachiopods, priapulids, arthropods, sponges, mainly based on the geochemical screening of body fossils and entombing clay matrix, indicate a more complex preservational history than hitherto expected. Presence of apatite in sclerites of palaeoscolecids, shells of brachiopods, and bradoriids in unweathered samples supports the conclusion that these organisms were primary biomineralizers. Furthermore, redox parameters for least weathered samples do not indicate deposition under anoxic conditions. It can be inferred that bottom-water anoxia conditions were not permanently present during the deposition.

Besides later weathering processes, clay mineral formation and/or alteration, carbonization, phosphatization, and perhaps pyritization played key roles in the preservation of the exceptional soft-bodied organisms. Using different geochemical proxies, such as various redox indicators and iron speciation, statistics on framboid sizes, classical geological observation and clay mineralogy, we can reveal that iron mineral precipitation onto organic carcasses of the Chengjiang-type fossils is mostly confined to later diagenetic processes during weathering: occurrence of Fe crystallites and framboides on soft-tissues and within dissolved skeletal parts reveal a later diagenetic origin or even latest replacement during relatively recent weathering, and thus is not crucial for the early fixation of highly decayable tissues. The different preservational traits of tissues in same individuals (carbonization, phosphatization etc.) are mostly due to the ambient geochemical micro-environment and the primary biochemistry of different tissues itself.

S17 – Dental ecometrics and the evolution of mammal faunas

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The intuitive understanding that dental form has functional meaning can be traced back at least to Aristotle and is most likely of palaeolithic origin. It served Cuvier well as a foundation of the earliest scientific reconstructions of fossil mammals and was an important component in the thinking of early evolutionists, Darwinian and Lamarckian alike. The increasingly sophisticated methods that have been developed in the last decades to quantify and analyse dental form still rely on such intuitive understanding and analogue with simple mechanical tools, but when applied in a context of large fossil datasets with good spatial and temporal resolution they become powerful tools for analysing the deep time context and dynamics of mammalian evolution. The general term 'ecometrics' has been proposed for the use of functional traits in this manner, both for macroecological and macroevolutionary analysis. Mean hypsodonty has been used to compute rainfall (humidity) patterns in the global biosphere today and to map palaeoprecipitation in the geological past. Together with cutting edge count, mean hypsodonty allows mapping of primary productivity of ecosystems in the present as well as the past, and therefore allows mapping of palaeobiomes in humidity-temperature climate space. Ecometric analysis has revealed that the later Cenozoic shift towards drier and cooler climates drove trends in relative abundance and community structure favouring herbivores with a dental capability for feeding in circumstances conducive of increased tooth wear. It also shows that trophic level strongly influenced the pattern of regular rise and fall of species investigated over their entire temporal range. At the level of communities, dental ecometrics has shown that species assemblages (chronofaunas) show both a pattern of regular rise and fall and a shifting spatial distribution that reflects shifting climatic conditions at the continental scale. Very recently dental ecometrics that do not rely directly on functional analogy but simply relate holistic morphometrics to observed function have shown promise both for understanding the developmental side of dental evolution and for resolving morphologies that lack counterparts among living mammals.

S7 – A pathological tail in a basal sauropodomorph dinosaur from South Africa

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The study of pathologies in fossil animals has great potential to provide insights into the paleobiology and life histories, as well as interspecific and intraspecific interactions of extinct taxa. In March 2008, a partial skeleton of the basal sauropodomorph *Massospondylus* (BP/1/6771) with an unusually short tail was collected from the upper Elliot Formation (Early Jurassic) in Eastern Cape Province, South Africa. Only 25 caudal vertebrae are present in BP/1/6771, and complete counts of caudal vertebrae for other basal sauropodomorphs indicate that approximately a third of the length of the tail was lost. The terminal three preserved caudal vertebrae are highly deformed and fused together with a large ventrally projecting mass of bone that lies largely beneath caudal 24. This hyperostosis is highly asymmetrical in morphology, has a complex surface topography that includes large pits and grooves, and cannot be homologised with vertebral elements or chevrons. CT cross sections show varying degrees of resolution, in which the neural arches are generally composed of densely packed trabecular bone, whereas the centra and the hyperostosis are mostly hollow and infilled with dense sediment. The neural canal seems to terminate beyond caudal 24, and does not pass through the remains of caudal 25. No evidence of a foreign object (e.g. a tooth) is visible. Based on these findings, we interpret the fusion of distal elements and the large hyperostosis as reactive bone growth following tail truncation, which is most likely the result of a traumatic amputation caused by an unsuccessful attack by a predator. Alternatively, the loss of the distal part of the tail could be also related to previous trauma or systemic infection. However, we consider a traumatic amputation more likely, given that the most terminal caudal appears to have been sheared in two, consistent with a disruptive impact. Although their fossil remains are relatively rare, isolated teeth from the upper Elliot Formation document the presence of large predators in this ecosystem, consistent with this scenario. The presence of reactive bone growth indicates that tail truncation could not have been immediately fatal, although such an injury may of course have contributed to the eventual death of the animal. If the scenario of traumatic amputation is correct, the tail pathology may provide a temporally early example of predator/prey interactions in the dinosaur fossil record and, given the at least temporary survival of the animal, indicate that large basal theropods were active predators.

S2 – Microvertebrate remains from the non-marine Triassic Madygen Formation of Kyrgyzstan

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The Middle to Late Triassic (Ladinian-Carnian) lake deposits of Madygen in southwestern Kyrgyzstan, Central Asia, represent a conservation and concentration Lagerstaette due to its abundant and diverse fossil remains of plants, aquatic invertebrates, insects, fish, and tetrapods. Sedimentation took place within a tectonically active basin that accumulated several hundred metres of alluvial, fluvial and lacustrine deposits. While the locality is mainly known for its macrofossil record, this report focuses on microfossil remains gained from wet chemical processing of bulk samples of the Madygen Formation. All described fossils come from dark greyish, carbonaceous bivalve-rich mudstones ('Muschelbank') at the base of the lowermost series of lacustrine sediments interpreted to represent littoral deposits.

Numerous disarticulated fish and tetrapod remains were handpicked from screen washed residues (processing with light petrol and 10 % formic acid). The assemblage is dominated by teeth and scales from actinopterygian fishes, whereas remains of sharks and tetrapods are subordinate. The quality of preservation varies. Some scales are well-preserved, others are broken and abraded. Teeth are rarely completely preserved. Bones are often fragmentary and thus difficult to classify.

Actinopterygian scales were grouped according to their surface morphology and, if feasible, assigned to taxa known from the lake. Apart from smooth scales ornamented scale types were found bearing a variety of ridges, furrows or tubercles partially resembling referred structures in *Saurichthys orientalis*, *Oshia ferganica*, and the palaeoniscids *Ferganiscus osteolepis* and *Sixtelia asiatica*. However, the diversity of isolated scale types exceeds the number of species known by articulated material. The classification of actinopterygian teeth is problematic, but three to four morphotypes can be distinguished.

Sharks are represented in the assemblage by over 100 juvenile, slightly triangular teeth and few dermal denticles of the hybodontid *Lonchidion ferganensis*. The available material points to a heterodont dentition consisting of three distinguishable tooth morphotypes. Moreover, rare dermal denticles suggest the occurrence of a xenacanthiform shark, whose presence is also indicated by the egg capsule *Fayolia sharovi*.

Tetrapod remains are represented by a variety of fragmentary bones, such as ribs, long limb bones, autopodial

elements, centra and neural archs of vertebrae, platy palatal bones, jaw bones, and bony scales. Furthermore one conical tooth with long root can be referred to a tetrapod.

The preliminary results indicate a wider spectrum of vertebrate taxa in the assemblage than previously assumed. Altogether, the microvertebrate remains are an important complement to the available articulated, macroscopic fossils, increasing our knowledge about diversity and palaeoecology of the Triassic Madygen lake environment.

S5 – Ostracoda as Quaternary lake level indicators on the Tibetan Plateau

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Ostracods are the most frequent Quaternary microfossils of the sand sized fraction preserved in sediments of the often saline lakes of the Tibetan Plateau. Their fossil associations and shell chemistry are reflecting environmental conditions and changes making this group one of the best proxies available in palaeoclimate studies of Tibetan Plateau lakes. One of the most important parameters for reconstructions is former lake level because this reflects the precipitation/evaporation/meltwater balance. We present recent water depth distributions of taxa and a water depth transfer function as quantitative approaches to reconstruct former lake levels, as well as a conductivity transfer function and intraspecifical morphological variation (noding) of the most abundant and most widely distributed species *Leucocytherella sinensis* as indirect approaches. The ecologically based methods are compared with shell chemistry studies relying mainly on stable isotope analysis. The Recent water depth distribution of taxa and related transfer functions deliver quantitative estimations of lake levels but are applicable for very similar ecological system conditions as present in the Recent lakes only. So, they are mainly restricted to reconstructions for the late Holocene and should be used together with other proxies. This restriction partly applies for conductivity transfer functions as well. A new and promising approach for tracing salinity trends in cores or outcrops is the variable noding of ostracod shells. Ambient salinities below the internal osmotic pressure of the animals cause the blowing up of tissues due to osmoregulation problems during moulting. Hence, higher numbers of and more prominent nodes are indicative for lower salinities of the water. However, quantitative estimates for salinity are not possible up to date. This is also true for stable isotopes, but further complicated by other factors than salinity influencing stable isotope signatures in ostracode shells and of the ambient water. The best approach is to combine these methods and to compare their indications with sedimentological and geochemical proxies.

S9 – Actuo-palaeontological 3D morphometric analysis of irregular echinoids

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Morphometric methods based on three-dimensional scanning techniques such as laser and CT scanning techniques have advanced rapidly as a useful tool in palaeontology within the past few years. These methods represent a new and exciting approach to rigorously and systematically study morphological variations within and between species. Statistical protocols of the geometric morphometrics as well as spatial representations of results allow for a direct comparison of intra- and interspecific morphological changes.

This study concerns the complex three dimensional shape of the skeleton of the irregular echinoid *Echinocardium cordatum* Pennant, 1777 using a population collected in Morgat, Bretagne, France. This echinoid is used as a model for eventually comparing morphologic variations in well-preserved fossil populations of irregular echinoids. A three-dimensional morphological representation is essential in order to capture morphological features of these sea urchin tests. The technology used and the methods applied to capture the 3D geometric morphometrics of this species are illustrated and preliminary results are discussed. The individual echinoids are scanned with a NextEngine™ laser scanner at high resolution. Post processing of the 3D models is performed with the open source software MeshLab and morphometrical analyses with the software tools Landmark and MorphoJ.

S14 – A new basal dicynodont (Synapsida, Therapsida) from the Late Permian *Cistecephalus* Assemblage Zone of South Africa

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Anomodont synapsids were the taxonomically and ecologically most diverse clade of terrestrial tetrapods during the Permo-Triassic, when they were the most abundant herbivores in terrestrial vertebrate ecosystems. They survived the end-Permian extinction, but had their greatest species richness in the Late Permian. Here, we present a new dicynodont anomodont (CGS CM 86-861) that was collected in *Cistecephalus* Assemblage Zone deposits on the farm Brak Fontein in the Western Cape Province, South Africa. The specimen consists of a small skull (~5.5 cm long and 6 cm wide) with lower jaws. The skull is well preserved but slightly crushed anteroposteriorly, resulting in breakage of the palate, braincase and intertemporal regions. In dorsal view, the skull is essentially triangular in outline, with a broad posterior and a comparably narrow anterior end. The intertemporal region was short and narrow, although this region is incompletely preserved. The zygomatic arches, postorbital bars, and the dorsal part of the occiput are not preserved. Unlike most dicynodont taxa, the specimen is tuskless. The lower jaw is very robust and dorsoventrally deep, a morphology that is similar to that of the basal dicynodont *Endothiodon*. Autopomorphies of the new taxon include the very short intertemporal region and the posterior position of the pineal foramen. Further preparation of CGS CM 86-861 revealed a number of additional rather primitive features, including the presence of a large ectopterygoid, broad and trough-shaped mid-ventral vomerine plate, few, medially located and anteriorly directed maxillary teeth, and a large number of posteriorly serrated dentary teeth. We included the new taxon in the most recently published and most comprehensive phylogenetic dataset for Anomodontia and the resulting single most parsimonious tree suggests its placement as the sister taxon to Therochelonia. This is supported by four shared derived characters, including the presence of a posterior median ridge on the palatal surface of the premaxilla without a flattened and expanded anterior area, the absence of a raised and sometimes rugose circumorbital rim, a mid-ventral vomerine plate that lacks a notable expanded area posterior to the junction with the premaxilla, and the presence of a rounded swelling at the anterodorsal edge of the lateral dentary shelf. The phylogeny further supports the recently suggested paraphyly of Endothiodontia, but positions Pylaecephalidae outside of Therochelonia, whereas recent studies suggested a sister-taxon relationship between pylaecephalids and emydopoids. Thus, the new taxon represented by CGS CM 86-861 further resolves the phylogenetic relationships of basal dicynodonts and provides valuable information about the early diversification of the clade.

S6 – Patterns of variation in salamander limb skeletogenesis

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It has been known for over a century that urodeles show a unique pattern in the formation of their limb skeleton that differs profoundly from the otherwise conserved pattern of skeletogenesis of other tetrapods. Tetrapods generally display a proximo-distal progression in the formation of skeletal elements and postaxial polarity in the order of digit formation. Salamanders on the contrary show preaxial polarity in the formation of their digits combined with a very early *de novo* condensation of the apomorphic *basale commune*, a carpal/tarsal element in the position of distal carpal and tarsal 1 and 2. The evolutionary history of this unique pattern in salamanders remains puzzling although the fossil record has shown that branchiosaurid temnospondyls also had preaxial polarity in limb development. However, it remains uncertain whether preaxial polarity in limb development is an ancient feature that among modern tetrapods is solely preserved in salamanders, or if it is a derived character representing either a synapomorphy of urodeles and branchiosaurids or a convergently evolved character. The patterns can be observed in early phases of skeletogenesis, i.e. the mesenchymal condensation and subsequent chondrification of limb skeletal elements, but is in parts even preserved in later ossification sequences. Preaxial polarity and the early formation of the *basale commune* have been observed in all salamanders that have been studied to date, yet variations within this common pattern become apparent, when looking at the details of limb skeletogenesis in different salamander taxa. Assessing and understanding the range of variation within the common framework of preaxial polarity is an essential step in further deciphering the evolutionary history of this developmental pathway. Variation occurs in three areas of the developing limb: the central and postaxial columns, and the digital arch. It affects the patterns of connectivity between mesenchymal fields as well as the overall timing of development in the different regions of the developing limb skeleton. Instead, a fourth area in the developing limb, the preaxial column, is very stable in its pattern of development in all taxa. We synthesize the known patterns in salamander limb skeletogenesis and present new data on *Cryptobranchus alleganiensis*, one of the most basal extant salamanders. The results indicate that no clear phylogenetic signal is present in the patterns of limb skeletogenesis and

although *Cryptobranchus* shares some aspects with other basal salamanders, i.e. the hynobiids *Salamandrella* and *Ranodon*, its pattern is most similar to Dicamptodon. Life history is known to influence the timing of the onset of fore- and hind limb development as well as the relative timing of digit development in salamanders. Interestingly, certain patterns during skeletogenesis also seem to be correlated with life history mode and hence may be correlated with the overall timing of limb and digit formation.

S13 – The evolution of coleoid cephalopods – What happened during the Triassic?

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In general, the evolution of coleoid cephalopods is characterized by increased swimming velocities (i.e. more space for a free muscular mantle) and improved hunting abilities (i.e. arms equipped with suckers and hooks). Accordingly, coleoids belong to the top predators in marine ecosystems (since their earliest Carboniferous representatives?). However, their influence on benthic, necto-benthic, nectonic and/or pelagic organisms was widely ignored e.g. in discussions on predator-prey interactions. Explanations for this general non-consideration were possibly an incomplete morphologic and systematic understanding and/or the (presumed) poor preservation potential of these mainly soft-bodied cephalopods.

Significant progresses in the past ten years of coleoid research required a re-evaluation of older evolutionary scenarios. A review of Permian and Triassic coleoids indicates a congruent picture of their evolution during that period. A comparatively large fossil gab in the early Triassic suggests a severe crisis after the P-Tr-Event, which is followed by a distinct radiation phase in the middle and late Triassic. Despite a short "outage" after the Triassic-Jurassic boundary, each of the Triassic higher-level taxa reappeared in the early Jurassic.

Although the aulacoceratids still dominated the coleoid community with a conservative morphology (tubular body chamber), the middle/late Triassic radiation is accompanied by three new more advanced coleoid subgroups. During the middle Triassic there emerged the first unambiguous members of the Phragmoteuthida and the gladius-bearing Vampyropoda. The first true members of the Belemnitida appeared slightly later in the late Triassic.

Morphologically, the latter differentiation is mainly distinguished by the reduction of the shell. The successive opening of the ventral body chamber in phragmoteuthids and belemnitids thereby appears as a minor morphologic change compared to the total loss of shell mineralization in vampyropods, which represents a fundamental and possibly instantaneous shell reduction.

S4 – Influence of environmental changes on the crystal fabrics and growth patterns in shells of the freshwater gastropod *Viviparus viviparus*

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In order to evaluate the effect of changing temperature on crystal fabrics and growth patterns of *Viviparus viviparus*, shell thick-sections of specimens kept in a tank under controlled conditions were analyzed under a Scanning Electron Microscope. Apart from a thin layer of irregular fibrous prisms at the growing surface, the shell of *V. viviparus* is dominated by crossed-lamellar fabrics with first, second and third-order lamellae. The homogenous appearance of 1st-order lamellae, arranged perpendicular to the growing surface, is interrupted by two main types of disturbance lines running parallel to the growing surface. (1) Lines representing boundaries without a change in crystal fabrics; (2) Lines marked by a distinct layer of irregular simple prisms. Disturbance lines separate areas, which show a gradual change in size, habit, and orientation of 2nd- and 3rd-order lamellae. Initial results suggest that the formation of type 2 lines is related to changes in environmental conditions (e.g., change in temperature and/or stress), while type 1 lines may be triggered by physiological processes. Daily growth lines have not been observed. The absence of daily growth lines may be linked to growth under unnatural conditions (tanks, artificial light etc.). Results of this study may help to better understand the underlying mechanisms governing the broad variety of different crystal fabrics within mollusk shells.

S25 – Neogene and Quaternary Eulipotyphlan fossil assemblages in Spain – Synopsis of the last 23 Ma of Erinaceomorpha and Soricomorpha evolution in Southwestern Europe

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We present for the first time a calibrated biostratigraphic chart with the Neogene and Quaternary insectivore assemblages from Spain. Our database is based on almost 400 fossil associations, some directly studied by the authors, the rest taken from literature, covering the last 23 million years. This time span is herein reduced to the most significant events which resulted in the configuration of the recent communities living in Spain. Early Miocene records of insectivores are rare. The beginning of the Middle Miocene shows a stepwise entrance of new elements, including gymnures of the tribe Galericini; and within Heterosoricidae, *Heterosorex* is replaced by *Dinosorex*. The Late Miocene is characterized by a renewal of the Galericinae and the extinction of Dimylidae, Heterosoricidae and Crocidosoricinae. Noteworthy are the entrance of Desmaninae and Amblycoptini, and a first increase of shrew diversity. The Pliocene records the last occurrences of galericines (*Parasorex*) and uropsilines (*Desmanella*), but it also represents the 'Golden Age' of shrews and the spread of Desmaninae. The beginning of glaciations in the Early Pleistocene resulted in a dramatic decrease of the diversity in Soricidae. Middle and Late Pleistocene deposits do indeed record a low diversity at the genus level, similar to the modern one, represented by the extant genera *Erinaceus*, *Galemys*, *Talpa*, *Sorex*, *Neomys* and *Crocidura*. *Suncus* and *Atelerix* were probably introduced in Spain by humans during the Holocene. In the Balearic Islands, this period sees the extinction of *Nesiotites*.

S11 – Carbon and nitrogen isotope study of the upper Ediacaran Gaojiashan Member in South China: insights in causes of the Cambrian explosion

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The Pc-C boundary hosts one of the largest and most prominent negative carbon isotopic excursions in Earth history and is debated to represent a global event which may have been critical for the evolution of early animal life. Although geochemical data from rock sections of the terminal Ediacaran to early Cambrian show a distinct negative carbon isotope excursion all over the world (e.g. Namibia, Australia, China, Siberia), the impact of local environmental variations in the isotope curves remains largely unclear. We determined carbon and nitrogen isotope data from the ~60m thick Gaojiashan Member (Dengying Formation, 551-542 Ma) to track changes of the paleooceanchemistry and -biology and relate them with comparable paleo-data sets on global scales. The late Ediacaran section is located at the north-western rim of the Yangtze platform (southern Shaanxi Province, South China). It shows a remarkably high resolution and a well preserved geological record of a coastal to nearshore facies transition. Isotope data of the carbonate-siliciclastic shallow water deposits reveal two major $\delta^{13}C$ features, a positive excursion (up to + 6 ‰) in the middle section and a pronounced negative (down to ~ -7 ‰) excursion in the uppermost strata. Our results suggest a deposition during a period of numerous and profound regional biogeochemical changes. Perturbations of the carbon cycle could be explained by e.g. increased continental siliciclastic input and enhanced nutrient supply that fueled bioproductivity. In the same interval, three successive fauna (dominated by Shaanxilithes, Gaojiashania, Cloudina) evolved in that area whereupon Gaojiashania is exclusively found in this part of the platform. Even though a sharp negative $\delta^{13}C$ excursion similar to the global Pc-C boundary peak is confirmed, its stratigraphical position is ambiguous. Whether the Gaojiashan environmental setting represented a restricted ocean basin at the edge of the platform or remained frequently influenced by open ocean conditions remains unclear.

S13 – Constraining the end-Permian crisis in the Karoo Basin, South Africa: new data from the Eastern Cape Province

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The Karoo Basin, South Africa, holds a key stratigraphic record preserving evidence for the events that affected the terrestrial ecosystem during the end-Permian crisis in the Southern Hemisphere. To date, the Permian-Triassic Boundary (PTB) as identified in this basin is based primarily on vertebrate biostratigraphy – the extinction of

Daptocephalus leoniceps (= *Dicynodon lacerticeps*) – supplemented with a stable Carbon isotopic trend. Both data sets are used to correlate terrestrial events with those documented in the marine realm, reported to be coincident with the zenith of marine extinctions at ~ 252.28 ± 0.08 Ma. Stratigraphic sections in which the PTB is described include: Bethulie and Caledon (Free State); and Carlton Heights, Lootsberg Pass, Tweefontain, Wapadsberg Pass, and Commando Drift Dam (Eastern Cape Province). To date, few chronometric constraints are known for this part of the Karoo Supergroup, and those reported in the literature represent maximum detrital zircon ages.

At Wapadsberg Pass, a *Glossopteris*-rich fossil-litter (O) horizon is preserved above an aggradational, wetland paleosol in a stratigraphic position ~ 70 m below the PTB. The low diversity flora consists of glossopterid canopy detritus along with sphenophyll ground cover in which an array of invertebrates are identified. It is underlain by poorly developed inceptisols with an average CIA index of 80. The palynological assemblage recovered from this litter is assigned to a late Changhsingian age, with several early Triassic forms identified. The assemblage is preserved in association with a tuffaceous siltstone, and several beds of tuff exist in the burial sequence. Recently, a litter horizon and sedimentary sequence with tuff were collected in a donga exposure near Lootsberg Pass, ~ 12 km distance, which may provide the first true datum in this part of the stratigraphy.

Zircon grains recovered from tuffite units at Wapadsberg Pass were pretreated by chemical abrasion to remove both internal and external alteration zones. U and Pb were analyzed by isotope dilution thermal ionization mass spectrometry (ID-TIMS) methods using the EARTHTIME (ET535) tracer (spike). U-Pb zircon ages indicate components that cluster in the NeoProterozoic (~ 1.0 Ga and ~ 0.6 Ga), Early Cambrian (534 to 527 Ma), Middle-to-Late Ordovician (456 Ma), Late Carboniferous (307 Ma), Permian (275 to 253 Ma), and latest Permian. Ongoing sampling will better constrain the maximum age of the fossil assemblage, allowing for the first chronometric constraint on the duration of the *Glossopteris* flora in this part of the southern hemisphere.

S5 – An integrated paleo-environmental analysis of a marine transgressive sequence from the northern Tethyan margin: the Lutetian to Priabonian beds of Adelholzen (Helvetic Unit, Bavaria, Germany)

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The northern Tethyan margin is a key region for the understanding of paleoceanographic processes during the collision of continental and oceanic tectonic plates. The here investigated Middle to Late Eocene sediments were deposited during a period with instable climatic conditions. In order to quantify paleoenvironmental changes, we developed a detailed age model based on planktic foraminifera-, calcareous nannoplankton-, and larger benthic foraminifera-biozonations, as well as stable oxygen and carbon isotope records. Foraminiferal, calcareous nannoplankton, and macrofossil assemblages were analyzed for changes in paleo-water depth, mixing and stratification, paleo-primary productivity (pPP), food supply, and bottom water oxygenation. The section at Adelholzen covers the almost complete Lutetian (biozones NP15a-16, E9-11, SBZ13-15) and Priabonian Stages (NP18-20, E14/15), while the intermediate Bartonian Stage (NP17) is largely missing. Paleo-water depth estimates range from 50 m (middle neritic, early Lutetian) to 530 m (upper bathyal, late Priabonian). Calculated pPP vary between 0.5 and 6.3 mgC/cm^2 Ky with highest values during the late Lutetian. The combination of assemblage composition (all investigated taxa), planktic and benthic foraminiferal accumulation rates, and derived parameters (C-flux to sea floor, pPP) enabled us to identify at least five distinct paleoceanographic events of at least regional significance. The changes affected nutrient availability, food supply, and bottom water oxygenation in different ways. However, pPP-values correspond to those of the centers of modern tropical-subtropical anticyclonic gyres, indicating highly oligotrophic conditions throughout.

S21 – Cracking the mystery of conifer cone construction using micro CT — a preliminary report

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The structure of the conifer seed cone is often crucial for identification and differentiation between species, and is reflected in both the gross morphology and construction of the cone. In fossil cones, compressions usually only show gross morphology, while permineralizations may

yield more data on the cone's internal bauplan. Until now, the traditional approach with permineralized cones has been to produce serial sections by thin-sectioning with a rock saw, which results in the loss of information between sections and the ultimate destruction of the fossil. Because three dimensionally preserved cones are relatively rare, the use of a non-invasive and non-destructive technique that generates data on the internal construction of the cone is preferable. Micro CT is one excellent technique that can be used to make virtual sections of silicified cones to crack the mystery of their internal construction, without having to literally crack open the fossil. We have applied this technique to a number of Late Jurassic cones from the Morrison Formation. Several taxa of conifer cones have been collected in Utah and Wyoming, and the best preserved cones come from northeast Utah, west of Dinosaur National Monument. These well preserved cones – some of the first silicified cones to be described from the Morrison Formation – are slender and narrowly ellipsoid in shape. Their external morphology shows numerous overlapping cone scales, but it is not possible to discern the number of ovules per scale, nor any details of the vascular system. To study internal construction, several cones were scanned using a v|tome|x s by GE phoenix|x-ray. Orienting the cones in a perfectly upright position increased resolution in the scans, and it was necessary to scan the cones in only one direction (longitudinal). The data was processed and bundled into an image stack using VGStudio MAX 2.0 software. The different tissues in the cone were then color-coded using AVIZO 6.3® and 7.0 by VSG to produce a three-dimensional reconstruction of the internal cone structure, which shows very clearly the shape and angle of attachment of the cone scales, the size, shape, abundance, and arrangement of the seeds, and the net-like vascular system along the cone axis. The three-dimensional imaging of these cones from the Morrison Formation are compared to micro CT scans of a recent cone of Pinus pinea and a "mystery cone" from Wyoming. The combined use of the micro CT and 3D visualization software is proving to be a powerful, nondestructive, and graphically innovative method of studying and reconstructing silicified conifer cones.

S3 – The biomineralisation strategy of the extant sphinctozoan coralline demosponge *Vaceletia* and its affinities to the Lower Cambrian Archaeocyaths

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The now extinct Archaeocyatha were a globally distributed and taxonomically diverse group of animals, widely believed to have been an early lineage of sponges. These animals are ecologically significant to paleobiology because they were the first metazoan-reef builders to occur in the Phanerozoic (Lower Cambrian). Although archaeocyaths and sponges are the earliest branching metazoans to display "enzymatically controlled" modes of biomineralisation, little is known about the process of skeleton formation in these animals in general. Because of its archeaocyath-like skeletal morphology, *Vaceletia* (an extant coralline demosponge) has been called a "living fossil" and a modern archaeocyath. To date, some aspects of *Vaceletia*'s biology have been investigated including its histological features, biomarker content, microbial symbiont abundance and the possible role of these symbionts in biomineralisation. The living part of the animal grows by producing a series of chambers terraced one upon the other, which in turn are arranged upon a non-living hyper-calcified stalk, or basal skeleton. In the first step of basal skeleton formation a primary organic skeleton, composed of irregular thin fibres surrounding a thick filament, is constructed. This organic framework is subsequently mineralised by aragonitic calcium carbonate. In the second step, the underlying ontogenetically older chambers are filled up with calcium binding mucus, which is subsequently mineralized. Analyses of the calcified organic framework have shown that it consists of proteins and sugars rich in galactose, glucose and fucose, the latter suggesting that bacterial EPS (exopolymer substances) are involved in the biomineralisation process. Biomarker analyses of the fatty acid content of *Vaceletia* reveal high amounts of mid-chain-branched-fatty acids, indicating that *Vaceletia* is a high-microbial abundance (HMA) sponge. In support of this, histological analyses indicate that up to 50 % of *Vaceletia*'s biomass is of microbial origin. While *Vaceletia* seems to display a eukaryotic-like "controlled" mode of biomineralisation (cf. an "induced" mechanism displayed by bacterial biofilms), it is likely that *Vaceletia*'s considerable bacterial community is contributing to the process of skeleton formation. We are continuing to study the details of this interaction using a variety of molecular and geochemical techniques, with the aim of understanding how the ability to biomineralise first arose in this lineage of sponges. We hope the results of this work will also provide deeper insight into how the Archaeocyatha may have biomineralised.

S19 – Richard Dehm Collection of pakicetid astragali (Mammalia, Cetacea) from the Eocene of Pakistan

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Fifty-six years ago Richard Dehm collected Eocene mammals at Ganda Kas in Pakistan. He named two genera and species of 'Mesonychidae' that were later recognized to be primitive archaeocete whales: *Ichthyolestes pinfoldi* and *Gandakasia potens*. Two more archaeocetes were described later: *Pakicetus attocki* and *Ambulocetus natans*. Dehm focused on teeth and never described the substantial collection of isolated and sometimes broken Ganda Kas 'artiodactyl' postcranial elements in the Bayerische Staatssammlung für Paläontologie und Geologie.

'Artiodactyl' astragali in the Dehm collection are of four sizes. The smallest are artiodactyls and belong to *Khirtharia dayi*. However, larger 'artiodactyl' astragali have no corresponding dental taxa. Association of 'artiodactyl' astragali with crania of archaeocetes in *Rodhocetus*, *Artiocetus*, and *Maiacetus*, indicate that Dehm's larger astragali are archaeocetes as well. Based on size, these represent *Ichthyolestes pinfoldi*, *Pakicetus attocki*, and *Gandakasia potens*, respectively. In these species, width of the astragalar body is correlated with premolar length (r = 0.99). The allometric slope is 0.62. *Ambulocetus natans* has an even larger astragalus. Astragali of the four Ganda Kas archaeocetes have modal widths of about 11.6, 15.6, 21.1, and 28.5 mm, respectively, each about six standard deviations apart.

Astragali of *Pakicetus* and other early archaeocetes are similar to those of primitive artiodactyls in being relatively long and narrow. In pakicetids the body and head are aligned and nearly parallel, and the body is equal in width or a little narrower than the head. The tibial trochlea has a higher lateral keel, which is about twice the width of the medial keel. The head is similarly asymmetrical, with a distinct lateral cuboid facet forming a curved rim separated by a crest from the wider medial trochlea for the navicular. In contrast, in primitive artiodactyls like *Diacodexis* and *Bunophorus*, the head is angled and offset medially, and the distal trochlea is angled obliquely relative to the tibial trochlea. Counted as they are here, the astragalus of a pakicetid has nine articular surfaces: two for articulation with the tibia, one for the fibula, four for the calcaneum, one for the cuboid, and one for the navicular.

Pakicetid astragali differ from those of primitive artiodactyls in having a flatter and shorter sustentacular facet, which is only about one-third the length of the whole astragalus. Pakicetid astragali also have distinctly separated lateral facets for articulation with the fibular process of the calcaneum. Both indicate reduced mobility of the astragalus on the calcaneum, contradicting interpretation of pakicetids as cursorial terrestrial mammals. Most mobility in later archaeocetes is in the tibio-astragalar joint, and pakicetids were already semiaquatic foot-powered swimmers specialized in this direction. A pakicetid pedal phalanx in the Dehm collection is similar to those of protocetids like *Maiacetus* in being long, broad, and flat.

S4 – Aging, maturation and growth of sauropodomorph dinosaurs as deduced from growth curves using long bone histological data

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Information on aging, maturation and growth is important for understanding life-cycles of organisms. In extinct dinosaurs, such information can be derived from the histological record of growth in the mid-shaft cortex of long bones. We constructed individual growth curves to estimate ages at death, ages at sexual maturity, ages were individuals are fully grown, and maximum growth rates based on growth records preserved in long bones of seven Sauropodomorpha. In particular, we studied six sauropod (one cf. *Mamenchisaurus*, two *Apatosaurus*, two indeterminate diplodocids, and one *Camarasaurus*) and one prosauropod dinosaur (*Plateosaurus*). Using the individual estimates obtained from growth curves, we established allometries for life-cycle characteristics. Growth models considered for each specimen were the von Bertalanffy model, the Gompertz model, the logistic model (LGM), and the Chapman-Richards model (CRGM). The inflection point of the growth curve is commonly used as an estimate of the age at sexual maturity, because unambiguous indicators of maturity in fossils are rare. While the first three growth models have an inherently fixed location of the inflection point, its location is flexible in the CRGM and thus the age of sexual maturity is explicitly estimated from the growth record. We subjected the different growth models obtained for each of the specimen to an AIC-based model selection process and based the estimation of life-cycle characteristics on the best growth model.

In accordance with several other studies on dinosaurs the LGM was the best model for our sample. Allometries established from our sample are consistent with literature data on other Sauropodomorpha. Our sauropods and the prosauropod needed a time span similar to extant megaherbivores to become fully grown and had similar maximum growth rates as seen in modern megaherbivores and ratites, but growth rates of Sauropodomorpha were lower than of an average mammal. Sauropodomorph life spans probably were shorter than in scaled-up ratites and even more so than in extant megaherbivores. As ratites are precocial and because in extant species mortality decreases with increasing body size the comparatively short life spans in Sauropodomorpha provide further evidence that this taxon could have been precocial. Sauropodomorpha reached sexual maturity later than megaherbivores and ratites. This could have been compensated for by a higher reproductive output facilitated by a larger body size.

In total, aging, maturation and growth patterns in Sauropodamorpha are consistent with those seen in recent megaherbivores and today's largest birds. Insights from the comparison of Sauropodomorpha studied with extant large taxa seem to be consistent with our previous knowledge about the life-cycle of these dinosaurs. We conclude that similar trade-offs and environmental factors could have shaped the life-cycle of extinct Sauropodomorpha and of extant megaherbivores and ratites.

S20 – Carnivora from the Miocene of Southern Asia and Africa: biogeographical implications

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Carnivoran mammals constitute one of the major components of terrestrial and aquatic ecosystems. They are taxonomically well-diversified and widely distributed during the Neogene period. They first appear in Africa during the early Miocene, broadly contemporaneous with the formation of the 'Gomphotherium land bridge'. Throughout the Miocene, the main African dispersal events involving Carnivora are characterized by the immigration of Eurasian taxa, comprising a substantial component of Southern Asian diversity. Unlike the extensive Siwalik Hills fossil record, Southeast Asian faunal communities are still poorly known, although recent discoveries enhanced their significant role in the biogeographical evolution of mammals. Here we describe new carnivoran faunas from the Middle Miocene of Thailand and Myanmar, from which only few and fragmentary records were previously known. These new faunas include several species of viverrids, mustelids, amphicyonids, felids, and a possible herpestid, and show specific and/or generic similarities notably with carnivoran assemblages from the Middle and Late Miocene of the Siwalik Hills (Pakistan and India), from the Late Miocene of the Yunnan province (China), and from several Early to Late Miocene localities in Africa. We mainly focus our study on two new occurrences of otters (Mustelidae, Lutrinae) from the late Middle Miocene of Chiang Muan and Mae Moh basins (Northern Thailand), from which otter-bearing levels are magnetostratigraphically dated between 12.4-12.2 Ma and 14.2-13.2 Ma, respectively. We report a new species of the piscivorous genus *Vishnuonyx*, previously recorded in the Middle and Late Miocene of Kenya and in the Middle Miocene of Pakistan and India, as well as the oldest occurrence of the bunodont genus *Sivaonyx*, of which numerous remains are found in the Mio-Pliocene of Central, Eastern and Southern Africa, and in the Late Miocene of Southern Asia. These data reinforce the hypothesis of an Asian origin for *Vishnuonyx* and *Sivaonyx*, with subsequent dispersal events into Africa between the late Middle and the early Late Miocene. Morphological similarities between *Vishnuonyx* and the Mio-Pliocene eastern African *Torolutra* are noted. We also discuss the primitive morphological features of the Asian *Sivaonyx* species, which give rise to the *Sivaonyx-Enhydriodon* bunodont lineages, common gigantic otters of Mio-Pliocene African ecosystems.

S3 – Gastropod palaeoecology of a Permian fauna from Coleman, Texas

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An Early Permian gastropod dominated fauna (Wolfcampian, 290 million years ago) from Coleman, Texas is described and interpreted in terms of diversity and palaeoecology. The benthic fauna consists mainly of gastropods. In addition it contains ostracodes, bryozoans, echinoderm ossicles, microconchids and rare scaphopodes. Moreover land plant remains are present. The gastropod fauna contains terrestrial and marine forms. Among the latter, the neritimorph *Naticopsis* is especially abundant. They have a special wrinkle structure of the shell and are covered with cements. Shell features and crust could be either typical for this species or a result of diagenesis. The microstructure of the *Naticopsis*-shell was studied with scanning electron microscope (SEM) and energy-dispersive X-ray spectroscopy (EDX). The crusts on the *Naticopsis* shells were formed during early diagenesis after the death of the specimens. The formation of the unusual wrinkled shell surface of the *Naticopsis* at Coleman is still unclear. The SEM- and EDX-analyses showed inclusions of silica in the outer calcitic shell layers of the gastropods.

The sediment was sieved and then sorted. The diversity of the gastropod fauna is low when compared with fully marine gastropod faunas such as that from the Permian Akasaka Limestone (Japan, Capitanian) and the Late Triassic fauna of the Mission Creek, (USA, Idaho, Norian). The fauna of Coleman represents a mixture of terrestrial and marine organisms.

The depositional environment is interpreted as a coastal lagoon with a small gateway to the open ocean at the downwind side of the continent. The water was brackish with a high variability of salinity (euryhaline). The area was situated in the tropics with warm temperatures and probably with periods of heavy rain. The plant components and terrestrial gastropods were transported into the lagoon via runoff.

S13 – Slipped through the bottleneck – a Palaeozoic echinoid from the Triassic Muschelkalk

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The mass extinction at the Permian/Triassic (P/T) boundary has caused the most dramatic decline in echinoderm diversity. Even the five extant clades that survived into the Mesozoic suffered a severe diversity loss before their post-Palaeozoic recovery commenced. With an exception of the ophiuroids, their Early Triassic fossil record is extremely poor. While the major diversification of the Crinoidea and their adaptation to different niches took place during Triassic times, almost all Triassic echinoids remained vagile epibenthic browsers. Traditionally, all post-Palaeozoic echinoids were considered offsprings of the Late Permian through Early Jurassic miocidarids. The Anisian fossil record, best documented in the Germanic Muschelkalk by complete specimens, comprises the well-known families Triadotiaridae and Serpianotiaridae displaying both cidaroid and euechinoid characters, and the incompletely known Triadocidaridae. The Triassic echinoid diversity indicates that at least three lineages have crossed the P/T boundary. However, all stem group echinoids with more than two rows of ambulacrals and interambulacrals were considered extinct before the end of the Palaeozoic.

Here, an unexpected find of a stem group echinoid from the Middle Triassic (late Anisian) Upper Muschelkalk of Eastern France is reported, which modifies the currently accepted concept of their extinction at the P/T boundary. Due to its imbricating ambulacral and interambulacral plates, the 31 mm wide, slightly lobated, flat test was highly flexible and compressed dorsoventrally without fractures. Except the apical system, which was lost when the specimen was collected, all characters are present. The number of the small polygonal, adorally imbricating ambulacrals is adapically less than 6 and increases to 12 below the ambitus. The pore pairs are adorally slightly larger than adapically. Peripodial rims could not be seen. Above the ambitus are five rows of adapically imbricating interambulacrals, the number of which is gradually decreasing to one singe rhomboidal plate at the peristome. The peristome is formed by ambulacrals with large pore pairs. The adoral ambulacrals have small indistinct tubercles, which may bear short, needleshaped spines. The lantern is preserved *in situ* but its apical part was lost together with the apical system. On the adoral side, some of the small teeth are visible.

The test plating suggests inclusion of the echinoid into the Early Carboniferous to Late Permian Proterocidaridae as a new genus. This Palaeozoic hangover modifies the P/T survival scenario that was not as simple as previously thought, and the extreme bottleneck paradigm must be considered as untenable. Moreover, isolated stem group echinoid ambulacrals from the Carnian of Central China give evidence for survival of Palaeozoic hangovers until Late Triassic times.

S2 – Deciphering the phylogenetic distribution of extinctions: a case study of Pliensbachian ammonites

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The disappearance of species has become a major scientific and societal concern in recent decades, and conservation biologists are devoting considerable effort to understanding current extinctions and their potential consequences. Palaeontologists, on the other hand, contribute to the debate by putting the current loss of biodiversity into a deep-time perspective. These two approaches to the study of extinction are currently converging as they both increasingly incorporate the same factor: phylogeny. This conceptual and methodological convergence has already revealed that the distribution of taxa currently threatened with extinction and past extinctions are phylogenetically non-random: taxa in some lineages are consistently more extinction-prone than others. This phylogenetic clustering is frequent at several spatial and temporal scales, suggesting that extinction-related key traits (or combination of traits) are themselves phylogenetically conserved.

However, there is currently no consensus on how to quantify the phylogenetic signal of extinction (which is treated as a binary variable). Proposed techniques involve the Moran's *I* autocorrelation coefficient, the Pearson's correlation coefficient, or indices using the sum of sister-clade differences. These approaches differ in their exploitation of taxonomic/phylogenetic information and in their ability to yield comparable measures of phylogenetic signal strength.

Moreover, there is a dearth of quantitative studies dealing with the phylogenetic distribution of extinctions in the geological past. There is currently no high-resolution study on that subject, and evolutionarily dynamic clades (i.e., clades with high rates of taxonomic turnover) have not been investigated in that perspective.

We therefore present a species-level dataset on ammonites (extinct cephalopods) of the early Pliensbachian (Early Jurassic, 189.6 Ma –183 Ma). Our dataset has one of the finest temporal resolutions available for such a remote geological interval, and it concerns a diverse clade with an excellent fossil record. We review the approaches used to quantify the phylogenetic selectivity of extinc-

tions and extinction risks, and we apply them to address the following questions: are early Pliensbachian ammonite extinctions phylogenetically clustered? If so, what are the phylogenetic levels concerned? How does that pattern vary over geological time and when the temporal resolution changes? To what extent does the survival of species correlate with the clustering of extinctions?

We found that ammonite extinctions were significantly clustered phylogenetically, a pattern that prevailed throughout the 6.6 Myr-long early Pliensbachian interval. This phylogenetic conservatism did not alter – or may even have promoted – the evolutionary success of this major cephalopod clade. However, the comparison of phylogenetic autocorrelation among studies remains problematic because the notion of phylogenetic conservatism is scale-dependent and the intensity of the signal is sensitive to temporal resolution. We recommend a combined use of Moran's *I*, Pearson's φ and Fritz and Purvis' *D* statistics because they highlight different facets of the phylogenetic pattern of extinctions and/or survivals.

S12 – Conodont age and correlation of the transgressive *Gonioclymenia* and *Kalloclymenia* Limestones (Famennian, Anti-Atlas, SE Morocco)

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The widely quarried and commercially exploited *Gonioclymenia* Limestone of the Tafilalt (Anti-Atlas, SE Morocco) represents a transgressive but strongly condensed and shallowing upwards unit that overlies unconformably or conformably Lower Devonian to Famennian deposits. It is characterized by abundant, large to giant-sized *Gonioclymenia speciosa*, which characterizes the Famennian V-B. Large slabs sold in rock shops indicate a direct association of *Gonioclymenia* and *Kalloclymenia subarmata*. *Gonioclymenia speciosa* can be recognized in many localities, but a massive marker limestone is restricted to the western and southern (e.g. Amessoui Syncline) part of the hemipelagic Tafilalt Platform. At Jebel Kfiroun South (southwest of Taouz), red iron crusts or nodules are intercalated. The first record of the *Gonioclymenia* Limestone goes back to Hollard (1960). Later, Ginter et al. (2002) described shark teeth from the upper Famennian sections of the Amessoui Syncline. They noted the presence of *Bispathodus ziegleri* (= *B. ultimus* M2 sensu Ziegler & Sandberg1984) in the *Gonioclymenia* Limestone of Oum el Jerane, which was consequently assigned to the *B. ultimus* (= former Upper *expansa*) Zone. It was recognized that the conodont age was in conflict with the ammonoid-conodont correlation elsewhere, but preference was given to the conodont dating. New samples show that conodont faunas of the true *Gonioclymenia* Limestone fall in the *B. costatus* Subzone of the *B. aculeatus aculeatus* (= former Middle *expansa*) Zone, which is regionally first recognized. A rare outcrop within a trench at Jebel Ihrs West was exposed for a brief interval. There, the *Gonioclymenia* Limestone was separated from an overlying second limestone with *Kalloclymenia* by a thin unit of deeply weathered marly shales. This *Kalloclymenia* Limestone provided the known conodont fauna of Ginter et al. (2002) with both morphotypes of *B. ultimus*. In addition various early siphonodellids occur. Joint occurrences of *Gonioclymenia* and *Kalloclymenia* are apparently caused by extreme condensation or are artificial assemblages based on the joint mounting of specimens from different layers. There is no evidence for a regional co-occurrence of both genera. This is supported by correlation into thicker sections of the Maider and Tafilalt Basin. Thus, *Kalloclymenia subarmata* is re-installed as a marker species of the Wocklumian UD VI-A. The Tafilalt *Gonioclymenia* Transgression may represent the regional expression of a eustatic pulse in the higher part of the *B. aculeatus aculeatus* Zone that is known on the Ardennes Shelf as the Epinette Event. The *Kalloclymenia* Limestone was formed during a different transgressive episode in the uppermost Famennian.

S25 – Solar cycles control ecological windows for lake bottom settlement by bivalves during the late Miocene

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A high-resolution multi-proxy analysis was conducted on a 6-m-long core of Tortonian age (~10.5 Ma; Late Miocene) from Lake Pannon (Austria). The sediments of Lake Pannon were studied with a 1-cm resolution to detect all small-scale environmental variations. Based on an already established age model for a longer interval of the same core, the study covers about eight millennia of Late Miocene time with a resolution of ~13.7 years per sample. Palynomorphs and ostracods were already documented to reveal distinct and repetitive shifts, which seem to be related to solar cycles. Herein we extend the study on molluscs, which were picked from the samples. As the shells were fragmented during washing, no individuals could be counted. Therefore, the abundance of molluscs was evaluated by using semi-quantitative cate-

gories: 0 = no fragments at all, 1 = rare fragments, 2 = frequent shell fragments, 3 = coquina layers with numerous fragments. Generally, molluscs are rare in most samples, indicating hostile conditions for bivalve settlement. The taxonomy of the represented species is well known from earlier studies on distinct coquinas from the same section and levels. The coquina layers are formed mainly by the small-sized, thin-shelled dreissenid bivalve *Sinucongeria primiformis*. It forms moderately dense pavements by monospecific gregarious assemblages. Most specimens are articulated and fully grown whereas juveniles are very rare. The assemblages represent characteristic “boom and bust” populations, which formed during sporadically established suitable conditions for settlement. The few mm-thin coquinas, comprising only one or maximally two generations, persisted as census assemblages for a few years on the otherwise rather hostile, poorly oxygenated lake bottom. Shell cavities are commonly incrusted with pyrite, pointing to anoxia as a cause both for their sudden death as well as for the missing displacement by bioturbation. Hence, the formation of bivalve pavements on the bottom of Lake Pannon was only possible for extreme r-strategists forming temporal boom-and-bust populations during “time windows” of improved ecological conditions. These opportunities are interpreted here to correlate with cyclic shifts in the epilimnion/hypolimnion relation and the corresponding oxygenation of bottom waters. Indeed, Lomb-Scargle periodograms and REDFIT analyses of the data revealed highly significant signals with periodicities of ca. 11, 37 and 75 cm. These cyclicities are expressions of the upper Gleissberg cycles, the 500-years cycle and the 1000-years cycle. This indicates that bottom water oxygenation and nutrient supply were strongly influenced by these solar cycles. This presentation is part of the FWF Project P21414-B16: Millennial- to centennial vegetation dynamics and surface water productivity in and around Lake Pannon.

S25 – Biostratinomie vollständiger Holothurien in einer unterdevonischen Echinodermen-Lagerstätte der argentinischen Präkordillere

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Holothurien (Echinodermata) sind wegen der weitgehenden Miniaturisierung bis völligen Reduktion der Skelettelemente ihrer Körperwand nur unter sedimentären Sonderbedingungen oder aufgrund sekundär verstärkter Wand-Skelettierung als vollständige Fossilien erhaltungsfähig. Aber auch dann sind sie in ihrer Wurm- oder Wurstform gewöhnlich eher unscheinbare Objekte. So wurde vor über 100 Jahren in einer Siltsteinlage des höheren Unterdevons der argentinischen Präkordillere eine Assoziation verschiedener Echinodermen (Asteriden, Ophiuren, Crinoiden u.a.) registriert und z.T. beschrieben; die darin ebenfalls enthaltenen kleinen Holothurien (*Andenothyone gondwanensis*) konnten aber erst viel später nachgewiesen werden.

Inzwischen wurde mehrere Kilometer entfernt in stratigraphisch etwa gleichaltrigen Schichten eine Siltsteinbank mit einer ähnlich zusammengesetzten Echinodermen-Fauna gefunden, die aber nicht nur *Andenothyone*, sondern auch noch zahlreiche Exemplare einer sehr großen, ungewöhnlich stark skelettierten Holothurie (*Prokrustia tabulifera*) enthält. Die einzelnen Echinodermen liegen meist regellos verteilt, teils in normaler (Mund-unten) Position, teils invers (Ophiuren, Asteroiden), teils im gleichen Niveau, teils "schwimmen" sie in unterschiedlicher Höhe im Sediment. Nur einige dreidimensional erhaltene Exemplare von *Prokrustia* zeigen auch eine hochgerichtete, angenähert J-förmige geopetale Orientierung.

Bei den Fund-Schichten handelt es sich um eine Abfolge grünlich-grauer Siltsteinbänke in meist von *Zoophycos*-Fächern durchsetzten dunklen, siltigen Tonschiefern. Sie werden als Sedimentfächer gedeutet, in denen bei Sturmereignissen aufgewirbeltes Material in beckennahe Bereiche transportiert und abgelagert wurde. Von Trübeströmungen mitgerissene Echinodermen fallen wegen ihres geringen spezifischen Gewichts wohl erst später aus und werden so teilweise durch Transport-Saigerung lokal konzentriert. Wahrscheinlich konnten aber auch beckennahe Echinodermen-Kolonien von distal nur noch schwachen Strömungen leicht umgelagert und verschüttet werden. Die vorliegende Assoziation ist wahrscheinlich durch einen solchen biostratinomischen Prozess entstanden.

Die ungewöhnliche, aufrecht J-förmige Stellung einiger Individuen von *Prokrustia* könnte anzeigen, dass diese in einem Trübestrom transportiert und zufällig so verformt und orientiert eingebettet wurden. Dann sollte es aber auch Stellungen geben, in denen die J-Enden nach unten gerichtet sind. Diese fehlen jedoch in dem vorhandenen Material.

Die starke Skelettierung der Körperwand von *Prokrustia* aus großen, unregelmäßig gerundeten Platten, die sich randlich regellos überlappen, lässt vermuten, dass eine derartig „gepanzerte“ Holothurie epibenthisch, auf der Sedimentoberfläche lebte. Viele Platten haben 2-5 unterschiedlich große Poren. Wahrscheinlich handelt es sich dabei um Durchtrittstellen der hydrocoelen Blindkanäle von Ambulacralfüßchen (Podien), die hauptsächlich dem Gasaustausch, teilweise auch zur Fortbewegung dienten. Stärkere Überlappung der Platten im konkaven Bereich der J-Form entspricht einer Wandverkürzung, d.h. neben einer passiven auch einer möglichen aktiven Einkrümmung des Körpers. Anzeichen reziprok unterschiedlicher Überlappung der Platten in longitudinaler und peripherer Richtung läßt auf differenzierte Kontraktion des ganzen Körpers schließen, die einer peristaltischen (Fort-) Bewegung gedient haben könnte. Aufrechte geopetale Stellungen bei *Prokrustia* werden deshalb als Fluchtreaktion einiger nach Verschüttung noch vitaler Individuen

gedeutet. Das physiologische Potential mancher rezenter Holothurien stützt eine solche Interpretation. Für die mit *Prokrustia* in der Echinodermen-Kolonie zusammen lebende kleine *Andenothyone* gilt dies aufgrund fehlender biostratinomischer Hinweise allerdings nicht.

S26 – Evolution of functional body regions in arthropods – A combined palaeontological and neontological approach

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Arthropods are generally considered as the most successful animal group. Part of this success results from the division of their body into functional units (tagmata). The question how these patterns of tagmosis evolved is under debate since long, but usually only modern groups, which have a relatively uniform tagmosis are included into analyses; fossils are often excluded. For my analyses I combined palaeontological and neontological data, also including developmental information, focussing on A) the head formation (cephalisation), which is linked to the formation of a dorsal head shield, and B) the specialisation of the appendages, which results in a ventral tagmatisation. Examples are listed in the following.

1) Already in the earliest representatives of Arthropoda *sensu lato*, lobopodians, cephalisation can be observed. My co-authors and I recently described a new Carboniferous lobopodian (Mazon Creek) with a pronounced head region including a much smaller appendage pair, which was probably not used for walking.

2) In the ground pattern of Arthropoda *sensu stricto* only the first appendage-bearing segment belongs to the head tagma. To reach the head of Euarthropoda (eye segment and four appendage-bearing segments) further segments were incorporated into the head in the course of evolution. One candidate along this evolutionary way is *Sarotrocercus oblitus* (Burgess Shale), which according to a recent reinvestigation with my contribution has a head with the eye segment and three appendage-bearing segments.

3) Within chelicerates an impressive example for appendage specialisation occurs. The first appendage pair of modern chelicerates is modified as prehensile claws consisting of only two to three elements. However, in the earliest chelicerates, great-appendage arthropods, the first pair of appendages consists of more elements, which were successively reduced during evolution. This evolutionary scenario was erected by my collaborators and me based on new data from *Yohoia tenuis* (Burgess Shale).

4) Later during chelicerate evolution the body became subdivided into two more or less pronounced tagmata, pro- and opisthosoma. The proximal parts of the prosomal appendages became a specialised feeding apparatus, which is usually not known in fossil representative. Yet recently my collaborators and I described relatively complete and three-dimensionally preserved feeding apparatuses of Carboniferous horseshoe crabs (Xiphosura) with the mouth opening.

5) Also within crustaceans certain tagmata evolved into specialised feeding apparatuses, e.g., in mantis shrimps (Stomatopoda). Here my collaborators and I found a new morphotype of raptorial apparatus in the Jurassic Solnhofen limestones based on which we reconstructed an evolutionary scenario with a stepwise transformation of the raptorial apparatus from Carboniferous stomatopods to modern ones.

All these new data became only available through the use of modern imaging techniques, including for example fluorescence microscopy. As many fossil and extant specimens show autofluorescence, fluorescence imaging allows a non-destructive documentation of the specimen.

S25 – Ein Bild sagt mehr als tausend Worte – Ein Aufruf für mehr Abbildungen in wissenschaftlichen Publikationen

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„Ein Bild sagt mehr als tausend Worte" ist ein bekannter Spruch, und er behält auch in der Wissenschaft seine Richtigkeit. Komplexe wissenschaftliche Zusammenhänge lassen sich durch Bilder meist weitaus leichter und effektiver vermitteln als durch textliche Erläuterungen. Text kann lediglich eindimensional darstellen, da er stets nur in Lesrichtung verstanden werden kann, während Abbildungen Zusammenhänge zumindest zweidimensional, bei gekonnter Darstellung auch drei- oder mehrdimensional darstellen können. Dies beginnt bereits bei der Abbildung von einzelnen Stücken. Neue Funde von Fossilien sinnvoll zu interpretieren erfordert nicht nur eine ausführliche Dokumentation und Darstellung der Stücke, sondern im besten Fall auch eine vergleichbare Darstellung verwandter und vergleichbarer Fossilien. In den meisten Fällen erfolgt solch ein Vergleich in Form von Verweisen auf Literatur. Für den Interessierten, der kein Experte auf diesem Gebiet ist, ist diese Art von Vergleich jedoch oft aufwändig und das Auffinden gerade älterer und nicht elektronisch verfügbarer Literatur schwierig bis unmöglich. Des Weiteren erschweren auch stilistische Unterschiede in der Darstellung einen Vergleich der eigentlichen Morphologie. Neben der Weiterentwicklung moderner Bild-

gebungsmethoden, wie etwa Computertomographie, Mikroskopie und Digitalmakrophotographie, hat sich auch die zeichnerische Darstellung weiterentwickelt. Scanner erlauben es Ausgangsdarstellungen einfach zu digitalisieren. Mit Hilfe moderner vektorbasierter Computerprogramme ist ein unproblematisches Nachzeichnen mit standardisierter Darstellung leichter als früher und für den nicht professionell Zeichnenden meist auch schneller zum Erfolg führend. Als Beispiel für diese Herangehensweise haben wir Darstellungen von Knochenfunden des Kopfes fossiler Elefanten nachgezeichnet. Die Ausgangsliteratur umfasst zum Teil mehr als 100 Jahre alte Literatur, aber auch Fachartikel der letzten Jahre. Die Abbildungen, die als Ausgangspunkt für unsere Nachzeichnungen dienten, beinhalten fotografische wie auch zeichnerische Darstellungen unterschiedlichen Detailgrades. Nach dem Nachzeichnen der Umrisse wurden Schattierungen und Einfärbungen bestimmter Strukturen wie der Zähne hinzugefügt. Durch die Anfertigung der Nachzeichnungen in einem vektorbasierten Grafikprogramm ist das abschließende Anpassen von Linienstärken und Schattierungsintensität unproblematisch. Das Ergebnis kann als Grundlage für die Vermittlung verständlicher evolutionär-morphologischer Vergleiche dienen. Computerprogramme wie die hier verwendeten gibt es auch als Open-Access-Varianten für Jedermann zum Herunterladen, z.B. Inkscape: inkscape.org.

S11 – A Cambrian morphotype in the Carboniferous: a long-legged, non-onychophoran lobopodian from the Mazon Creek Fauna

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Lobopodians are principally worms with legs. They represent the evolutionary oldest representatives of Arthropoda (sensu lato). In the Cambrian, two major morphotypes of lobopodians can be distinguished: 1) Short-legged forms, which have stout, conical appendages that are shorter than the diameter of the body, and 2) long-legged forms, which have tubular appendages that are at least twice as long as the body diameter. Short-legged forms are also found among the modern fauna: Onychophora and Tardigrada are both representing this morphotype. Also in the post- Cambrian fossil record the short-legged forms are represented, e.g., in the Silurian, the Carboniferous or the Eocene. Long-legged forms were thought to go extinct in the uppermost middle Cambrian with the spectacularly 3D-preserved *Orstenotubulus evamuellerae* being the youngest representative of this morphotype to date. We report here a single fossil, representing a new, much younger species of long-legged lobopodians, *Carbotubulus waloszeki* from the late Carboniferous Mazon Creek fauna. The specimen has a worm-like body with ten pairs of elongated, tube-like, laterally oriented appendages that are more than twice as long as the body diameter. The anterior part is drawn out into a long proboscis-like snout. The first pair of appendages is slightly set off from and significantly smaller than the succeeding appendages. This indicates that the animal possesses a functional head tagma. This supposed ancient morphotype co-occurs with a representative of one of the most modern morphotypes within lobopodians, an onychophoran, *Ilyodes inopinata*. The specimens of *I. inopinata* found in Mazon Creek show an exceptional preservation of the body annulation, a significantly larger number of appendages compared to *C. waloszeki*, fine papillae absent in *C. waloszeki* and a more complex head, including antennae, jaws and slime papillae. The long-legged lobopodians thus did not go extinct in the late Cambrian, but survived significantly longer. This is a further example of a presumably "typical" Cambrian morphotype, which survived significantly longer. Findings like the one described here thus dampen the supposed major extinction at the end of the Cambrian.

S11 – Functional morphology of *Leanchoilia superlata* (Megacheira, Chelicerata sensu lato) from the Burgess Shale (middle Cambrian, British Columbia, Canada)

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Leanchoilia superlata is the most common representative of a group called great-appendage arthropods in the fauna of the famous middle Cambrian Burgess Shale Lagerstätte. Great-appendage arthropods are early representatives of the evolutionary lineage of chelicerates and thus are crucial for understanding the early evolution of this very successful group of sclerotised arthropods. *Leanchoilia superlata* was often considered as a sluggish animal, feeding

as a scavenger or even on mud. We reinvestigated more than 1000 specimens present in the large collection of the Royal Ontario Museum, Toronto, with modern imaging techniques such as polarised-light macrophotography and composite imaging. Our reinvestigation demonstrates that *L. superlata* is, in contrast to earlier interpretations, a very agile predator. The first appendage, termed great appendage, consists of six elements as in other closely related species such as *Yohoia tenuis*. The armature, large size and orientation of this appendage indicate that it was used for capturing prey, although in a different manner to other great-appendage arthropods that used their great appendage similarly to modern mantis shrimps. The second appendage of *L. superlata* is very small and equipped with elongated setae, functionally acting as a specialised mouth part. All successive appendages possess a massive basipod with median armature that was used in food processing; a large membranous area allowed a movement reminiscent of the mandibles of some modern crustaceans. Also the endopod with its seven segments was equipped with median setae and was most likely not used for walking, but involved into the feeding process. The large paddle-shaped setose exopods are divided into two units that allow to partly fold the exopod during the recovery stroke, while stabilising it during the power stroke, demonstrating that *L. superlata* was an effective swimmer. This interpretation is supported by the finding that *L. superlata* does not possess a broad body as previously suggested, but has a slender central body proper that allows flexing it into various directions. The impression of a massive body has been caused by very elongate, almost wing-like tergopleura. Our reinvestigation of *L. superlata* demonstrates that a detailed morphological investigation of these fossils is crucial for a sound autecological interpretation of early animals and with this form a basis for the evolution of early ecosystems.

S13 – An arthropod Lagerstätte in the Norian (Late Triassic) of Seinstedt, eastern Lower Saxony

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Outcrops near Seinstedt in the northern foreland of the Harz Mountains (eastern Lower Saxony, Germany) show a rare example of a continuous section of Late Norian to Early Rhaetian age with biostratigraphic control by conchostracans. The outcrops have yielded an exceptional association of well preserved fossils, especially within the Late Norian part of the section. Sediments and fossils indicate lacustrine deposits within a floodplain environment. In addition to diverse insects and conchostracans, there are a still undetermined syncarid, decapod malacostracans and a xiphosuran (*Paleolimulus fuchsbergensis* Hauschke & Wilde, 1987). Vertebrates are represented by articulated fishes (Semionotiformes), scales of presumptive coelacanthiformes, and a single historic record of a prosauropod humerus (*Plateosaurus* sp.). Plant remains typical of a Late Triassic/Early Jurassic Laurasian flora include fragments of conifers (*Hirmeriella muensteri*; cones of Cheirolepidiaceae), Equisetopsida and other groups.

Insect remains are rather common in the claystone; venation and even colour are well preserved. In most cases the fossil insects are isolated wings, indicating a long time of floating at the water surface before burial. Currently, there are more than 60 specimens known from nine orders, including several new taxa. Cockroaches (Blattodea) are most common with considerably more fore- than hindwings. The Elcanidae (Orthoptera: Ensifera) are also common with one or two species of *Archelcana* Sharov, 1968. Wing fragments of larger orthopterans probably belong to Hagloidea. Insects with aquatic larvae are represented by mayflies (Ephemeroptera), dragonflies (Odonata: Protomyrmeleontidae, Italophlebiidae), water beetles (Coleoptera) and nematoceran dipterans (Diptera: Eoptychopteridae) in addition to some aquatic larvae of yet unknown affinities. Scorpion flies (Mecoptera) include species of *Pseudopolycentropus* Handlirsch, 1906 and *Mesotanyderus* Riek, 1955. A fragmentary hymenopteran forewing probably belongs to *Sepulenia* Rasnitsyn, 1968 (Hymenoptera; Sepulcidae). A new species, *Ipsvicia langenbergensis* Barth, Ansorge & Brauckmann, 2011 was recently described and three specimens of a dysmorphoptilid homopteran (Homoptera: Dysmorphoptilidae) were recorded, two of which are complete specimens.

In conclusion, the outcrops near Seinstedt are among the most promising Late Triassic insect localities in Europe. The fauna contains typical late Triassic and early Jurassic elements. Biogeographically, some taxa with close Gondwanan relationship are most remarkable.

S6 – Different developmental patterns between ankylosaur and stegosaur osteoderms: implications for the behavior variations among thyreophoran dinosaurs

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Ankylosaurs and stegosaurs are characterized by huge and bizarrely shaped osteoderms. Their function and evolution remain controversial. Proposals for possible functions have included defense, display, species recognition, and thermoregulation. In this study, we explored developmental patterns in the osteoderms of the ankylosaur *Pinacosaurus* and stegosaur *Stegosaurus* to shed light on the evolutionary history and functional implications of osteoderms in thyreophorans.

Late juvenile *Pinacosaurus* lack large postcranial osteoderms, with the exception of the cervical half-rings and small bony ossicles. This developmental delay of osteoderm formation with respect to the body skeleton is similar to living reptiles. Contrary to this, a juvenile *Stegosaurus* (DMNH 33359) already has a well-developed dorsal plate. Additionally, a histological comparison between the body skeleton and osteoderms of a growth series of *Stegosaurus* shows that the osteoderms continue to grow well after skeletal maturity has been reached. In terms of evolutionary heterochrony, these observations indicate predisplacement and hypermorphosis in stegosaur osteoderm evolution.

Developmental variations of *Pinacosaurus* and *Stegosaurus* osteoderms are observed in their cortical histology. The thickness of collagen fiber bundles in *Pinacosaurus* osteoderms and cortical bone of *Stegosaurus* spikes increases from juvenile to adult. All *Stegosaurus* osteoderms and *Pinacosaurus* ossicles are comprised of metaplastic bone, but juvenile *Pinacosaurus* cervical half-rings show periosteal bone deposition, with typical woven bone tissue as seen in the long bones.

Also, important histological differences exist between adult individuals of *Pinacosaurus* and *Stegosaurus* osteoderms. In *Pinacosaurus*, the structural and histological features of osteoderms (cranial osteoderms, cervical half-rings, and clubs) are similar to those of small osteoderms embedded in the skin in that both have thin compact bone surrounding thick cancellous bone and abundant collagen fibers. In contrast, the spike-shaped osteoderms of *Stegosaurus* have a uniform structure that differs markedly from the plates in having thick cortical bone. Both spikes and plates lack abundant, thick collagen fiber bundles. This suggests that *Stegosaurus* spikes and *Pinacosaurus* osteoderms were reinforced but by different strategies and for different purposes, i.e., inflicting wounds and protecting against penetration by teeth, respectively. *Stegosaurus* plates, on the other hand, have a weaker structure due to their spongious structure and their function was more likely for species recognition, display, and/or thermoregulation. Therefore, these results suggest that, by using different functional osteoderms, behavior may have varied between different thyreophorans.

S25 – Diversity and phylogeny of extant and fossil cervids (Ruminantia, Artiodactyla)

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Cervids form the second most diverse family of living ungulate mammals; a number of successive, adaptive radiations since their first appearance in the fossil record 19 million years ago (early Miocene) led to the diversity seen in the extinct and extant fauna. Despite their widespread distribution, ecological, economic and cultural popularity, knowledge on their morphological and molecular diversity is deficient effecting many questions related to the taxon, particularly its intrafamilial phylogenetic relationships.

In this study, morphological data, consisting of 150 craniodental characters, and molecular data from fossil and living cervids are compiled for the first time to get more insight into phenotypic and genotypic diversity. Previous studies generally focused on subsets of data, i. e. including either fossils or living cervids or using either morphological data or molecular data. Molecular data, comprising of some or all of the mitochondrial genome and nuclear gene regions for 40 living and one extinct species (cytochrome b only), were combined with morphological data in a supermatrix. Three different optimisation criteria, Maximum Parsimony, Bayesian Inference and Maximum Likelihood were used for phylogenetic analyses.

The results show polyphyly for several taxa of the "New World deer" and indicate a very complex evolutionary history of South American deer. For most of their history, cervids were highly diverse only in Europe and Asia until they entered North America 5 million years ago. A relatively late migration into South America (3 Ma) followed by a rapid radiation, might explain these ambiguities.

S18 – From fossils to molecules – diversification and historical biogeography of liverworts

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The fossil record of liverworts dates back to the Devonian or Ordovician; however, the state of preservation of these fossils hampers assignments to extant lineages. The situation turns for the better in the late Mesozoic and Cenozoic where numerous liverworts have been conserved in the form of amber inclusions. Most of these inclusions match the morphology of extant genera, supporting the hypothesis that the liverwort flora of the Early Cenozoic closely resembled the extant one. We combined the information from DNA sequence variation of extant liverwort species and the fossil record to produce a chronogramm for the Jungermanniopsida, the most species-rich clade of liverworts. This clade is made of two main lineages of simple thalloid and one main lineage of leafy liverworts. Lineage through time plots provide evidence for a nearly constant accumulation of diversity in terrestrial lineages whereas epiphytes show an enhanced diversification in the Cretaceous. This enhanced diversification of epiphytic liverworts correlates with the rise of the angiosperms. We contrast the different patterns and provide approaches of explanation.

S12 – New proetid and phacopid trilobites from the Middle Frasnian (Upper Devonian) of the Tafilalt (Anti-Atlas, SE Morroco)

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Due to their excellent preservation and high diversity, Moroccan trilobites are of special interest both for professional paleontologists and private collectors. The majority of known trilobites are Lower to Middle Devonian in age. Here we describe discoveries of rare Middle Frasnian proetid and phacopid trilobites from three localities in the Tafilalt region (SE-Morocco).

Two localities, Jebel Amelane and Seheb el Rassal Section, Section C, yielded the first phacopids from the Middle Frasnian. On a global scale, very few large-eyed Frasnian phacopids have ever been described. The new findings, therefore, help to fill a significant gap in phacopid evolution. The Jebel Amelane specimens occur in a red marker unit (Bed 4) near the top of MN Zone 6 of the conodont scale. The Seheb-el-Rhassal material derives from the regional Upper *Sandbergeroceras* Bed (Bed 28), a 10-14 cm thick nodular limestone. It falls in the *Naplesites* Zone (UD I-G_1) of the ammonoid scale and in MN Zone 7. Important morphological features of material from both localities are a kidney shaped visual surface with 13 dorsoventral rows with a maximum number of 5 lenses per row, a relatively smooth glabella, with fine granulation only developed in the anterior part, and a median shallow but not interrupted vincular furrow. From Upper Devonian strata of Morocco only three phacopid genera, *Omegops* Struve, 1976, the *"Phacops" granulatus* Group, and *Trimerocephalus* McCoy, 1849, are known. All are Famennian in age and show very different morphological characteristics. The observed features of the new Frasnian form are typical for *Chotecops* Chlupáč 1971. In a restricted sense, it is a basal Emsian to Upper Givetian genus. Regionally the youngest so far known representatives are early Eifelian in age. The material extends the range of the genus significantly (if *Phacops pronini* Maximova, 1955 is excluded).

The section at Bou Tchrafine consists of Upper Emsian to Frasnian deposits. A new trilobite fauna was found near the top of Bed N (*Beloceras* Zone, UD I-H, MN Zone 10). The Proetidae specimens have a short (sag.) preglabellar field, a cephalon border with widely spaced, border-parallel terrace lines, a violin-shaped glabella with fine granulation, a wide (tr.) occipital lobe, and long furrowed genal spines. All these characters are typical for the subfamily Cornuproetinae, which is known from Lower and Middle Devonian strata of the Tafilalt. The new species does not belong to *Richteraspis* Alberti, 1969, the so far only Upper Devonian genus of the subfamily. There are also no similarities with Givetian genera. In addition an associated, small fragmentary phacopid cephalon was collected that is questionably placed in *Chotecops*.

S3 – Fossilized digestive systems in 23 million year old wood-boring bivalves

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Fossilized remnants of the digestive system of wood-boring pholadoidean bivalves are reported from 23 million years old deep-water sediments in western

Washington State, USA. They are reconstructed using serial grinding tomography and computer-based 3D visualizations. Two types are distinguished: (i) a U-shaped structure with a groove on its inner side and with the tips of the U typically pointing into the direction of boring, this structure is interpreted as the caecum of xylophagains; (ii) an elongate structure with a central groove and thin tubes running parallel to it on its upper and lower side, these structures are interpreted as the caecum and the intestine, respectively, of teredinids. Thin section observations show that these structures are filled by a mass of fine, woody material.

S12 – Latest Devonian and Carboniferous tabulate corals from the Western Palaeotethys - palaeodiversity, palaeogeography and facies relations of a neglected taxon

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Tabulate and rugose corals as well as stromatoporids were severely affected by the Frasnian-Famennian extinction event, but had completely different post-Frasnian histories. Palaeozoic Stromatoporoidea got extinct at the Devonian-Carboniferous boundary, Rugosa radiated again, reaching almost their Devonian diversity, but Tabulata remained subordinate. We evaluated diversity and faunal dynamics in the western Palaeotethys realm on species level, based upon thorough bibliographic study and supplementary data from the Paleobiology Database. In spite of considerable taxonomic uncertainties, interesting trends have been derived.

A completely new faunal cycle started in the latest Famennian without any previous taxa remaining. The cycle ended in the Kasimovian, comprising all together about 75 species from 33 genera and 14 families. Diversity curves yielded a slight peak in the "Strunian", a decline in the Hastarian and a maximum in the Ivorian. Continuing diversity decline during the Viséan is interrupted by a well expressed Brigantian peak. Data are missing for Serpukhovian and Bashkirian; Moscovian-Kasimovian records are scarce. The low Hastarian diversity is related to the high extinction rate at the DC boundary and the low origination rate in the Hastarian. Declining diversity during the Viséan is due to steadily increasing extinction and decreasing origination rates, a trend only reversed during the Brigantian. The "Strunian"-Mississippian diversity curve of rugose corals is strikingly similar. Both correlate well with sealevel variations. In both groups the "Strunian" diversity peak proves a taxonomically quite independent subcycle. The Ivorian peak is apparently related to the Avins event. The Brigantian peak introduced Asiatic taxa (*Multithecopora*, *Sinopora*, and *Verolites*). The quasi-extinction of tabulates at the end of the Viséan is related to the prograding Variscan orogeny, which caused widespread break-down of carbonate platforms. Syringoporidae, Michelinidae and, to a lesser degree, Favositidae are the most diverse and most abundantly occurring Carboniferous tabulate families. The normative diversity curve of the Syringoporidae parallels the general trend of tabulates, but diversity of Michelinidae almost continuously decreases; Favositidae are not significantly changing. Like the Michelinidae, they are not recorded after the Brigantian. This indicates that the Favositidae (*Emmonsia*, *Squameofavosites*, *Sutherlandia*) were conservative, living predominantly in deeper-water and muddy facies opposed to Syringoporidae and Michelinidae, which preferred carbonate environments. The differing diversity curves indicate also declining disparity during the later Mississippian. Communicate fasciculate taxa (syringoporids) gained predominance and were the only post-Viséan survivors in the western Palaeotethys.

Faunistic differences along the southern Laurussian carbonate platforms show an eastern realm with Roemeriidae, Multithecoporidae and Sinoporidae, more diverse Syringoporidae and less diverse Michelinidae. A vast province includes most regions along the southern margins of Armorica, and Northern Africa, with taxa differing from the platforms south of Laurussia. Catalonia and the Rhenohercynian Zone (Germany, Portugal) constitute a facies realm characterized first by mixed siliciclastic-carbonate deposits and later by pelagic carbonates with common Favositidae (*Sutherlandia*) and the Palaeacid *Smithinia*.

S5 – Agglutinating foraminifera from Mississippian (Viséan) pelagic carbonate environments of Menorca and the Cantabrian Mountains – a neglected tool to decipher deep-water environments

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Classification and interpretation of Palaeozoic pelagic carbonate environments are hampered by assumed monotony of carbonate facies and missing of generalized facies models, although varying basin topography, oxy-

gen supply, and varying bathymetry in general, have to be considered. Two case studies from the late Mississippian of Menorca (Balearic Islands, Spain) and the Cantabrian Mountains (northern Spain) show that agglutinating foraminifera are an important tool for an improved interpretation. Their usage is based on the almost neglected Gutschick-Sandberg model, which differentiates three biofacies. (1). The Saccaminid biofacies typifies the 'upper platform slope' with a quite diverse fauna consisting of encrusting taxa (*Tolypammina*, *Hemisphaerammina*) and globular, often spined taxa (e.g. *Psammosphaera*, *Pseudoastrorhiza*, *Thurammina*. (2). The *Hyperammina* biofacies typifies the 'middle platform slope'. It is low diverse on genus level, consisting predominating of the unilocular tubular *Hyperammina*. (3). The *Reophax* biofacies typifies oxygen-deficient basin environments with notable occurrences of the "*Reophax*" group. It contains taxa with restricted apertures. Two additional biofacies are observed. A distal *Hyperammina* biofacies is observed below the proper *Hyperammina* biofacies with predominating tiny and extremely slender morphotypes and other morphotypes showing a partially restricted tube either in early or late ontogeny. An *Ammodiscus* biofacies (*Ammodiscus* + *Hyperammina* + "*Reophax*") is recognized between *Hyperammina* and *Reophax* biofacies in less oxygen-deficient basinal settings.

In Menorca, an about 10 m thick series of late Viséan carbonate pelagites with intercalations of mostly red shales is developed between black bedded cherts below and a shale-greywacke succession above. Limestones consist exclusively of thin-bedded, light grey mudstone, bioturbated mudstone, radiolarian mudstone, and some radiolarian calciturbidites. Constantly high percentages of morphotypes characterizing the distal *Hyperammina* biofacies together with low percentages of *Ammodiscus* + "*Reophax*" characterizing the *Ammodiscus* biofacies indicate basinal, but not dysoxic settings. Rare, commonly ramiform, dwarfed conodont elements and blind trilobites confirm the very deep ultrapelagic setting, which underlines the existence of a wide Palaeotethys between Armorica and Gondwana.

In the Cantabrian Mountains variegated pelagic limestones and a middle bedded chert member form the some thirty meter thick, predominantly Viséan Genicera Formation. In the type section carbonate microfacies types include radiolarian mudstone, bioturbated radiolarian and microbioclast bearing mudstone, pelagic bioclastic wackestone, partly with iron stromatolites, microbial mudstone, and pelagic debrisflow sediment. Repeated changes in the foraminifer fauna with exclusion of taxa typifying the Saccaminid biofacies and continuously increasing percentages of morphotypes from the "*Reophax*" biofacies demonstrate the existence of deepening upward cycles (transgressive cycles) with co-occurring installation of successively more important dysoxic conditions. Cycles often end with pure *Ammodiscus* biofacies, which apparently indicate the breakthrough to deep, but not restricted open marine conditions.

S24 – Dental microwear analyses in *Armantomys* (Gliridae, Rodentia) from the Madrid Basin during the Middle Miocene Climate Transition

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The Middle Miocene Climate Transition (MMCT) represents a period of climatic deterioration recorded at global scale. These climatic changes are reflected in the Spanish rodent record by a gradual, but intense, faunal turnover. This time interval is well-represented in the Madrid Basin by several very rich and well preserved rodent assemblages, making the basin an appropriate region to check how these climatic changes influenced the distribution and evolution of the mammalian faunas.

In this study we focus on two localities from the Madrid Basin: El Cañaveral and Casa Montero. The faunal comparison between these two assemblages represents one of the strongest turnovers within the MMCT in Spain. There are extinctions of taxa common during the early and middle Aragonian (e.g., the glirid *Simplomys simplicidens*), migrations (e.g., the cricetid *Cricetodon*), as well as local evolutionary events of several lineages (e.g., the glirid *Armantomys*). *Armantomys* is supposed to be a specialist glirid, with a large size and relatively high crown teeth. The lineage, *Armantomys aragonensis – A. tricristatus*, is characterized by morphological dental changes that are recorded among the Madrid assemblages. This taxon has been chosen to test for dietary changes correlated to environmental variability, because it is a specialist that shows morphological change correlated to climatic changes.

Dental microwear analyses have been profusely used for inference of mammal paleodiets and environmental reconstructions. However, this methodology has been mainly applied to large mammals. Studies on rodents, and especially on the family Gliridae, are rare. The aim of the present work is to record variability and changes in microwear features in the lineage, *A. aragonensis – A. tricristatus*. The results indicate a less specialized diet than proposed before for this hypsodont glirid, probably with a low seasonal variation. The comparison of the microwear from *Armantomys aragonensis* and *A. tricristatus* indicates that there are no significant differences between both species, and therefore no changes in diet can be inferred.

S5 – The Foraminifera.eu Project – status and perspectives

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The Foraminifera.eu Project wants to foster the interest in foraminifera. It builds a bridge between science and community. It is run by amateurs. Professional foraminiferologists get a platform to share their knowledge with inexperienced ones. We offer practical help in sample-processing and do SEM- and optical imaging and classification for free. Foraminifera.eu has become a popular website with more than 3800 monthly unique visitors viewing more than 35.000 pages. Regarding the key-word "foraminifera", it is ranked in the top 3-7 at Google. More than 120 scientists and amateurs are contributing samples, images, drawings, ideas and/or are working on mutual projects.

Searchable foraminiferal database and images: As a major service and outcome we have established a freely accessible foraminiferal image database with an online multi-criteria search query based on high quality SEM and optical images and drawings: www.foraminifera.eu/querydb.php. So far, 5400+ illustrations are searchable on 19 data-criteria with 2500+ defined values. Six of the criteria are taxonomical, two morphological, four geographical, four stratigraphical, two source-related and one is faunal. An illustrated key to genera offers a multi-criteria search query on 7 criteria with about 100 defined values for about 480 genera. With a fast internet conncection, any query results appear within seconds in a plate like presentation of images accompanied by basic data. Each result is linked to its single webpage with a bigger image and accompanying information.

Community character and practical help: About 30 of the 3800 monthly visitors contact us. Most want information, literature, samples or technical help. With about 2 per month we are able to establish a mutual project, resulting in more than 120 contributors after 5 years of existence. A major group provides samples and/or specimens in order to receive SEM-images and to discuss their classification. The second largest group are scientists contributing illustrations as a courtesy or to make the own collection accessible worldwide and searchable through the database-query. A remarkable input in 2012 was the permission by Dr. James E. Conkin and Prof. Barbara M. Conkin to use their whole work on Paleozoic foraminifera. We loosely cooperate with the World Modern Foraminifera Database, namely with Prof. Bruce W. Hayward. Special projects with 3-5 members work on Index Foraminifera, Maastrichtian Foraminifera of Northern Europe, Foraminifera of the Sternberger Gestein and the ongoing analysis of drill-cores for the Geological Survey of Hamburg. A section of mini-lectures has been added with some basic texts. In September 2011 a weekend workshop for beginners "Introduction to Micropaleontology" was held in Hamburg and another one is planned for 2013. A roadshow on foraminifera with 15 posters and several objects for displays has been created and shown so far in Northern Germany. The next shows will be near Augsburg September-December 2012.

S5 – A multiproxy approach to the reconstruction of relative sea-level changes in the Holocene Pearl River delta of China

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The Holocene deltaic evolution of the Pearl River, China's third largest river, is subject of extensive investigations, owing to the vast economic growth of adjacent cities such as Guangzhou, Macau or Hong Kong. Cores from across the delta plain have been drilled in an attempt to obtain a three-dimensional picture of postglacial palaeoenvironmental changes. A recent study that was based on 90 boreholes led to crude reconstructions of the evolution of the delta. More detailed analyses are required, however, to recognize and evaluate small-scale palaeoenvironmental changes. In this context, the resolution potential of the various faunal groups occurring in the cores for picking up environmental signals has been analysed. This resulted in a high-resolution reconstruction of the Holocene evolution of core PRD 10 (24 m long) based on sedimentological and biological proxies.

The highest precision in reconstructing relative sea-level changes is reached by a combined analysis using faunal, floral, and sedimentary proxies. This multiproxy approach also allows comparisons between the resolution potentials of the main faunal groups. Bivalves (10 taxa), gastropods (22 taxa), foraminifera (4 taxa) and ostracods (32 taxa) dominate the faunal spectrum of the core. Other fossils such as charophyte oogonia and diatom frustules are rare.

The evolution of the Pearl River delta reflects established global and regional sea-level curves. The core site was inundated in the course of the postglacial sea-level rise about 9600 years ago, leading to the development of brackish conditions with maximum salinities between 7500 and 6800 years ago. The subsequent progradation of the delta front resulted from a cessation of the postglacial sea-level rise, and fluvial input dominated the delta at the core site henceforth. Successive short-lived marine ingressions became abundant about 2300 years ago, possibly representing shifting delta lobes.

Palaeocommunity analyses of ostracods yielded the most detailed palaeoenvironmental reconstruction, but the main steps of delta evolution can also be inferred from macrofaunal and foraminiferal analyses.

S3 – Oxygen deficiency in Lake Sihetun (NE China) and its consequences – Formation of a Lower Cretaceous fossillagerstätte

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Volcanic Lake Sihetun of the Lower Cretaceous Yixian Formation, western Liaoning, has provided excellent conditions for superb fossil preservation, most notably feathered dinosaurs and early flowering plants, which reveal the evolution of major clades such as birds and angiosperms. Although the fossils are well described, their palaeoenvironmental context, in particular that of the lacustrine fauna, has not been studied in detail. Several studies proposed mass mortality events caused by repeated volcanic eruptions to explain the concentration of well preserved fossils. First palaeoenvironmental evidence for extreme conditions within the lake has been proposed five years ago, when it was suggested that observed recurring mass mortality events of invertebrates had been caused by seasonal anoxia. Here we present a high-resolution sedimentary analysis that allows further predictions about lake evolution and the palaeoenvironmental parameters involved.

The evolution of Lake Sihetun is subdivided into four phases: Phase 1 is characterized by rising water levels and shallow-water deposits. Suspension-derived deposits governed Phase 2, while Phase 3 was dominated by hyperpycnal inflow. A fan delta prograded into the lake during the final Phase 4.

Research focuses on phases 2 and 3, as their deposits yield most of the excellently preserved fossils. Modes of fossil preservation, however, are distinctly different in sediments of either phase. For example, growth increments of clam-shrimp carapaces are well preserved in Phase 2, but poorly preserved in Phase 3. Conversely, insect fossils are excellently preserved within Phase 3, while intricate structures are often concealed by comparatively crude framboid replacement and subsequent alteration in deposits of Phase 2.

Microfacies analyses indicate that environmental conditions fluctuated distinctly during Phase 2. Most of the time, the lake was eutrophic and characterized by dysoxic bottom waters, indicating predominantly holomictic conditions. However, there is also evidence for euxinic, meromictic interludes with high concentrations of dissolved gases (CO_2, CH_4, and H_2S). It is proposed here that sudden outgassings might have caused mass mortality events within the lake and on land. A climatic shift from dry to humid marked the transition from Phase 2 to Phase 3, when holomictic conditions were fully re-established.

S11 – A major earthquake shook up a key Precambrian-Cambrian boundary stratigraphic section: Karatau Range, Kazakhstan

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Precambrian-Cambrian (Pc-C) boundary sections of Kazakhstan have the potential to provide key information on paleoenvironmental conditions in low, near-equatorial latitudes but are to-date poorly investigated. We here report on a major seismite obfuscating the stratigraphic architecture at the Pc-C boundary in the Karatau Phosphate basin (Malyi Karatau Range) of southern Kazakhstan. There, the "Lower Dolomite" of the Chulaktau Formation straddles the Precambrian-Cambrian boundary and directly underlies some of the world's largest sedimentary phosphate deposits. Its (terminal Ediacaran or basal Cambrian?) age is debated due to the reported but questionable occurrence of SSF of the *Anabarites* zone of Nemakit-Daldynian age. Thus, detailed chemostratigraphic profiles aiming at reconstructing global paleoenvironmental change across the Pc-C boundary can at present not be time-correlated. The "Lower Dolomite", however, is not a stromatolitic bioherm, as previously identified in the literature, but a complexly deformed carbonate unit which was regionally deformed by folding, boudinage, thrusting, imbrication, and brecciation while still in a semilithified state. Minor channelization and bank margin slumping at the top of the unit was followed by karsting, prior to the deposition of SSF-bearing phosgrainstones and -rudstones in a high-energy, shallow-water, carbonate-phosphatic coastal environments. We thus interpret the "Lower Dolomite" as an incompletely lithified carbonate platform deformed by at least one large seismic event Mb > ~8, accompanied by regional coseismic uplift of soft sediment above sea level. The presence or absence of basal Cambrian SSF in this unit has to be interpreted with utmost caution because soft-sediment folding and faulting, release of overpressured pore water, and multiple karst fill processes all provided ample opportunity to remove or relocate key index fossils. Lithostratigraphic correlation with paleogeographically not-too-distant sites in south China, however, suggest that the "Lower Dolomite" may be Nemakit-Daldynian (basal Cambrian) in age.

S11 – "Small shelly fossils" of the Middle Cambrian Manuels River Formation at its type locality along Manuels River, Conception Bay South, Avalon Peninsula, Newfoundland, Canada

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A Middle Cambrian fauna of phosphatised "small shelly fossils" preserved in calcareous and siliceous concretions within the dark grey to black shales of the Manuels River Formation has been studied, for the first time, at the type locality of the formation in Conception Bay South, Newfoundland, Canada. The fairly low-diversity assemblage consists of the brachiopods *Eoobolus priscus* (Poulsen, 1932) and *Vandalotreta djagoran* (Kruse, 1990), spicules of hexactinellid sponges and fragments of trilobites and indeterminate taxa. As a result of the early-diagenetic formation of the concretions, the fossils are generally well preserved in three dimensions unlike the flattened specimens found in the surrounding shales. The faunal association and the homogeneous lithology of the formation indicate a shelf setting. Diversity decreases upwards within the formation, which suggests a progressive change in depositional environment caused by, for example, sea-level rises and variations in water turbidity. This project is founded by the Klaus Tschira Foundation, Heidelberg.

S13 – Discovery of *Psiloceras spelae* and associated microfauna in the Triassic-Jurassic Boundary Beds of the Hallstatt-Zlambach Basin (Northern Calcareous Alps)

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In the Northern Calcareous Alps three west-east arranged sedimentary basins have distinguished with a continuous sedimentation from the Triassic to the Jurassic: the Allgäu Basin in the north, the Eiberg Basin in the middle, and the Hallstatt-Zlambach Basin in the south. The international Triassic-Jurassic boundary and its GSSP is defined in the Eiberg Basin (Kuhjoch section, Karwendel Syncline) at the FAD of the ammonite *Psiloceras spelae*. The Hallstatt-Zlambach Basin in the south is of special interest because it was connected via the Meliata Ocean directly with the Tethyan Ocean. This basin is characterized by intensive tectonics with faulting, folding and thrusting. Outcrop conditions are mostly bad because more or less clayey marls predominate in the Late Rhaetian Zlambach beds, which are the youngest sediments of the Hallstatt-Zlambach Basin at most localities. In the area of the Zlambachgraben near Bad Goisern (Salzkammergut) ammonites of Hettangian age have been known since the 19th century, but continuous T-J boundary sections were not known and most ammonites are found in moraine blocks. More detailed recent investigations resulted in the finding of marly sediments above the Zlambach beds. The microfauna of these more or less clayey and micaceous marls is different from that of the Zlambach beds and is related to that of T-J boundary marls (Tiefengraben Member) of the Eiberg Basin. Last year, an intensive search for ammonites in marls with *Praegubkinella turgescens* yielded rare specimens of *Phylloceras*, which are associated with *Psiloceras spelae tirolicum* in the Karwendel Syncline. This year I found in these beds specimens of *P. spelae*. Between the Zlambach beds and the overlying boundary marls finely bedded silty marls are exposed with mica on the bedding planes. These beds can be compared with the Schattwald beds of the Eiberg- and Allgäu Basins. They contain few and tiny microfossils. The T-J boundary marls are less well bedded. On bedding planes clusters of fragmentary plantaxes are frequently found and few beds with scattered aragonitic shells and fossil debris also occur. The microfauna (mainly foraminifera and ostracodes) of the marls is well preserved and diverse. The fauna of foraminifera is composed of Textulariina, Nodosariacea and aragonitic Oberhauserellidae. Most Duostominidae of the Zlambach beds disappeared. The Oberhauserellidae show the same evolutionary trend as found in the Eiberg Basin. The Nodosariacea are composed of Nodosariidae and Polymorphinidae. Many genera and species of the Nodosariidae being typical for the Zlambach beds have disappeared. Members of the Nodosariidae of the Hallstatt-Zlambach Basin are larger-sized and higher diverse than their counterparts in the Eiberg Basin. Some species, which are rarely found in the Zlambach beds are frequent in the boundary marls. Some of them also appear in the Pre-Planorbis Beds of Great Britain. Overall the Nodosariidae of the boundary marls can be regarded as an impoverished version of the Zlambach fauna.

S20 – Evolutionary consequences of Cenozoic climate change on African lacertid lizards (Squamata: Lacertidae)

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The Lacertidae is a large family of Old World lizards with considerable variation in clade size, morphology and ecology. In contrast to the global pattern of increasing biodiversity towards the tropics, African lacertids are most diverse in arid habitats, despite being spread throughout the continent. This disparity in species richness is surprising given that desert lacertids are thought to be evolutionarily younger than their mesic relatives, suggesting increased speciation rates in arid habitats. To identify the evolutionary factors underlying this pattern, we used a combination of phylogenetic, morphological, and ecological approaches

to estimate timing and rates of diversification for the main lineages, and to test if historical shifts in ecology, morphology, and rates of diversification coincide with paleoclimatic events. A time-calibrated molecular phylogeny for Lacertidae was constructed based on 1012 bp of the nuclear gene RAG1 and 4 fossil-calibrated nodes with hard minimum and soft maximum bounds. Our results indicate that lacertids arose in the early Cenozoic and entered Africa about 36 million years ago, with the majority of their African radiation occurring in the end-Eocene and Oligocene. Based on branching times from the phylogeny, lineage accumulation and rates of diversification were estimated for each group. The African radiation as a whole shows higher rates of diversification than its palearctic sister clade throughout the Oligocene to mid-Miocene. Within the African radiation, independent clades with arid-dwelling taxa also show higher diversification rates early in their evolutionary histories than equatorial African and temperate groups. Colonization of arid habitats within each clade is also accompanied by similar morphological transformations, including an overall decrease in ossification and fusion of cranial bones. Ancestral state reconstructions of such characters suggests that the origin of these traits coincided with the onset of aridification in Africa and most likely represent adaptations to desert habitat. Our results highlight the importance of deserts as centers of reptile evolution and emphasize the role that expected climate change will play in the future of lizard diversification.

S20 – Late Neogene vegetation change in the South West African tropics (Namibia) and the expansion of modern savannas

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The Miocene-Pliocene is the period of major savanna grassland expansion in Africa, and the time of expansion of C_4 plants, which are adapted to dry and warm conditions. The driving forces behind this expansion are still unknown: increasing general aridification, increased seasonality, cloud cover, intense herbivory, and fire abundance are considered to play important roles. It is mostly believed that strong upwelling associated with decreasing sea-surface temperatures played a major role in the desiccation of the African continent. However, direct evidence for this link has been rarely reported, and it is still poorly known how tropical savannas developed in southern Africa The main scientific objective of this study is to gain insights into the variability of tropical vegetation with emphasis on the expansion of grasslands and its driving forces. The current study focuses on the continuous marine sediment sequence of ODP Site 1081, offshore Namibia (19°37'S, 11°19'E, 794 m water depth). The period from 9.2 to 2.8 Ma was studied for its pollen, spores, and charcoal content and the $\delta^{13}C$ composition of higher plant waxes. The results suggest relatively humid conditions with a rather strong signal of woodlands and mountain vegetation between 9.2 and 8.3 Ma. From 8.3 Ma on, a gradual change to drier conditions is recorded by a strong increase in grass pollen indicating a spread of savanna grasslands. This increase represents the major savanna grassland expansion in south-western Africa during the studied period. At 7.2 Ma, large amounts of charred particles indicate increased fire activity, probably related to the establishment of savanna grasslands providing large amounts of fuel for bushfires. Furthermore, these fires had an impact on the composition of grasslands by favouring C_4 grasses and establishing modern-like C_4 vegetation in SW Africa. The aridification trend is further continued by an expansion of desert and semi-desert from 5.8 Ma onwards.

S18 – Dipteren im Baltischen Bernstein – eine aktuelle Übersicht

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Dipteren gehören mit 42-63 % zur häufigsten Insektenordnung innerhalb der Arthropodeninklusen des Baltischen Bernsteins. Die Diversität der im Bernstein überlieferten Zweiflügler wurde eingehend dokumentiert (Loew 1861; Meunier1892-1923; Hennig 1937-1973) und katalogisiert (Evenhuis1992). Aktuell sind die Nematocera mit 28 Familien vertreten: Tipulidae, Limoniidae, Cylindrotomidae, Pediciidae, Trichoceridae, Nymphomyiidae, Dixidae, Corethrellidae, Culicidae, Simuliidae, Ceratopogonidae, Chironomidae, Chaoboridae, Tanyderidae, Psychodidae, Scatopsidae, Ptychopteridae, Bibionidae, Hesperinidae, Anisopodidae, Mycetophilidae, Diadociidae, Ditomyiidae, Bolitophilidae, Keroplatidae, Lygistorrhinidae, Sciaridae und Cecidomyiidae.

59 Familien der Brachycera wurden nachgewiesen: Xylomyidae, Stratiomyidae, Xylophagidae, Rachiceridae, Rhagionidae, Athericidae, Tabanidae, Vermileonidae, Acroceridae, Bombyliidae, Mythicomyiidae, Therevidae, Apsilocephalidae, Scenopinidae (unpubliziert), Asilidae, Empididae, Hybotidae, Atelestidae, Dolichopodidae, Platypezidae, Opetiidae (unpubliziert), Phoridae, Syrphidae und Pipunculidae; davon ist die Sektion Acalyptratae mit 34 Familien vertreten: Micropezidae, Pseudopomyzidae, Cypselosomatidae, Diopsidae, Psilidae, Megamerinidae, Conopidae, Pallopteridae, Lauxaniidae, Chamaemyiidae,

Dryomyzidae, Sciomyzidae, Sepsidae, Natalimyzidae, Clusiidae, Acartophthalmidae, Odiniidae, Anthomyzidae, Aulacigastridae, Periscelididae, Neurochaetidae, Asteiidae, Carnidae, Milichiidae, Cryptochetidae, Chloropidae, Heleomyzidae, Proneottiophilidae, Chyromyiidae, Sphaeroceridae (unpubliziert), Camillidae, Drosophilidae, Campichoetidae. Die Stellung der Hoffeinsmyiidae im System ist noch ungeklärt. Die heute allgegenwärtigen Calyptratae sind fossil bislang nur durch die Anthomyiidae mit einem Exemplar nachgewiesen. Zwei Familien aus dem baltischen Bernstein sind als ausgestorben zu betrachten: Proneottiophilidae und Hoffeinsmyiidae. Der hohe Anteil von "*incertae sedis* Inklusen" unter den acalyptraten Dipteren wird unter anderem durch taxonomische Schwierigkeiten erklärt. Familien mit rezent niedriger Abundanz, spezieller Lebensweise oder besonderen Ansprüchen an ihr Habitat sind fossil recht selten überliefert, wohingegen die Familien mit rezent hoher Abundanz durch eine hohe Individuenzahl nachgewiesen sind. Chironomidae, Sciaridae und Mycetophilidae s.l. stellen insgesamt 65 % der Individuen der Diptereninklusen, während Vertreter von Gattungen mit speziellen Habitatansprüchen lediglich durch Einzelexemplare bekannt sind. Der Gesamtheit von 144.000 rezenten Dipterenarten in 189 Familien stehen aktuell etwa 1.000 im Baltischen Bernstein beschriebene Taxa in 350 Gattungen und 87 Familien gegenüber.

S9 – Recent thecideide brachiopods – What can modern cryptic brachiopods tell us?

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The main focus in brachiopod research is clearly on fossil taxa. This is due to their impressive fossil record and their comparably small number of Recent representatives. However, investigations of Recent brachiopods, their morphology, ontogeny, and biology can lead to a much better understanding of their adaptations, ecology and phylogeny in the past.

Thecideide brachiopods are a group of cryptic cementing brachiopods with a fossil record dating back to the Upper Triassic. In the past decades, studies on Recent thecideides have led to an advanced knowledge about their habitat preferences, life cycle, and biology. Furthermore, morphological investigations of Recent shell material, especially using SEM, have revealed an unexpected diversity at the genus and species level. A set of reliable phylogenetic and taxonomic shell characters for both the ventral and dorsal valve, have been established on the basis of excellently preserved, undamaged Recent shell material. Histological studies of the soft tissue including the brooding apparatus revealed unexpected dependencies between morphological shell structures and the soft tissue. These findings can, in turn, facilitate decisions about whether morphological structures in fossil shells were damaged post mortem or preserved in their original condition.

In addition, investigations of Recent material preserved in living position, e.g. on the underside of corals, and containing various ontogenetic stages has led to an appreciation of the degree of plasticity of thecideide shell characters, which is strongly influenced by growth and external factors due to their cementing habit. Thus, a better distinction between intraspecific vs. interspecific variability is now possible. Furthermore, intensive studies of the early and late shell ontogeny in thecideides led to the detection of a common ontogenetic pattern trough time and enabled conclusions to be drawn on the evolution of distinct thecideide lineages.

Theideide morphology has changed little over time and, as a result, modern and fossil representatives resemble each other in many ways. This has enabled the inclusion of a few exceptionally well preserved fossil specimens in a phylogenetic analysis based on Recent morphological characters. This analysis, in combination with a molecular phylogeny, enables a more detailed understanding of in-group relationships between thecideide lineages. The results obtained in this study agree, in many respects, with the currently accepted classification and biogeographic distribution of extant thecideide brachiopod taxa.

To further elucidate the unknown origin of this enigmatic brachiopod subgroup, new methods such as micro-computed tomography (or microtomography) will help to integrate studies on fossil and extant representatives and to generate comprehensive data sets for future analyses.

S2 – Quantitative morphology using x-ray computed tomography and the species concept in palaeontology: a case study from cephalopods

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Species description in palaeontology is based on the morphology of preserved hard parts. Due to their accretionary growth conserving ontogenetic changes molluscs are, in contrast to e.g. crustaceans, ideal candidates to study ontogenetic change, intraspecific variability, and macroevolutionary patterns. Ammonoids, an extinct group of cephalopods (Mollusca) are among the most important stratigraphic marker fossils from the Devonian to the Cretaceous. With respect to their importance in the field

of biostratigraphy, ammonoid species were usually differentiated from each other utilizing a static ("Linnean") rather than a dynamic ("Darwinian") approach. This static method does not account for intraspecific variation, co-variation, and ontogenetic changes. Many species were thus validated on the grounds of more or less subtle morphological differences of the adult stage. During the last decades the approach of species description has changed significantly, taking ontogeny as well as the use of intraspecific variability analyses into account. More recent studies of Mesozoic ammonoids document a wide intraspecific variability in conch parameters and ornamentation, when a sufficient amount of specimens were available.

Application of non-destructive methods like surface scans and x-ray computed tomography became increasingly important for the study of ammonoid conchs. A surface scan of the ammonoid conch enables a detailed morphological description of the most important parameters (conch geometry: general shape and coiling rate, conch ornament including direction and course of the growth lines, ribs, and constrictions). Computed x-ray tomography allows studying the complex internal structure of chambered cephalopods (e.g. septal spacing, suture line).

Combined, the two methods are powerful, non-invasive tools that allow for comprehensive studies of fossil shapes and therefore open a new means to improve the palaeontological species concept. The techniques can also be applied to study very rare material, such as holo-, para- or neotypes. The detailed morphological description and the increased number of available characters for species description enable subsequent cladistic analyses to test existing phylogenetic hypotheses of the studied groups. Once obtained, 3D morphological datasets are available for further studies e.g. functional morphology using finite element analysis, volumetric analysis, development of a 3D morph-database seems also promising.

S13 – "… and they all lived happily ever after": palaeoecology of benthic faunas in the aftermath of the end-Permian mass extinction

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Key features of post extinction faunas are reduced ecological complexity, low diversity, and the dominance of taxa with broad environmental and geographic ranges. With respect to the aftermath of the end-Permian mass extinction, all these features have been reported in previous studies supporting the view that the delayed recovery after the end-Permian crisis largely resulted from persisting environmental stress. Among others, the fauna of the lower Triassic Virgin Formation (Early Spathian, Western U.S.) has repeatedly been cited as a typical example of a post extinction bottom fauna suffering from sustained environmental stress. However, this view is challenged by more recent studies that suggest that the recovery was a rather volatile process with notable restoration signals seen in various clades, palaeogeographic regions, and stratigraphic intervals.

Considering these advances, a reassessment of the ecology and diversity pattern of the Virgin fauna is of great importance for the understanding of biotic restoration and evolutionary processes after the biggest crises in the history of metazoan life. We integrated new quantitative fossil collections providing species level identifications and sedimentological data to discriminate between local facies effects and potential wide-ranging post-extinction stress factors that influenced diversity and the ecological structure of benthic ecosystems.

The Virgin fauna yields a bulk diversity of 30 benthic species (22 genera) of body fossils and 14 ichnogenera and, thus, represents the most diverse marine assemblage reported from the Early Triassic so far. Benthic communities of open marine, shallow-subtidal environments are both, ecologically and taxononimcally, surprisingly diverse. Low diverse communities are restricted to habitats providing evidence for local environmental stress unrelated to presumed post extinction effects. However, cluster analyses of the quantitative data set show that taxonomical differentiation between habitats was still low. This indicates a time lag between increasing within-habitat diversity (alpha diversity) and the onset of taxonomical differentiation between habitats (beta diversity). We suggest that taxonomical habitat differentiation after mass extinction events starts only when competition within habitats exceeded a certain threshold, which was not yet reached in the late Early Triassic of the investigated area.

This interpretation offers an alternative explanation to previous suggestions that the prevalence of generalistic taxa after the end-Permian mass extinction reflects persistent environmental stress. It also supports recent studies that emphasize that the recovery was well underway already during the Early Triassic. The onset of increasing beta diversity could be a potential criterion for distinguishing two major steps in recovery phases: the first ending with habitat saturation and the second ending with completion of ecosystem differentiation. Faunal successions that straddle recovery episodes could represent evolutionary test cases underlining the effect of ecosystem saturation, which possibly explains the sudden onset of taxonomic diversification during other phases of recovery and evolutionary radiations.

S4 – The first bivalve-based annually resolved paleoclimate archive of the central and northern North Sea spanning AD 1040 to 2010

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Knowing the natural climate variability of the late Holocene is important to contextualize present climate change. Specifically, little is known about seasonal to inter-annual variability in the extratropical oceans, which play a major role in governing the climate system. The resolution of existing marine climate archives is insufficient to evaluate precisely how amplitudes and frequencies of quasi-decadal climate modulations changed through time. To temporally extend the instrumental record backward we rely on high-resolution climate archives such as mollusk shells and tree rings. This study presents the first millennial-scale (AD 1040-2010), absolutely dated and annually resolved bivalve shell master chronology (*Arctica islandica*) from the North Sea. The chronology was constructed from 32 shells with overlapping life spans by applying standard cross-dating techniques used in dendrochronology (COFECHA, ARSTAN) and a new algorithm specifically developed for bivalves. The average EPS (expressed population signal) value exceeds 0.93, which is significantly higher than the accepted threshold of 0.85 by Wigley (1984 J. Clim. Appl. Meteorol. 23, 201-213) confirming the robustness of the constructed bivalve sclerochronology. Wavelet transformation of the new bivalve master chronology reveals strong spectral power at periods of ca. 70 to 120 years. Remarkably, times of major regime shifts (Medieval Warmths to the Little Ice Age, and LIA to the Modern Warmths) are dominated by ~12-40 years oscillations and are associated with multi-decadal variability.

S2 – Environmental patterning in trilobite morphological disparity

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Despite the mounting evidence that taxonomic diversity dynamics are patterned environmentally and that taxonomic diversity and morphological disparity are decoupled both temporally and spatially in many clades, very little work has been done assessing whether disparity is also influenced by environment. If some morphologies occur only in some environments, then overall morphological disparity will depend on the availability of those environments. Here I investigate whether trilobite disparity through time shows environmental patterning. Morphology was measured using outlines of the cranidium (the medial sclerite of the headshield) as illustrated by Foote. Environmental categories considered were tropical vs extratropical, carbonate vs siliciclastic, shallow water vs deep water, and reef vs non-reef environments and I used occurrences from the Paleobiology Database (PBDB) to determine taxon affinity for each environmental category. Many of the species in the morphological dataset are not represented in the PBDB in sufficient numbers to assess species-level affinity for these taxa. However, the overall ability of genus-level affinities to predict species-level affinities is high. Therefore, I assigned each species its genus affinity for each of the four environmental categories. Results show that there are areas of morphospace occupied only by tropical and/or deep water species and that the Ordovician increase in disparity is largely driven by deep water taxa.

S25 – Berriasian–Valanginian (Early Cretaceous) vertebrate faunas of northwestern Germany

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The predominantly fluvio-lacustrine and subordinated brackish-marine deposits from the Berriasian through early Valanginian of northwestern Germany yield diverse vertebrate faunas. With few exceptions these faunas are generally poorly documented. Here we provide a survey of vertebrate taxa from this area. For a better overview, we subdivide the dataset according to three key geographical areas. All records are based on first-hand observations of collection specimens and/or a few selected publications. This information will support further analysis of faunal composition and distribution, palaeoecology and palaeo-zoogeographical comparison with adjacent areas. [*] = Ichnotaxa and higher clades partially or entirely represented by ichnofossils.

1. South-central Lower Saxony mountainous region: 1a. Münder Fm., Serpulit Mbr., early Berriasian – Lacustrine, oligo- to hyperhaline facies. Elasmobranchii: *Hybodus* spp.; Actinopterygii: *Scheenstia* spp., *Callipurbeckia minor* (Agassiz), *Pycnodus mantelli* Agassiz, *Microdon hugii* (Agassiz), *Eugnathus* sp., *Pholidophorus*

splendens Struckmann; Crocodylia: gen. et sp. indet.; Pterosauria: *Ctenochasma roemeri* von Meyer. – 1b. Bückeberg Fm., Obernkirchen Mbr., early to late Berriasian – Fluvio-lacustrine facies. Elasmobranchii: *Hybodus* spp., *Palaeoxyris jugleri* (von Ettingshausen); Actinopterygii: *Indaginilepis rhombifera* Schultze, *Scheenstia mantellii* (Agassiz), *Scheenstia* sp., *Callipurbeckia minor* (Agassiz), Elopomorpha indet.; Testudines: *Pleurosternon bullockii* (Owen); *"Emys" menkei* Roemer, *"Glyptops" typocardium* (Seeley), *Chitracephalus* sp.; Sauropterygia: Plesiosauria indet., ?Leptocleididae indet. (= *Plesiosaurus degenhardti* Koken); Crocodylia: Goniopholididae indet., *Goniopholis simus* Owen, *Pholidosaurus schaumburgensis* von Meyer, *Pholidosaurus* sp.; Pterosauria: *Purbeckopus* cf. *pentadactylus* Delair [*]; Theropoda: ?Tyrannosauroidea indet. [= *Altispinax dunkeri* (Dames)], Troodontidae indet. [*], *"Bueckeburgichnus" maximus* Kuhn [*], *"Megalosauripus"* isp. [*], div. (ichno)gen. et (ichno)sp. indet. [*]; Sauropoda: *Brontopodus* isp. (= *"Rotundichnus muenchehagensis"* Hendricks) [*]; Ornithopoda: ?Dryosauridae indet. [*], Iguanodontia indet. [*]; Ankylosauria: (?) gen. et sp. indet. (= ?*Hylaeosaurus* sp.), *Metatetrapous valdensis* Nopcsa [*]; ?Ceratopsia: *Stenopelix valdensis* von Meyer.

2. Sehnde area, Lower-Saxony: Bückeberg Fm., Obernkirchen/Osterwald Mbrs., latest Berriasian to early Valanginian – Fluvio-lacustrine to brackish-marine facies. Elasmobranchii: *Hybodus* spp., ?*Egertonodus* sp.; Actinopterygii: ?*Scheenstia* sp., Macrosemiidae indet. ?Leptolepidae indet., ?Ichthyodectidae indet.; Testudines: *Pleurosternon* sp.; Sauropterygia: Plesiosauria indet.; Crocodylia: ?*Goniopholis* sp., ?*Pholidosaurus* sp., ?Hylaeochampsidae indet.; Ornithopoda: ?*Owenodon* sp. indet.

3. Gronau area, Northrhine-Westfalia: Bückeberg Fm., Osterwald Mbr., early Valanginian – Lacustrine to brackish-marine facies. Elasmobranchii: *Hybodus polyprion* Agassiz, *Lonchidion crenulatum* Patterson, *Lonchidion* cf. *inflexum* Underwood & Rees, *Egertonodus basanus* (Egerton), *Lissodus* sp., *Petalorhynchus* sp.; Actinopterygii: *Microdon muensteri* (Agassiz), *Sphaerodus semiglobosus* Dunker, ?*Scheenstia* sp., *Caturus* sp., *Ionoscopus* sp., *Callopterus* sp., Pachyrhizodontidae indet.; Testudines: *Desmemys bertelsmanni* Wegner; Sauropterygia: *Brancasaurus brancai* Wegner; Crocodylia: ?*Goniopholis* sp.; Ankylosauria: ?*Hylaeosaurus* sp.

S19 – Peculiarities in ichthyosaur long bone microanatomy

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Ichthyosaurs represent one of the most successful groups of Mesozoic marine reptiles. Because they include the first air-breathing vertebrates that adapted to a pelagic life style, these reptiles are a particularly interesting group for understanding the evolutionary processes involved in secondary adaptation to an aquatic life. Within ichthyosaurs, several morphologies linked to diverse ecological grades along an anguilliform-thunniform continuum are encountered. These ecological differences should be recorded in bone microanatomical features. Their analysis in various ichthyosaur (e.g. *Mixosaurus*, *Temnodontosaurus*, *Ichthyosaurus*, *Stenopterygius*, *Ophthalmosaurus*) long bones (humeri and femora) highlights differences in their microstructure and compactness. Comparisons with other extant and extinct marine taxa reveal the uniqueness of the ichthyosaur bone microanatomy and permit inferences about their locomotor abilities.

S15 – Reappraisal of the Upper Jurassic *Dysalotosaurus* locality 'Ig/WJ' at Tendaguru, based on historic, taphonomic, and demographic data

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Dysalotosaurus lettowvorbecki is a small ornithopod dinosaur from the Middle Dinosaur Member of the Upper Jurassic Tendaguru Formation of Tanzania. In contrast to other dinosaurs from the same formation, the remains of this species where found only in the locality 'Ig/WJ', which was discovered in 1910 in the vicinity of Tendaguru Hill. This locality yielded mass accumulations of skeletal remains of *Dysalotosaurus lettowvorbecki*. The origin of these mass accumulations is still under debate. Unfortunately, the taphonomical analysis of the processes of burial and fossilisation are hampered by the incompleteness of excavation records. To improve the knowledge of this unique locality, we analyzed the available field notes, unpublished excavation sketches and letters of the heads of the German Tendaguru Expedition, Werner Janensch (1909-1911) and Hans Reck (1912-1913), as well as fossil material of *Dysalotosaurus lettowvorbecki* housed in the collections of Berlin, Göttingen, London, München, Stuttgart and Tübingen.

In contrast to previous views, four bone beds from at least three different stratigraphic levels, dominated by isolated vertebrae and long bones of *Dysalotosaurus*, were recognized. Accumulations of mud clasts and re-

worked caliche nodules characterize the bone beds as channel lag deposits. At least one of the bonebeds shows a distinct elongation in approximately W/NW to E/SE, similar to the orientation of many long bones, so that this spatial arrangement and orientation could be explained as the result of reworked infillings of a tidal channel or of a small riverbed influenced by tides. Despite the extensive disarticulation of the bones, the slight sorting in favor of large, compact, and robust bones, and their common breakage and distortion, no unambiguous signs of preburial weathering, scavenging, or abrasion are known. Thus, all four bonebeds most likely originated from a single concentrated death site and are the autochthonic or paraautochthonic result of one or more reworking events, probably tides. Based on the available data, all individuals died at the same place, but more sedimentological data is necessary to clarify if death occurred suddenly or over a short period of time.

Based on the number of femur fragments, 130 individuals with different ontogenetic stages were excavated. The age distribution of all individuals is untypically m-shaped, due to the underrepresentation of early juveniles (< 4 years old) and 9 to 11 year old individuals. The maximal estimated age is 19 years. The underrepresentation of early juvenile individuals is most likely caused by predation and a poor chance of fossilization, whereas underrepresentation of mid-age individuals could have multiple reasons, e.g. young individuals reaching sexual maturity might have been banished from the herd or a catastrophic event might have destroyed a nesting site about 10 years ago.

S26 – The ontogeny of *Dysalotosaurus lettowvorbecki* (Ornithischia: Ornithopoda) and implications for the evolution of ornithopod dinosaurs

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Ornithopod dinosaurs are one of the most successful dinosaur groups. They were matching modern ungulate mammals concerning diversity of morphology, ecology, and behavior and they were even outmatching them concerning the range of body sizes or locomotion patterns.

Dysalotosaurus, a basal iguanodontian ornithopod from the Upper Jurassic Tendaguru Formation of Tanzania, is known from thousands of bones of different ontogenetic stages. It also represents an intermediate stage within Ornithopoda concerning body size and phylogenetic position. *Dysalotosaurus* is, therefore, an ideal model to investigate the means by which morphologies and growth patterns have changed during evolution leading to the success and diversity of ornithopod dinosaurs.

The ontogeny of *Dysalotosaurus* was studied by using a multi-methodical approach. Qualitative observations were combined with statistical analysis of intra-elemental measured distances (allometry) and with analysis of the microstructure of several long bones to reconstruct the growth pattern and life history of this dinosaur. Several of the obtained results could be confirmed independently by more than one of the applied methods, which make them more plausible.

Hatchlings were absent in the fossil record but precocial breeding behavior can still be proposed for this dinosaur, because the articular ends of the smallest known long bones, belonging to approximately one year old juveniles, were already well ossified externally and internally. On the other hand, none of the known individuals of *Dysalotosaurus* was fully grown indicated by the highly incomplete fusion of the skull elements and the neurocentral sutures of the vertebrae and by the lack of an External Fundamental System (EFS) in the bone microstructure as a sign of ceasing growth. Despite this slightly incomplete ontogenetic series, numerous morphological changes were observed in the skeleton during growth, such as the relative lengthening of the skull, increasing robustness of elements, or relative shortening of the hind feet, among others. Important aspects of the life history of *Dysalotosaurus* could also be reconstructed, especially the time of sexual maturity at an age of 10 years and the life span of up to 20 years. The maximum growth rate was comparable to a large modern kangaroo.

The ontogeny of *Dysalotosaurus* shows that many morphological changes during ornithopod evolution are dominated by peramorphic heterochrony, which is mainly expressed as predisplacement. However, there is a larger variety of ontogenetic modifications present even in single elements, which resulted in either reduction and/or extension of structures at various evolutionary stages and demonstrates high morphological plasticity of ornithopod skeletons.

This study further helps to exclude ontogenetically changing and, thus, misleading characters from future phylogenetic analyses and, finally, to reconstruct the degree and kind of seasonality, formerly influencing the life of ornithopods, by looking at the development and regularity of growth cycles expressed in their bones.

S23 – Ausstellen! Chancen der interdisziplinären Konzeptentwicklung

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Als wichtiger Schlüssel zum Verständnis der Entwicklung des Lebens und der Erde genießt die Paläontologie

seit jeher ein großes öffentliches Interesse: Paläontologische Themen werden vielfach kontrovers diskutiert und sind in der Lage, alle Altersgruppen zu faszinieren.

Das Medium Ausstellung ist eines der wichtigsten Kommunikationsmittel zwischen Wissenschaft und Öffentlichkeit. Viele Museen blicken bereits auf eine lange Tradition zurück und stehen gleichzeitig vor der Aufgabe, aus historisch gewachsenen Sammlungen immer wieder neue und innovative Ausstellungen zu entwickeln. Neu entstehende Ausstellungen müssen aus der Fülle von Angeboten herausstechen und der heutigen, kritischen Informations- und Erlebnisgesellschaft gerecht werden.

Die Entwicklung von Ausstellungen ist deshalb selbst schon zu einem vielfach untersuchten Thema geworden. Friedrich Waidacher definiert in seinem Handbuch für Museologie: » Das Idealziel eines erfolgreichen Ausstellungsbesuches bedeutet Eintauchen in einen ästhetisch ansprechenden, physisch komfortablen Raum mit gut organisierter, klarer und anregender Information « (Waidacher, 2005, S. 132).

Die Gestaltung von Räumen bieten über den hier genannten » Wohlfühlfaktor « hinaus vielfach ungenutzte Chancen der Inhaltsvermittlung: Material, Form und Farbe können selbst zu Informationsträgern werden, und die Vermittlung unterstützen. Hierbei helfen interdisziplinäre Methoden Ausstellungsziele, Inhalte und Gestaltungsprinzipien zu entwickeln und umzusetzen. Eine vernetzte Arbeitsweise zwischen den beteiligten Disziplinen wie Wissenschaft, Didaktik, Architektur, Szenographie, Design u.v.m. bietet erweiterte Möglichkeiten, Inhalte auf einer unmittelbaren und emotionalen Ebene zu transportieren. Die räumliche Gestaltung fungiert so nicht bloß als umschließender Rahmen einer Ausstellung, sie schafft zusätzliche Vermittlungszugänge. Je mehr unterschiedliche Zugänge angeboten werden, desto größer ist die Wahrscheinlichkeit, dass Informationen aufgenommen, verankert und verstanden werden können.

In unserem Vortrag möchten wir erläutern, wie auf dem Weg zum fertigen Ausstellungskonzept aus Vermittlungszielen eine inhaltsbezogene, räumliche Gestaltung entstehen kann, und wie die parallele Entwicklung von Ausstellungsarchitektur und -design hilft, Inhalte zu klären und zu organisieren. Am Beispiel des Geomuseums Münster stellen wir hierzu unsere Erfahrungen und Arbeitsmethoden vor.

Plenary – Evolution and environment in the Caribbean Neogene

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Isolation of the Caribbean from the Pacific approximately 3.5 Ma ago provides a model system for understanding how oceanographic change has affected the ecology and evolution of tropical marine ecosystems. Close similarity of taxa to living species, coupled with independent evidence for biotic and environmental change, allow formulation of falsifiable hypotheses to establish cause and effect. Upwelling and planktonic productivity sharply declined and carbonate production increased during the last 1 Ma before the oceans divided. These changes resulted in several-fold increases in extinction rates and a shift from benthic communities dominated by mollusks and other suspension feeders to increases in highly productive coral reefs and shallow-water seagrasses. These environmental changes resulted in further changes in life habits, diets, life histories, and the intensity of biological interactions that are consistent with predictions of basic evolutionary theory. Deposit feeding and chemosymbiotic bivalves increased at the expense of suspension feeders and epifaunal bivalves increased relative to infauna. The time molluscan larvae spend in the plankton and incidence of asexual reproduction among free-living bryozoans sharply decreased. Rates of gastropod drill predation doubled. The interplay of oceanographic change with the functional and life history characteristics of different taxa set off chain reactions of events that are expressed in time lags and asynchrony of extinction of different taxa spread out over 1-2 Ma. The consequences of physical environmental change depend as much upon the cascading series of ecological interactions set off by the initial change in physical conditions as the magnitude and nature of the physical changes per se.

S14 – A new basal dinocephalian from the Middle Permian Mezen fauna (Russia) and its implications for the evolution of basal therapsids

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The fossil record of Synapsida, the mammalian lineage of amniotes, is particularly well studied especially close to the origin of mammals, providing detailed information on the evolutionary history of the mammal body plan. The transition from pelycosaur-grade synapsids to therapsids documents a major step on this macroevolutionary transition and early therapsids have great potential to provide valuable insight into the diversity and complexity of these changes. Among early therapsids, Dinocephalia

and Biarmosuchia are among the most basal clades. Especially the abundant dinocephalians occupied a wide range of ecological niches and dominated terrestrial ecosystems for a short period of time in the Middle Permian. For the present study, we investigated a new skull from the Middle Permian (Roadian/Wordian) Mezen faunal complex of northern European Russia, using three-dimensional computed tomography (CT). Although much of the internal anatomy of the cranium in this specimen is lost, some features relevant for phylogenetic analysis could be identified. The skull is characterized by a mosaic of primitive and derived characters that allow an identification of this specimen as basal therapsid and therein as basal dinocephalian. Primitive therapsid features include: pterygoid teeth along the entire length of the transverse process; a prearietal forming the anterior border of the pineal boss; loss of the supratemporal resulting in a contact between paroccipital process and squamosal; and a smaller sized quadrate that contacts the squamosal and the paroccipital process equally. Other features place the specimen clearly within Dinocephalia: palatal ramus of the pterygoid is developed as a ridge; teeth of the palatine are restricted to a reniform boss; undercutting of the temporal fenestra under the orbit; enlargement of the temporal fenestra; and enlargement of the muscle attachment area on the postorbital and parietal. The tooth morphology, with a functional canine, albeit not much larger than the postcanines, differentiates the tooth row into an incisiform, a canine and a postcanine region. A complete intermeshing of the incisors is present in the skull (also described for some biarmosuchians), and there is a lingual heel at the base of the crown of the incisors. Additional specimens of the same taxon are represented by further cranial and postcranial material. The preserved longbones show further affinities to Dinocephalia, whereas the vertebral column shows rather plesiomorphic features, such as the slender built of the vertebrae and the high in number of caudal vertebrae. This combination of characters in addition to the lack of derived tapinocephalian and anteosaurid characters, identify the new taxon from Mezen as basal member of the clade. The new taxon provides new insight into the early evolution of therapsids, underlining the complex evolutionary history between derived pelycosaur-grade synapsids and early therapsids.

S12 - Late Silurian to earliest Middle Devonian evolution of Rhenish brachiopods

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Pridolian (late Silurian, 418 Ma) through early Eifelian (early Middle Devonian, 387 Ma) faunas from the Rhenish Massif (Germany) document the brachiopod evolution during this geological time interval. The faunal succession reflects environmental fluctuations in a tropic epeiric sea, driven by local, regional and global forces, such as climate and sea-level fluctuations.

In connection with detailed taxonomical studies based on materials from different museums and institutional collections, a high-resolution brachiopod stratigraphy applicable to different facies types is developed. In the present study, 24 brachiopod zones and 16 faunal intervals are proposed for the interval under consideration. A series of bio-events with more or less strong faunal turnover could be recognized. The distribution patterns are very different: Whereas a number of species or genera just appear during a short geological interval, other taxa exhibit a long evolutionary history characterized by gradual phylo-morphogenetic change.

The Rhenish shelf sea was located at the southern margin of the Laurussia continent. Side-by-side comparisons of Rhenish faunas with faunas from other parts of the world allow to draw palaebiogeographical conclusions. The relationships to faunas of northern Peri-Gondwana (e.g., Armorican Massif, Iberian Chains, Cantabrian Mountains, Anti-Atlas) have turned out to be very close, so that the “Rheic Ocean” between Laurussia and Gondwana was rather a narrow sea-way, not representing a barrier for the migration of brachiopod larvae. On the other hand, southern Chinese faunas, for example, are regarded as representing a completely separate development.

The major stratigraphical units can be recognized in Europe and North Africa. In the future, combination with other biostratigraphies (ichthyostratigraphy, palynostratigraphy) or sequence stratigraphic studies, hardly having been tackled in the Rhenish Massif so far, is promising. The idea of “holostratigraphy” is worth following for the integration of the Rhenish Devonian in global stratigraphical schemes and ecological-evolutionary units.

S12 – Revision of Rhenish Lower Devonian Brachiopoda

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In recent years, numerous brachiopod taxa from the Rhenish Lower Devonian (Rhenish Massif, Germany) have been revised or newly described by the present speaker, up to now 130 species within 72 genera, including the first description of 6 genera, 4 subgenera, 8 species and 3 subspecies. The Rhenish taxa are compared with supposedly related (congeneric) forms on a world-wide scale in order to clarify possible phylogenetic relationships.

The still ongoing studies have resulted in a constantly growing knowledge on brachiopod phylogeny, systematics, biostratigraphy, palaeobiogeography and palaeoecology.

The Rhenish Lower Devonian documents the history of an extensive tropical shelf along the southern border of the Old Red Continent. Varying rates of subsidence and sedimentation and a fluctuating sea-level governed the development of palaeogeography and palaeoenvironments. Within stratigraphic units, lateral variations in the taxonomic composition of brachiopod assemblages reflect a wide spectrum of marine biotopes from the deep shelf to intertidal settings. Vertical changes, on the other hand, show the successive appearance and disappearance of brachiopod taxa and the morpho-phylogeny in a number of lineages. As the siliciclastic successions are extremely thick and low time-averaged, numerous evolutionary steps can be differentiated throughout the Lower Devonian.

A newly introduced brachiopod zonation allows not only precise age-assignments and correlations within the Rhenish Massif, but far-reaching interregional correlations, as well. It helps, for example, to correlate levels envisaged for a revised basal Emsian GSSP boundary and the traditional Rhenish boundary interval. It is further attempted to integrate the succession of Rhenish brachiopod faunas with ecological-evolutionary subunits of possible supraregional or even global significance. As regards Early Devonian palaeobiogeography, faunal relationships suggest the presence of a separate "Maghrebo-European Subrealm" within the Old World Realm. The "Rhenish Province" represents the northern part of this subrealm, opposed to the "North Gondwanan Province" in the south (including, at least, the faunas of the Armorican Massif, Iberian Chains, Cantabrian Mts., Anti-Atlas/Ougarta Chains and NW Turkey).

S25 – New excellently preserved fossils from Late Cretaceous Arnager Pynt, Bornholm shed a light on the Mesozoic history of sub-class Amphidiscophora (Hexactinellida, Porifera)

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Whereas they are generally rare in the fossil record, Hexactinellida (glass sponges) of the order Lysscainosida (sub-class Hexastrophora) are very common in the Late Cretaceous (Coniacian) Arnager Limestone, on the isle of Bornholm. This locality is unique in terms of preservation state and diversity of non-rigid Hexactinellida. However, the hexactinellid sub-class Amphidiscophora is even less known and has been documented so far only for the Mesozoic by a single complete specimen, *Hyalonema cretacea* Janussen & Hauschke 1995 from the German Münsterland Basin, by a few findings of microscleres (amphidiscs), and by isolated root tufts from Arnager Pynt, preliminarily identified as *Hyalonema* sp. New findings of completely preserved fossil Hexactinellida, which will be described as two new species of the family Hyalonematidae, confirm the status of the Arnager Limestone as a unique window in the fossil record of the Porifera. The largest of the fossils, a complete sponge, 21 cm long including the root tuft, may represent a unique transition between the genera *Hyalonema* and *Monorhaphis*. The first genus characterized is by slender, mostly twisted root tufts of long, relatively thin anchoring spicules, whereas representatives of the latter are characterized by one single, long thick (up to 1 mm diameter), anchoring needle fixing the sponge in the sediment. The present fossil is conspicuous by a comparably wide root tuft of diverging spicules, a few of which show a remarkable diameter of up to 5 mm. This sponge fossil therefore may represent a so far "missing link", the only known transitional form between the two closely related genera. These new excellently preserved specimens furthermore extend the fossil record of the family Hyalonematidae and the "modern" Amphidiscophora from Late Campanian down to the Coniacian.

S7 – An asymmetric ammonite from the Toarcian of Cénaret (Lozère, France)

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Ammonite pathologies are well-documented in the fossil record and they are helpful for understanding ammonite biology. This study focuses on a Toarcian ammonite specimen from Cénaret (Lozère,France) that shows a poorly-known pathology characterized by a strong, if not full, asymmetry in ornamentation. The specimen was found in 2009 by Sebastien Blanchard, in marls that most probably belong to the Bifrons Subchronozone.

We identified this peculiar specimen taxonomically with our own expertise and with a blindfold test by asking several ammonite workers to identify separately the two faces of the ammonite.

The left side of the specimen shows an ornamentation typical of *Hildoceras semipolitum*, whereas the right side indicates a *Brodieia primaria*. Furthermore, the observation of the suture lines leads to the same identifications. Importantly, no evidence of injuries can be found on the shell after a careful observation of the entire ammonite coiling with a scanning electron microscope. Potential causes for such an anomaly are: potential interfecondity

between the two taxa, ancestor-descendant relationship, gynandromorphism or alteration of reaction-diffusion processes. Although the actual process responsible for the observed asymmetry remains elusive, most hypotheses challenge the phylogenetic relationship usually inferred for the genera *Hildoceras* and *Brodieia*.

To our knowledge, only two specimens with a similar anomaly have been reported in the literature, but they differ from ours on several aspects. In 1976, an ammonite from the Middle Callovian of Corlay (Saône-et-Loire, France) was identified as *Kosmoceras jason* for the right side and as *Kosmoceras baylei* for the left side. These two taxonomic entities belong to the same lineage and are contemporaneous. On the other hand, in 2011, German authors described a specimen from the lower Oxfordian (Cordatum subchronozone) of Switzerland (Aargau canton) that can be identified as *Cardioceras praecordatum* (left side) and as *Cardioceras densiplicatum* (right side). Interestingly, these two taxa are respectively older and younger (Lower Oxfordian, Praecordatum subchronozone and Middle Oxfordian, Vertebrale subchronozone) than the actual age of the pathological specimen described by these authors.

Overall, the specimen from Cénaret shows that ammonite ornamentation, and to a lesser extent suture lines, can be subject to an individual-level variability. Although similar pathological specimens seem to be rare, they are crucial for deciphering shell-building processes and for refining phylogenetic relationships.

S3 – Emergence and evolution of wood-fall communities

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Wood-fall communities are considered as one of the great four chemosynthesis-based communities although they are only partially fuelled by chemosynthetic processes. The keystone species in modern deep-sea wood-fall communities are wood-boring xylophagain bivalves living in symbiosis with symbiotic xylophagous bacteria, which decompose the cellulose of the wood. Xylophagain bivalves, in turn, produce large quantities of fecal pellets, the bacterial decomposition of which increases the amount of hydrogen sulfide in the sediment around the wood from which it is eventually released. This abundance of hydrogen sulfide attracts species characteristic of chemosynthesis-based communities such as bathymodiolin mussels, and thyasirid, lucinid, and vesicomyid clams. Other taxa that feed directly on wood include limpet gastropods, chitons, and squat lobsters, and there is a diversity of gastropods that graze on the bacterial mats. Most Cenozoic wood-fall associations are quite similar to their modern counterparts, at least in terms of mollusks. Some particularly well-preserved communities are known from western Washington State, USA, and include also crinoid fragments, ostracodes, cephalopod beaks, and fish teeth, thus providing additional insights into the food-webs at these communities. Other examples of Cenozoic wood-fall communities are known from the Neogene of New Zealand which are dominated by limpet gastropods, and the Pliocene of northern Italy where associations with typical modern wood-fall taxa and some unusual, apparently now extinct provannid gastropods were found. The Mesozoic record is still scarce; Late Cretaceous examples from northern Japan have a similar taxonomic composition as modern communities, although they are less diverse and lack bathymodiolin mussels. The wood-feeding habit of xylophagain bivalves in the Late Cretaceous could be confirmed by the presence of the characteristic fecal tubes that these clams build to protect their boreholes. In contrast, Jurassic wood-fall associations found in Poland are composed of a very different set of mollusks compared to Cretaceous to modern examples. They lack wood-boring bivalves and in general appear to lack chemosymbiotic taxa. Only chitons and limpet gastropods found in the Jurassic wood-fall communities are similar to those of their modern counterparts. Thus, wood-fall communities resembling modern communities of this type likely emerged with the appearance of xylophagain bivalves in deep-sea environments, probably during the Late Jurassic to Early Cretaceous.

S12 – Causes and consequences of Famennian and Tournaisian biocrises revisited

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The Famennian and Tournaisian are characterized by a complex succession of biotic crisis with variable magnitude, often associated with global black shale and sandstone deposits. However, their ultimate causes are discussed controversially (cooling-warming, glaciation-deglaciation, sea-level rise or sea-level fall, etc.). Most of these hypotheses have not been proven so far because geochemical data from the event intervals are absent or ambiguous due to hiatuses, facies changes, reworked sediments, the lack of fossils, and highly condensed facies.

The most severe extinction events of 1st order are the Kellwasser Event at the Frasnium/Famennian boundary and the Hangenberg Event at the Famennian/Tour-

naisian (D/C) boundary. They are characterized by globally widespread black shale depositions during anoxic and transgressive pulses. Additionally, a major transgression is marked by the Lower Alum Shale mass extinction Event at the base of the *crenulata* Zone (basal Middle Tournaisian). The overall low Middle to Late Famennian global sea level was additionally interrupted by several small-scale, sudden transgressive events associated with biotic crisis, such as the *Annulata* Event in the Upper *trachytera* Zone, the Dasberg Event in the Lower/Middle *expansa* Zone, the Epinette and Etroeungt Event in the Middle and Upper expansa zones. While the most severe bioevents were a subject of intensive studies in the past, small-scale events of 2nd to 5th order are not well known. Limited faunal, geochemical and sedimentological data exist for the events, only, and evidence for environmental changes, including carbon and oxygen isotope proxies, are scarce or even still missing in Europe and elsewhere.

To test what is the trigger for Famennian and Tournaisian faunal turnover, a multidisciplinary approach will be applied here for the reconstruction of climate and oceanographic changes by using high-resolution biostratigraphy, geochemistry and sedimentology from pelagic successions. The focus lies on the relationship between bioevents, eustatic sea-level changes, the global carbon cycle and changes in seawater temperatures.

S17 – Mammal molar teeth, a tribosystem of durability

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Mammal cheek teeth work as solid antagonistic systems providing exposed surfaces with interfacing materials (normally food). Because functioning teeth always involve solid boundary friction, fluid friction and mixed friction in the occlusal gap, it is best described as a tribosystem of sliding lubrication. While the organic matrix of food covers a range of magnitude in physical properties, its abrasive particles are the major component contributing to wear induced by the diet. The general process of wear, however, applies to all mammals, posing the following questions:

(1) Are there general tribological mechanisms that underlie the diversity of anatomies and classical macroscopic functional traits?

(2) Which general mechanisms of wear shaped mammal teeth in evolution and apply across anatomic and systematic affinities?

The key to answer these questions is a general model of tooth wear that reflects the mechanical constraints in all chewing systems independent from species, diet and habitat.

At given constant parameters for chewing vectors and geometry of the model surface, we propose the following general model of tooth wear that involves five basic variables: 1: Proportion of abrasives, 2: Size of abrasives, 3: Matrix resistance, 4: Orthal load and 5: Horizontal component of chewing movement. The model is tested applying ISO 3D surface texture analysis to wild caught and captive ungulates and primates which represent a large ecological spectrum. Silica controlled feeding experiments of rabbits provide experimental data.

S14 – The relationships of *Deuterosaurus* and phylogeny of the Dinocephalia

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Although it was one of the first therapsids to be described and was extensively studied in the 19th century, *Deuterosaurus biarmicus* from the Middle Permian of Russia has long been problematic from a systematic standpoint. Precladistic studies of *Deuterosaurus* differ strongly in their placement of the taxon, and it has been included in both of the major dinocephalian subclades, Anteosauria and Tapinocephalia. To test the relationships of this taxon, *Deuterosaurus* was included in a new phylogenetic analysis of Dinocephalia. Anteosauria, Tapinocephalia, and the traditionally recognized dinocephalian families Anteosauridae, Estemmenosuchidae, and Tapinocephalidae are supported as monophyletic (Styracocephalidae is monotypic, and as only a single titanosuchid, *Jonkeria*, was included in the analysis, the monophyly of this group could not be tested). *Deuterosaurus* is found to be deeply nested within Tapinocephalia, and its position as the sister group of Tapinocephalidae is strongly supported. *Styracocephalus* is recovered as the successive sister group to *Deuterosaurus* + Tapinocephalidae (although this position is weakly supported) and a clade containing Estemmenosuchidae + Titanosuchidae is present at the base of Tapinocephalia. The enigmatic Russian taxon *Parabradysaurus*, sometimes considered a close relative of *Estemmenosuchus*, falls outside of Estemmenosuchidae + Titanosuchidae and occupies a variable position at the base of Tapinocephalia. The recognition of *Deuterosaurus* as a tapinocephalian provides important new information on the origins of the highly autapomorphic tapinocephalid cranium.

S7 – Paläopathologie schalentragender Cephalopoden (Palaeopathology of shell-bearing cephalopods)

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Wachstumsstörungen, die auf genetische Defekte, Krankheiten, Parasiten/Epöken oder auf Verletzungen durch Räuber-Beute-Interaktionen zurückgehen und nur einzelne Individuen einer Population betreffen, werden unter pathologischen Phänomenen zusammengefasst. Paläopathologische Forschung an Cephalopopden beschränkt sich naturgemäß auf Anomalien der fossil erhaltungsfähigen teils kalkigen, teils aus Skleroproteinen gebildeten Hartteile (Gehäuse, Rostren, Kiefer, Statolithe, Gladien und Brutkammern).

Pathologische Einzelfälle sind bis in die jüngste Vergangenheit hinein oft fehlinterpretiert und als eigenständige Taxa beschrieben worden. Anhand zahlreicher Beispiele wird gezeigt, dass paläopathologische Forschung insbesondere für ausgestorbene Cephalopoden-Gruppen eine bisher wenig genutzte Quelle zum paläobiologischen Erkenntnisgewinn darstellt. Neben der Objektivierung von Taxonomie und Systematik, erschließt sich aus der Ätiologie paläopathologischer Syndrome eine breite Palette von differenzierten Interpretationen zu Lebensweise und Lebensraum. Wenn man die Anomalien nicht mehr als bloße Kuriositäten begreift, sondern sie nach funktionalen Toleranzgrenzen auslotet, eröffnen sie eine Vielzahl von aut- und synökologischen Aspekten. So werden exemplarisch bei den Ammonoideen autökologische Aspekte, wie Fragen nach der Normalstellung der Gehäusemündung, der Effizienz des hydrostatischen Apparates (auf der Basis von quantitativen Verletzungsanalysen), der möglichen Funktion von Gehäusemodifikationen (Skulpturen, Parabeln, Apophysen) und auf der Basis von Epöken der Bewegungsrichtung der Tiere und Abschätzungen des Individualalters diskutiert. Synökologische Themen erschließen sich vornehmlich aus Räuber-Beute-Interaktionen, die vor allem aus spezifischen Schalenverletzungen ersichtlich werden. Insbesondere seit der in der Trias einsetzenden Radiation benthischer Crustaceen, die zum Teil charakteristische Gehäuseverletzungen hervorrufen, lassen sich die Taxa einer Ammoniten-Taphozönose mit Hilfe quantitativer Populationsanalysen nach der Häufigkeit ihrer Bodenkontakte aufgliedern. Sie zeigen schließlich, dass in den unterschiedlichen Stockwerken der Wassersäule jeweils typische Ammoniten-Vergesellschaftungen lebten. Stärker skulptierte Gehäuse stellen eine offensichtliche Reaktion auf den steigenden Prädationsdruck durch die Krebse bei bodennah lebenden Formen dar, während glattschalige Taxa eher von Fischen in der freien Wassersäule attackiert wurden. Aufgrund von größenabhängigen Analysen spezifischer Verletzungsmuster kann über die Analyse bevorzugter Prädatoren gezeigt werden, dass jurassische Ammonoideen-Taxa teils im Verlauf ihrer Ontogenese ihre bevorzugte Lebensweise bzw. den Lebensraum gewechselt hatten, teils aber zeitlebens einer konstanten Feindbelastung ausgesetzt waren.

Regenerationsmechanismen und- phänomene nach Gehäuseverletzungen unterscheiden sich bei ekto- und endocochliaten Cephalopoden grundsätzlich. Bei den Ektocochlia erfolgt eine Reparatur durch den Mantel von innen, bei den Coleoideen, deren Gehäuse vom Mantel umgeben ist, von außen. Kontroverse Spekulationen über mögliche Tendenzen einzelner Ammonoideen-Taxa zur Endocochlie können hier einen klärenden Lösungsansatz finden.

Die Auswahl von Beispielen macht deutlich, dass paläopathologische Forschung ein bisher nur wenig genutztes Reservoir zur Objektivierung der Taxonomie und Systematik darstellt sowie zu wesentlichen Aspekten der Paläoökologie, der Lebensweise und dem Lebensraum schalentragender Cephalopoden. Insbesondere zeigen Abnormitäten die Toleranzspielräume funktionaler Merkmale auf und sind somit ein wichtiger Schlüssel zum Verständnis des „Normalen“.

S8 – Bored bones: an experimental study on the microbial degradation of bones in marine environments

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Microorganisms play an important role in the bioerosion of bone in marine environments, evident from the abundance of microborings in Recent and fossil bones. But the identity and activities of these microorganisms remain poorly known. We used two experimental setups to study the diversity, identity, activity and distribution of microorganisms on bones. First, whale and fish bone fragments were exposed to known collagenolytic bacterial strains and to an environmental microbial sample under sterile, controlled laboratory conditions. Second, whale bones were placed in aquaria with a steady stream of Baltic Sea water, and samples were taken at regular intervals from both setups. Intense microbial activity was evident in both setups within days to weeks. SEM imaging and DNA sequencing revealed a diversity of microorganisms on all bone types

and experimental setups and also significant differences among them, and even between whale and fish bones from the same sample bottle. We then used SEM images, and DAPI and FISH staining to document the distribution of the microorganisms on and within the bones.

S3 – Environmental impacts on the evolution of the deep-sea methane-seep fauna

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Methane-seeps in the deep-sea harbor unique ecosystems dominated by animals living in symbiosis with chemosynthetic bacteria and are therefore independent from photosynthetic primary production. When and how this fauna evolved and whether its independent food-source buffers it from environmental impacts is a matter of debate. Sulfide-rich environments in shallow water were considered as sites where animals acquired pre-adaptations enabling them to colonize deep-sea methane seeps or where they survived extinction events in their deep-sea habitats. Cenomanian (Late Cretaceous) shallow-water seep communities from the Tropic Shale in the Western Interior Seaway, USA, provide a possible refutation of these hypotheses. Contrary to the expectations, the taxa of the Tropic Shale seeps were not found at coeval or younger deep-water seep or vent deposits. Furthermore, a cluster analysis of faunal similarity among Cretaceous vent and seep faunas revealed no distinction between pre- and post-Cenomanian seep faunas but instead strong similarities among Aptian to Late Cretaceous seep faunas. This suggests that a low temperature gradient from shallow to deep water did not facilitate invasions of deep-sea vents and seeps from shallow water and that pre-adaptation for living at deep-sea vents and seeps did not evolve at shallow-water methane seeps. The vast majority of adaptations to successfully colonize deep-sea vents and seeps were most likely acquired below the photic zone.

S6 – Ontogenetic patterns of the Late Devonian ammonoid *Cymaclymenia* from Morocco

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Cymaclymenia is a late Famennian (Late Devonian) ammonoid genus with a wide geographic range; species of this genus are often the dominant components in the cephalopod assemblages. In the Late Devonian successions of the Anti-Atlas of Morocco, *Cymaclymenia* and closely related genera occur in a rock succession spanning approximately 4.5 Ma. The presence of well-preserved material allows for a study of the conch ontogeny using high-precision cross sections.

Cymaclymenia and related genera (the stratigrahically older *Procymaclymenia* and the stratigraphically younger *Postclymenia*) display a characteristic allometric growth of their conchs with evolute inner whorls that become more involute during ontogeny. However there occur differences in the timing and expression of ontogenetic changes, which characterise evolutionary pathways of these forms.

A total of 39 specimens were analysed in terms of metric data (the cardinal conch parameters conch width index, umbilical width index, and whorl expansion rate) as well as well as data derived from a Fourier outline analysis of the shape of the apertures. Both methods led to similar results and therefore compliment each other.

Three major patterns can be observed, when the evolution of conch geometry and suture line are analysed:

(1) At the beginning of cymaclymeniid evolution, the conch geometry and also its ontogeny are not variable; modification of the suture line is the most significant morphological change.

(2) In the time of maximum species richness within the Cymaclymeniidae, the suture line shows little variation. At the same time, the conch geometry varies within wide ranges from thinly discoidal to pachyconic. Differences are mainly caused by variations in the lengths of ontogenetic changes.

(3) At the end of cymaclymeniid evolution (with the extinction of the entire group), a significant heterochronic change takes place, in which the juvenile conch morphology (with widely umbilicated, discoidal conch) is expanded to the adult stage.

The investigation shows that the detailed analysis of ontogenetic trajectories in Devonian ammonoids is a powerful tool for the reconstruction of phylogenetic relationships and for the quantification of evolutionary change through time.

S17 – Why have a dP4? Deciduous upper premolars in the talpid *Desmanella engesseri*

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Not all modern day talpids undergo tooth replacement; if they have deciduous and permanent dentitions, the deciduous one is shed early in live. Rarely, deciduous teeth of fossil moles are found, like for *Eotalpa* from the Lower Oligocene of Belgium, *Suleimania ruemkae*, *Theratiskos rutgeri* and *T. mechteldae* of the Lower Miocene of Anatolia, Turkey and *Mystipterus pacificus* of the Middle Miocene of Oregon. The dP4 of *Desmanella engesseri* was found in the rich Early Miocene (MN 3/4) fissure filling Petersbuch 28, a locality near Eichstätt (Bavaria, Germany). It is unique among the known dP4 because it lacks the protocone, which is replaced by a large cingulum. The tooth's lingual part slopes downward in posterior direction and forms a strong posterior emargination. It might have taken over part of the M1's function for a short time. In *Eotalpa*, the dP4 is a functional predecessor of the M1, in *Theratiskos* and *Mystipterus*, the dP4 is nearly similar to the P4 and should have had a similar function. *Suleimania* is also singular, because its dP4 is more complex than the P4 and has a large protocone, which is reduced on the P4. Probably this tooth also took over part of the M1's function.

S6 – Comparing intraspecific variability of ammonoids

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Heritable phenotypic variation is usually thought to be the raw material for evolution and natural selection. Knowledge of the intraspecific variability of any taxon is therefore essential for systematics and diversity studies. Heritable variation is, however, hard to separate from morphological variation resulting from a plastic response to the environment, especially in extinct groups. For instance, a large part of the intraspecific variability in shelled molluscs could be caused by differences in growth rates, which could also explain certain recurrent patterns in intraspecific variability in the shells of coiled mollusc shells. Probably because of a low amount of specimens, poor preservation of study materials and/ or the lack of time and/ or motivation, intraspecific morphological variability has been poorly studied in ammonoids (as it is the case in most other groups of fossil and extant organisms). In ammonoids, this might lead to biases and problems such as, e.g., overlooking the influence of coiling on the intraspecific variability, oversplitting of taxa, and insufficient knowledge of taxa.

We have finished first studies on variability in relation to coiling with loosely coiled ammonoids of the genera *Anetoceras* and *Erbenoceras* from the early Emsian (Early Devonian) of Morocco and could demonstrate high degrees of intraspecific variability in both genera. We compared the morphometric data of the Moroccan material with published specimens of the same age worldwide. This led to the conclusion that the current amount of valid ammonoid species of the studied interval (> 20) is not supported by differences in the classical dimensional shell characters. Since the suture lines of these ammonoids are extremely simple, they are insufficient to base species exclusively on their suture line courses. This led to the conclusion that the existing wealth of species with loosely coiled shells has originated from oversplitting and has no profound scientific base. Estimates of ammonoid diversity are thus probably too high for the early Emsian.

In the past decade, we have collected and measured many Palaeozoic ammonoids, predominantly of Early and Middle Devonian age, but also of Late Devonian and Carboniferous age. These included species that have the advantages that several of which originated more or less close to the origin of the respective clade and that several show traces of ancestral characters especially in the early parts of ontogeny. An important plesiomorphic trait is the loose coiling, which is seen in several early Emsian ammonoid species. Our material of these very early forms led to the hypotheses that (1) intraspecific variability (at least of some characters) is intimately linked with coiling and therefore, (2) earlier forms are more variable than more derived forms with more tightly coiled shells.

To test the relation of the degree of intraspecific variability of conch parameters with coiling, we measured additional datasets of ammonoids from the late Emsian, the Eifelian, and the Carboniferous; the representatives of which have more or less tightly coiled shells. We used the coefficient of variation as a measure of the range of variability. Preliminary tests appear to support the two hypotheses, but further tests are needed before drawing a conclusion.

S25 – Soft-part preservation in heteromorph ammonites from the Cenomanian-Turonian Boundary Event (OAE 2) in the Teutoburger Wald (Germany)

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Excellent preservation of ammonites in Cretaceous rocks has been documented several times already. For instance, Lebanese Plattenkalke have yielded heteromorph ammonites with phosphatised soft tissue and, more recently, US-American baculitids (also heteromorphs) were published showing a perfectly preserved radula *in situ*. Several decades ago, WR extracted 17 flattened individuals of baculitid ammonoids with carbonised and partially also phosphatised soft parts from thin laminated marlstones belonging to the OAE 2 of the Late Cenomanian Hesseltal Formation of Lengerich in the Teutoburger Wald mountains (Westphalia, Northwestern Germany). The advantage of these specimens is that the shell is dissolved although it appears like it has been deposited with the soft parts because the shell outline is still visible as well as such shell structures that were not carbonatic such as the siphuncle and the melanin-rich parts of the shell (megastriae, aperture). Several of these ammonites preserve remains of the buccal mass including jaws (more or less articulated) and radulae. Additional remains which were not mineralised in vivo have been found. Most of which are much more difficult to homologise with organs of their Recent counterparts. For example, behind the mouth parts, two specimens display two lateral, symmetrically arranged more or less oval structures. In one of the two specimens, these two are linked with each other and this connection covers the supposed oesophagus. According to this arrangement, these oval structures have been interpreted as remains of the cephalic cartilage with the eye capsules, which were previously unknown from ammonoids. Further soft-parts include structures, which we interpret as digestive tract including oesophagus, crop, stomach and (?) the caecum as well as remains of what might have been the oviduct. In the same horizon, patchy occurrences of numerous isolated upper and (less abundant) lower jaws (probably also from baculitids) as well as radulae occur. These jaw-accumulations may represent regurgitates or droppings of larger predators. These cephalopod remains were deposited in an epicontinental setting, perhaps at a palaeodepth between 200 and 600 metres. In this Late Cretaceous fossillagerstätte, ammonite upper jaws and anaptychi are among the most abundant fossils.

S25 – First Miocene holomorphic stingray (Chondrichthyes, Myliobatiformes, Dasyatidae) from SE Asia

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Stingrays form a monophyletic group, the Myliobatoidei, which is characterized inter alia by one or more barbed spines on the tail, which is secondarily lost in manta and porcupine rays. The suborder is the most diverse group of rays with 59 living species in nine genera and eight families, Hexatrygonidae, (sixgill stingray), Plesiobatidae (deep water stingray), Urolophidae (stingarees), Urotrygonidae (round rays), Dasyatidae (whiptail stingrays), Gymnuridae (butterfly rays), Myliobatidae (eagle rays), and Potamotrygonidae (river stingrays). Myliobatoids are the most derived and specialized group of rays inhabiting a wide range of aquatic environments from deep-marine habitats (e.g., some plesiobatids) to lakes and rivers (e.g., Potamotrygonidae). While most marine species are demersal, some developed pelagic life-styles such as the mobulids.

The fossil record of myliobatioid rays extends back into the Cretaceous with questionable teeth from the Hauterivian (Early Cretaceous) probably being the oldest records of this group. Late Cretaceous stingrays are exclusively represented by isolated teeth, dermal denticles and rare caudal spines from the Cenomanian (Dasyatidae and Gymnuridae) and Campanian-Maastrichitian (Myliobatidae and Rhombodontidae) of North and South America, Africa, Europe, and the Middle East. They are absent from the Pacific, which seemingly is a collecting bias. In the Cenozoic, the fossil record of stingrays also consists almost entirely of isolated remains. The most complete, holomorphic specimens occur in the Eocene of northern Italy (marine) and north-western U.S.A. (freshwaters).

Road constructions in 1909 and subsequent excavations in 1923 near the city of Pataenoeang Asoe E in the Maros District of southern Sulawesi (Indonesia), yielded abundant well-preserved fossil fishes including an almost complete ray skeleton. The single known specimen only lacks portions of the posterior body including the tail. The fossil-bearing sediments are yellowish, micritic and laminated limestones of Miocene, probably Burdigalian age based on foraminifers. This ray was described very cursory in 1926 as *Trygon vorstmani* without providing an in-depth anatomical account or identification of characters to distinguish this specimen from any other extant or extinct ray. Moreover, the name *Trygon* represents a junior synonym of *Dasyatis* as well as a collective taxon for inclusion of different, not closely related sharks and batoids (e.g., species now assigned to *lkamauius*; *Taeniura*). Here, we present a morphological and systematic revision of this specimen. According to several anatomical features including dermal denticles and teeth, the specimen is shown to represent a member of myliobatoid stingrays although the characteristic caudal spine is not preserved in the specimen. The character combination distinguishes the specimen readily from all other myliobatoids. The Sulawesi ray is the only known fossil batoid from SE Asia and single holomorphic myliobatoid specimen from the Neogene.

S9 – Divergence estimates of major squalomorph clades (Chondrichthyes, Neoselachii) and their impact on phylogenetic hypotheses

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Attempts in dating the divergence and origin of living sharks, rays and skates employing molecular clock approaches increased significantly in recent years. The use of single or multiple fossil occurrences and the inferred stratigraphic age of these fossils often are, however, unsatisfactory or cause problems. Consequently, new approaches including phylogenetic bracketing and stratigraphic information were developed lately to provide constrained node age estimates of major vertebrate lineages. Cartilaginous and bony fishes received surprisingly little attention and only few molecular analyses attempted to provide information on the divergence of major fish lineages. Recently, we provided a modified approach incorporating fossil occurrences and fossil record analyses using diversification patterns based on subsampling analyses as evolutionary framework to establish node age estimates for squatiniform sharks. Squatiniformes is member of the Squalomorphii, which forms a monophyletic clade within Neoselachii and is sister to the Galeomorphii. Currently, squalomorph sharks are divided into six monophyletic lineages, Chlamydoselachiformes, Hexanchiformes, Echinorhiniformes, Pristiophoriformes, Squatiniformes and Squaliformes (in systematic order from plesiomorphic to apomorphic). The placement of chlamydoselachid and echinorhinid sharks into distinct orders, nevertheless, is continuously debated. Here we present "hard" minimum and "soft" maximum dates for the divergence for all major squalomorph shark lineages and compare the results with current hypotheses of their interrelationships. Our results show that previous phylogenetic hypotheses, in which these two orders are not recognized are in better accordance with estimated divergence times minimizing ghost-lineages considerably. Although the fossil record cannot be taken at face value for divergence times, the methodologies employed here provide reliable node age estimates that offer verifiable support for establishing the origin and divergence of major neoselachian shark lineages. This analytical procedure also might help distinguishing between competing phylogenetic hypotheses because it allows to directly evaluate ghost-lineage lengths to minimize differences between systematic arrangements and divergence times.

S9 – 47 Ma old true bugs (Insecta: Heteroptera) – do they have connections with extant ones?

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Sites with outstanding fossil insects are known from all over the world, and they are in the focus of paleoentomological research. Especially Tertiary insects are well comparable to extant genera. The similarities of extinct and extant bugs from two Eocene fossil sites in Europe and the USA were investigated in this study.

The UNESCO World Heritage Site Grube Messel is located in Germany, and Green River is located in the United States of America. With an age of ~47 Ma (Messel) and ~50 Ma (Green River) both sites have similar ages. The richness in fossil insects is enormous in both locations. In order to compare the sites in taxa diversity, several groups of the true bugs (Insecta: Heteroptera) were chosen for further investigation. Heteropterans are a very interesting insect group, which until now has been poorly studied in both sites.

The present study focuses on the so-called assassin bugs (Heteroptera: Reduviidae), which are widely distributed predaceous insects. Recent Reduviidae represent the second largest group within the true bugs with more than 6,600 described species.

In Messel, more than 60 fossil specimens of assassin bugs were found which belong to the extant groups Harpactorinae and Elasmodeminae. Among Harpactorinae, the fossils can be determined as belonging to the Harpactorini, Ectinoderini, and Apiomerini. Extant Ectinoderini are restricted to the region between Sri Lanka and New Guinea and there was no fossil record of this group until now. The discovered fossils extend the known biogeographical range of this group considerably, which can be explained by the worldwide warm climate during the middle Eocene. After global climate changes, the Ectinoderini seemingly only survived as relicts in the area between Sri Lanka and New Guinea.

About 25 reduviid specimens were detected in the Green River collection. As in Messel, Elasmodeminae can be identified, but Harpactoninae are not present among the investigated fossils. Two specimens of the Elasmodeminae probably show sexual dimorphism. Both specimens share many morphological traits, e.g. wing venation and coor pattern. Only the shape of their heads is different, and this is known to vary between sexes in reduviids. Additionally, one fossil belonging most likely to the Triatominae is present in Green River. Triatominae is an assassin bug group, which is today responsible for

transmitting Chagas disease to mammals in South America. If this determination can be confirmed, this fossil will be the oldest known representative of this group.

By comparing fossils and extant taxa new information concerning the paleobiogeography can be gained and former habitats can be understood better.

S2 – Substage-level extinction rates of Early Jurassic radiolarian genera

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The Early Jurassic epoch was a time of significant changes in the Earth system. Best known is the Toarcian deposition of black shales, along with the multiple perturbations recorded in stable isotope data from many sections worldwide, which suggest major environment changes manifested as the Toarcian Oceanic Anoxic Event (T-OAE). As radiolarians are an important element of the Mesozoic zooplankton, outlying values in their rate of diversity changes could indicate global events in the oceanic ecosystem. We analyzed Early Jurassic radiolarian diversity history on the basis of the Paleobiology Database (PBDB) and aim to provide new insights into the effect of the T-OAE and possibly other Early Jurassic events.

The amount and quality of data available within the PBDB allowed us to attempt diversity analysis at a finer stratigraphic resolution than the stage level previously used in most studies. High data density is a prerequisite for analyses at substage resolution, therefore we checked and revised existing data as necessary and complemented it by entering most other published references on Early Jurassic radiolarians. Our analyses are based on the latest developments in diversity metrics and methods, such as the corrected three-timer taxonomic rates and various bylist subsampling methods of fossil occurrences.

It was recently demonstrated that the background extinction rates of radiolarians were significantly different in the Triassic and the Jurassic periods. We found three peaks in the Jurassic extinction rates that appear as outliers from this background (exceeding more than one and a half times the interquartile range from the median): the Hettangian stage, the Late Sinemurian and the Early Toarcian substages. The Hettangian peak is interpreted as the 'dead clade walking' effect, a lag of elevated extinction rates after the end-Triassic mass extinction. The Early Toarcian peak is correlated with the T-OAE, and known as the Toarcian Radiolarian Event, marking an interval of elevated turnover between the *Parahsuum simplum* and *Hexasaturnalis hexagonus* Assemblage Zones. The intervening peak in the Late Sinemurian, possibly suggesting a Sinemurian -Pliensbachian boundary event, might also reflect a global event, that has not been widely recognized previously, although a recent study reported carbon isotope excursions and regionally developed organic-rich shale deposits. Thus this newly recognized radiolarian extinction peak may be important for the hitherto poorly understood Sinemurian-Pliensbachian boundary event.

S5 – Mikro-Computer-Tomographie und 3D-Rekonstruktion der planktonischen Foraminifere *Globigerinoides sacculifer*

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Die Technik der hochauflösenden röntgenbasierenden Mikro-Computer-Tomographie (Mikro-CT) ermöglicht mittlerweile die zerstörungsfreie, dreidimensionale (3D) Modellierung und biometrische Quantifizierung des Gehäuses und des Innenraums von Foraminiferen.

Zu den vorausgegangenen Analysen benthischer Foraminiferen (Speijer et al. 2008, Briguglio & Hohenegger 2011) wird hier dieses Verfahren erstmalig an planktonischen Formen angewendet.

Als Objekt diente ein mikrosphärisches Exemplar der rezenten planktischen Foraminifere *Globigerinoides sacculifer* (Brady) aus dem Südatlantik vor der Insel Ascension.

Eingescannt wurde am Mikro-CT „v|tome|x s" der Firma GE Measurement & Control des Steinmann-Instituts, Universität Bonn. Unter Verwendung des Visualisierungs- und Analyseprogramm Avizor 6.0 ließ sich neben einer Veranschaulichung des Gehäuses, mitsamt Poren und Resten abgebrochener Stacheln, auch der Innenraum mit Gesamt- und Einzelvolumina der Kammern nachbilden.

Die aus den Volumina errechneten Wachstumsraten zeigen ein exponentielles ontogenetisches Wachstum für *G. sacculifer*.

Das 3D-Modell erlaubt zudem biomorphometrische Parameter, wie Radien der Kammern, Größe des Gehäuses und Schalendicke, komplett zerstörungsfrei und genau aufzunehmen.

In weiterer Arbeit werden diese biometrischen Analysen an anderen Arten planktonischen Foraminiferen des Gebiets vor Ascension durchgeführt, um steuernde Faktoren über innerartliche Variationen bei unterschiedlichen ökologischen Faktoren, wie Temperatur, Salinität und Wassertiefe in der Morphologie, den Volumina und den Wachstumsraten bestimmen zu können.

S17 – Zahnverschleiß an Säugetierzähnen – destruktiv oder konstruktiv?

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Für Säugetiergebisse ist der fortschreitende Verschleiß der Zähne eine typische Alterserscheinung. Deswegen wird der Zahnabrieb meist als eine negative Begleiterscheinung angesehen. Allerdings erreichen viele Zähne erst nach einer Phase des Einschleifens die volle Funktionalität.

Zwei Formen des Zahnabriebs werden unterschieden, die Abrasion (ein Abtrag durch Nahrung) und die Attrition (ein Abtrag durch Zahn-Zahn Kontakte). Ein Abtrag durch Korrosion kann zumindest bei Wildtieren vernachlässigte werden. Die Attrition wird häufig als eine mehr oder weniger zufällige Nebenerscheinung betrachtet.

Abrasion und Attrition sind zwar nicht scharf von einander abzugrenzen, unterscheiden sich aber deutlich in der Dominanz bestimmter Merkmale, wie der Rundung von Schmelzkanten, der Auskolkung des Dentins, und vor allem in der Inklination der Facetten. Daraus ergibt sich eine unterschiedliche Ausformung der Kauflächen (eben, gestuft, oder gefurcht). Hypsodontie tritt nur selten in Zahnreihen auf, die von Attritionsfacetten dominiert werden. Dagegen sind hypsodonte Zähne vielfach dort entwickelt worden, wo die Abrasion dominiert.

Zahlreiche Beispiele aus der Diversität der Säugetierbezahnungen zeigen, dass speziell den Attritionsfacetten eine große Bedeutung in der Gesamtarchitektur zukommt. Große Attritionsfacetten bilden die Fleischschneidescheren von Carnivora, Creodonta, aber ebenso von *Thylacoleo*, einem Beuteltier. Die bilophodonten Molaren, etwa von *Deinotherium*, *Lophiodon* oder *Diprotodon* sind durch Attritionsfacetten gekennzeichnet. Diese Facetten werden oft schon im Zahnkeim als leicht überkragende und krenulierte Kanten angelegt und garantieren damit ein optimales Einschleifen. Da diese Attritionsfacetten steil stehen, bedingen sie eine „gestufte Kaufläche". Dagegen liegen die Schneidekanten in Bezahnungen mit verstärkter Abrasion meist in einer ebenen Kaufläche, wie bei den Elephantidae oder Arvicolidae.

Den Attritionsfacetten fällt eine wichtige Rolle bei der Führung der Kaubewegungen zu. Das gilt besonders für die „gefurchten Kauflächen", wie sie bei vielen Multituberculata zu beobachten sind. Nur eine präzise geführte Längsbewegung ist funktional möglich. Bei dem fossilen Beutler *Ektopodon* ist bei einer ganz ähnlichen Kaufläche eine Querbewegung vorgegeben. Weniger auffallend, aber funktional nicht minder wichtig, sind die gefurchten Kauflächen bei den Laub fressenden, selenodonten Artiodactyla. Dort steuern die gewinkelt stehenden Attritionsfacetten die Kaubewegung in lingualer Richtung. Diese strenge Führung verliert sich aber beim Übergang zu Grasnahrung mit der zunehmenden Abrasion.

Gegenüber einer strengen Führung des Kauweges durch Attritionsfacetten, steuern Abrasionsfacetten den Kauweg nur wenig. Die letzteren überwiegen in bunodonten Gebissen.

Selbstverständlich ist der Abrieb an Zähnen destruktiv, aber Attritionsfacetten erweisen sich als Führungsbahnen für den Kauweg und damit als wichtige Bauelemente der Zahnarchitektur. Diese Sichtweise auf den Zahnverschleiß und die Ausrichtung der Attritonsfacetten lässt die konstruktive Bedeutung einzelner Zahnelemente, wie etwa die des Mesostyls oder der Cingula, in einem neuen Licht erscheinen.

S13 – Caudal swimming in the Triassic fish *Saurichthys*

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Palaeozoic actinopterygians usually had more or less fusiform bodies and heterocercal tails with – supposedly – a powerful dorsal and a more or less weak ventral lobe. A new bauplan may have emerged near the Permian-Triassic boundary with the appearance of the Saurichthyidae, which were important predators in marine and freshwater systems throughout the Triassic. The body of these fishes was long and slender, with an elongated, pointed head and far posteriorly positioned pelvic and unpaired fins. The caudal fin, termed "abbreviate-diphycercal", consisted of symmetrical epaxial and hypaxial lobes whose lepidotrichia were directly inserted in the vertebral column, which proceeded straight between them. The dorsal and anal fins were symmetrical and resembled the caudal fin in overall shape; this disposition is called a "double-tail configuration" and is known to have a high hydrodynamic efficiency. The caudal fin was separated from those dorsoventral fins by a narrowing caudal peduncle and preceded by a series of broad dorsal and ventral scales (scutes), covering all or a part of this interval. Each scute had a V-shaped external outline and a deep keel on the inside, fitting into a groove on the outside of the following scute. These structures substantially limited the lateral flexibility of the caudal peduncle, thus increasing the lever action of the tail. The streamlined head and slender body reduced turbulences around the fish, protecting it from being perceived by the prey.

Similar gross morphologies are found in numerous extinct and extant actinopterygians and generally related to

a piscivorous lifestyle. The body shape is optimized to allow rapid acceleration in order to overtake and catch the prey rather than to facilitate steady swimming.

Tailbeat frequency, amplitude and the length of the propulsive wave are characteristic parameters of fish swimming. Thrust increases with area of the propulsive surfaces (i.e. the caudal and dorsoventral fins) and decreases with increasing body curvature. A stiffer body would therefore be more efficient. The ratio of muscle mass to the total mass of the body is a further critical character.

Hydrodynamic modeling enables us to reconstruct the probable swimming behavior of *Saurichthys* and to explore the impact of morphological parameters whose changes are documented in the fossil record. The working hypothesis is that by their appearance near the Permian-Triassic boundary, saurichthyids possessed a novel propulsive mechanism superior to those of contemporaneous ray-finned fishes. Although saurichthyids died out in the Early Jurassic, this body shape has been developed independently several times in different actinopterygian lineages and seems to be incessantly linked to this chasing behaviour.

S12 – Depositional facies settings of Late Devonian sequences in northwestern Thailand: a multidisciplinary approach.

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Detailed stratigraphy and facies studies have been undertaken in two Late Devonian sections in northwestern Thailand: the Mae Sariang section is characterized by very homogeneous carbonates deposited in environments with strongly reduced and/or interrupted sedimentation. Features such as hardgrounds, Fe/Mn crusts, and microbialites are very common. The rare megafossil content and low diversity, presence of pelagic fauna (such as cephalopods, conodonts of the palmatolepid-polygnathid off-shore facies, entomozoacean ostracods and rare tentaculitids), all indicate a pelagic facies setting. In contrast to the Mae Sariang section sediments of the Thong Pha Phum section further to the south are mainly represented by inner shelf deposits with a divers faunal association. Facies data are confirmed by geochemical investigations. Frasnian and Famennian conodonts collected from the Mae Sariang and the Thong Pha Phum sections in the westernmost part of Thailand are used to reconstruct the Nd isotopic composition of seawater during the Late Devonian. At Thong Pha Phum, the seawater was characterized by very low εNd values (between -13.1 and -18.2) and very high Sm/Nd ratios (between 0.36 and 0.66). This chemical composition reflects a strong influence of the riverine Nd input from a very old continental basement and a short distance to the coast. In contrast, the seawater at the Mae Sariang site was characterized by much more radiogenic signatures (εNd values from -8.7 to -11.1) and uniform, low Sm/Nd ratios (between 0.20 and 0.23). Extremely low εNd values recognized at Thong Pha Phum attest to a passive margin continental setting and a paleogeographic position very close to a continental area where Paleoproterozoic and Neoarchean rocks were eroded. The talk summarizes the results of this multidisciplinary approach of with respect to facies, sedimentology, geochemistry and plate tectonic consequences.

S25 – A new teleost from the Late Jurassic Plattenkalks of Ettling (Bavaria, Germany)

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The first results of the description and a preliminary cladistic analysis of a new teleost from the Late Jurassic Plattenkalks of southern Germany are presented. The fossils were found during the recent excavation of the Jura-Museum Eichstätt at the quarry of Ettling (Markt Pförring) near Ingolstadt. The new species was detected within the collection of the Jura-Museum Eichstätt, while studying specimens of *Orthogonikleithrus hoelli*. It attracted attention due to a differing number of vertebrae. A closer look at this fish revealed even more morphological and anatomical differences to *O. hoelli* and other closely related teleosts. Among others, the new fish is distinguished by the low number of vertebrae of 37 to 39, very short ethmoidal region of 12 to 15 % of head length, short interopercle, paraspheniod without dentition, large orbitospenoid, preopercle sensory canal with two or three short tubules, anterior ceratohyal not fenestrated, 7 to 8 hypurals present, 4 uroneurals present the first one is a stegural. The preliminary cladistic analysis shows that the new species belongs to the family Orthogonikleithridae but it is still unclear whether it belongs to the genus *Leptolepides* or if a new genus has to be created.

S13 – Morphological evolution and extinction patterns of the Ammonoidea at the Permian-Triassic boundary of Iran

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The classical Permian-Triassic (P-Tr) boundary sections in the vicinity of Julfa (NW Iran) and in the Baghuk Mountain area (Central Iran) have high potential for the study of the end-Palaeozoic extinction event. The lithostratigraphic record of the P-Tr boundary beds in the Julfa area is rather uniform over a distance of 35 km. It comprises the *Paratirolites* Limestone (four meters of red nodular limestone), Boundary Clay (60-190 cm), and Elikah Formation (400 m gray platy limestones). Sections in the Aras Valley and at Kuh-e-Ali Bashi display very similar successions of latest Permian ammonoids. Sections in the vicinity of Abadeh in Central Iran show a similar succession and faunal composition.

Excellent correlation of the sections can be achieved and enables the detailed documentation of the demise of the Paleozoic faunas. The *Paratirolites* Limestone, the youngest Permian carbonate formation that represents about the upper half (appr. 1.2 Ma) of the Changhsingian stage, can be subdivided in terms of ammonoid biostratigraphy, complementing lithostratigraphic, carbonate microfacies, stable isotopes, and conodont data.

The unit can be subdivided into at least four clearly separable ammonoid zones, allowing discrimination into ~300,000 year intervals. The study region can therefore serve as a standard for the Tethyan development of the P-Tr boundary. A stepwise temporal development of the Late Permian ammonoid faunas is observed. In contrast to earlier studies, the *Paratirolites* Limestone is not uniform in its ammonoid faunas but shows some distinct patterns:

(1) The abundance of ammonoids decreases at the top of the *Paratirolites* Limestone; only the top part of this rock unit shows sometimes a mass occurrence of small ammonoids.

(2) A morphological development from simpler suture lines (with unserrated prongs of the external lobe) at the base of the *Paratirolites* Limestone towards more complex sutures with stronger frilled external lobes in the middle portion of the rock unit, and finally a rebound towards simpler suture lines (succession of the genera *Dzhulfites*, *Paratirolites*, and *Abichites*).

(3) A general simplification of the conch geometry from trapezoidal to compressed whorl cross sections.

(4) A smoothing of the shell ornament (loss of coarse sculpture such as ventrolateral nodes with a development to faint ribs).

(5) A conspicuous size decrease of the ammonoid conchs (from up to 200 mm diameter to 30 mm). This size reduction can be seen in the paratirolitid lineage (genera *Paratirolites* and *Abichites*) but also in the immigration of small-sized ammonoids such as *Neoaganides*.

The top of the *Paratirolites* limestone shows the extinction horizon with numerous small ammonoids with simplified suture lines. These data indicate that the evolution of the ammonoids has severely been affected already within the Changhsingian. The data demonstrate the complex morphological evolution of the latest Permian ammonoids prior to the mass extinction event.

S15 – Tooth replacement in Dicraeosauridae – Insights from CT images of *Dicraeosaurus hansemanni*

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Among Dicraeosauridae, tooth bearing elements are known exclusively from the Late Jurassic taxon *Dicraeosaurus hansemanni* of the Middle Dinosaur Member of the Tendaguru Formation (Tendaguru, Tanzania). The preserved material consists of three premaxillae, one maxilla, and one dentary, which all preserve complete rows of alveoli, but only few replacement teeth in situ. Based on the alveoli, the tooth count of *Dicraeosaurus hansemanni* can be reconstructed to 4 premaxillary, 12 maxillary, and 16 dentary teeth. The tooth bearing skull bones were investigated by computed tomography using an Aquilion CX (Toshiba) at the Leibniz Institute for Zoo- and Wildlife research, and the obtained data was edited using OsiriX (32 Bit Version 3.71).

In the premaxillae, a row of 4 to 5 replacement teeth in each alveolus is present. Interalveolar septa separate the rows of replacement teeth from each other, but open at the labial margin into an alveolar trough. In the maxilla, the rostralmost 4 alveoli have 4 replacement teeth, but their number decreases to 2 between the 6th and 9th alveolus and 1 between the 10th and 12th alveolus. The dentary shows 3 replacement teeth in each of the rostralmost 4-6 alveoli. The 7th to 11th alveoli bear two replacement teeth, and the 12th to caudalmost dentary alveolus bear each only one replacement tooth. The interalveolar septa of the maxilla and the dentary are complete, except for two overlapping replacement teeth.

In comparison with other diplodocoids, the tooth count of 4 premaxillary, 13 maxillary, and 16 dentary teeth is more than in diplodocids (*Diplodocus*: 4/9-10/10) and less than in rebbachisaurids (*Nigersaurus*: 4/25/34). However, the number of 5 replacement teeth in the premaxilla is similar to *Diplodocus*, and differs from the tooth-battery of *Nigersaurus*. Generally, the decrease in the number of replacement teeth from frontal to caudal in the jaws indicates a change of turnover-rates. It is very likely that, like in other diplodocoids, the frontal teeth were used for active food acquisition, whereas the more caudal teeth served for transporting the food towards the esophagus and as guide bars. Additionally, the dentary replacement teeth in the same developmental stage as the maxillary teeth are mostly 50% smaller than the latter, but the rostral teeth of different tooth rows of the dentary are more similar in size. This suggests more frequent replacement of the frontal dentary teeth, as in the premaxilla, but within the limits of space given by the more narrow construction of the dentary. Finally, the lower number of replacement teeth in the rostral dentary suggests smaller turnover-rates than in the premaxilla, which can be explained by less abrasion of the dentary teeth, as in diplodocids.

S22 – Tracing shifts in dispersal syndromes: fruit ecology in modern vegetation and Paleogene/Neogene plant assemblages

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Fruit dispersal spectra and seed size distribution of woody taxa were studied in different forest types in Japan and China (40 sites/units respectively) to trace shifts in fruit traits along the latitudinal and altitudinal gradients. The dispersal syndromes distinguished are fleshy and non-fleshy zoochorous, anemochorous, autochorous, and hydrochorous. The forest types studied are broad-leaved evergreen, mixed mesophytic, broad-leaved deciduous, sub-humid sclerophyllous, and differing tropical forests. Clear relationships are evident between dispersal mode, seed size class distributions and the various forest types. The distribution of dispersal modes and of seed size classes differs significantly between the vegetation types. Animal dispersal is more important in broad-leaved evergreen and tropical moist forests, whereas wind dispersal is more common in sub-humid sclerophyllous, tropical monsoon, and deciduous forest types. Large seeds (> 15 mm) of fleshy-fruited taxa are predominant in tropical moist forests but almost absent in the other forest types. Large seeds of non-fleshy animal-dispersed taxa, however, are found across all forest types. Abiotic dispersal mechanisms are consistently low across the forest types.

35 Eocene and Neogene floras from Europe (fruits, leaves, and pollen of woody taxa) were analyzed to trace fruit dispersal syndromes in the fossil record, i.e. in paratropical, broad-leaved evergreen, mixed mesophytic, broad-leaved evergreen and broad-leaved deciduous forests. Additionally, zonal and azonal taxa were distinguished to test whether the dispersal syndromes are equally distributed in the zonal and azonal record. The results show very similar partitions of dispersal fractions in the fossil record compared to modern forests. Paratropical forests bear highest values of fleshy zoochorous taxa and lowest of anemochorous ones. Fleshy zoochorous proportions are still high in broad-leaved evergreen forests. They are lowest in sub-humid sclerophyllous and broad-leaved deciduous ones. For anemochorous taxa this trend is inverse, lowest values derive from paratropical forests and highest from sub-humid sclerophyllous and broad-leaved deciduous ones. Non-fleshy zoochorous taxa always show relatively low percentages but their values are somewhat higher in subhumid sclerophyllous and broad-leaved deciduous forests than in broad-leaved evergreen ones. Autochorous and hydrochorous proportions are always very low. Regardless of the age, the anemochorous fraction is always higher in the azonal record. This study unravels an important vegetational trait from the fossil plant record thus contributing to a more comprehensive understanding of ecosystem evolution and dynamics.

S8 – Experimental silicification of calcite and aragonite shell: toward an understanding of the microstructural controls on silica replacement

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The replacement of calcium carbonate shell with silica during diagenesis is one of the most important, yet poorly understood preservation styles in the fossil record. Silicified fossils reveal exquisite three-dimensional detail that can be invaluable for systematic description. However, not all taxa silicify in the same way or with the same frequency and this style of preservation is uncommon in post-Paleozoic sediments. As a result, silicification is affected by a taphonomic megabias that distorts our view of the fossil record of shelled invertebrates, particularly bivalves and brachiopods. A better

understanding of the physical and chemical drivers of silicification is critically needed.

In this study we utilize laboratory experiments on modern shells to gain new insights into the silicification process. These experiments allow us to address the relative importance of shell microstructure, mineralogy, silica availability, and Ca-saturation state on silica replacement of calcium carbonate. Bivalves of the genus *Mytilus* were placed in solutions of sodium metasilicate and kept at a constant pH of 1, 2, and 4 in replicate sets. All specimens were collected live and stripped of soft tissues prior to immersion in solution. The periostracum was retained in a subset of samples and in others it was removed with dilute sodium hypochlorite.

Silicification appears to be controlled by the availability of inter- and intra-crystalline organics in the shell and occurs preferentially in high-organic microstructure. Under SEM, specimens in solution for 60 days showed silica (confirmed by EDS and electron microprobe analysis) either adsorbed to, or replacing the organic sheaths surrounding the crystallites. This occurred in both the fibrous calcitic and the aragonitic nacreous shell layers. The initial stages of our experiments resulted in weight loss of 5-10 % in shells and generated an open, honeycomb-like structure as the low-organic cores of crystallites dissolved and the high-organic crystal sheaths were replaced by silica. The early phase of silicification is thus a partial replacement of shell microstructure in the presence of abundant silica in solution in conjunction with low pH. This initial texture has not yet been identified in SEM studies of silicified fossils. It is possible that silicification of shells includes several generations of silica precipitation – very early silicification of organic matrix concurrent with dissolution of crystallites, followed by permineralization of the resulting cavities in the shell framework. This suggests a heretofore unrecognized complexity in the silicification process which may help to explain the patchiness of the silicified fossil record.

S25 – First chimeroid, batoid and shark records (Chondrichthyes: Holocephali, Elasmobranchii) from the uppermost horizons (Late Eocene, Telms 6 and 7) of the La Meseta Formation, Seymour Island, Antarctica

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The known Eocene elasmobranch fauna from the La Meseta Formation on Seymour Island (Antarctic Peninsula) currently comprises 24 taxa in 15 families. Sharks represent the majority of taxa, whereas batoids are extremely rare. So far, only three batoid taxa have been identified. Chimeroid remains (Holocephali) are abundant but no taxonomic study of all remains has been carried out up to now. The distribution of chondrichthyans is, as far as known, uneven throughout the Eocene sections. The lamniform shark, *Striatolamia macrota*, is the dominant taxon in all studied assemblages from Telms 1-5. Chondrichthyan diversity was low in Telm 1, which characterizes the start of the sedimentary sequence. The depositional environment is interpreted as low-energetic and/or protected lagoon or estuary during warm, wet, and seasonal climatic conditions until the middle Eocene. Gradual cooling towards the top of the La Meseta Formation correlates with abrupt drops in sea surface temperatures. The highest diversity of chondrichthyan fishes, both holocephalans and elasmobranchs, occurs in Telms 4 and 5 when climatic conditions changed to strongly seasonal and cool-temperate. The composition of this assemblage represents a cool-water fauna with *Palaeohypotodus rutoti*, which is considered a Palaeocene relict form, being the dominant elasmobranch of this assemblage. Chondrichthyans seemingly disappeared at the end of Telm 6 and no remains have been found in Telm 7 up to now, although bony fish, penguin and whale remains are very abundant in the upper parts of the La Meseta Formation. The reasons for the sudden disappearance were disputed in recent years since it cannot be explained with any rapid temperature decline. Here, we present the first chondrichthyan remains from the uppermost part (upper Telm 7) and additional new material from Telm 6 of the La Meseta Formation. The material was collected during Antarctic summer campaigns 2011 and 2012 by an Argentine-Swedish field party as a joint project of the Instituto Antártico Argentino (IAA) and the Swedish Polar Secretary (SPFS). The fossiliferous upper horizons of the La Meseta Formation are composed of poorly consolidated, marine sandstones and siltstones which were deposited in a coastal and/or deltaic environment. The small assemblage includes teeth of benthopelagic lamniform sharks, a batoid and a chimeroid. Small-toothed taxa were not recovered. The low diversity of this assemblage agrees well with the observed trend of a general decrease in taxonomic diversity of chondrichthyans throughout the middle part of the depositional sequence, which might correlate with habitat loss on the upper shelf of Antarctica due to shelf ice development.

S25 – Die „Vaginatenkalke“ des Ostseeraumes – Palökologische Interpretation des Mittelordovizischen (Darriwilium) Massenvorkommens endocerider Cephalopoden

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Während des Mittleren Ordoviziums wurden Cephalopoden zu einer wichtigen Komponente in den Makrofaunen der Baltoskandischen Karbonatplattform. Der bekannte Begriff „Orthocerenkalk" zeugt von der Häufigkeit der fossilen Überreste von Cephalopoden in den baltoskandischen Sedimenten dieser Zeit. Über die Ursachen der Massenvorkommen war bisher wenig bekannt. Taphonomische Effekte wie zum Beispiel stratigraphische Kondensation wurden als Ursache ebenso in Betracht gezogen wie ökologische Veränderungen.

Von uns wurde nun erstmals die taxonomische Zusammensetzung der Cephalopoden und ihre absolute und relative Häufigkeit an verschiedener Lokalitäten der Baltoskandischen Karbonatplattform verglichen. Wir konzentrierten uns mit unserer Analyse auf das älteste Cephalopoden-Häufigkeitsmaximum, welches mit den sogenannten „Vaginatenkalken" in die Kunda Stufe des unteren Darriwilium fällt.

Die Fossilgesellschaften in den Sedimenten dieser Zeit werden durch orthokone Endoceren dominiert. In proximalen Ablagerungsräumen sind zudem aufgerollte Tarphyceriden häufig und in küstenfernen Bereichen bilden Orthocerida eine wichtige Komponente.

Die raumzeitliche Veränderungen in der absoluten und relativen Häufigkeit der wichtigsten Cephalopoden-Gruppen zeigen an, dass während der Kunda Zeit die Populationsdichte und Habitatausbreitung der Cephalopoden ein Maximum erreichte. Diese Blütezeit ist exakt zeitgleich mit einem markanten Häufigkeitsmaximum in Süd-China und ist damit supraregional. Sie markiert einen kritischen Zeitabschnitt innerhalb der Großen Ordovizischen Radiation. Sedimentologische und palökologische Hinweise deuten darauf hin, dass eine global erhöhte Nahrungsverfügbarkeit in den Meeren zu dieser Blüte führte.

S22 – Gnetophytes from the late Early Cretaceous Crato flora: ecological and phytosociological aspects

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Plant fossils from lake environments open valuable windows to the past, often combining both the whole-plant aspect as well as insights into the autecology and phytosociolology of these plants. The flora from the late Aptian Crato Formation of northeastern Brazil has a particular potential for reconstructing fossil seed plants within their paleoenvironment, that included spore bearing plants, gymnosperms and angiosperms. The Crato angiosperms yield magnoliid taxa, monocots and eudicots. Some of them were water plants, among them at least two nymphaealean taxa. Besides angiosperms fossil representatives of Gnetophytes and related taxa, as well as gymnospermous seed plants of unknown provenance are of particular interest, as they are much more diverse than today.

In general, these gnetophytes *sensu lato* are often shrubs or herbaceaous plants occurring in monotypic stands. Some of them were possibly scrambling plants (Spreizklimmer). Besides ordinary reproduction strategies vegetative reproduction played an important role. These plants were, based on their anatomy, well adapted to an extreme seasonal climate with short rainy seasons for rapid growing and reproduction in an overall semiarid environment. Semiarid conditions are also inferred by independent geological, sedimentological and palaeontological data. Among the gnetophyte component *Cariria orbiculiconiformis* in particular may be regarded as an r-strategist, quickly occupying available space in unstable environments. Our reconstruction of a quickly spreading plant is supported by the comparatively large number of reproductive structures on individual branching systems. Several other vegetative features imply that this plant was able to quickly propagate vegetatively, a strategy frequently found in disturbed habitats. An interesting taphonomic aspect is also that *Cearania heterophylla* grew on a clastic substrate outside the area where the plattenkalk accumulated, but still nearby the lake. Other gnetophyte taxa that are similar in their overall habit to the extant genus *Ephedra*, may have had also similar ecologic requirements, e. g. (semi)arid to arid environments where these plants covered large areas. Overall, gnetophytes *sensu lato* occupied large areas, and were the major ground cover. They also occupied most likely special niches along the Crato Lake where they were perhaps much better adapted to semiarid climate, disturbed environments, seasons with heavy rainfall than other seed plants including the early angiosperms.

S19 – More than wet feet – Whole body involved! On the interaction of propulsory habits and vertebral column in aquatic mammals.

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The mechanical conditions that must be fulfilled by the anatomical structures of animals are the same, regardless of their taxonomic relationships. Therefore, the results obtained in mammals have relevance for reptiles or amphibians as well. Water carries body weight, but does not offer options for concentrated application of forces. Therefore the propulsive organs need great surfaces, but do not require extreme resistance, that means autopodia shaped as flippers rather than hooves or balls. Because of the viscosity and density of water, it causes stronger resistance against movements than air. Therefore, the load arms of the flippers cannot be very long (stylopodia and zygopodia must be short.) Their shortness makes, however, locomotion on land slow. A way out is to replace striding locomotion on land by bound or halfbound which are faster and imply undulatory movements in a vertical plane, as common in "small mammals". An efficient propulsion can be accomplished by neglecting the limbs and instead emphasizing undulation of the body stem. Laterally directed movements of the head, e.g. for capturing pray are performed best, if the anterior limbs, which absorb the reaction forces, are placed in the middle of the dorso-ventral diameter of the trunk, so avoiding rotations about a longitudinal axis. Such limbs, however, are poorly suited for giving support to the trunk in terrestrial conditions. The "sprawling" limbs of semi-aquatic amphibians and reptiles are a compromise between these conflicting demands. If the animal is immersed in water, limbs attached to the ventral part of the trunk evoke rotational moments about a horizontal, transverse axis. These torques are advantageous because they keep the head above the surface, as long as the swimmer keeps close to the water surface. In swimming below the surface, their use is a waste of energy. A long, mobile neck allows catching of swift prey with clearly less energy than orientation of the whole body. The long neck, however, requires a stabilising of the trunk to suppress *compliance*. For this purpose, hindlimbs or a long tail are well suited. The preferred movements of a particular fossil can be derived from the resistance of the vertebral column against compressive forces, that is thickness of the vertebral bodies. For a number of aquatic mammals the forces acting along the vertebral column have been analysed and compared to their swimming movements.

S21 – A new flora from the Upper Permian of Bletterbach (Dolomites, N-Italy)

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Late Permian floras are scarce in Europe and thus still incompletely understood. Our knowledge about them is mostly based on records of the classical Kupferschiefer floras of the European Zechstein Basin. These records are mostly compression floras without or at least only with badly preserved cuticles. Thus studies on both, macroremains and cuticles in comparison, are still incomplete. Also in the Dolomites and in the Vicentinian Alps, only few plant bearing localities of late Permian age are known. One of these is the Bletterbach gorge. The locality is located near Bozen/Bolzano in the Dolomites, between the small villages Aldein/Aldino and Radein/Redagno (Northern Italy). Upper Permian rocks of the Gröden Sandstone are yielding tetrapod footprints of a very high diversity and also perfectly preserved cuticles of small twigs and leaves, which can be found in the so called "cuticle horizons" below and immediately above the waterfall. A recently discovered fossiliferous horizon from this area yielded well-preserved cuticles and *in situ* pollen, but also well-preserved plant megafossils. The new flora shows a high diversity in taxa. Representatives of almost all typical late Permian groups (horsetails, seed ferns, cycads, ginkgophytes, conifers) can be distinguished. The sphenophyte remains are few and badly preserved, in the seed ferns, on the other hand, at least two different leaf taxa can be distinguished (*Sphenopteris* sp., *Lepidopteris martinsii*) as well as some ovuliferous organs belonging to the genus *Peltaspermum*. Also some putative cycadophytes were identified, with two different species of *Taeniopteris*. Based on their macromorphology three different leaf-types can be distinguished within the ginkgophytes. The conifers are the most abundant and diversified group, with *Ortiseia leonardii*, *Ortiseia visscheri*, *Pseudovoltzia liebeana*, *Quadrocladus* sp. and *Pagiophyllum* sp. documented also by several different female and male cones. Remains of doubtful botanical attribution comprise *Dicranophyllum*-like leaves and *Leptostrobus*-type of female fructifications as well as permineralised wood and charcoal. Remains of lycophytes reported previously from the Bletterbach cannot be confirmed. Some of the groups recovered from the new fossiliferous horizon are recorded for the first time from the Bletterbach. The new material will offer a much better basis for comparisons with plant remains from the Zechstein Basin and will thus increase the knowledge on late Permian floras of Europe.

S13 – Diversity of plants and continental tetrapods in the Triassic of the southern alps: palaeobotanical and ichnological evidences

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More than 60 sites bearing plant fossils and tetrapod tracks were discovered in Triassic rocks of the Southern Alps. In the Bithynian-Pelsonian interval (early-late Anisian) the ichnoassociation documents a diverse tetrapod fauna composed of lepidosauromorphs, basal amniotes, archosauriformes and possibly dinosauromorphs. The rich Pelsonian flora testifies one of the best examples of early recovery of ecosystems after the end-Permian mass extinction. During the Illyrian (late Anisian) the ichnoassociations are represented by lepidosauromorphs, archosauriformes and dinosauromorphs. Small archosaurs are definitely replaced by medium- to large-sized individuals. The marine sediments of the Ladinian yielded a flora dominated mostly by conifers and seed ferns; tetrapod footprints are missing from this interval. During the Carnian the flora reaches a diversity comparable to Pelsonian time, and is marked by the first occurrence of unequivocal bennettitaleans and putatively the first cheirolepidiacean conifers; Marattiales, Dipteridaceae and Matoniaceae experienced a wide radiation. The Carnian faunal assemblage, composed of dinosauriforms, dinosaurs and non-dinosaurian Archosaurs is one of the most diverse discovered to date for this interval and testifies to one of the earliest reliable evidence of dinosaurs in the northern Pangaea. From the latest Carnian to the end of the Norian faunal associations were dominated by dinosaurs, with tracks attributed to archosauriformes and dinosauromorphs being only minor components of the biotas. Norian floras are poorly known but seem to be dominated by conifers with only rare bennettitaleans.

As a whole, the numerous tetrapod track associations provide a series of snapshots trough time that show a huge increase in variability reflecting the morphological diversity spanning from a stem-amphibian to a crurotarsan, to dinosaur foot. They seem to mirror the global body fossil record of diapsids (with the exception of the Olenekian) but are almost completely devoid of synapsids and amphibians. Fossil plants and palynomorphs provide a stringent palaeoecological and palaeoclimatic frame for faunal changes and allow searching for the possible causes of occurrence or absence of tetrapod groups in distinct time intervals. The nearly complete absence of non-diapsid tetrapods, for example, appears correlated with a paucity of fluvial-lacustrine environments, while the dominance of dinosaurs in the Norian can be explained in the context of a monotonous harsh carbonate platform environment. Also the rich plant fossil associations record some evolutionary trends as the radiation of modern fern families and the appearance of entire new groups such as the bennettitaleans.

S13 – 3D Reconstruction of the first xiphosuran from the Muschelkalk (Triassic) of the Netherlands based on microCT and neutron tomography

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The specimen described here represents the first record of a xiphosuran (superfamily Limulacea) from the Triassic of the Netherlands. The slab with the fossil has been found in the Lower Muschelkalk of Winterswijk and shows the ventral side of the carapace with prosoma, opisthosoma, and telson still in articulation on the surface. Furthermore, moveable spines at the margin of the opisthosoma are obviously also in articulation, indicating optimal taphonomic conditions such as minimal transport and rapid burial of the specimen. Usually, xiphosurans in the fossil record are preserved in a dorsal view. Therefore, the taxonomy of fossil xiphosurans is mainly based on anatomical features of the dorsal surface of the carapace. However, the dorsal side of the specimen from Winterswijk is completely embedded in micritic limestone and the specimen is too delicate for preparation. Sectioning is precluded as such fossils are rare and valuable. Missing information on distinctive characters of the carapace and the internal anatomy meant that, when first described in 2009, the specimen could only be assigned to the superfamily Limulacea with certainty. However, a comparison of the specimen with other Triassic limulids from Central Europe suggested that the specimen probably belonged to the extinct genus *Limulitella*.

In 2010 we examined the limulid from Winterswijk by means of neutron tomography and microCT at Helmholtz-Institute Berlin for Materials and Energy. The data from the tomographic experiments enabled us to reconstruct the three-dimensional shape of the whole specimen in 3D and to study the dorsal surface and other hid-

den features in detail for the first time. Furthermore, the tomographic slices revealed the presence of a telson at the caudal end of the carapace and at least three walking legs on the ventral side of the prosomal shield. The carapace is slightly depressed due to compaction of the embedding micritic limestone. The anatomy of the carapace confirms our suggestion of 2009 that the specimen can be assigned to the genus *Limulitella*.

The application of neutron tomography and microCT for non-destructive investigations of Triassic limulids yields new information on their morphology and anatomy. This is a prerequisite for a detailed phylogenetic analysis and a refined view of limulid evolution.

S24 – Sound localisation in small anomodonts

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In the transition from nonmammalian synapsids to mammals the extraordinary mammalian hearing mechanism evolved utilising the bones of the old reptilian jaw articulation as ear ossicles and the brain volume expanded considerably. Consequently modern mammals are able to hear high frequency sound, whereby they use both timing and diffraction cues to determine directions of sound by independent pressure receiver ears.

The anatomy of the hearing apparatus of nonmammalian synapsids strongly suggests that their hearing capabilities were restricted to low frequency sound. As a consequence, nonmammalian synapsids could not use diffraction cues for directional hearing, because interaural level differences of diffracted sound with frequencies below about 10 KHz are negligible.

Interaural time differences can also be used for sound localisation. They are generated by different sound path lengths to the ears. However, timing cues are too small in animals with short interaural distances. Accordingly, small nonmammalian synapsids must have had the "small animal problem" with the localisation of sound such as modern insects, songbirds and lizards. These animals use the mechanism of sound localisation according to the principle of pressure difference receivers. They have a pneumatic interaural connection allowing a contralateral communication of the eardrums inside the head. As a result both time and level differences of incoming sound are significantly enhanced.

There are good arguments that nonmammalian synapsids used pressure difference receivers for sound localisation. Firstly, it is the only known possibility for animals with a small head to localise low frequency sound. Secondly, nonmammalian synapsids had a less obstructed pathway between the ears due to the small brain capsule. Many authors went so far to suggest that directional hearing with pressure difference receivers was the ancestral condition in all major vertebrate groups. Because nonmammalian synapsids did not have well ossified tympanic cavities, little is known about the presence and anatomical boundaries of the tympanic cavities in these animals.

Our examinations by means of neutron computed tomography at the Swiss Spallation neutron Source and at Helmholtz-Zentrum Berlin of skulls of the small anomodonts *Diictodon* and the uncertain taxon "*Cryptocynodon schroederi*" revealed paratympanic sinuses in the otic region and the brain capsule. Paratympanic sinuses are an anatomical evidence for a tympanic cavity and may help to reconstruct parts of their anatomical boundaries. The extensive brain pneumaticity of *Diictodon* and *Cryptocynodon* suggests the presence of large tympanic cavities around the stapes connected medially to each other. In all probability connections to the mouth cavity and to the mandibular trough also existed. Our results strongly suggest that *Diictodon* and *Cryptocynodon* localised sound by pressure difference receivers.

S11 – Diversity of Ptychopariid trilobite larvae from the Skryje-Týřovice Basin

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Preservation of ontogenetic stages of trilobites in the Skryje-Týřovice Basin is known from several localities, which are peculiar to specific sediments in higher parts of Buchava Formation (Fatka, 2004). Up to now, there have been known protaspid and early meraspid specimens of these trilobite taxa: *Sao hirsuta* Barrande, 1846; *Skreiaspis spinosus* (Jahn, 1895), *Paradoxides (Hydrocephalus) carens* Barrande, 1846; *Paradoxides (Eccaparadoxides) pusillus* (Barrande, 1846) and problematic Raymond's and Barrande's larvae.

Current research based on biometric measurement, geometric morphometrics and detailed study of morphology of the exoskeleton shows considerable diversity of especially ptychopariid trilobite larvae. Old material from collections of J. Barrande, R. Růžička (National

Museum, Prague) and M. Šnajdr (Czech Geological Survey) was reinterpreted. According to this study, four types of ptychopariid protaspides are present in sediments of the Skryje-Týřovice Basin: *Sao hirsuta*, and three species which are left in the open nomenclature (Ptychopariida sp. A, Ptychopariida sp. B and Ptychopariida sp. C). Taxonomical affinity and possible mode of life of these early ontogenetic stages are discussed.

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S24 – Form, function and feeding: a biomechanical model of *Erlikosaurus andrewsi* (Dinosauria: Therizinosauria) and its evolutionary implications

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Theropod dinosaurs have historically been regarded as an exclusively carnivorous and predatory group. However, recent analyses have suggested that herbivory may have been more widespread amongst the different theropod clades than previously thought, leading to far-reaching ramifications for the evolution of dietary specialisations in theropods. Therizinosauria represents one such clade and their highly unusual anatomy has led to a variety of dietary assumptions. These range from piscivory and insectivory to various forms of herbivory, whereas the edentulous tip of the snout has been regarded as evidence for the presence of a keratinous beak. However, these assumptions have not been subjected to a more rigorous, biomechanical analysis.

We analysed the biomechanical behaviour of the skull and lower jaws of *Erlikosaurus andrewsi* – the only therizinosaur preserving a nearly complete and articulated skull. Using information derived from CT scanning, the complete skull of *Erlikosaurus* was digitally reconstructed and subsequently served as a foundation for the detailed reconstruction of the adductor musculature, allowing for the estimation of individual muscle and bite forces. The estimated bite forces for *Erlikosaurus* are relatively low, both in actual numbers as well as in comparison to other theropods or in relation to its body size (ca. 100-200 kg). Different finite element (FE) models were created, incorporating muscle and bite force estimates, to test the mechanical capabilities of *Erlikosaurus*. Two hypothetical models were further tested, which contained a keratinous sheath or beak, covering the edentulous premaxilla and partly the maxilla.

The results of the finite element analysis demonstrate that even the comparably low bite forces would cause increased stress values in the skull of *Erlikosaurus*, in particular when applied to the posterior teeth. The addition of a keratinous beak on the skull and lower jaws considerably reduces the generated stresses for the anterior bite scenarios. The lack of wear facets, tooth occlusion and the possible presence of a large gut to process plant material, further suggest that the available bite force would not have been used for extensive mastication and chewing processes. This supports a hypothesis that *Erlikosaurus* would use the edentulous snout (potentially covered by a keratinous sheath) and anterior teeth to procure plant matter by branch-stripping and cropping of soft vegetation.

S25 – The cranial myology of *Erlikosaurus andrewsi* in three dimensions – A novel approach for digital muscle reconstructions

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The cranial musculature and in particular the adductor or jaw closing muscles play a fundamental role in an animal's life. As the morphology and arrangement of the adductor muscles primarily affect feeding processes, mastication and bite force, they ultimately have important ramifications for dietary and ecological questions. However, knowledge on the muscle structure is not readily available in fossils. Furthermore, estimations of bite force and bite performance in fossil animals are a challenging subject in palaeontology and highly dependent on the reconstruction of the cranial musculature. In the past, the reconstruction of the (cranial) muscles was restricted to the identification of muscle attachment sites or simplified computer models.

This study presents a novel approach for the detailed, digital reconstruction and visualisation of the adductor musculature, exemplified for the Cretaceous therizinosaur *Erlikosaurus andrewsi*. This not only allows for a higher accuracy of measurements (length, cross-section, attachment angle and volume) in comparison to traditional two-dimensional approaches, but also provides a rigorous test of hypotheses on muscle arrangement and topology. Based on the digital muscle properties, muscle and bite force estimates are calculated. Bite force estimations are found to be the lowest at the tip of the snout (44-66 N) and respectively higher at the first (60-90 N) and last tooth (91-137 N) position. Nevertheless, bite forces are comparably low for *Erlikosaurus andrewsi*, both in actual numbers as well as

in comparison to other theropod dinosaurs. The results further indicate that the low bite performance was mainly used for leaf-stripping and plant cropping, rather than active mastication or chewing processes. Muscle and thus bite force in *Erlikosaurus andrewsi* (and most likely all therizinosaurs) are considerably constraint by the cranial anatomy and declines in derived taxa of this clade. This trend is reflected in the changes of dietary preferences from carnivory to herbivory in therizinosaurs.

S1 – Dispersal routes of South American land mammals: paleogeographic and paleontological constraints often agree

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As plate reconstructions are refined and as the accuracy of molecular divergence dating improves, remarkable support has developed between the two methods. Some vertebrate paleontologists invoke land bridge connections between continents to explain the distribution of seemingly related groups of mammals across major seaways and oceans but it is now apparent that some of these so-called land bridges did not exist for the times required. Plate tectonics now has a reasonable inventory of "land bridges" including where and when they may have played a role in terrestrial reptilian and mammalian dispersal. As more new fossil species are found on different continents, phylogenetic relationships often support major plate motions. Phylogenetics can also offer insight into when seaways may have first severed dry land dispersal routes by providing a framework of testable hypotheses to explore proposed paleogeographic reconstructions.

For instance, seafloor spreading between South America and Africa opened a possibly intermittent seaway by the end of the Aptian (112 Ma) but subsequent tectonic and sedimentary events may have delayed the final break between the two continents until the middle of the Albian (106 Ma). Similarly, India with Madagascar may have maintained a link with Antarctica via Sri Lanka until the end of the Aptian but by the earliest Albian a deep seaway separated India/Madagascar/Sri Lanka from East Antarctica. Hypothetical land bridges connecting Madagascar to South America could not have existed after the beginning of the Albian. Suggested dispersal paths for land mammals from Africa to South America after Albian time include land-based routes through Antarctica or through Eurasia to North America and then on to South America via the Caribbean-Central America region. Based on the known plate tectonic movements of the major continents, the route from Africa via Antarctica must have been severed prior to the end of the Aptian when the Mozambique Ridge off Africa cleared the Astrid Ridge extension of Antarctica. Plate tectonics and the terrestrial mammal fossil record from Seymour Island, Antarctica, support dispersal of mammals from South America to Antarctica and possibly onto Australia until as late as the Eocene. Central to South American routes are problematic for the Cenozoic until the Miocene at the earliest. There may have been intermittent land bridges between North America and South America with a possible land bridge including short-island-hops during the Maastrichtian, and a fairly certain near-land bridge that arose temporarily in the middle Late Miocene (Tortonian) that lasted perhaps no more than 1.5 million years and then subsided, only to arise again in the Pliocene to inaugurate the Great American Interchange along the present Isthmus of Panama.

S5 – Diversity history of Cenozoic diatoms

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Cenozoic diatoms are a dominant component of the global plankton, and it is important to understand their evolutionary response to Cenozoic climate change. Their diversity history also provides an opportunity to test paleobiologic diversity reconstruction methods with unusually well preserved fossil records. While reasonably comprehensive catalogs of species have been used to calculate the diversity history of planktonic foraminifera, coccolithophores and dinoflagellates, no comparable catalogs have yet been published for marine planktonic diatoms, and only two (contrasting) modern diversity curves have been published.

Cenozoic diatom diversity was calculated from species first and last occurrences ('range-through' method) extracted from the Neptune database of marine microfossil occurrences (Lazarus 1994) by Spencer-Cervato (1999) (SC99). Her results showed a major increase in diversity throughout the Cenozoic, with an initial Eocene increase, and much higher diversity from further increase beginning in the mid Miocene. Rabosky and Sorhannus (2009) (RS09) used the same database and standard paleobiologic subsampling methods to obtain a different result, wherein diatom diversity peaked in the Eocene and declined to low-

er levels that increased only modestly throughout the rest of the Cenozoic. We use both a new, as yet unpublished catalog of diatom species, and a new version of the Neptune database (NSB, based at the MfN in Berlin) to calculate new diversity estimates for Cenozoic diatoms. Unlike the earlier studies with Neptune, in our analyses of NSB occurrence data we combine subsampling with additional analyses to compensate for biases in subsampled estimates due to changing patterns of dominance, and the development of largely endemic polar floras during the Cenozoic.

Our results from analysing both the catalog data and from NSB are similar. They show a small temporary Eocene diversity peak, followed by strong further diversity increase beginning in the mid Miocene, resulting in much higher late Neogene diversity than in the earlier Cenozoic. While a simple compilation of diversity (SC99) is indeed biased towards over-estimatation of increase due to sample size bias, failure to consider changing dominance and biogeography when using subsampling methods (RS09) leads to equally severe underestimation of diversity increase. Our own results are still underestimates of the extent of diatom diversification, in that we have not included the effects of systematic changes in preservation and style of data recording over the Cenozoic, both of which have probably biased the data against detecting diversity increase over time.

S5 – Building a global infrastructure for 21st Century marine micropaleontology

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Marine micropaleontologic research addresses problems that are global in scope and increasingly needs tools to access and synthesise data on a global scale. Current data systems are inadequate: ocean drilling program databases contain only a subset of raw primary data; archives e.g. Pangea hold fragmentary, non-standardised literature results. The MfN Berlin leads development of two databases that address this need -the most recent version (NSB) of the Neptune database of microfossil occurrences, and the IODP supported master Taxonomic Name Lists of marine microfossil species (TNLs). The MfN also is lead curator for the Micropaleontology Reference Centers – a global network of nearly 200,000 marine microfossil slides/samples, and develops the MRC database.

Neptune originated at the ETH, Zürich in the 1990s (Lazarus, 1994); was improved by porting to standard internet capable database software, and with additional data records, by the NSF supported Chronos project in the 2000's. NSB, with financial support from CEES, Oslo, was created by Lazarus (MfN) and P. Diver, chief programmer for Chronos after the end of the Chronos project. NSB holds > 500,000 occurrence records for several thousand marine microfossil species; age models for sections; and taxonomy with synonyms. Neptune has been used/cited in > 40 publications, primarily in evolution studies, or as a source of global age information; including several in Science, Nature and PNAS. Improved community access to NSB is planned for the coming year.

The TNL database of IODP has recently been created by members of IODP's Paleontology Coordination Group (PCG) to allow integration and exchange of paleontology data throughout the multi-agency IODP effort. It contains over 18,000 evaluated species names for planktonic foraminifera, radiolaria, coccolithophores, diatoms and dinoflagellates. The TNL is based on IODP's own databases, the Neptune taxonomy tables and several large community databases. It will be hosted at IODP and maintained under supervision of the PCG, and is expected to provide a standard source of taxonomic names for use by both IODP and the general science community.

The MRC database is sample, not taxon oriented, but shares a common format for sample names with the other databases. Future development is planned to cross-correlate to the NSB age-model library, thus allowing rapid searching for slides/samples by age that in turn are linked to the results of other NSB searches.

With convergence of data content, data technologies (all these databases use Postgres) and growth of internet data exchange standards, the NSB, TNL and MRC databases are becoming more closely linked to each other, forming a global federated structure for use in 21st century marine micropaleontologic research.

S13 – Early Triassic microbialites and carbonate factory changes across the Permian-Triassic boundary near Julfa (NW Iran) and Abadeh (Central Iran)

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Permian-Triassic boundary sections in the regions of Julfa (NW Iran) and Abadeh (Central Iran) display three characteristic rock units: (1) the *Paratirolites* Limestone (4-5 m thick) with the mass extinction horizon (P-Tr extinction event) at the top surface (2) the 'Boundary Clay', and (3) the Elikah Formation with the conodont P-Tr boundary near the base.

The *Paratirolites* Limestone is the uppermost of the Permian carbonate formations. It is a pelagic red nodular marly limestone and represents a skeletal-dominated benthic carbonate factory. Microfacies studes show a decline in carbonate accumulation towards the top of this unit, where increasing numbers of reworked hardground clasts, bored and encrusted bioclasts and lithoclasts, ferruginous crusts, and dissolved cephalopod shells occur. The reduction in the carbonate accumulation culminates at the transition from the *Paratirolites* Limestone into the 'Boundary Clay', where red claystone and shales with only few marly nodules replace the carbonate factory. At this transition occurs also a significant reduction of biogenic components. In Central Iran, in the transition from the 'Boundary Clay' to the overlying grey platy limestone beds of the Elikah Formation occur one or more enigmatic 'calcite fan' layers of probably abiotic origin. The skeletal carbonate factory of the Late Permian was restorted with the deposition of micritic limestone with stromatolitic and thrombolitic fabric at the base of the Elikah Formation. Densely laminated bindstone, aggregate grain grapestone, wackestone with calcite spar-filled voids, and oncoid floatstone represent a microbial-dominated carbonate factory.

Microbial carbonates deposited in the Early Triassic Elikah Formation are represented by different types of microbialite and stromatolite. In the sections near Julfa the organosedimentary deposits are controlled by benthic microbial communities; they can be classified based only on their microstructure. They comprise fine-grained agglutinated stromatolite, poorly structured thrombolite, and cryptic microbialite. In the sections near Abadeh, in contrast to the sections near Julfa, the occurrence of the microbialite and stromatolite is more diverse and large-scale features with conspicuous morphology and internal structure occur. They comprise heart-shaped, flower-shaped, isolated and amalgamated forms. Thrombolite mounds with clotted mesofabric, planar and domal stromatolites with laminated mesofabric predominate.

The P-Tr boundary sections in Julfa area and Central Iran were deposited on a carbonate shelf (platform) in equatorial latitudes. Skeletal, biotically controlled benthic carbonate factory of the Late Permian has been replaced by the biotically induced carbonate factory of the Early Triassic, with periods of abiotic precipitates within the 'Boundary Clay' and in the Elikah Formation. Microbialites deposited in the aftermath of the P-Tr mass extinction are considered to be anomalous are mentioned as biotic responses to periods of unusual ocean chemistry.

S14 – The early evolution of terrestrial tetrapod communities

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The general pattern observed within the trophic structure of modern terrestrial tetrapod communities is a predominance of herbivores over carnivores, specifically with respect to their relative abundance (number of individuals). However, early tetrapod communities were dominated by carnivorous taxa. Herbivorous tetrapods only became a major component of terrestrial ecosystems later during the Paleozoic and long after their first appearance in the late Pennsylvanian. Here we address the question of the exact timing and modalities of this shift between carnivore and herbivore proportions in terrestrial ecosystems. Based on the number of specimens, we study the variation in the trophic structure, the body size distribution and the taxonomic composition of tetrapod assemblages from the Late Carboniferous to the Late Permian. We compiled a dataset of 151 terrestrial and sub-aquatic genera, derived from 175 fossil assemblages from North America and Eastern Europe. Preliminary results show that herbivores become a major component of terrestrial ecosystems by the late Early Permian (Leonardian). From the early Middle Permian (Roadian), this structure is well established, both in North America and Eastern Europe. This shift seems to represent a global signal as contemporaneous faunas from the Karoo Basin (South Africa) also show a high dominance of herbivorous taxa. In Eastern Europe and in North America, this shift is accompanied by a modification in the body size distribution within carnivores. Indeed, carnivore-dominated communities are mainly composed of small species during the Pennsylvanian and of large species from the end of the Carboniferous. However, when herbivores become dominant in communities, carnivores tend to decrease in size, showing more medium-sized individuals. Finally, North American faunas (Early to Middle Permian) and Eastern European faunas (Middle to Late Permian) are taxonomically distinct, the former being dominated by "pelycosaurs", the latter by therapsids. However, beyond the traditional view of a temporal transition between these faunas, the Roadian assemblages from both continents suggest that their taxonomic structure is further imprinted by a strong geographic heritage, while showing the same ecological structure.

S25 - Integrated palaeontology of the Early Aptian at the southern margin of the Lower Saxony Basin: An unusual near-shore bay deposit including OAE 1a

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A recent building site allowed studying the fossil record of the Lower Aptian succession of the Alstätte Bay, at the southern margin of the Lower Saxony Basin in northern Germany, in great detail.

The lowermost part of the succession contains accumulations of the belemnites *Neohibolites* and *Oxyteuthis* intercalated in the claystone succession. These accumulations are interpreted as storm-derived, scoured pebble beds with the clay material winnowed out. Above the belemnite layers the so-called Fischschiefer occurs, a 2.1 m thick laminated claystone interval (black shale). It shows TOC values of up to 2 % and is interpreted as local expression of the global Oceanic Anoxic Event 1a (OAE 1a). The basal part of the Fischschiefer is fairly continuously laminated, whereas its upper part is characterized by an alternation of laminated and non-laminated beds. Despite a lowered circulation, indicated by the finely bedded black shales and a change in microfauna, nektic as well as benthic macroorganisms (gastropods, bivalves, ammonites) occur throughout the Fischschiefer. Nevertheless, in some layers exceptional preservation occurs, e. g. rare articulated teleost fishes.

A brownish interval immediately above the Fischschiefer, characterized by a very negative carbon stable isotope excursion, exceptional preservation modes (e.g. articulated asteroids) and remarkable trace fossils, might have been overprinted by early diagenesis.

The typically Boreal faunal character in the lower part of the section changes around 2 m above the Fischschiefer, where the association gets influenced by Tethyan organisms. The faunal shift is considered to be due to the maximum flooding of the continuous, long-term sea level rise of the Early Aptian, which is also interpreted as a shift from a restricted to open bay environment. A close neighbourhood of the marine bay environment to the continent is obvious by numerous plant remains, particularly in the lower part of the section. The rich ammonite and nautiloid fauna, including *Prodeshayesites*, *Aconeceras*, *Sanmartinoceras*, *Cymatoceras* is, however, indicating purely marine conditions throughout the stratigraphic column.

S20 – Palaeoecological context of the early Miocene African mammal transition: evidence from dental microwear of tragulids

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Today, Africa is home to diverse mammalian taxa. However, during most of the Paleogene, Africa was dominated by an endemic fauna (e.g. anthracotheres, arsinoitheres, creodonts, hyraxes, proboscids) different from modern communities. In particular, hyracoids were the most diverse herbivorous ''ungulates'' of the African Paleogene. By the late Oligocene/early Miocene, the appearance of land bridges between Afro-Arabia and Eurasia facilitated the intercontinental dispersal of mammals. Because of these faunal interchanges, Afro-Arabian mammalian communities experienced a significant transition, which represents the first step toward the establishment of the modern African fauna.

Oligocene mammal localities are rare in Africa. Thus, most of our knowledge about this faunal turnover comes from early Miocene sites. Understanding environmental dynamics and the habitats available to early Miocene mammals is important for understanding the driving forces behind these changes. Several early Miocene sites are known in East Africa but the Songhor and Rusinga deposits (Kenya) are among the richest. Moreover, these sites comprise large mammalian assemblages of both archaic African and immigrant Eurasian species. Nonetheless, despite intensive studies, there is no consensus regarding palaeoenvironmental reconstruction for either Rusinga or Songhor. Reconstructions of Rusinga habitats have ranged from semi-arid/open to rainforest settings; and Songhor is generally regarded as "forested" but the specific type(s) of forest are not known. Our ongoing researches at Rusinga helps to fill in these gaps.

Rusinga and Songhor yield some of the earliest occurrence of tragulids in Africa. These Eurasian immigrants are represented by several species of Dorcatherium, are the most common ruminants at the sites, and occupy an important portion of the herbivore niche. Here, we reconstruct the diets of four Dorcatherium species from Rusinga and Songhor using dental microwear texture analysis. Results suggest that these species were mixed feeders that included both graze and browse in their diets. This implies that, despite reconstructions of forested settings,

at least some grass was available at Rusinga and Songhor. Furthermore, whereas modern tragulids (e.g. chevrotains) have a diet dominated by fruit and other browse items, our results demonstrate that such a specialized diet cannot be assumed for fossil tragulids, and that this family was more diverse in Africa in the past. Noticeably, ongoing morphological studies indicate that the skeleton in Dorcatherium is also more generalized than in chevrotains, suggesting that modern tragulids may be even more specialized than previously acknowledged.

Finally, our research project contributes to understanding the palaeoecological context of the transition underwent by Afro-Arabian mammalian communities at the Oligo-Miocene boundary. For instance, we show here that at least some of the Eurasian immigrants were generalist, adaptable animals (i.e. not niche specialists), compared to the inconsistently diverse archaic African taxa. Competition between immigrant and endemic African mammals frequently favored the former.

S23 – Das "Lange Jetzt", Anthropozän-Fossilien und transdisziplinäre Wissenschaften – Herausforderungen und Chancen für die paläontologische Öffentlichkeitsarbeit

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Die Faszination der Paläontologie für die Öffentlichkeit speist sich zu einem großen Teil aus der Faszination für Dinosaurier und anderer Urtiere. Hier treffen Science-Fiction-Fantasien auf die Erkenntnis, dass es solch „unwirkliche" Wesen und Welten wirklich gegeben hat und die Paläontologie dies erklären kann. Die langen erdgeschichtlichen Zeiten, die Fossilien und das über die heutige Welt Hinausgehende, das Andersartige sind der Schlüssel für diese Wahrnehmung.

Die öffentliche Fixierung auf Dinos und fossile Seeungeheuer erschwert es jedoch, die weiteren Themen der Paläontologie zu vermitteln. Paläontologie wird kaum mit Zukunftsrelevanz in Verbindung gebracht, obwohl das Fach nicht nur wesentlicher Bestandteil der Erdsystemwissenschaften, sondern auch essenzieller Partner für die Anthropozän-Wissenschaften ist. Planetare Leitplanken, Interkonnektivität von Geo-, Bio-, Hydro- und Atmosphäre sowie der Anthroposphäre, die Rolle des Menschen als geobiologischer Systemfaktor, aber auch Lösungsansätze für ein nachhaltiges Management der Welt können auf Szenarien aus der Erdgeschichte, auf stratigraphische Methoden und auf aktuogeobiologische Erkenntnisse nicht verzichten.

Vieles von dem was wir jetzt tun hat Auswirkungen in geologischen Zeiträumen. Dies gilt etwa für anthropozän bedingte Klimaänderungen, massive Änderungen der Sedimentation, Lücken nach Artensterbeereignissen, oder nukleare Unfälle. Der Kurzskaligkeit dieser Welt kann die Paläontologie die Bedeutung der Langskaligkeit entgegensetzen. Zukünftige Anthropozän-„Fossilien" wie Spuren menschlicher Bautätigkeit, Haustiere, invasive Arten, Chemofossilien oder Müllpartikel können erklären helfen wie es generell zu Fossilbildung kommt, wie diese transportiert und abgelagert werden. Zukunftszenarien müssen auch auf erdgeschichtliche Szenarien zurückgreifen. So können Szenarien der Perm/Trias, oder Paläozän/Eozän-Grenze auch als Zukunftsmodelle, teilweise sogar zum Test numerischer Klimamodelle verwendet werden. Viele andere Wissenschaften benötigen also Wissen und Methoden der Paläontologie und Geobiologie. Historiker mischen sich sehr wahrnehmlich in die Anthropozän-Debatte ein, warum nicht auch Erdhistoriker? Auch mit Archäologen, Geographen, Sozial- und Geisteswissenschaften sollte interdisziplinär geforscht werden.

Eine moderne Paläontologie kann viel für die Etablierung der Wissensgesellschaft tun: die vielfach geforderte Transdisziplinarität benötigt Partizipation, ein Ansatz, der in der Paläontologie durch wissenschaftliche Kooperation mit Hobbypaläontologen sehr gut etabliert ist. Paläontologische Sammlungen und Museen erlauben daneben die Authentifizierung von Forschung durch Objekte, die gleichermaßen wissenschaftliche Objektdatenbanken wie auch Kulturgüter darstellen. Nicht zuletzt ist es notwendig, sich auch an Visionendiskussion zur Zukunft der Erde zu beteiligen. Ausstellungen können auch vorwärtsgewandt gestaltet werden, auch an Anthropozän-Ausstellungen sollte sich die Paläontologie beteiligen. Es liegt auch an der Paläontologie, die Entwicklung der Erde nicht nur in der Vergangenheit, sondern auch für die Zukunft als Prozess anzusehen, bei dem nun eben der Mensch zum Teil dieses Prozesses geworden ist, indem er Paläontologie-relevante Themen wie Stratigraphie, Anpassung, Selektion, Sedimentation, Meeresspiegel, Klima, geobiologische Stoffflüsse, trophische Strukturen und weitere ökologische Dynamik wesentlich und auch auf langfristigen Skalen mitbestimmt.

Eine Paläontologie, die relevant nicht nur für Dinosaurier und Meeresungeheuer, sondern auch für biofuturistische Szenarien ist, hat das Potenzial, Faszination in einer neuen aktuellen Dimension zu schaffen.

S12 – Givetian conodont biodiversity patterns (Middle Devonian) in the Spanish Central Pyrenees

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Studies on Middle Devonian conodont biodiversity are scarce and almost restricted to the last century (1970's and 80's). From these works a general idea on a mid-Givetian (up to the upper *varcus* Zone) low diversity episode following an extinction event and a Givetian high-diversity episode after an innovation event was established.

The amount of data accumulated in three key Pyrenean sections during the last decade permits testing this idea and improving details on Givetian conodont biodiversity as our data come from a thorough systematic work that follows a detailed bed by bed sampling of each section considered herein.

Results show a minimum of diversity in the timorensis Zone that it is followed by a slight increment in the *rhenanus/varcus* Zone that precedes the highest biodiversity episode in the *ansatus* Zone. After the *ansatus* peak the conodont biodiversity falls about half in the successive *semialternans/latifossatus* Zone; this descending tendency continues in the lower *hermanni* Zone and reverses in the upper *hermanni* Zone. However, the lower *disparilis* Zone represents one of the lowest diversity times. After this pulsation, the pattern changes and a higher diversity trend starts in the upper *disparilis* Zone and continues in the *norrisi* Zone.

The Pyrenean biodiversity pattern shapes the two main prevailing Givetian diversity episodes as follows: 1) the conodont low-diversity episode was considered to last up to the Upper *varcus* Zone (=*semialternans/latifossatus*). However, Pyrenean records show that the conodont high-diversity peak took place earlier, in the *ansatus* Zone (= Middle *varcus*). 2) The Late Givetian Episode was considered of high diversity coinciding with a radiating phase; however, there are two moments of reduced diversity (lower *hermanni* and lower *disparilis* zones) indicating that this Episode had, at least in the Pyrenees, some pulses.

Pyrenean data suggest that careful examination of local sequences in key areas under a standardize protocol can play an important role in understanding in detail the Givetian conodont biodiversity pattern, that in term, can serve as a basis for further evolutionary, palaeogeographical and palaeoecological studies.

S14 – An Early Carboniferous bonebed on Spitsbergen

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Following the evolution of tetrapods during the Devonian period and their global distribution in Late Devonian time, only two single finds of tetrapod fossils have until recently been known from the first 20 million years of the subsequent Carboniferous period. Fossils from the Early Carboniferous are considered vital for documenting the acquisition of crucial anatomical features during the transition from water-dwelling tetrapods to truly terrestrial vertebrates. The presence of an actual hiatus in the fossil record, generally known as "Romer's Gap", has recently been challenged by several new finds in Scotland. Here, we report on the first discovery of tetrapod remains from the Early Carboniferous of Spitsbergen.

Fieldwork at the mountain Triungen (Dickson Land) on Spitsbergen during the summer of 2010 has led to the discovery of a fish- and tetrapod bonebed in the basal strata of the Triungen Member (Hørbyebreen Formation). The Triungen Member is the lowermost unit in the Billefjorden Group (Hørbyebreen and Mumien Formations) composed of fluvial sandstones and conglomerates interrupted by lacustrine and flood-basin shales, coal seams and plant-bearing sandstones. At Triungen, the strata of the Triungen Member rest with an angular unconformity on the folded redbeds of the Early Devonian Wood Bay Formation. As the oldest post-deformational unit above the Old Red Sandstone (ORS) sequence, the member is decisive for dating the Svalbardian orogenic event. Originally dated as Tournaisian, it was later thought to be entirely of Famennian age. Recently, a coal seam 60-65 metres above the base has been dated as Viséan, while the uppermost ORS-, and thereby youngest pre-deformational unit, the Plantekløfta Formation (not present at the Triungen locality), has given a Late Famennian age. Assuming these recent datings (and that of the overlying Mumien Formation as also Viséan) being correct, it is likely that the basal-most strata of the Triungen Member belong to the Tournaisian and/or earliest Viséan, and accordingly correspond to "Romer's gap".

The fossils were found primarily in the soft sandstones right above the basal conglomerates, but also in the conglomerates themselves. Apart from numerous plant fragments, only vertebrate remains have been found. The material is very fragmentary and mainly composed of teeth and scales, but also includes cranial, mandibular and postcranial elements. Unquestionable tetrapod remains include a rib with an uncinate process and several vertebrae. Probable tetrapod elements include a tabular horn and mandibular fragments. Prominent components of the fossil material are sarcopterygian (onychodontiform) teeth, including a parasymphyseal tooth whorl. After earlier sporadic accounts of Carboniferous occurrences of onychodontiforms having been rejected, the group is today generally believed to be restricted to the Devonian. The new finds at Triungen suggest that onychodontiforms nevertheless persisted into the Carboniferous.

S22 – A new fossil gnetophyte from the Aptian Crato-Formation of Brazil

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During the Late Mesozoic gnetophyte diversity was especially high in northern Gondwana and comprised in South America more than a dozen taxa. The Aptian Crato-Formation of northeast Brazil yields several non-described and/or only partially described taxa. A new fossil gnetophyte taxon from this location is discussed here. The Araripe Basin is well-known for its abundance of well-preserved fossils, but this new taxon is of special interest, because several, nearly complete specimens in various developmental stages are preserved. Seedlings show roots, cotyledons and a first set of normal leaves. Young plants include a first set of leaves and reproductive structures and also the mature plants are preserved with roots, axes, leaves and reproductive organs. These plants have an articulated gnetoid habit with slender long-jointed stems, opposite decussately arranged leaves at nodes and a typical gnetoid stem anatomy. Terminal reproductive organs exhibit cone like structures. Female cones consist of about 12-16 bracts in an opposite-decussate arrangement and ovules. (Dispersed) male cones are quite similar in structure, but with smaller bracts. In-situ pollens are elongated oval shaped, polyplicate and inaperturate with a psilate surface.

The new taxon is a shrub-like plant and exhibits several adaptations for open sunny habitats under a warm and seasonally dry climate of the lower latitudes, as assumed based on various proxy data for West Gondwana during the Early Cretaceous, e.g. sparse narrow leaves and a well developed root system.

A phylogenetic analysis of the new taxon was carried out using Pinus and Araucaria as outgroups. The characters of the three extant Gnetales *Welwitschia*, *Ephedra* and *Gnetum* plus the features of several fossil gnetophytes were used to build a data base. The data were converted into a data matrix and entered into the program PAUP* 4.0b10. The shortest of several trees resulted in a sister relationship of the new taxon and *Welwitschia*.

S4 – Gorgonian and scleractinian corals record ambient seawater neodymium isotopic composition

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The neodymium (Nd) isotopic composition of the aragonitic skeleton of scleractinian deep-water corals is related to the ambient seawater signal and this 1:1 relation has been recently used to reconstruct the water mass circulation in the North Atlantic and in the Southern Ocean. Motivated by these findings, we have analyzed the Nd isotopic composition and concentration of the high-magnesium calcite skeleton of deep-water gorgonian octocorals. These corals are distributed in most ocean basins and are long-lived, representing potential archives of past oceanic circulation at sub-decadal resolution. Corals from the families Isididae (genus *Keratoisis*) and Coralliidae (genus *Corallium*), were retrieved alive from the Atlantic, Pacific, and Southern Oceans as well as from the Mediterranean Sea at water depths between ~500 to ~1300 m. Seawater samples from two profiles in the Mediterranean Sea were also collected at the same locations and depths as the coral samples in order to compare seawater Nd isotopic compositions with the coral skeletons. The Nd isotopic composition was obtained using a VG Sector 54-30 thermal ionization mass spectrometer by dynamic multicollection after chromatographic purification. The neodymium concentration was analyzed along different tracks parallel to the growth bands using a 193nm laser ablation microsampling system connected to a Varian 820 inductively coupled plasma mass spectrometer. The gorgonian calcite skeletons and the surrounding seawater share equivalent Nd isotopic compositions, which clearly show that these calcite corals are reliable archives of water mass circulation.

Further building on the clear 1:1 relationship between seawater Nd isotopic composition and that of cold-water corals we have analyzed a Holocene time-series from Northern Norway across the last 11 ka. Pairs of Nd isotopes and radiocarbon in U-series dated corals showed a strong correlation, which could be used to reconstruct a persistent North Atlantic Current inflow into the Norwegian Sea during the Holocene. It also allowed us to track a clear trace of a strong deglacial melt-water runoff from the decaying Fennoscandian Ice-Sheet during the Early Holocene. During phases of meltwater runoff, the corals showed a more negative Nd isotopic signature than the Atlantic Water and the radiocarbon clock was strongly biased to apparently younger ages. These apparently younger reservoir ages deviated by up to 400 years from the U-series derived calendar ages.

Our research demonstrates Nd isotopic composition in cold-water corals as a very powerful tool for paleoceanographic reconstructions.

S15 – The freshwater coccolepids (Actinopterygii, Chondrostei) from the Jurassic of Patagonia

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Due to a bias in the fossil record, Jurassic freshwater fish faunas are very scarce, and only a few of Late Jurassic age are known worldwide: the Almada Fauna from the Cañadón Calcáreo Formation in central Chubut province, Argentina, the Talbragar Fauna from the Talbragar Beds in Australia, and the fish assemblages from the Morrison Formation in the USA. The Almada Fauna is the only Late Jurassic freshwater fish fauna so far reported from South America.

The Almada Fauna is preserved in the lowermost part of the Cañadón Calcáreo Formation (latest Oxfordian-Tithonian) and it is mainly composed by very well-preserved and abundant teleosts, representing a single species, *Luisiella feruglioi*, and numerous specimens representing a small chondrostean. Other actinopterygians, probably non-teleostean neopterygians, are also present, but extremely rare, and all specimens recovered so far are poorly preserved. Among these fishes, the chondrostean, which was originally named †*Oligopleurus groeberi*, and later referred to the genus †*Coccolepis*, was found to represent a new coccolepid genus. Coccolepid features of the new genus include the presence of sharply pointed denticles covering the dermal bones of the skull roof, maxilla, and scales, amioid type scales, nasal bones ornamented with thin concentric ridges, a small postrostral bone not reaching the rostral, and a large supracleithrum, which is as large or larger than the cleithrum. Distinct features of the new genus include the long and slender, but robust lower jaw, suboperculum, branchiostegal and gular plates ornamented with concentric ridges, gular plate traversed by a sensory canal, supracleithrum longer than cleithrum, a small and oval postcleithrum, and the presence of fringing fulcra only in the caudal fin.

The cladistic analysis of the relationships of the new coccolepid genus shows that Coccolepidae (including †*Coccolepis bucklandi* and †*"Coccolepis" groeberi*, the latter representing a new genus) is the sister group of the Acipenseriformes within a monophyletic Chondrostei. Additionally, a survey of the fossil record of the family Coccolepidae shows a shift from marine to continental waters during the Late Jurassic, which is also observed in the fossil record of the acipenseriforms.

S5 – Cretaceous Palaeogeography: Ostracoda versus larger Foraminifera from Northern Somalia and their relations to those of the southern Tethys

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The Cretaceous deposits of northern Somalia either unconformably overlie deeply weathered Jurassic sediments or pan-African basement. As the basal conglomerate of the Cretaceous carries large pebbles of parauthochthonous latest Jurassic/earliest Cretaceous limestones (dated by calpionellids), this unconformity most probably corresponds to the "late Valanginian unconformity" observed within the basins of the Arabian Peninsula and Iran.

Northern Somalia comprises sediments of Aptian through Cenomanian age, unconfomably overlain by deposits of Campanian and Maastrichtian/Danian age. The Cretaceous sedimentary sequence resulted from a carbonate ramp deepening to the East; its faunal content and tectonic history identifies it as the southernmost outlier of the Arabian Peninsula basins.

The first Cretaceous deposits are of limnic origin (basal Aptian) which grade into a thick marginal marine limestone sequence of Early Aptian age (Eastern Ahl Medo), at first mostly unfossiliferous. Larger Foraminifera gradually occur higher up in the sequence: *Choffatella descipiens*, *Valserina transiens* and subsequently *Palorbitolina lenticularis*, all of the Early Aptian. No ostracodes could be isolated from these deposits. Also in very good accordance with the other shallow marine Tethyan foraminiferal faunas are the overlying late Aptian to Cenomanian sediments containing the more or less complete *Mesorbitolina*, *Orbitolina* and *Conicorbitolina* lineages. As well, *Praealveolina* and its "relatives" occur in the latest Albian to Early (Mid-)Cenomanian carbonates. This is in accordance with the meanwhile progressively important ostracod fauna (Cenomanian: e.g. *Cythereis*, *Rehacythereis*, *Peloriops*, *Metacytheropteron*, *Veeniacythereis*, *Glenocythereis*) so that during the Early Cenomanian an "North African – Middle East palaeobiogeographical province (N.A.-M.E.-P.)" was established.

This harmonic distribution pattern was acutely disturbed due to the uplift of northeastern Africa/Arabia/Iran due to the separation of the Afro/Madagascan and the Indo/Seychelle block during the Turonian. This is well expressed by the proliferation of the phylogenetic lines of the ostracod genera and species of the N.A.-M.E.-P. in northern Africa and the Levantinian regions during this time and thereafter (e.g. *Protobuntonia numidica*, *Mauritsina*, *Cristaeleberis* and others). In contrast, during the renewed subsidence of the central parts of the Arabo/

Iranian basins since the Coniacian only those genera of ostracods reappered, which were already present in the region prior to this event (e.g. "*Brachycythere*"). Here, new genera of ostracodes appeared, which evidently could not spread into northern Africa's seas until the vast Late Paleocene transgression (e.g. *Kaesleria*, *Phalcocythere*). This differs conspicuously from the contemporaneous occurrence of the foraminiferal genera (e.g. *Orbitoides*, *Loftusia*, *Omphalocyclus*, *Pseudorbitolina*) in Northern Somalia and the other Tethyan regions, which had their first appearance later than Turonian in the Mediterranian.

The differences in the distribution of the Late Cretaceous Ostracoda and larger Formanifera might be sought in the dispersal of their larval stages, as the larger foraminifera may have had an initially planktonic life-style, while the mentioned ostracods always lived benthonic.

S9 – Enigmatic Cryogenian medusoid fossils from North China: a unique bauplan with possible metazoan affinity

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The latest calibrated molecular clock speculates the origin of metazoa deep in the Cryogenian, which is supported by the paleontological discoveries that diversified animal embryos occur shortly after the Marinoan glaciation, and further by the geochemical studies indicating that the oxygen rise with respect to Neoproterozoic Oxidation Event started in Cryogenian. However, with several dubious pre-Ediacaran candidates being proposed recently, unequivocal animal fossils are still no older than Ediacaran in age. Millimetric to centimetric medusoid fossils from the Xingmincun Formation (southern Liaodong Peninsula, North China), thought to be 700-800 Ma old, have the potential to corroborate the Cryogenian origins hypothesis, but previously lack satisfying interpretation of their bauplan, phylogeny and paleoecology owing to inadequate taphonomical analysis. Therefore, we restudied these fossils based on new material. The taphonomy of the Xingmincun medusoid fossils is similar to that of non-mineralized Burgess-Shale-type fossils, which were buried rapidly by gravity-flow muds and preserved as 2-D films. Three preservational types are distinguished reflecting local variation in diagenesis and weathering. Based partially on taphonomic evidence, we interpret the Xingmincun medusoid fossils as remains of free living, soft-bodied, umbrella-like organisms. Individual fossils normally are composed of concentric annuli with the unique "half convex, half concave" structures, which are deduced deriving from the different mechanical behaviour between alternating weak and strong annuli during compaction, indicating primitive soma differentiation. Direct evidences of asexual reproduction in schizogony and budding are also demonstrated. Comparisons with Precambrian macroscopic fossils and extant taxa do not allow us to place the medusoid fossil organisms into any known taxonomical group. Be that as it may, it seems most parsimonious to regard them as a metazoan stem group intermediate between Placozoa and Cnidaria, or as a stem group of the latter taxon, although the alternative hypothesis of a protistan affinity cannot be ruled out. On the other hand, another group of medusoid fossils, which are preserved together with the aforementioned ones but invariably lack concentric relief and occur in swarms, are still undefined in affinity based on currently available material. Regardless of whether they were metazoans or protists, the Xingmincun medusoid fossils are an important supplement to our knowledge of the Precambrian biosphere. If they are in fact metazoans, then they provide direct support for the molecular clock hypothesis, and their distinct morphology and life style would expand our concept of the earliest animals. Even if they are actually giant protists, this is a new and highly developed group that we have never known before, revealing a new aspect of the protistan world that goes beyond our expectations.

S6 – Ontogenetic data from fossils with reference to the 'Orsten'-type of preservation

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Individuals of a species may differ from each other significantly depending on the developmental age of the individuals. Such ontogenetic information ('4D data') contributes to phylogenetic systematics, as it provides significant new characters. These may be larval features absent in the adult or process-related features, i.e. giving answers to when certain structures appear during ontogeny and how they change during development. Especially for taxa with aberrant adult morphologies the inclusion of ontogenetic data is simply necessary for plausible systematic placements. While molecular developmental biology has gained more and more attention in the recent years, the importance of developmental information from fossil species has often remained underestimated, although only

information from fossils providing developmental information is capable of reconstructing ancestral developmental patterns not represented in extant species any more. Therefore it is of value to search for ontogenetic data also in the fossil record. Only few ontogenies of fossil species could be studied more extensively so far. Especially Trilobita are a good example providing "fossil ontogenies". The major source of developmental information in the fossil record has become the 'Orsten'-type of preservation. The minute but uncompressed fossils from the 'Orsten' with preservation of structures in finest detail are often represented by a number of developmental stages. They allow the reconstruction of sometimes long successive instar sequences. These extraordinary fossils enabled us to follow up the morphogenetic changes of many features of especially arthropod fossils, such as eyes, limbs, or setal patterns, throughout the developmental sequence. Taking their Cambrian age into account, 'Orsten' fossils provide us with an exceptional insight deeply back into the history of development and evolution. Of major significance is, e.g., the eucrustacean *Rehbachiella kinnekullensis*, a branchiopod known exclusively from Cambrian 'Orsten' material preserved in 3D. Of this species no less than 25 successive stages, thus semaphoronts, could be distinguished morphologically. The latest known stage is considered to be still immature, so we have to expect even more stages until reaching adulthood. Other examples from the 'Orsten' material include other rather modern crustaceans, but even from those that are representatives of the early evolutionary lineage towards modern crustaceans, most valuable ontogenetic data are available uncovering ancestral traits. With this data base, ontogeny as a process turns out to be a useful tool for the reconstruction of early crustacean phyogeny. In many cases the 'Orsten' record provides us with only very few or even only one larval specimen, but sometimes the record includes even material of apparently embryonic stages. These and other examples are presented and the phylogenetic signal provided by such fossils is evaluated.

S24 – Going south: drift in Miocene mammalian biodiversity hotspots

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Is biodiversity equally distributed in time and space? In 2005, the question 'What determines species diversity?' was selected as one of the 25 most important fundamental but unanswered questions in science. For paleontologists the challenge is to reconstruct biodiversity patterns of the past. Historical data can show how hotspots came to be, and, more importantly in these days of crisis, how they came to their demise. The difficulty lies in that no single locality gives a complete overview of the biodiversity in a particular period.

We plotted the number of fossil mammal genera in Europe for Mammal Neogene units 3 to 11 (20-7.75 Ma), Early to Late Miocene.The data were obtained from the New and Old Worlds (NOW) database. The maps clearly testify of the patchiness of the fossil record. However, when comparing the data from different zones, there is initially a distinct trend of a southward movement of the hotspots, leading to a climax in France ca 12Ma (MN 7/8) and the most southern hotspot around 11Ma (MN 9) in the Vallès-Penedès Basin (Catalonia, Spain). The Vallesian is followed by a period in which the diversity is more evenly distributed.

Making separate analyses for small and large mammals show that the pattern is better observable in rodents and insectivores than in the ungulates and carnivores. Presumably, this is due to the higher completeness of the fossil record of micromammals.

S1 – The physiographic and biogeographical relationships of Northeastern Brazil during the Cretaceous

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The tectonic separation of Africa and South America is one of the classical examples of continental rifting and drifting. It is recognized today as a poly-phased and diachronous series of events, each with its own temporal, structural and geographical boundaries, which cumulatively impacted the region's physiographic landscape and its biota for almost 60 million years. The biogeographical consequences of this protracted and complex geological history are unlikely to be straightforward or simple.

Northeastern Brazil provides an important case study in how tectonic, physiographic and biogeographical patterns were related during the Cretaceous. The distribution of Cretaceous fresh-water fishes in that region has been interpreted in the light of its tectonic and physiographic history. New data suggest that, beginning in the Aptian, Northeastern Brazil was still connected to Africa but was separated physiographically from the rest of South America by a continuous epicontinental seaway. The existence of such a seaway has important biogeographical implications, not only for the timing of dispersals from Tethys into the proto-South Atlantic, but also for the isolation

of terrestrial biotas. The pre-Albian fresh-water biota of Northeastern Brazil was first Gondwanan, but then may have been "African", not "South American". It is even possible that Northeastern Brazil remained in contact with Africa and was isolated from the rest of South America well into the Albian and/or Cenomanian.

The interpretation of Northeastern Brazil's rich Aptian-Cenomanian Cretaceous terrestrial fauna as South American may therefore be erroneous, despite the present-day distribution pattern of its fossils. For example, giant mawsoniid coelacanths are widespread within pre-Albian lacustrine and fluvial deposits across much of western Gondwana, but younger fossils have been found only in Africa and Northeastern Brazil. Traditionally, these later occurrences were considered an example of transatlantic isolation, with separate late Cretaceous populations in Africa and South America. However, all the "South American" occurrences are in Northeastern Brazil, and if this region was then part of Africa, mawsoniids may actually have been extinct in "mainland" South America by the Aptian or Albian.

This case study illustrates how improved understanding of shifting physiographical boundaries through time can suggest new and sometimes surprising interpretations of past biogeographical distribution patterns.

S11 – Still in hiding? – Problems of recognizing early Radiolaria

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The siliceous skeletons of the Radiolaria are among the most beautiful features in modern organisms, but they are invariably very small and inconspicuous in the fossil record. Therefore, radiolarians are rarely searched for in palaeontology and even the modern ones have not been investigated in the detail they deserve.

The Radiolaria form a very important component of modern planktic life in every oceanic basin of the planet and have been this since a long time. Their evolutionary origin, however, is shrouded in mystery and most fossils identified as early Radiolaria have to be referred to other groups. As radiolarians include extant taxa, a comparison of modern species with fossil ones is possible and can provide us with important information on the biofacies and ecology of marine basins during Earth history.

The earliest definite radiolarians have been discovered in stage 5 of the Cambrian Series 3 ('Middle Cambrian') of Australia. Older radiolarian records include rare spherical siliceous objects, but have to be scrutinized in more detail and none have been verified as genuine radiolarians so far. Thus, records of specimens from the Fortunian (Terreneuvian) to the Series 2 of the Cambrian System have to be excluded from the radiolarian record and referred to other taxonomic groups or are still in dispute.

The oldest definite radiolarian faunas are known exclusively from carbonate successions in the Middle and Upper Cambrian of Australia, China and North America. Their biostratigraphic and biogeographic distribution is unknown due to the poor and spotty record. The Middle Cambrian radiolarian fauna is dominated by spicular forms and includes the families Archaeoentactiniidae and Palaeospiculidae. These faunas are moderately diverse and show a strong restriction in the structural development of their skeletons, invariably based on a single point-centered primary spicule.

Three main groups can be differentiated in the Cambrian, taxa with point-centered and bar-centered spicules and taxa without a recognizable spicule. The evolution of Palaeozoic radiolarians apparently starts with taxa bearing a single point-centered spicule, the Archaeoentactiniidae. A differentiation of this spicule leads into various directions of sphere development and branching of the primary spicule and also to the multiplication of the number of primary spicules during the Middle and Upper Cambrian (Echidninidae). The enigmatic Aspiculidae without a recognizable spicule in their shells originate in the Upper Cambrian and may be referred to as early Spumellaria. The bar-centered taxa of the Parachaeoentactiniidae are present from the Upper Cambrian on and may represent the earliest Entactinaria, a common group from the Ordovician onwards, while the upper Tremadocian is dominated by the Aspiculidae and the newly evolving Proventocitiidae.

S16 – Sauropodomorph locomotion and how it shaped sauropod gigantism

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Studies of dinosaur locomotion typically assume that dinosaurian limbs kinematics and gaits are similar to those of mammals. This assumption is the basis of Alexander's Formula, which allows calculating walking speeds from trackways. However, various morphological features of dinosaur limbs cast doubt on the validity of this assumption, pointing instead to a preference for shorter strides and higher stride frequencies in typical dinosaurs than in mammals. Sauropod dinosaurs with their enormous size and resulting fully pillar-like limb posture are an ideal test case for this novel hypothesis, as adaptations for both high stride frequencies

and short stride length should be more obvious than in smaller and more cursorial groups.

Kinetic/dynamic modelling in MSC.ADAMS and musculoskeletal modelling in SIMM allow estimating the muscle moment arms and diameters, and from these the available joint torques, as well as calculating limb joint torque patterns associated with the supposed gaits of sauropods, for both the classical interpretation based on the mammalian pattern and the power-walking gaits recently suggested. Direct comparison of these results allows drawing conclusions on the energetically most efficient mode of locomotion of sauropod dinosaurs. Comparison with more cursorial basal taxa such as *Plateosaurus* offers the chance to assess the development of sauropod locomotion, and sheds light on an important but often underestimated aspect of the development of sauropod gigantism.

S4 – Aragonitic cold-water corals as geochemical archives of ocean temperature

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The reconstruction of key environmental parameters is accomplished by the application of geochemical climate proxies, such as the stable carbon isotope ($\delta^{13}C$) and oxygen isotope ($\delta^{18}O$) composition of coral aragonite. This study evaluates the potential of the live-collected coral species *Caryophyllia cyathus*, *Desmophyllum cristagalli* and *Stenocyathus vermiformis* as recorders of ocean temperatures at 500 m water depth off the Azores archipelago. Scanning electron and optical microscopy were applied for microstructural analysis of the coral skeleton and the spatial distribution of $\delta^{13}C$ and $\delta^{18}O$ was investigated along the coral wall (theca). Background data, including data from high-resolution temperature logs and on the ambient seawater isotopic composition, were compared with stable isotope-based temperature reconstructions to test the suitability of these cold-water corals as geochemical archives and to explore the role of vital effects on skeletal geochemistry. The theca of the three coral species displays a regular macron-scale banding pattern of the coral wall, but also a complex micron-scale build up that impedes the chronological interpretation of cold-water coral growth bands. Although all of the corals experienced identical and near-stable salinities and temperatures, the stable isotope signatures vary within and among species. Both $\delta^{13}C$ and $\delta^{18}O$ values fluctuate in relation to growth bandings and are therefore most likely dependent on calcification rates and associated kinetic vital effects. All corals are considerably depleted in ^{13}C with respect to the carbon-equilibrium with ambient seawater, which indicates a significant incorporation of respired CO_2 into skeletal aragonite. $\delta^{18}O$ values vary by up to 3.6 ‰ among the growth bands of one *D. cristagalli* specimen, which would translate into reconstructed temperature amplitude of 16°C. This, however, contrasts with the minute recorded intra-annual temperature amplitude (annual mean 12.33° ± 0.25°C). Nevertheless, $\delta^{13}C$ vs. $\delta^{18}O$ regression lines can be used to infer ambient temperatures with the lines technique (Smith et al. 2000; Palaios 15, 25-32), which yields temperatures that coincide with the measured maximum temperature range in the case of *D. cristagalli* and for most *C. cyathus* samples, but deviate by 2.95°C from the measured annual mean in the case of the *S. vermiformis* specimen.

S6 – Finally grown up: is this what a morphologically adult lissamphibian looks like? New data for ontogenetics and phylogenetics from an Oligocene newt (Salamandridae: Pleurodelinae)

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Lissamphibians, especially caudates, share features with immature and neotenic temnospondyls and seymouriamorphs (lepospondyl ontogeny being largely unknown). This fact features prominently in the discussion about the origin of Lissamphibia. Paedomorphosis has also been a common mechanism of evolution within Caudata.

Pleurodeline salamandrids (newts), particularly the extant *Tylototriton* and *Echinotriton* and the Eocene to Pliocene *Chelotriton* and *Brachycormus*, show peramorphic features: sculpture on the skull, long ribs, presacral neural spines ending dorsally in flat sculptured surfaces that articulate with each other, and contacts of the maxilla to pterygoid and quadrate. In some pleurodelines, the jaw joints lie level with the occiput (slightly caudal in some *Chelotriton* specimens), farther caudal than in any other caudates or even some lepospondyls. Yet, unlike the terrestrial *Tylototriton* and *Echinotriton*, *Chelotriton* and *Brachycormus* were aquatic as shown by their hyobranchium and their ribbon-like tails.

MB.Am 45.1 (stored at the Museum für Naturkunde) is a late Oligocene natural mold of an articulated pre-

sacral skeleton in dorsal view. While likely referable to *Chelotriton*, it is more peramorphic and larger than all previously known specimens. The jaw joints lie so far caudal to the occiput that the squamosals are inclined rostromedially to caudolaterally, unlike in any other caudate. The ribs are longer than three vertebrae, and at least some of them are curved ventrally; both features are unique among lissamphibians. Carpus and hyobranchium are at least partly ossified. Most of the skull (like the neural spine tables) bears pustular sculpture; the maxilla is honeycombed. The squamosal is uniquely broad rostrocaudally (compared to other caudates). The premaxillae bear very temnospondyl-like alary processes. The specimen is superficially so similar to Carboniferous amphibamid temnospondyls that it was even identified as one on a label; but features like the frontosquamosal arch and the craniodorsally directed rib spines show unambiguously that MB.Am 45.1 is a pleurodeline as identified by others, there is no trace of any bones absent in other caudates but present in temno- or most lepospondyls, and the matrix fits only the site stated on the back side of the specimen (Orsberg near Erpel, western Germany).

To test whether the peramorphic reversals of MB.Am 45.1 have an impact on the phylogenetic position of caudates or modern amphibians in general, we added it to a large analysis of tetrapod phylogeny that contains *Gerobatrachus*, an amphibamid expected to pull Caudata if not Lissamphibia into Temnospondyli. Still, MB.Am 45.1 emerges as a caudate; Lissamphibia is monophyletic; to move Lissamphibia from Lepo- to Temnospondyli requires 14 extra steps, diphyly 17.

S6 – Ontogenetic changes in the skull elements of the Late Jurassic dwarf sauropod *Europasaurus holgeri*

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Juvenile sauropods are very rare in the fossil record. There is no extensive ontogenetic growth series for sauropod skulls, and consequently, the morphological changes in ontogeny are not well understood. This study explores such changes in the most complete collection of disarticulated skull bones of a single sauropod taxon, the dwarf basal macronarian *Europasaurus holgeri* from the Kimmeridgian of northern Germany. A total of 122 skull bones representing at least 14 skulls were examined. The skull material includes different individuals of various ontogenetic stages. Because size alone is not a good indicator for determining ontogenetic stage, size-independent characters were used to stage the bone elements.

Since the original description of *Europasaurus*, new skull material has been found so that an updated skull reconstruction of an adult individual is now possible. This updated reconstruction shows a smaller external naris and a larger orbit as compared to the original reconstruction.

Among the important ontogenetic changes in the skull of *Europasaurus* are the decreasing ventral exposure of the jugal, which is extensive in the young individuals, as well as the increasingly erect nasal process of the premaxilla. These changes, including the large orbit and other skull parts are paedomorphic characters resulting from dwarfing. The ventral exposure of the jugal and the inclined premaxillary nasal process in the juvenile *Europasaurus* represent the retention of plesiomorphic characters seen in basal sauropodomorphs (e.g. *Plateosaurus* and *Massospondylus*) and basal sauropod dinosaurs (e.g. *Shunosaurus*). Apart from three partial braincases, only isolated skull bones have been found, indicating the lack of fusion of the skull bones. This is regarded as another paedomorphic character. Detailed studies of the skull bones proved that the material represents two morphotypes independent of ontogenetic stage. One such distinctive feature is the dimorphic shape of the orbital margin of the frontals.

S12 – Land plants and the Late Devonian extinction events

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The Devonian Period was named in 1839 after the County of Devon in England. However, since that time the Devonian of the British Isles has not contributed greatly to our understanding of Devonian stratigraphy. The marine sequence in South Devon is a series of fragmented and tectonically deformed terranes with a generally poor fossil content. To the north the facies is largely Old Red Sandstone of continental origin and with the fossils restricted to fish, plants and spores. This means that developments in our understanding of Devonian stratigraphy and extinctions events have come from deeper water marine sequences such as in Germany, Belgium and more recently Morocco. However, with the development of this higher resolution Devonian event stratigraphy, it has now proved possible to identify these extinction events within the Old Red Sandstone continental sequences. Here they are found to have a distinct sedimentological character revealing major palaeoclimatic perturbations. This

means we can now attempt to understand how land plants change during an extinction event by integrating the palaeoclimate and palynological records. A key question is whether land plants are driving the Earth System perturbations or merely responding to it. This may be merely a matter of scale with Devonian extinction events being relatively rapid whereas the evolution and global spread of large trees in the Mid and Late Devonian can instead be regarded as an irreversible much longer term change.

The first 'Late Devonian' extinction is the Taghanic Event in the late Givetian. This has a distinctive motif within the terrestrial environment with an initial warm wet episode followed by a period of sustained cool aridity and finally two warm wet events with accompanying marine transgressions. Here the extinctions within the land plants occur with the sustained aridity and are represented, at least in Euramerica, by a major reduction in diversity with the surviving flora being dominated by archaeopteridalean progymnosperms.

The Frasnian-Famennian Mass Extinction can be recognised from a terrestrial section in East Greenland. Here there are two paired episodes of a warm wet high insolation event followed by sustained cool aridity. The warm wet episodes represent the Lower and Upper Kellwasser Events. The extinctions in land plants are concentrated in the transition between the upper warm wet and cool aridity.

The terminal Devonian-Carboniferous boundary event is somewhat different. Here the episode of cool aridity (representing a high latitude glacial event) precedes the warm wet event that represents the deglaciation. The plant extinctions occur within the deglaciation and were probably driven by habitat loss.

S15 – Middle Jurassic vertebrates from Berezovsk in western Siberia (Russia)

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The Berezovsk coal mine in the Nazarovo Basin in southern Krasnoyarsk territory of western Siberia has yielded a rich Middle Jurassic (Bathonian) vertebrate assemblage. The fossils occur in floodplain claystones and siltstones of the Itat Formation above a coal seam of more than 50 m thickness without vertebrates. About 12 tons of sediment have been screen washed in 2010-2012 for the recovery of microvertebrates. The isolated microvertebrate remains are concentrated in one slightly sandy siltstone layer of 20-30 cm thickness and are often somewhat water worn. Accidentally, partial turtle shells occur within the microvertebrate level.

The most common fossils are scales and bones of paleonisciform and sinamiid fishes. Dipnoans are extremely rare and are represented only by few fragments of dental plates, in contrast to the contemporaneous near shore deposits of the Balabansai Formation in Kyrgyzstan, where lungfish are abundant. Chondrichthyans are also very scarce, and only few teeth of presumably fresh water hybodontiform sharks have been recorded from Berezovsk.

Xinjiangchelyid turtles are the dominant tetrapods, represented by thousands of isolated shell plates, postcranial and cranial bones, and few partial shells of a new taxon. Crocodiles (cf. Goniopholididae) are surprisingly rare. Amphibians are represented by the large stem caudate *Urupia* and a more derived smaller taxon. Noteworthy is the absence of labyrinthodonts that persisted in other Asian Middle to Late Jurassic ecosystems in China, Mongolia, and Kyrgyzstan. So far also no frogs and albanerpetontids have been recorded. Squamates are represented by few jaw fragments and other bones of an unidentified scincomorph. Similarly uncommon are remains of a choristodere possibly related to *Cteniogenys*. Dinosaurs are represented in the screen washed fossiliferous layer by isolated teeth of sauropods, theropods, stegosaurs, and basal ornithischians similar to heterodontosaurids. Higher in the section a bone bed occurred with several partially articulated skeletons of an undetermined stegosaur and bones of the tyrannosauroid theropod *Kileskus aristotocus*. Isolated teeth of pterosaurs are common, but otherwise only a single pterosaur bone fragment has been found.

Nonmammalian synapsids are represented by isolated teeth of a tritylodontid. More than two hundred mammalian specimens have been recovered so far. Most common are edentulous jaw fragments and isolated mammal teeth or tooth fragments as in other fluvial deposits. The Berezovsk mammal assemblage includes the eleutherodontid haramiyid *Sineleutherus issedonicus*, diverse docodonts (*Itatodon tatarinovi*, *Simpsonodon sibiricus*, and *Hutegotherium yaomingi*), an amphilestid-grade eutriconodontan, a new multituberculate, as well as the cladotherians *Amphibetulimus krasnolutzkii* and a new taxon of Dryolestidae. The multituberculate and the dryolestid are among the oldest in the fossil record. The vertebrate assemblage from the Itat Formation is very similar to that from the British Bathonian Forest Marble Formation and suggests a lack of a provincialism in the Middle Jurassic Laurasian landmass.

S15 – From sauropods to cycads – The Late Jurassic terrestrial record of the Swiss Jura Mountains

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The Late Jurassic of the Swiss Jura Mountains is built up of shallow-marine carbonates deposited on the large and structurally-complex Jura carbonate platform, which was located at the northern margin of the Tethys at a palaeolatitude of approximately 30° N. These Late Jurassic sediments were for a long time thought to be entirely marine deposits, despite the fact that numerous dinosaur (sauropod, *Cetiosauriscus greppini*) bones had already been discovered in 1850 in a quarry near Moutier (Kimmeridgian, Canton Bern). However, such finds of terrestrial remains were believed to be washed in and to occur only very exceptionally. This only changed, when Meyer in 1989 reported the first large sauropod tracksite, the Lommiswil quarry near Solothurn (Late Kimmeridgian, Canton Solothurn). During the subsequent years, over 25 additional tracksites were discovered in the Kimmeridgian Reuchenette and Tithonian Twannbach Formations (Cantons Bern, Jura & Neuchâtel), and this cumulated in 10 years of systematic excavation and documentation of several, large dinosaur tracksites on the future course of Highway A16 (Late Kimmeridgian, Canton Jura). Altogether, the Swiss Late Jurassic dinosaur track record currently encompasses at least 17,000 tracks, including > 280 sauropod trackways ranging in pes length from 10 to 125 cm, and > 400 tridactyl trackways ranging in pes length from 5 to 80 cm.

Compared to the extensive track record, the body fossil record is comparatively scarce and comprises – apart from the sauropod bones mentioned above – an isolated allosaur tooth from the cave *Silberhöhle* near Röschenz (Late Oxfordian, Canton Baselland), two isolated theropod teeth from the Turtle Limestone of Solothurn (Late Kimmeridgian, Canton Solothurn), and a left stegosaur femur from Oberbuchsiten (Late Oxfordian, Canton Solothurn). The Moutier sauropod assemblage contains a large theropod tooth that can be attributed to the taxon *Ceratosaurus*. Pterosaur remains have been reported from Porrrentruy and excavations on Highway A16 (Late Kimmeridgian, Canton Jura), from the Turtle Limestone of Solothurn (Late Kimmeridgian, Canton Solothurn; Meyer & Hunt 1999), and from the Péry-Reuchenette quarry (Late Oxfordian, Canton Bern; collection *Fondation Paléontologique Jurasienne*). The continental record is completed with equisetalean sphenophytes (*Neocalamites*), cycads (*Zamites*) and auracarian conifers from the Péry-Reuchenette quarry and the Graitery (Late Oxfordian, Canton Bern), up to 1.75 m long often branched axes of the tree *Protocupressinoxylon* from excavations in the *Marnes à virgula* on the future course of Highway A16 (Late Kimmeridgian, Canton Jura), by finds of charophytes and limnic ostracods (Late Oxfordian, Canton Jura), and by sedimentological evidence (e.g.: inter- to supratidal features, desiccation cracks, palaeosols, "microkarst" features).

All this evidence indicates that large parts of the Jura carbonate platform were emergent during several and prolonged time periods allowing the development of a soil and vegetation cover and dinosaur populations, but also the migration of dinosaurs and exchange between dinosaur faunas from further south (Iberian Massif – Massif Central) and further north (Rhenish Massif – London-Brabant Massif). Accordingly, the Jura carbonate platform occupied a key position for the exchange of terrestrial faunas between the Southern and Northern hemispheres (today's Africa and North America) and is important for the reconstruction of terrestrial Mesozoic ecosystems and their evolution, and for palaeobiogeographical reconstructions. Finally, there is still a great potential for future discoveries of terrestrial fossils in the Late Jurassic of the Swiss Jura Mountains. The present contribution provides an overview on the above-mentioned discoveries and localities including an exhaustive bibliographic list.

S6 – Measuring phenotypic integration in the limbs of the Jurassic ichthyosaur *Stenopterygius quadriscissus*

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Understanding the patterns and basis of morphological integration is considered one of the central questions of evolutionary developmental biology. Despite its applicability to questions of evolutionary and paleontological interest, there are few studies on integration in fossil vertebrates. In this study, we examine limb integration in the Lower Jurassic ichthyosaur *Stenopterygius quadriscissus*, with the aim of examining the impact of ontogeny and anagenetic changes over short geological time spans on metrics of limb integration. We selected six length measurements, three from the proximal elements of the forelimb and three from the proximal elements of the hind limb, and collected these data from a sample of 60 individuals spanning a wide range of body sizes. We then further divided the data to account for differences in ontogenetic maturity and stratigraphic provenance. We applied several statistical techniques to measure relative integration in the subsamples. Firstly, we used matrix correlation to detect changes in the structure of the trait correlation matrices in the absence of changes in total integration. Secondly, we calculated the variance in eigenvalues as a measure of total integration. Lastly, we used partial correlation and edge exclusion deviance to examine the identity of the strongly integrated elements.

Both ontogenetic and stratigraphic effects had a significant influence on correlation matrix structure, measured values of integration, and the identity of strongly integrated elements. Ontogenetic effects were relatively stronger than stratigraphic effects. While adults showed the lowest levels of overall integration, the integration of serially homologous elements was relatively greater than in juveniles. This was unexpected due to strong divergence in limb size and, theoretically, hind limb function in derived ichthyosaurs. Ontogenetic differences in the relative integration of the forelimb to the hind limb are probably related to early locomotor demands on the forelimb, and suggest that developmental constraints are not driving the pattern observed. Specimens from the stratigraphic class encompassing the largest amount of time showed lower total integration, probably due to time averaging, and also a different pattern of strongly integrated elements. This suggests that correlation patterns can change within a species over relatively short geological time spans (< 1 million years). We conclude that patterns of trait integration are not static across ontogenetic or evolutionary time in ichthyosaurs, but that the general trends observed are similar to those seen in distantly related tetrapod groups, such as mammals and lissamphibians.

Plenary – Impacts of global warming on plant biodiversity and ecosystem function: a 200 million year old case study form East Greenland

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The functioning of modern terrestrial ecosystems has been shaped by an evolutionary legacy of four mass extinction events, multiple geologically driven global warming and cooling events, meteorite impacts, the evolution of advanced plant reproductive grades and plant extinction. Studies from the fossil plant record have revealed that global environmental change of a magnitude similar and greater to that predicted by the year 2100, can result in the collapse of terrestrial ecosystems, resulting in high species level turnover and extinction.

In the case of the Triassic-Jurassic boundary (~200 million years ago), ecosystem collapse was preceded by prolonged ecological degradation. A common response of fossil plant communities to global environmental perturbation includes increasing dominance, decreasing evenness, loss of biodiversity and likely reduced productivity. High resolution records of fossil leaves and pollen indicate that ecosystem diversity can be maintained in response to major climatic change via continental scale migration and recruitment of immigrant taxa, yet the functional consequences of these changes are difficult to evaluate. Return of global environmental conditions to pre-excursion norms usually results in a rebound in plant diversity but with drastically altered ecological composition and evidence for ecosystem instability for hundreds of thousands to millions of years. The presentation will focus on the ecological and evolutionary consequences of a global warming event at the Triassic-Jurassic boundary and the feedback effects of plant adaption on fire ecology and marine biodiversity.

S2 – Occupancy-estimation techniques: turning sampling failures into useful information in palaeobiology

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Ideally palaeobiologists would wish to have abundance data for all of their sites. Many of our most powerful analytical tools in palaeobiology rely on abundance data and the use of abundance data has led to important advances in our understanding of biodiversity trajectories in time and space. However, abundance data are time-consuming to collect and reliably determining abundance, even in extant communities, can be difficult. Statistical ecology has developed a range of tools based on occupancy, or presence-absence, data that can overcome some of these difficulties. This suite of tools is ripe for application to palaeontological datasets. A critical element in ecological techniques aimed at estimating the effects of sampling is to break the probability of finding a taxon of interest in at a particular site within the known range of a taxon into two elements: 1) the probability that the taxon is to be found at that location, given its presence in a larger search area; 2) the probability of detecting that taxon, given that it is present at this locality. The latter is referred to as detectability and when this probability is less than 1, the taxon may be present but not detected, leading to false absences. However, occupancy-based techniques offer a refined means for statistically modeling, in a likelihood-framework, whether an absence is a true absence or the result of detection failure by carrying out repeated surveys of the area of interest. In such surveys, the repeated failure to find the taxon increases the support for genuine absence of that taxon on the site. The simplest models are for single taxa but can be extended to multi-species assemblages and incorporate heterogeneous detection probabilities for different taxa. Detection probabilities for common taxa can also be extended to rarer taxa with similar ecological requirements. Palaeontologists face an additional complication: absences can be generated

by a range of geological factors. However, the logic of occupancy-based ecological modeling frameworks has the potential to be adapted to incorporate geological factors as co-variates. A shift towards occupancy-based studies could greatly enhance the value of fieldwork by deriving information from sampling failures as well as successes and opens up the possibility of large-scale sampling projects that would offer useful data without the need to collect, curate and store large amounts of fossil material, as only a single exemplar of each taxon from each site is required. Previous presence-absence data sets could become valuable resources in their own right but would be even more useful in guiding future sampling programmes, which would aim at estimating detection probabilities. Occupancy-based methods offer a route to separating true absences from false absences in a rigorous manner, which would have tremendous implications across the whole of palaeobiology.

S8 – Encrustation and bioerosion on the giant clam (*Tridacna maxima*) shells from the Egyptian Red Sea coast

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The living giant clams (*Tridacna maxima*) have been collected from coastal sites of the Egyptian Red Sea (Abu-Ghusun Lagoon, Hurghada Harbors, and El-Esh area). This species is widely distributed in the Red Sea, Arabian Sea, and Indo-Pacific province. Encrustation and bioerosion represent the most characteristic taphonomic features of the giant clam shells. Clionoid sponge bioerosion predominates on the upper valve, while bivalves, corallinacean red algae, serpulid worms, large foraminifera, and colonial corals are the main encrusting on the upper and lower valve. Thicker shells, their epifaunal life habit and faster growth rates in *Tridacna maxima* provide a good hard substratum for numerous marine organisms and indicate a long life span of this bivalve on the seafloor.

S22 – Carpodeposits from a late early Miocene estuarine environment (Korneuburg Basin, Lower Austria)

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The Korneuburg Basin, located 20 km north of Vienna, comprises a late Early Miocene (Karpatian = late Burdigalian) pull-apart basin within the Alpine-Carpathian thrust belt, at the northwest margin of the Central Paratethys. The 20 km long and up to 7 km wide asymmetrical half-graben is bordered to the west against the Waschberg Unit and Flysch Unit by the synsedimentary Schliefberg fault. On the eastern side is an onlap on the Flysch Unit and the connection to the Vienna Basin. The Korneuburg Basin sediments consist of clay, clayey silts with thin coaly layers and fine to medium grained sands and reach a maximum thickness of about 800 m in the southern part. The construction of a motorway northwest of Korneuburg exposed an excellent 1.8 km long profile south of Stetten of the Karpatian Korneuburg Formation. The rich fossil content (e.g. foraminifera, molluscs) provides evidence of sedimentation in intertidal mudflats, coastal swamps and shallow sub-littoral settings within an estuary and changing environmental conditions.

Between 113 and 156 m of profile West, silts and fine sands with high amount of plant fragments are interrupted several times and erosively cut by up to 4.5 m thick medium to fine sands with cross bedding, water escape structures, fining upward cycles, and mass occurrences of coalified wood fragments. The sediments are interpreted as shallow sub-littoral muddy and fine sandy flat deposits, erosively cut by high-energy sandy cannels.

15 samples were taken from the macroscopic plant bearing layers of sand, and silt or clayey silt or a coaly layer for the investigation of seeds and fruits. The carpodeposits, which are accompanied by strongly eroded molluscs, some fish teeth, otoliths, single ostracods, foraminifers, are allochthonous deposits from different source areas.

The sandy to silty layers include mainly poorly preserved seeds and fruits from different environments. *Actinidia*, *Ampelopsis*, Araliaceae, *Eurya*, *Fagus*, *Myrica*, *Liquidambar*, *Pterocarya*, *Rubus*, *Sambucus*, *Sinomenium*, *Tetraclinis*, *Vitis* represent trees, shrubs and lianas of mesophytic hinterland and lowland forests. The first record of *Cayratia* from Austria occurs there. Herbaceous elements such as *Scirpus*, *Carex*, *Cladiocarya* represent a reed facies. *Decodon*, a partly woody element, grew at the margins of water bodies. *Potamogeton* and *Lemnospermum* represent aquatic plants. Other herbaceous elements are *Batrachium*, Chenopodiaceae, *Ranunculus*, cf. *Spirellea*, Solanaceae, and *Umbelliferopsis*. Samples from clay or coaly clay layers include partly the same elements as the sandy layers, but additional reed elements such as *Cladium*, *Typha*, *Spirematospermum*, *Saururus*, and the water plants *Nymphaea* and *Stratiotes*. Trees, shrubs and lianas of the swampy habitats are represented by *Glyptostrobus*, *Salix*, and calamoid palms.

In sum about 1200 seeds and fruits have been extracted, representing about 50 taxa, of which 1/3 was unknown from the Korneuburg Basin.

S13 – Carbon isotope fluctuations and benthic environments in the north-alpine Rhaetian

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The end-Triassic biotic crisis near to the Triassic/Jurassic boundary (TJB) is well-known as one of the "Big Five" mass extinctions. The processes, which may have caused this crisis are still controversely discussed. A worldwide negative excursion of $\delta^{13}C$ close to the TJB is thought to be caused either by sudden decrease in primary productivity, CO_2 outgassing during the end-Triassic CAMP volcanic activity, or the addition of isotopic light carbon from methan hydrates. The perturbation of the carbon cycle has also been documented by changes in the isotopic composition of fossil leaves and changes of the stomatal characters indicating a high CO_2 concentration in the atmosphere. According to these hypotheses the global T/J biotic crisis was a catastrophic event in the latest Rhaetian. Studies of the stratigraphic record of marine animal genera however suggest high extinction rates during Norian and Rhaetian times and the diversity decline was not just a result of extinction but also due to low origination rates of taxa and may thus not be classified as a true "mass extinction event". According to some authors the "end-Triassic mass extinction" is the result of an artificial concentration of extinctions at the TJB due to "compiled correlation effect" in the literature. Recent analysis of stomatal index and density of fossil seedfern leaves and geochemical research on pedogenic carbonate nodules are suggestive of strongly rising atmospheric CO_2 concentration and fluctuating climate in the Rhaetian. It seems therefore probable that the end-Triassic event was preceded by climatic change, which effected the composition and diversity of terrestrial and marine biota prior to the TJB interval. This hypothesis is supported by new carbon isotope data from the Rhaetian Kössen Formation, which point to perturbations of the global carbon cycle in the Late Rhaetian. The stratigraphic interval with the most significant $\delta^{13}C$ negative shift, termed as Late Rhaetian Event (LRE), has been studied in detail with respect to changes of facies and microfossil associations. The data show that the microbenthic communities were largely controlled by fluctuations of oxygen concentration related to sea level changes but were not affected by the LRE. Palynological results however suggest a climatic shift towards higher humidity during this interval.

S8 – Long-term stability of Pleistocene reef-coral communities from Vanuatu

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The Pleistocene was a time of significant changes in climate and sea level. Marine environments changed rapidly and life had to adapt to new conditions within a relatively short time. This is a challenge for slowly growing and sessile organisms such as corals. Interestingly, Indo-Pacific coral reefs show a long-term stability throughout the Pleistocene according to the few published quantitative studies from this region.

In Vanuatu, a volcanic archipelago at the Eastern margin of the Coral Sea, we studied reef terraces from four different interglacial Pleistocene episodes, as well as one from the early Holocene. The taxonomic composition and diversity of the coral communities was analyzed, and their respective environments were reconstructed. Multivariate statistical methods were used for testing if significant changes between reef communities of the different terraces occurred or not. The data was also compared to available recent data from the Ocean Biogeographic Information System (OBIS). The results show no significant differences among communities from different times in similar reef environments. Thus, they could cope well with changes in global climate and sea level. The changes in species composition, which nevertheless could be observed, seem to be only correlated with environmental changes from reef crest to reef slope. Our results are in contrast to the currently observed instability and degradation of coral reefs that are not natural, but caused by human impact.

S18 – First record of the family Micropterigidae (Insecta, Lepidoptera, Homoneura) from Bitterfeld amber

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Species of the family Micropterigidae represent the most ancestral evolutionary line of extant Lepidoptera. The fossil record is comparatively rich, encompassing Jurassic compression fossils from Dobbertin in Northern Germany and inclusions from Cretaceous Lebanese

and Burmese ambers as well as from Eocene Baltic amber. Despite of intensive collecting and research on the Baltic amber entomofauna only four inclusions containing Micropterigid moths are known up to now. They represent four species in the genera *Baltimartyria* and *Micropterix*. In contrast, the few years of extracting amber from coal mines near Bitterfeld, Germany, have yielded a total of 8 inclusions. The material is deposited in the Museum für Naturkunde Berlin and was studied taxonomically. Four species were recognised representing two or three genera which are not recorded from Baltic amber so far. The specimens were documented in detail, and their diagnostic characters were outlined and compared with species from extant genera of Micropterigidae from the Northern and Southern Hemisphere. The results are discussed in terms of phylogeny and systematic placement of the new species and concerning the historical biogeography of the family.

S8 – Environmental instability may support ecological stability: an example from Pleistocene reefs of the Red Sea

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While coral communities are known for their stability in spite of dramatic sea-level changes through the Pleistocene glacials and interglacials, little is known about other reef organisms, such as molluscs that are ecologically much more diverse. During the Last Glacial Maximum (LGM, 20 000 yr BP), environmental conditions of the Red Sea became hostile for marine life. A dramatic drop of sea level (-120 m) reduced water exchange with the Indian Ocean and led to a strong increase of salinity (+10 ‰). Nevertheless, Red Sea reefs seem to have fully recovered in the Holocene. The high endemism in the Red Sea suggests that Holocene communities did not just assemble by immigration and re-settlement after the LGM. We compared the ecological guild composition of interglacial and modern mollusc communities, taking into account the variable preservability of species. This was performed by artificially degrading modern assemblages to simulate taphonomic processes and to make them comparable with Pleistocene assemblages. We found that the ecological structure of interglacial mollusc communities is very similar to modern ones. This supports the hypothesis of persistence of reef mollusc communities despite the strong environmental disturbances during the LGM.

S2 – A new method to compare fossil assemblages with Recent communities

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The distortion of the fossil record has been a hot topic in palaeontology for decades. Many methods have emerged to correct for biases in palaeoecology. Despite considerable progress on statistical methods such as sampling standardization, taphonomy is still a substantial issue. Particularly challenging is, the comparison of fossil assemblages with modern biocoenoses or thanatocoenoses, with the aim to test for community stability through time.

I have developed a method to artificially degrade modern assemblages to see how they will be structured in fossil form given preservation quality. The method is a mathematical simulation of taphonomic processes and uses an empirical index of "preservability" for each species. With increasing degradation, species with the lowest preservability will disappear from an assemblage. To test the ecological stability of marine mollusc communities, the degradation approach was combined with an ecological guild analysis. Despite the use of an empirical index, preliminary results show an unexpected high similarity between fossil and modern assemblages across environments. Implications of these results are that molluscs passed through the Pleistocene glaciations without significant changes in community structure. Experimental taphonomy will increase the robustness of the degradation method and allow for quantifying ecological change in fossil communities.

S4 – SEM and Raman spectroscopic analysis of limb bones from a small-bodied theropod (?Tetanurae) from the Kem Kem Formation, Morocco

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The Late Cretaceous Kem Kem Formation of Morocco preserves a riverine/deltaic fossil ecosystem and its flora and fauna. The formation is famous for yielding abundant vertebrate remains. However, large-bodied predators are apparently over-represented in the material that has

been recovered from the formation and little post-cranial material from small-bodied predatory dinosaurs has been found. We present comparative anatomy and osteology of three small bones from the Kem Kem Formation: The smallest bone, 81 mm in length, is a radius whereas the longer two, 134 and 138 mm in length, are both humeri. The characteristic shape and morphology of the shorter of the two humeri indicates that it belonged to a tetanuran theropod dinosaur. A total body-size estimate from the two humeri derived from allometry estimates the length for the theropod at about 2 m. Despite the weathered and degraded appearance of these fossils, optical and SEM examination of a thin section of one humerus revealed eight distinct lines of arrested growth and an external fundamental system, indicating a mature adult at least 8 years in age. SEM-based analysis of a thin section provides evidence that in fact this bone is well-preserved and may contain original apatite. Raman spectroscopy was used to compare the profile of this theropod apatite to that from a modern duck bone prepared in the same way and to a standard sample of inorganic apatite. The fossil material has a strikingly similar profile to the duck bone, with a broader peak than that of the well-crystallised mineralogical standard specimen of apatite presumably due to the presence of other elements. The difference in the peaks between the duck and theropod bones indicates that some diagenetic alteration has taken place but not a significant amount. On this basis, one aspect of future work on this material will be a micro-CT scan of the third well-preserved smaller bone not investigated here. Work with SEM-EDX revealed that it is possible to measure rare earth element (REE) concentration with modern SEM technology, opening up the possibility of using SEM-EDX in future to perform taphonomic pathway analyses based on REE previously confined to ICP-MS techniques, which would make such studies easier and more routinely available. This will be explored by comparing the results from SEM-EDX with those from ICP-MS at the Scottish Universities Environmental Research Centre.

S22 – Early Cretaceous palaeoequatorial vegetation and adaptations to a seasonally dry climate

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During the Early Cretaceous the paleoequatorial area was a region with varying precipitation and seasonal drought, in contrast to the modern all-year wet tropical climate zone. The Cretaceous vegetation differed clearly in its composition from more northerly, slightly cooler vegetation belts with higher rain fall. In addition, various plants of the palaeoequatorial region, belonging to different orders, exhibit adaptations to drought. Early Cretaceous tropical floras were composed of a low diversity fern component, a few cycadophytes and seed ferns, various conifers and angiosperms and a high proportion of gnetophytes sensu lato, a group that existed since the Permian and was most likely early in earth history adapted to drought. The fern component consists mostly of a small soil covering taxon, *Ruffordia*, that grew in open habitats. These wide open lands were also covered by a variety of ephedroid and welwitschioid gnetophytes. Angiosperms, still mostly members of basal groups, including also magnolialian and monocot taxa, and a few basal eudicotyledons, seem to have grown in aquatic environments or at least relatively close to rivers and/or areas with a higher water table. Nevertheless, a few taxa may have been adapted to more open, sunny habitats as well. Certain anatomical features, such as small leaf size, glands, and densely spaced spinules may be interpreted as adaptations to drought resistance. Of special interest is the interplay between gnetophytes and angiosperms. During the Early Cretaceous the first group had a broader ecological range, as evidenced by the fossils' general habit and leaf and root data, while the range of angiosperms was still somewhat limited. It seems that angiosperms developed only during the Late Cretaceous higher hydraulic capacities and were therefore able to take over many of those niches that were occupied by gnetophytes.

S23 – Paläontologen als Vermittler im Natur- und Geotourismus

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Ein wichtiger Baustein im sich aktuell entwickelnden Natur- und Geotourismus ist die naturkundliche Wissensvermittlung. Ihre Relevanz reicht vom gut erschlossenen Weltnaturerbe mit geo-paläontologischen Inhalten bis zum einfachen Geotop an einer lokal bedeutsamen Stelle. Die professionelle Vermittlung der Themen an diesen Orte und damit ihrer Bedeutung ist ein wichtiger Aspekt der touristischen Inwertsetzung. Geschieht dies aus Mangel an Sachverstand nur unzureichend, ist jede Anstrengung vergeblich den touristischen Gästen solche wertvollen Orte nachhaltig verfügbar zu machen. Da jeder dieser Orte zwangsläufig mit der Natur- und Landschaftsgeschichte

seiner Umgebung verknüpft ist, liegt hierin ein interessantes Spannungsfeld für Paläontologen mit einer breiten Ausrichtung. Wer Erfahrungen in Museen mit einer naturhistorischen Abteilung gesammelt hat, wird viele seiner erworbenen Fertigkeiten auch hier nutzbringend anwenden können – sei es bei der Gestaltung von didaktisch sinnvollem Informationsmaterial, der richtigen Beschilderung von Geotopen oder aktiv als Gästeführer im Dialog mit den Besuchern. Die besonderen Fähigkeiten eines modernen Paläontologen tragen in erheblichem Maße zu Qualität und Nachhaltigkeit dieser Angebote bei.

S6 – Molecular divergence dating: its potentials, its uses, and its problems

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Molecular divergence methods, or "molecular clocks", have become the primary neontological tool for dating the origins of evolutionary lineages. Since its inception, molecular dating has become more than just an instrument for the determination of clade ages; time-calibrated phylogenies are now required for many different investigations such as biogeography, rates of diversification and the evolutionary history of phenotypic traits. While the original molecular clock was assumed to tick at a constant rate, it is now known that the speed of the clock is subject to tremendous variation across (and within) species, clades, genes and genomes. Accurately accounting for rate variation is therefore one of the most crucial problems in molecular dating. A great improvement has been the advent of Bayesian approaches, which make it possible to model rate variation as a prior statistical distribution. However, an even more important factor for rate variation is the calibration of the clock, as it provides a temporal starting point for the molecular rate of the calibrated lineage. Calibrations are traditionally performed with fossils, but this practice has been criticized by paleontologists claiming that the selection of a fossil for calibration is often insufficiently justified and may result in severe dating errors. Athough Bayesian approaches also offer the possibility of modeling fossil calibrations as prior distributions with minimum and maximum bounds, clades with poor fossil records still pose a major problem given that their few preserved fossils are only point occurrences without explanatory power. Because of this, many researchers look for alternative ways of calibration, the most prominent being the use of geological dates such as the origin of an island or the rise of a mountain chain, but there is almost no discussion about the question if, and how, geological dates should be applied. While frequently ignored in methodological discussions, the use of geological dates has become the black box of molecular divergence dating, a major drawback that deserves further attention.

Here we discuss the potentials of molecular divergence dating in answering both neontological and paleontological questions, and review some of the recent "best practices" for applying prior distributions and fossil-based calibrations in a Bayesian framework. We also present a few case studies in which the application of geological dates as calibrations has led to false estimates, and suggest more rigorous methods for the use of such information in the absence of a good fossil record.

S5 – Systematic occurrences of malformed (teratological) acritarchs in the run-up of Early Palaeozoic $\delta^{13}C$ isotope excursions

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The Late Ordovician and Silurian are characterised by several strong, global positive $\delta^{13}C_{carb}$ excursions. Some of them exceed + 5 ‰ and thus belong to the strongest perturbations of the carbon cycle in the Phanerozoic. The onset of the excursions is characterised by extinction and/or turnover events of several groups of marine invertebrates. The causal mechanisms of the carbon cycle perturbations, however, are still unknown and currently a matter of vigorous scientific debate. Our own investigations in the Hirnantian (latest Ordovician) have shown that the onset of the major $\delta^{13}C$ excursion (HICE) is characterised by very high abundances of acritarchs showing abnormal, teratological forms. A critical review of published reports of abnormal acritarchs from the Late Ordovician to Early Devonian, and a correlation of their occurrences with the global stable carbon isotope curve, show that high abundances of teratological forms of acritarchs are often coeval to the run-up of $\delta^{13}C$ excursions. High abundances of teratological forms in modern marine protists are commonly observed in environments with a high degree of environmental stress. In the fossil record, the challenge is to attribute abnormal forms of organisms to specific environmental circumstances. Our study implies that they are somehow related to the global carbon cycle, i.e., to carbon isotopic composition of the ambient sea water, and that they share a common extrinsic cause with the contemporaneous extinction and/or turnover events in other fossil groups.

S11 – Controls on global biodiversity patterns during the Cambrian radiation

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How and why the profound increase in disparity, diversity and biomineralization happened in the Early Cambrian is still far from being resolved. We use the Paleobiology Database to address three questions that pertain to the controls of diversification: (1) When exactly was the major pulse in diversification (if there was one); (2) how is the evolutionary radiation manifested in different environmental settings; and (3) was the global diversification driven by a higher species richness in local communities (alpha diversity) or rather by an increase of between communities (beta diversity)? We updated and refined stratigraphic correlations, calculated turnover rates and compared the patterns of alpha, beta and gamma diversity from the Ediacaran to the early Ordovician. The results reveal that (1) Global diversity rose steeply during the Fortunian to Stage 3 and then declined erratically through the Cambrian; (2) different from alpha diversity, which has a pronounced peak in stage 2, beta diversity is well correlated with global diversity suggesting that an increasing partitioning of diversity among environments and regions were a major driver of the Cambrian diversity increase; and (3) the shift from an aragonite sea to a calcite sea is manifested in a sharp decline of fossil occurrences with aragonitic skeletons from the Fortunian to Stage 3, which suggests that Cambrian seawater chemistry may have been a major trigger of the Cambrian explosion.

S25 – Taxonomy, biostratigraphy and palaeobiogeography of Late Cenomanian – Turonian (Cretaceous) ammonoids from Wadi Qena, central Eastern Desert, Egypt

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Marine Upper Cenomanian – Turonian strata are well exposed in the Eastern Desert of Egypt. The southernmost outcrops are located in the central part of Wadi Qena, where the lower Upper Cretaceous is represented by the fossiliferous Galala and Umm Omeiyid formations. From these strata, numerous ammonites have been collected bed-by-bed and 13 taxa have been identified, which are systematically described. Four of them (*Euomphaloceras costatum*, *Vascoceras globosum globosum*, *Thomasites gongilensis* and *Pseudotissotia nigeriensis*) are recorded from Egypt for the first time. The ammonite ranges are used for a biostratigraphic zonation of the lower Upper Cretaceous succession in the northern and central part of Wadi Qena: the Upper Cenomanian has been subdivided into two biozones (the *N. vibrayeanus* and *Vascoceras cauvini* zones, with a barren interval in between), while the Lower Turonian contains three biozones (a lower vascoceratid Zone, followed by the *Choffaticeras* spp. Zone and a new upper Lower Turonian biozone based on the occurrence of *Pseudotissotia nigeriensis*). The Middle Turonian does not allow a biozonation due to the absence of ammonoids. One biozone has been recognized in the lower Upper Turonian. Palaeobiogeographically, the ammonite assemblage has a Tethyan affinity. During the Early Turonian, influences of the Vascoceratid Province were predominant with strong affinities to typical Nigerian faunas. This shows the significance of faunal exchange between Egypt and Central and West Africa via the Trans-Saharan Seaway. Compared to contemporaneous ammonoid faunas from the northern part of the Eastern Desert, Boreal influences are much less obvious in the study area: only 50 % of the ammonites of Wadi Qena are also known from the Boreal Realm. In contrast, in the contemporaneous successions of Wadi Araba (ca. 130 km to the north), already 85 % of the identified Lower Turonian ammonoids are also known from the Boreal Realm. This observation may indicate relatively steep north-south environmental gradients. Thus, the present study greatly enhances the knowledge on the Upper Cretaceous ammonoid palaeobiogeography and biostratigraphy of Egypt and adjacent areas.

S2 – The role of body size in marine invasion through the Suez Canal: implications for the fossil record

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Biotic interchanges are a common phenomenon in the history of the Earth. Proper understanding of factors controlling those events is often difficult due to vagaries of the fossil record. The opening of the Suez Canal in 1869 re-established a direct link between the Mediterranean and Indo-Pacific realms, allowing hundreds of species to

spread from the Red Sea (RS) to the Eastern Mediterranean (EM), with mollusks being one of the most prolific groups. This almost unidirectional interchange can be regarded as one of the largest human-mediated biogeographic experiments providing an excellent system for testing macroecological hypotheses.

Body size correlates with many key life history traits and it has been long proposed to play an important role in mediating dispersal and establishment success of species. Here we test this relationship using a taxonomically standardized database of body size and ecological characteristic of extant bivalves from the northern RS and the Levantine coast of the EM. Although our data suggest that successful RS invaders are a random sample of their source species pool in respect to body size, they are significantly larger than native EM species. Explanation of this pattern can be found in distinct shapes and modal values of the regional body-size frequency distributions (SFD) in the two areas. Right-skewed SFD, documented also in the number of Eastern Pacific bivalve provinces, characterize the RS species pool and differs significantly from more log-normal Mediterranean SFD. The causes of this discrepancy are not clear and may be related to different biogeographic affinities of the two biotas or to the late Neogene extinctions and history of recolonization of the EM basin.

These preliminary results suggests that even though interregional differences in SFDs may translate into greater competitive abilities of the RS invaders and thus contribute the asymmetry of the interchange, other ecological or live history traits can be more important in determining which species from the donor region will spread across the barrier and colonize the novel areas. In spite of the apparent lack of size-selectivity among invaders, continued inflow of the RS species will progressively shift the EM SFD towards values typical for the Indo-Pacific realm, underscoring the importance of geographic barriers and species invasions in shaping body-size patterns in regional biotas.

S8 – Taphonomy and diversity of mass accumulation of clypeasteroid echinoids

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Clypeasteroid echinoids, which first evolved during the early Cenozoic, became one of the most important contributors to sedimentary successions in shallow water environments especially during the Miocene. These clypeasteroids include such well known genera as *Clypeaster*, *Parascutella* and *Amphiope*. The presence of sturdy tests due to robust plate connections and internal supports, their occurrence in very large numbers as is known to occur for various sand dollars in Recent marine settings, and also their presence in higher energy, shallow water environments are all factors contributing to their fossilization in high densities. In this presentation, new detailed sedimentological and palaeontological data from clypeasteroid occurrences in Sardinia and Catalonia are combined with previous studies from the Tethys and Paratethys marine realms. The sedimentology, taphonomy and taxonomy of these events are summarized and compared. Detailed data has been collected with respect to the dominant taxa, density and orientation of the echinoids, percent complete tests vs. fragments, presence or absence of encrustation and bioerosion and so on. The differences in these parameters are correlated to the positions of the accumulations within both carbonate and siliciclastic sedimentary sequences. The implications of these deposits for analyzing the diversity of clypeasteroid echinoids are discussed. These accumulations are furthermore compared to those of other dominating shelly contributors within the Cenozoic as a whole.

S24 – Adaptive radiation in a gastropod species lineage of late Miocene Lake Pannon

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During the late Miocene, Lake Pannon existed as huge, slightly brackish lake in the Pannonian Basin. With an estimated surface area of 290,000 km² during its maximum extent, it formed one of the greatest long-lived lakes during that time. The endemic evolution of its remarkable gastropod fauna produced several species lineages with outstanding morphological variability.

This investigation documents morphological evolution in the *Melanopsis impressa* species lineage over a time interval of 1.6 Ma, by means of a morphometric analysis. The Fast Fourier Transform method was employed to 448 specimens from several localities in the Vienna Basin. During the first 800,000 years, morphological stasis prevails, hence no net change of the average smooth morphology. This is followed by a sudden burst of morphological evolution with the first occurrence of several new, slightly shouldered to globular phenotypes. In a subsequent, more dramatic shift, these morphologies drift apart, resulting in a bifurcation of the occupied morphospace. In the final

studied time slice, one of the emerging branches, together with all intermediate forms, becomes extinct.

These morphological developments could be related to changes in the paleoenvironment, as documented by a comprehensive set of isotope, stratigraphic and geophysical data. These give about constant environmental conditions for the interval of stasis, promoting the action of stabilizing selection on the morphological traits. Coinciding with the appearance of new phenotypes, a massive rise in lake level is documented. This surely had a strong effect on the availability of habitats and distribution of nutrients. The strong correlation between environmental parameters and appearance of several new phenotypes is interpreted as an adaptive radiation. The following morphological bifurcation is thought to reflect successively evolving discrepancies of ecological requirements, hence the establishment of isolated ecological niches. Probably, this ecological separation promoted divergent natural selection and, given the widely separated morphologies, finally led to the establishment of reproductively isolated species, a process known as ecological speciation. In the final interval, Lake Pannon faced drastic environmental changes, with strong seasonal fluctuations of lake level and nutrient supply, lake stratification and algal blooms. This resulted in the extinction of the major part of the gastropod fauna.

S8 – Predatory vs. non-predatory boreholes in fossil and Recent echinoids

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Drilling predation is important among many fossil and Recent invertebrates and since the fossil record of boreholes is excellent, drilling predation has been the subject of many key studies dealing with predation in deep time. Whereas molluscs and brachiopods are mainly drilled by muricid and naticid gastropods, the main drilling predators of echinoids are cassid snails (helmet conchs) which spezialized on echinoids as prey. The fossil record of the Cassidae dates back to the Late Cretaceous but not until the radiation of the family in the Eocene, cassid predation became increasingly important. Based on actualistic observations, studies on cassid predation on echinoids follow two assumptions: (i) circular boreholes in echinoid tests are of predatory origin and (ii), if the borehole completely penetrates the echinoid test, the predatory attack is considered lethal and thus, successful.

However, some non-predatory organisms produce borings in echinoid tests and many of these are not lethal. Especially parasitic ascothoracid crustaceans and eulimid gastropods produce traces which can be easily confused with predatory borings. In addition, dwelling structures of endolithic foraminifers and copepods, produced either in vivo or post mortem, can be similar to cassid drillings. The proper interpretation of boreholes found in echinoid tests is therefore crucial for unbiased studies of interactions among echinoids and their drilling antagonists (predatory or parasitic) or bioeroders.

S25 – First record of chambered hexactinellid sponges from the Palaeozoic

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Most chambered sponges (the polyphyletic group of „Sphinctozoa“) are hypercalcified types and most of them probably belong to the Demospongia. „Spinctozoa“ occur from the Cambrian to the Recent and are the most abundant sponges in Late Palaeozoic and Triassic reefs and shallow water limestones. Among hexactinellid sponges, chambered forms are very rare including taxa only from the Late Jurassic and the Late Triassic of Europe, Russia, Tadjikistan, Iran or China. There are five genera described *Casearia* Quenstedt, *Caucasocoelia* Boiko, *Dracolychnos* Wu & Xiao, *Pseudoverticillites* Boiko and *Innaecoelia* Boiko, the latter of which is synomised with *Casearia* by most authors.

To date, there are no reports on chambered hexactinellid sponges before the Mesozoic. Moreover, the first representatives of the order Hexactinosida apparently occurred in the Ordovician, but well preserved and diversified representatives of the order Hexactinosida were thought to evolve not before the Late Devonian.

The chambered sponges studied herein stem from the famous Lower Devonian (Emsian) locality of Colle in the Cantabrian Mountains of northern Spain. The Colle outcrops have been well known for their well preserved and abundant invertebrate fossils since the 19th century. The studied interval within the Valporquero Formation includes coral biostromes and small bryozoan-crinoid mud mounds. The latter grew in an outer ramp setting just below the storm wave base. The mud mound fauna includes the hexactinellid sponge fauna. The sponges are characterized by cylindrical to conical, frequently branched multi-chambered bodies with an axial spongocoel. The

outer morphology reflects the internal segmentation. Stacked annular chambers show variable size and shape with some chambers fully encasing the previous chamber. The cortex on the dermal surface is formed by a single layer of hexactines with spherically enlarged multiradiate nodes producing triangular meshes. On the gastral surface, within the spongocoel, the fused hexactines exhibit polygonal to rounded meshes, representing possible exhalant canal openings. Chamber fillings show a dictyonal hexactine network with rectangular meshes.

The general characters of the Colle hexactinosidan hexactinellids fit the diagnosis of *Casearia*. Based on the irregular shape and size of the chambers, the lack of dermalia and gastralia above single cortical layer as well as the absence of proper skeletal canals, the material has been classified as a new species.

The oldest representative of *Casearia* is also the first chambered hexactinellid sponge from the Palaeozoic. Moreover, it is the first record of hexactinosidan sponges from the Early Devonian partly filling the long gap between Late Ordovician and Late Devonian hexactinosidan record.

S2 – Habitat breadth and geographical range predicting evolutionary rates in Mesozoic bivalves

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Numerous environmental and intrinsic biotic factors have been sought to explain patterns in diversity and turnover. In the current study we utilized taxonomically vetted and sampling-standardized data sets of more than 50,000 taxonomic occurrences in the PaleoDB to test (1) whether habitat breadth predicts genus durations and diversity dynamics of marine Mesozoic bivalves, and (2) whether this effect is independent of the well-known positive relationship between geographical range and longevity.

Bivalve genera were categorized as narrowly or broadly adapted according to their proportional occurrence counts within different settings of lithologic and bathymetric categories. Habitat breadth was then defined as a combined measure of those proxies. Our analysis showed that mean values of Foote's extinction and origination rates are significantly higher for narrowly adapted taxa compared to broadly adapted taxa in various environmental categories and likewise decrease with increasing habitat breadth. These differences are evident in all analyzed stratigraphic intervals. Further, linear models and respective model rankings showed that geographical range and habitat breadth both have a significant effect on genus durations and on diversity dynamics. These results reaffirm the role of geographical range and furthermore suggest that habitat breadth is an equally important key predictor of extinction risk and origination probability in Mesozoic marine bivalves. Thus, habitat generalists, regardless of their geographical range, exhibit longer genus durations and are generally less prone to extinction. This shows that being widespread alone does not prevent taxa to become extinct – widely distributed taxa that are more specialized may be more endangered than one would expect.

In addition, the slopes ('partial' coefficients) of the linear models were used to visualize selectivity patterns in origination and extinction with respect to habitat breadth through time. Whereas there is no pronounced ecological selectivity in origination throughout much of the Triassic and Jurassic, in the Cretaceous origination of specialized taxa is favoured. As generic bivalve diversity increases throughout the Mesozoic the observed pattern may best be explained by diversity-dependence. In contrast, extinction rates are generally higher for specialized taxa. Furthermore, extinction selectivity during times of mass extinction is indistinguishable from background levels (end-Triassic), or only slightly elevated for environmentally restricted genera (end-Cretaceous). This suggests that the underlying mechanisms do not change in times of global crisis and that broad adaptation buffers against both background and mass extinctions.

S3 – The Cassian biota – Ecology and geobiology of the Triassic diversity hotspot

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The famous Cassian Formation (Late Triassic, N Italy) provides unique insights into an early Mesozoic tropical ecosystem. Various palaeo-environments with different fossil assemblages have been reported. Basically carbonate platforms and reefs are present and interfinger with basins filled by marls and mass flow deposits. Climate was tropical warm but with a high seasonality as is indicated by high resolution $\delta^{18}O$ records from megalodontoid bivalve shells consisting of pristine aragonite.

More than 1000 invertebrate species have been described from the Cassian Formation – no other early Mesozoic fauna is as rich. Gastropods are by far the most

diverse group followed by bivalves. Strong mollusc dominance is a modern, advanced feature of the Cassian biota. Even alpha diversity (within sample) can be very high reaching up to 200 species in samples from some of the sites. Standardized quantitative sampling methods must be applied (mesh size is most important). The diversity of the Cassian biota is probably in the magnitude of modern tropical shallow water biota.

Rarefaction standardization shows similar diversity of bulk and surface collections in some faunas. However, species richness and faunal composition (rank abundance) changes strongly. Mollusc and gastropod dominance is also evident on the sample level and throughout entire Cassian Formation.

Contrary to previous suggestions, stunting or dwarfism is not a general feature of the Cassian fauna. However, recent findings suggest that the faunas of some horizons of the basin sediments are stunted probably due to oxygen depletion. General stunting due to stressed environmental condition would be in conflict with high diversity and complexity. Triassic standing diversity of gastropods and other invertebrates peaks in the Carnian but this is probably not entirely due to the monographic effect causes by the Cassian fauna. The standing diversity curve parallels important environmental parameters? throughout the Triassic i. e., inferred atmospheric O_2 and CO_2 concentration and the temperature.

S9 – Mobility in the hip of *Iguana* and implications for deducing the range of motion in early reptiles

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Being phylogenetically close to the last common ancestor of amniotes, diadectids represent key fossils for the understanding of the anamniote to amniote transition. We are currently investigating the functional morphology of the postcranium of *Orobates pabsti* Berman et al., 2004, a basal diadectid from the Lower Permian of Thuringia, Germany. One aspect that concerns the reconstruction of locomotor capabilities in fossil vertebrates is the determination of possible range of motion (ROM) in joints. ROM is often used to base or constrain hypotheses on limb movement of fossils during locomotion. Significantly, soft tissues are usually not fossilized, but potentially have an influence on ROM. Here, we use a neontological approach to test for the influence of soft tissues on ROM in the hip of an extant model for *Orobates pabsti*, the green iguana (Iguanidae: *Iguana iguana* Linnaeus, 1758). ROM is determined by conducting x-ray motion analysis in combination with CT-based reconstructed bone models. Anatomically defined coordinate systems are used to measure 3D mobility of the femur (protraction/retraction, abduction/adduction, long-axis rotation) in the hip joint with the animation software Maya. The method results in detailed measurements of six degrees of freedom (translations along and rotations about x-, y-, and z-axes) and precise animations to visualize the movement. Starting with the fully intact cadaver, soft tissues are removed in stepwise fashion and measurements of mobility are repeated. The last of these sequential measurements is without any soft tissues left, creating a similar situation to that paleontologists face when deducing ROM from fossil material. In the next step, we compare the ROM to the actual range of movements that take place during a stride cycle of a living iguana. The discrepancy between mobility (ROM) and actual movement during locomotion will be discussed.

S26 – The evolution of the brain of Artiodactyla (Mammalia)

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The study of brain evolution, and particularly that of the neocortex, is of primary interest because it directly relates to how diversity and behavioural variations arose both between and within vertebrate groups. Among placental mammals, artiodactyls (or even-toed ungulates), have achieved one of the most successful diversifications. As a result, they widely predominate today over other ungulates in terms of specific and ecological diversity. Modern artiodactyls also show a wide array of brain morphologies, including one of the biggest and most complex mammalian brains: the dolphin brain size, expressed as a function of the body mass ["encephalization quotient"], ranks between that of apes and humans. Accordingly, recent studies focused on the evolutionary increase of brain size in Artiodactyla, with a special attention to cetaceans. Yet, the first evolutionary steps of artiodactyl brain remains poorly understood and the first 10 million years of artiodactyl brain evolution were undocumented so far.

The increased use of high-resolution X-ray computed tomography (CTscan) recently gave an unprecedented access to internal structures of fossils, and triggered new interest for vertebrate cranial endocast studies, built upon the fundamental studies in "paleoneurology" performed during the second half of the 20th century.

This work presents the evolutionary history of the brain of Artiodactyla in a broad comparative context, by adding to the existing picture the virtual endocranial casts of 14 Early and Middle Eocene representatives of basal artiodactyls, including *Diacodexis*, the earliest representative of the group. This allows the tracking of the neocortical structure of artiodactyls back to its simplest pattern, and reveals that the earliest artiodactyls share a simple neocortical pattern, so far never observed in other ungulates. These results demonstrate that artiodactyls experienced a tardy pulse of brain volume increase (or encephalization) during the Late Neogene, well after the onset of cortical complexity increase. Comparisons with Eocene perissodactyls (taxa related to horses, rhinos, and tapirs) show that the latter reached a high level of cortical complexity earlier than the artiodactyls. Both groups are considered to be ecological competitors (herbivorous), and several hypotheses have been proposed to explain the mid-Cenozoic decline of perissodactyls diversity and the coincident rise of Artiodactyla. Maintain of a simple and weakly-convoluted brain pattern in Artiodactyla, could have guaranteed a better plasticity of the nervous system and might have incidentally permitted a better response of artiodactyls to the environmental deterioration tied to the global cooling episode which occurred around the Eocene-Oligocene boundary (known as the *Grande Coupure*). As a complementary hypothesis, it can be assumed that perissodactyls, which neocortex structure was already settled, had therefore a lower range of potential responses.

S20 – The fish fossil record and associated aquatic environments: a framework for the interpretation of African fish paleobiogeography during the Neogene

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The biogeographic patterns (range dispersal, contraction and isolation) that lead to freshwater fish evolution depend on major hydrographical constraints, ranging from the quality of the aquatic environment to opportunities for dispersal through freshwater courses. As a consequence, modern fish distributions have long been used to delimitate ichthyo-provinces that coincide with the borders of hydrographical basins. This is notably true in continental Africa where a dozen major provinces have been defined. Hydrology also controls the fossil record, i.e. the only window onto the geological timescale of fish evolution and diversification. While paleontological evidence constitutes valuable information to reconstruct paleobiogeographical relationships, its use requires previous identification of patterns in the fossil record and of environmental controls.

Modern African fish arose and diversified over 100 Ma ago when we consider extant orders, during a long period of geographical isolation of the Afro-Arabian plate (with only scarce faunal exchange in and out the continent). The earliest-known extant genera are Paleogene in age but modern African fish diversity mostly appears in the Neogene. This time period starts in Africa with the collision of the Afro-Arabian plate allowing invasion by a few Asian taxa. This time span is marked by the active opening of rifts, including the Red Sea, and the associated rise in relief all along the eastern side of the continent, by high frequency eustatism, and by the increase of seasonality including marked late Neogene aridification in sub-tropical areas.

If the fish fossil record clearly depends on attributes of fish taxa (diversity, distribution, species lifespan), the results of our review show that a variety of environmental factors have a major effect. These factors include taphonomy, sedimentary environments, erosion, and depositional processes, and are controlled by tectonics, climate, and eustasy, and vary according to their geographic location. Indeed, each region and even, at a lower scale, each area, will present its own environmental characteristics and a specific balance between the factors that shape the fossilization process and the fossil record. Moreover, besides shaping the freshwater fish fossil record, the environment limits or favours access to outcrops, further shaping our knowledge of the fossil record. One important issue is that while replaced in the paleoenvironmental context, the fossil distribution of a taxon may shed light on its evolutionary history including paleodiversification events and/or changes in its habitat.

S9 – Cambrian lobopodians, extant onychophorans and early cephalisation in Panarthropoda

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Cambrian lobopodians are important for understanding the early evolution of the arthropod head. Despite the soft-bodied preservation, typically the organisation of the cephalic region in these animals remains obscure. We therefore analysed new material of the Early Cambrian lobopodian *Onychodictyon ferox* Hou, Ramsköld & Bergström, 1991 from southern China and compared its exceptionally preserved head structures to other fossil lobopodians and to the Recent onychophoran *Euperipatoides*

rowelli Reid, 1996. Our findings suggest that the head of the last common ancestor of fossil lobopodians and extant panarthropods (Onychophora, Tardigrada and Arthropoda) comprised a single ocular segment with a proboscis and a terminal mouth. The lack of specialised mouthparts in *O. ferox* and the involvement of non-homologous mouthparts in onychophorans, tardigrades and arthropods argue against a common origin of mouth chambers and definitive mouth openings among panarthropods, whereas the embryonic stomodaeum might well be homologous at least in onychophorans and arthropods.

S25 Rudist taxonomy based on grinding tomography and biomedical software

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Previous taxonomic studies of the genera *Mathesia* and *Polyconites* were based on two-dimensional sections and isolated fossils from the matrix. Therefore, there has been little research on the three-dimensional spatial distribution and size of the internal features, lacking a technique that is suitable for large and low density-contrast specimens. The tomographic technique described herein is based on automatic serial grinding and serial scanning; the resulting images have been treated with biomedical image software and 3D-reconstruction editing and processing software.

The maximum resolution of this method is equivalent to a voxel size of about 10 μm^3, providing sufficient quality to display even mm sized features. The technique has been applied to a monospecific association of *Mathesia darderi* and in two specimens of *Polyconites verneuili* from the Aptian and Albian of Spain. The myocardinal system of the left valve of *Mathesia darderi* has been illustrated and described using isosurfaces reconstructions. In *Polyconites verneuili*, fifteen quantitative characters have been obtained using multiplanar virtual cuts, volume-rendering, and isosurfaces reconstructions. Their study revealed the shape, size, and distribution of the ectomyophoral, body and accessory cavities, the lengths and volumes of the teeth, and the arrangement of the myophores. We conclude that this technique facilitates the study of rudist bivalves and is suitable for other fossils with low density contrast.

S18 – Mid-Cretaceous amber forests from France

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Extensive field investigations for Cretaceous paralic deposits across a latitudinal gradient in western France revealed several amber-rich outcrops of Albian and Cenomanian age. Among these, Charentese amber constitutes one of the major world deposits in terms of abundance and diversity of inclusions, providing an exceptional insight into a mid-Cretaceous coastal forest ecosystem. Another Cenomanian amber was also recovered from the Pyrenees, with an overall quality and fossil content which are remarkably similar to those of the Albian amber of Spain. More recently, a new Cenomanian amber was discovered in Vendée, that exhibits an exceptional quality and fossil richness not encountered in any of the other French Cretaceous deposits. A comparison between the amber properties and fossil biota from the three areas suggests a similar plant source for the resin but with distinct environmental conditions.

S25 – Morphological disparity on the palates of Pterodactyloidea (Pterosauria) and its implications for the ecology of the clade

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The fragile nature of pterosaur skeletons has virtually limited good preservation of their remains to isolated *Lagerstätten*. Even in those deposits, three-dimensional fossils are uncommon and specimens are, in most cases, strongly compacted, usually obliterating anatomical features. Mainly because of that, the pterosaur palate is poorly known, for its study depends on three-dimensional preservation or rare palatal views of compressed specimens. Recently, a model for pterodactyloid palate was proposed through the recognition of some evolutionary trends on the transition between non-pterodactyloid and short-tailed pterodactyloid taxa. However, the reassessment of well-known specimens with palatal preservation, in addition to information from yet undescribed material, led to the conclusion that this model cannot be generalized for Pterodactyloidea. In fact, the palatal anatomy within this clade reveals a great disparity between dif-

ferent lineages, with, for example, the "reversion" to the non-pterodactyloid condition in the derived azhdarchoids and the extreme reduction of some palatal elements in Anhangueridae. Pterosaurs are considered as mostly piscivorous animals, with a great number of taxa interpreted as such. Indeed, all the taxa studied on the present research (*Pterodactylus*, *Pteranodon*, *Anhanguera*, *Tupuxuara* and *Thalassodromeus*) were previously interpreted as piscivorous. Nevertheless, the strong morphological disparity here observed suggests that piscivory emerged several times in the evolutionary history of Pterodactyloidea. It is also likely that the parental taxa of the species studied herein had diverse and complex feeding habits. Thus, piscivory cannot be regarded as the average feeding habit for pterodactyloid pterosaurs. Actually, the fact that this feeding strategy was so often suggested for pterodactyloid taxa seems to be biased by "*Lagerstätten* effects": fossil deposits with preservation of pterosaur remains are usually associated to lacustrine or marine environments and tend to preserve piscivorous forms. Pterodactyloid feeding habits, therefore, were probably much more diverse than the fossil record leads us to believe.

S7 – Test malformations in Holocene and Recent Foraminifera from athalassic and marginal marine environments as an indicator for extreme environmental conditions

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Test malformations in foraminifers are well known and often described in scientific literature. Discussed reasons for test malformations are extreme environmental conditions like sudden changes in salinity, hypersalinity, oxygen deficiency and heavy metal pollution.

Studying Holocene athalassic foraminiferal associations from the Aral Sea, Central Germany, and Saudi Arabia, we found high rates of malformations. At least 10 % of the tests proved to be malformatted, often much more. Deformations of single chambers and changes of growth directions are frequent. Twins and other forms of multiple tests are relatively rare. Extreme salinity values and non-marine ionic composition of the water are the probable causes for this pathological pattern of test malformation.

To examine if the malformation pattern is the same for marginal marine brackish water environments, we analyzed foraminiferal associations from ten sites (alpha-mesohaline to polyhaline) at the southern Baltic Sea coast as a reference. The proportions of malformatted tests from sites without distinct anthropogenic impact were between 1.4 and 2.6 %. Those of the sites influenced by habitat disturbance, eutrophication or toxic substances are between 0.9 and 9.9 %. The variability of salinity and its absolute value seem to be less important for malformations than oxygen deficiency or toxic substances.

The generally higher proportion of malformatted tests in athalassic in comparison to marginal marine settings implies environmental conditions at the limits of specific ecological tolerance, but the absent of competition with other taxa, occupying a similar ecological niche in saline athalassic waters. The unusually high proportion of malformatted tests can be used as evidence of the identification of athalassic foraminiferal associations in the fossil record; also it always indicates extreme environmental conditions.

S20 – Fish paleobiogeography: the Neogene setting of the modern ichthyofauna in Africa north of the equator

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In Africa, the evolution of freshwater fishes is directly dependent on physical modification of landscapes, namely connections or disruption among drainage basins that reflect underlying geological evolution and climatic changes. Indeed, for freshwater fish, basin boundaries constitute barriers to dispersal that constrain their distribution and strongly influence spatial patterns of assemblage composition. When considering organisms with such physically constrained dispersal, past events leave a perceptible imprint on species diversity, and barriers such as long-term basin boundaries are often considered more relevant to contemporary phylogeographic patterns than are current environmental conditions. The Nilo-Sudan province, that roughly corresponds to the half of Africa located north of the Equator, has by far the best Neogene fossil record of this continent, including sites associated with the proto-Nile (Lake Edward and Albert Basins, Lake Turkana), the Chad Basin, and with the northern coastal basins in Egypt, Libya and Tunisia. The suggestion of an early Neogene homogenous Nilo-Sudan fish fauna has been much referred in the literature, and has been primarily based on widespread distribution of taxa such as Lates (Nile perch) and catfish of the family Clariidae. However, many of the taxa have only been known at the generic level or above, a situation which still partly applies. In this presentation, we will show how using fossils identified to the specific level provides a powerful tool for reconstructing paleobiogeographical relationships among bioprovinces at an intra-continental level through the Neogene.

Contrary to what has been proposed so far, the Nilo-Sudan fish fauna is represented by well diversified taxa that are heterogeneously distributed. We focus on three such taxa: the catfish genera *Synodontis* and *Calarius*, and the perciform fish *Semlikiichthys*, all present in Afro-Arabia during the Neogene as evidenced by their fossil record. *Synodontis* is known from at least 18 Ma and is today one of the most widespread catfish in Africa. *Carlarius gigas* is today restricted to the Niger inner delta, but in the past had a wider distribution including Chad and Libya. *Semlikiichthys* is an extinct Neogene genus with two species with disjoint distributions, one in the Chad basin and one in eastern Africa and along the Nile. Using combined analysis of phylogenetically supported biogeographical hypotheses and the distribution of fossil fish, we will discuss the setting of the modern African icthyofauna, notably the existence of strong East/West connections prior to 7 Ma between basins north to the Central African Shear Zone and their disruption under geological controls.

S12 – Eurypterid (Chelicerata, Eurypterida) findings in Famennian saliniferous deposits of the Devonian of the Pripyat trough (Starobin Potassium salt deposit, Belarus)

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Six well-known findings of eurypterid remains within the Starobin potassium salt deposit were identified between 1976 and 2012. All of them occur in a clay-halite (potassiferous) deposit, namely in clayey interbeds of the Osovets beds of the Streshin regional stage which is of Famennian in age. The first specimen of a eurypterid remain was found in 1976 and has a length of about 20cm. The second finding is represented by a relatively well-preserved prosoma of a eurypterid with one pair walking legs from the ventral surface and was found 1981 or 1982. The third one which was found in 2002 has a length of about 12 cm, but is it not well preserved. In 2006 a leg of a sea scorpion was found and fifth finding followed in 2008 which contained a ventral part of a well preserved eurypterid which has a length of 25 cm. Very recently, in June 2012 a nearly complete sea scorpion was found. It is the largest specimen ever found in these sediments and has a length of 34 cm. The specimens are stored in different institutions and detailed description is not finished yet. We will preliminary studies on taxonomy of four eurypterids. Results suggest that eurypterid remains found in the Famennian saliniferous deposits belong to new a species and a new genus. Furthermore, it seems likely that the eurypterids are endemic.

S14 – Biomechanics and functional preconditions for terrestrial lifestyle and their influence on the general tetrapod bauplan

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Living on land exposes the animal's body, in contrast to an aquatic lifestyle, to the influence of earth gravity. The weight of the animal pushes downward and evokes at the points of ground contact upward directed reaction forces. Within the body, this leads to internal forces or stresses, which must be resisted by appropriate structures: Skeleton, musculature and ligaments. Stress patterns in symmetrical support on the limbs of both sides depend from bending of the trunk, a fact discussed since the 19th century and clearly identified since 1946. Bending stresses require the existence (or justify the persistence of the old-inherited) vertebral column as well as longitudinal muscles along the ventral and dorsal contour of the trunk (m. rectus abdominis and dorsal musculature around the shoulder and the neck's basis). In asymmetrical support on three, or two limbs, as occurs regularly during locomotion, torsional stresses must be expected on the basis of theoretical considerations. Neither the torsional stresses, nor the anatomical structures to resist them have yet been investigated in any detail. To determine the flow of stresses in a tetrapod body we used the finite-element method (FEM). As a completely new result, we found higher values of torsional stresses than those caused by bending. The observed patterns of compressive stress components agree remarkably with the arrangement of compression-resistant materials: vertebral column, shoulder girdle, and ribs. The tensile stresses correspond precisely with the arrangement of the longitudinal and oblique muscles forming the body wall. Torsional stresses concentrate along the periphery of a body, leaving the trunk cavity free from mechanical stresses as an unloaded space for the intestines. Our results so yield explanations for the general tetrapod bauplan with its characteristic arrangement of the vertebral column, the well developed series of bony and cartilaginous ribs, the costal angle and the basic orientation of the pectoral limb girdle.

For catching prey, lateral snapping, similar to (semi-aquatic) crocodiles, is an energy-saving technique. Using the same movement on land is possible, and requires sprawling and flexed forelimbs. A very good example for the development of the necessary "terrestrial" traits in a perhaps still basically aquatic animal is the Late Devonian *Tiktaalik roseae*. The mechanical analysis can also be

used to check, confirm or refine former hypotheses about the lifestyle at the borders between water and land of this early representative of the transition to living on land.

S3 – Microdigitate Fe/Mn microbialites from the Äspö tunnel (Sweden) – A modern example of the microbial subterranean fossil *Frutexites*

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The Äspö Hard Rock Laboratory offers a unique window into the subterranean terrestrial biosphere, where the growth of chemolithoautotrophic and heterotrophic microbial consortia at the rock-water interfaces strongly depends on the flow, oxygen content and the chemical composition of the fluids available. As part of a highly oxygenated, fluid-dropping system, net-like mineralizing microbial mats are observed to cover the surface of rock boulders. These microbial systems are organized in laminated, divergently branched microcolumns, mainly composed of iron hydroxides, iron and manganese oxides. They strongly remind of fossil *Frutexites* structures such as found at the base of the Naukluft Nappe Complex (NNC) in Southern Namibia – submillimeter-sized, Fe&Mn-rich microfossils, where the microstructure preservation is strongly controlled by its polymineral character. Fluorescence in situ Hybridization (FISH) on thin sections displays distinct areas of densely packed bacteria and archaea within these modern *Frutexites* microbial fabrics. They are shown to harbor a particular, highly active and diverse microbial community as indicated by Denaturing Gradient Gel Electrophoresis (DGGE) on the base of the 16S level as well as of functional genes encoding key enzymes of the main metabolic pathways. Time series incubations prove that the lamination of these modern *Frutexites* structures is continuously generated and reproducible as a function of time and continuous subterranean fluid feeding.

S23 – Erlebnis Geowissenschaften (Paläontologie): Öffentlichkeitsarbeit der Geologischen Dienste (Beispiel Hessisches Landesamt für Umwelt und Geologie, HLUG)

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Das Umweltinformationsgesetz (UIG) verpflichtet u.a. die LA und die Geologischen Dienste Informationen auf Nachfrage an die Öffentlichkeit weiter zu geben. Daraus hat sich in zunehmendem Maße eine intensive und facettenreiche Öffentlichkeitsarbeit entwickelt.

Unterschiedliche Veranstaltungen (Hessentag, Kinderuni, Girls day, Exkursionen und Führungen, Mitgestaltung von Ausstellungen; Tag des Geotops, Tag des Bodens; Flyer zu Gestein des Jahres, Fossil des Jahres, Boden des Jahres), Veröffentlichungen (u.a. populärwissenschaftliche Reihen: Geotope, Hessens Unterwelt, Hessens geowissenschaftliche Museen; Jahresberichte (Themen aus der laufenden Arbeit)) und eine gut strukturierte Internet-Präsentation sind die grundlegenden Mittel, Kontakt zum interessierten Bürger und geologisch und erdgeschichtlich interessierten Touristen herzustellen. Beispiele hierfür sind: Geoparks, Lehrpfade (Weinlehrpfad), Rad- und Wanderwege (Rheinsteig, Kellerwaldsteig, Urwaldsteig) aber auch Hochwasserschutz, Qualität der Badeseen, Luftmesswerte, Lärm-Reports (z.B. an Bahnstrecken).

Die professionelle Arbeit bzw. die fachlichen Aufgaben des HLUG beinhalten u.a. die Erfassung (FIS), Bewertung und Begründung von Vorschlägen z.B. von Geotopen, aber auch Bereitstellung von Kartenwerken und Fossilabbildungen.

Das öffentliche Interesse für den Schutz der Archive unserer Erdgeschichte hat stark zugenommen. Die öffentliche Erkenntnis wächst, dass erdgeschichtliche Bildungen Einblicke in den Aufbau und Entstehung unseres Planeten ermöglichen und die Entwicklung des Lebens zu erklären helfen (fossil wie rezent) und wissenschaftliches Allgemeingut geworden ist, das auf Dauer geschützt und erhalten werden muss.

S25 – Ein hochauflösendes Profil vom miozänen Randecker Maar: Neue Einsichten in die Entwicklung eines fossilen Kratersees

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Das Randecker Maar, ein unter-/mittelmiozäner (MN 5) Kratersee im Kirchberg-Uracher Vulkangebiet auf der Schwäbischen Alb, ist seit der Mitte des 19. Jh. bekannt. Die ausgesprochen fossilreichen Seeablagerungen sind vor allem wegen der teils ausgezeichnet erhaltene Flora und Insekten berühmt. Obwohl gewisse Trends vermutet werden, fehlen detaillierte Kenntnisse zur vertikalen und lateralen Entwicklung der Ablagerungs- bzw. Lebensräume.

Bei neuen Grabungen des Staatlichen Museums für Naturkunde Stuttgart, in Kooperation mit dem Geowissenschaftlichen Institut der Universität Tübingen in den Jahren 2009 und 2011, konnte nun erstmals ein rund 8 m Mächtigkeit umfassendes Profil hochauflösend vermessen und beprobt werden. Im Wesentlichen besteht das Profil aus fein laminierten Tonen, Mergeln und Kalken; es ist reich an Pflanzenresten und Gastropoden und endet in einem massigen Süßwasserkalk. Die Laminit-Abfolge wird unterbrochen von einer Winkeldiskordanz, gefolgt von einer matrixgestützten Breccie mit Jura-Komponenten mit einer Anreicherung von Großsäuger-Fossilien, darunter der Erstfund eines Krokodilschädels. Die hochauflösende Beprobung führte zu einer guten Dokumentation einer Vielzahl an Fossilien, darunter Diatomeen, Pollen, Makroflora, Insekten, Gastropoden, Amphibien, Reptilien, Vogelreste und Säugetiere. Neben den Makrofossilien des Profils werden gerade Messungen eines Gamma Ray Logs sowie im Dünnschliff vermessene Laminite ausgewertet.

Das ergrabene Profil erlaubt erstmals, eine Entwicklungsphase des Randecker Maarsees von mehreren tausend Jahren im Detail zu interpretieren. Erste Hinweise auf Zyklizitäten in den Laminiten deuten auf klimatisch kontrollierte Sedimentation. Das ist von großer Bedeutung, da dies neue Einblicke in das Klima während des miozänen Klimaoptimums aufzeigen könnte.

S15 – The dinosaur fauna of the Middle Jurassic Cañadón Asfalto Formation of Chubut, Argentina

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Following their origin in the Triassic, dinosaurs radiated in the Jurassic, until most important lineages were established towards the end of this period. However, especially for the Middle Jurassic, the dinosaur fossil record is rather poor, and thus the pattern of this diversification remains poorly known.

Although several isolated dinosaur finds from Middle Jurassic rocks of the southern Hemisphere are known, a diverse Gondwanan dinosaur fauna of this time has only been reported from the Cañadón Asfalto Formation of Chubut province. Recent geological work has furthermore demonstrated that this formation is older than the traditionally accepted Callovian-Oxfordian age, with new data ranging from the latest Toarcian to the earliest Bathonian.

Described dinosaur taxa from the Cañadón Asfalto Formation include the sauropods *Patagosaurus fariasi* and *Volkheimeria chubutensis*, the theropods *Piatnizkysaurus floresi*, *Condorraptor currumili* and the recently described *Eoabelisaurus mefi*, and the ornithischian *Manidens condorensis*. Furthermore, two more, undescribed taxa of sauropods, a new taxon of large-sized theropod and an undeterminate, large cerapodan ornithischian are also present. Thus, the fauna consists of at least ten taxa, including at least four medium-sized to large predatory dinosaurs.

Regarding the phylogenetic relationships of the dinosaurs from the Cañadón Asfalto Formation, the fauna seems to represent a transitional fauna between the Early Jurassic faunas known from southern Africa and other localities, and the Late Jurassic and Cretaceous faunas. *Manidens* is a heterodontosaurid closely related to *Heterodontosaurus* and other heterodontosaurids from the Early Jurassic of southern Africa. All of the sauropods from the Cañadón Asfalto Formation are eusauropods, in contrast to the "prosauropod" dominated Early Jurassic faunas, but they represent different stages on the stem line to neosauropods, which came to dominate sauropod faunas in the Late Jurassic. Concerning the theropods, *Piatnitzkysaurus*, *Condorraptor* and the undescribed taxon represent basal tetanurans and are thus amongst the oldest representatives of this important clade. The diversity of basal tetanurans in this early Middle Jurassic unit reflects the obviously rapid radiation of the group. *Eoabelisaurus* represents the oldest known representative of the abelisaurids, a predominantly Gondwanan lineage of large theropods that became especially prominent in the Cretaceous.

Concerning the biogeographic relationships of the Cañadón Asfalto dinosaurs, a surprisingly high level of endemism is striking. Thus, *Manidens* represents an endemic southern Gondwanan radiation of heterodontosaurids, *Patagosaurus* and one of the undescribed sauropod taxa are sister-taxa, as are *Piatnitzkysaurus* and *Condorraptor*. Given that no abelisaurids are known from the Jurassic of the northern Hemisphere, *Eoabelisaurus* also indicates a southern Gondwanan endemism of early abelisaurids. This endemism in a Pangean world indicates that regional climatic and geographic conditions might be more important in explaining the distribution of terrestrial vertebrates than often recognized.

S24 – Mollusc faunas as indirect indicators for palaeo-seagrass vegetation

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Seagrass ecosystems play an important role in sedimentation processes and nutrient cycling and support local biodiversity by providing food and shelter for numerous associated organisms. These ecosystems have been around since the Late Cretaceous. In order to understand their

emergence in geological time and their response to past perturbations we have to be able to recognise seagrass communities in the fossil record. However, seagrass itself hardly fossilises and therefore we are searching for indirect indicators to recognise ancient seagrass vegetation.

In this contribution we review molluscan evidence for palaeo-seagrass settings. Indicator species are rare since the majority of seagrass associated molluscs occurs in other marine habitats as well. Furthermore, shallow marine habitats appear to be patchy, both spatial and temporal, resulting in mixed occurrences of seagrass and non-seagrass faunas. Often only the high abundance of certain mollusc groups and the general taxonomic composition of a fauna points to seagrass environments.

However, the distribution of gastropod trophic guilds in species richness versus abundance data appears to yield patterns that may be very characteristic for the identification of fossil seagrass associated faunas.

We are currently applying Indirect Paleo-Seagrass Indicators (IPSI's) to a number of fossil and modern shelly samples, both from seagrass and non-seagrass environments. Identifying seagrass environments enables us to assess diversity trends in such ecosystems through time and to study their response over time intervals with major environmental and climate change.

S25 – Early Cretaceous bathyal holothurians from the western North Atlantic Ocean (Blake Nose, ODP Leg 171B)

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Sediments recovered from the lower bathyal ODP Leg 171 at Site 1049 on the Blake Nose escarpment (western North Atlantic) offer an opportunity to study well-preserved fossil deep-sea echinoderms, including sea cucumbers. Among echinoderms, holothurians are the most common megafaunal elements in the deep sea, from bathyal to hadal depths. Today, several holothurian groups are unique in being confined to the deep sea, including members of the Laetmogonidae (Elasipoda), Synallactidae (Aspidochirotida), and Myriotrochidae (Apodida). While there is some knowledge on shelf-sea holothurian records, deep-sea taxa are virtually unknown. Thus, the Blake Nose records provide insight into deep-sea assemblage structures and enable a first assessment of possible depth gradients among early Cretaceous holothurian groups. Here we present the first detailed analysis of early Cretaceous holothurian assemblages from Blake Nose. The fauna consists of dissociated ossicles and other skeletal elements, dominated by members of the Laetmogonidae and Myriotrochidae; representatives of the Chiridotidae are less frequent. Laetmogonid holothurians are surface-dwelling species and predominantly bathyal, represented within our material by diagnostic body wall ossicles only. Myriotrochid and chiridotid sea cucumbers live in large aggregations in soft sediments, documented in the present material by distinct body wall ossicles and calcareous ring elements. All these fossil species are closely related to modern representatives, like *Pannychia* (Laetmogonidae), *Myriotrochus* (Myriotrochidae) and *Chiridota* (Chiridotidae).

This is the first report of a fossil holothurian species closely related to a laetmogonid genus other than *Laetmogone*. The discovery of a middle to lower bathyal holothurian community of modern composition of early Cretaceous age implies that at least a significant part of the modern deep-sea fauna is much older than previously assumed.

S9 – Giant Mesozoic holothurian larvae?

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Gigantism in larval stages of Recent animals has been reported in several invertebrate and vertebrate groups, even in echinoderms. Indirectly developing species in aspidochirotid and apodid sea cucumbers have a planktonic feeding auricularia larva, with distinct calcareous ossicles and/or spherules. Modern giant pelagic holothurian auricularia larvae ("*Auricularia nudibranchiata* Chun, 1896"), with a length up to 15 mm, have been reported from the Atlantic and Pacific Ocean since the late 19th century. Very recently, this type of larvae was linked to a cosmopolitan bathyal/abyssal synaptid holothurian species (*Protankyra brychia* Verrill, 1885).

Concerning the evolutionary history of holothurian larvae, the bad news is that sea cucumbers have a relatively poor fossil record, which is based almost completely on isolated skeletal elements. The good news is that distinct holothurian larval skeletal elements are still preserved in

fossil sediments like those of other echinoderm groups (Echinoidea, Ophiuroidea), but were mostly neglected or overlooked by palaeontologists and zoologists.

Here we report new early Jurassic and late Cretaceous holothurian larvae material from several localities in Germany and France. The investigated well-preserved larval wheels are similar in shape and morphology to the ossicles of the modern giant pelagic "*Auricularia nudibranchiata*". This indicates that giant pelagic holothurian auricularia larvae may have been present at least since the early Jurassic.

S25 – 100 Jahre Paläontologische Gesellschaft – Geschichte(n) … Von A(bel) bis Z(ittel) über J(aekel)

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Am 12. August 2012 kann unsere „Paläontologischen Gesellschaft" auf ein Jahrhundert Geschichte mit „Höhen und Tiefen" zurückblicken. Den damaligen Gründungsaufruf versandte Otto Jaekel (1863-1929) im Mai 1912, wobei er ausführte, daß es „…einer Gesellschaft…" bedarf „…die die Vertretung der Interessen der Palaeontologie energisch in die Hand nimmt, sowie einer Zeitschrift, in der sie ihre Forschungsergebnisse […] konzentrieren kann, und ihr gleichzeitig als Organ für ihre fachlichen Bestrebungen und für ihre Vertretung nach außen hin dienen würde".

Vorliegender Beitrag unternimmt den Versuch einer kurzen und kompakten Vorstellung der Geschichte und Entwicklung der „Paläontologischen Gesellschaft", von der Gründung unserer Gesellschaft bis zum „Niedergang" am Ende des 2. Weltkrieges, wie auch vom Neuanfang 1948 und der Wiederbegründung bis hin zur deutschen Wiedervereinigung und hinein in das jetzige Jahrtausend. Ausgewertet wurden hierzu die verfügbaren Daten und Archivalia zu unseren Mitgliedern und dem Vorstand, sowie anderen, die Geschicke der Gesellschaft bestimmenden Personen. Ebenso berücksichtigt wurden die Publikationen und Zeitschriften unserer Gesellschaft, nebst Unterlagen zu den jährlichen gesellschaftlichen Treffen, wie Tagungen und Exkursionen.

S14 – The origin of high fiber herbivory and its significance in the initial diversification of amniotes

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Herbivory has been an important innovation in the history of life on land because its acquisition allowed terrestrial animals to become primary consumers, and access directly the vast resources provided by the primary producers, the terrestrial plants. The earliest known evidence of herbivory is provided by late Paleozoic insects and amniotes. Insect herbivory was already well developed by the Late Carboniferous (Pennsylvanian), as evidenced by insect-plant interactions, as well as studies of insect morphology. Similarly, terrestrial vertebrates also show evidence of herbivory (based on dental, cranial and postcranial morphology) near the Permo-Carboniferous boundary. In particular, the establishment of this feeding strategy among amniotes and their closest relatives, the diadectids, during the late Paleozoic led to a fundamental reorganization of terrestrial vertebrate ecosystems. Late Carboniferous and Permian synapsids, the lineage that ultimately led to mammals, dominated terrestrial vertebrate ecosystems (communities) during the crucial initial stage in diversification of land vertebrates, and include not only the first herbivores but also the first large top predators. Prominent among these are two clades of synapsids, the large herbivorous caseids, the largest terrestrial vertebrates of their time, and the edaphosaurids. The fossil record shows a clear pattern, based on time calibrated phylogenies, that herbivory and the associated increase in body size evolved independently at least four times among early terrestrial tetrapods, including two distinct clades of synapsids, a clade or reptiles, and the enigmatic diadectids.

This pattern is consistent with the broader picture of amniote evolution, one that shows repeated evolution of terrestrial herbivory during evolutionary history from the Paleozoic to the present. Despite its obvious importance, little is known about the evolutionary origins of this feeding strategy, and the frequently repeated acquisition of herbivory by subsequent amniote taxa during the last 300 million years.

Traditionally, the evolution of the cleidoic egg, which freed amniote tetrapods from their dependence on bodies of freshwater for reproduction, has been considered the key innovation responsible for the group's success in colonizing terrestrial environments during the late Paleozoic. However, the fossil record does not support this hypothesis because there is no evidence for extensive diversification during the early stages of amniote evolution. Instead, rapid initial diversification of amniotes is strongly correlated with the first appearance of herbivorous tetrapods at the end of the Pennsylvanian, leading to the hypothesis that herbivory is a key innovation in terrestrial vertebrate evolution.

S3 – Cap carbonate related microbial biosignatures

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Extremely negative carbon isotope signatures ($\delta^{13}C$ -55 ‰ VPDB) from the Doushantuo cap carbonates of South China were taken as a key evidence supporting the "methane hydrate hypothesis" explaining the enigmatic cap carbonate deposition after Marionan glaciation ~635 Myr ago. However, the hypothesis was currently challenged by interpreting the extreme carbon isotope signals in the Doushantuo cap carbonate as carbonate cements precipitated from hydrothermal fluids more than 1.6 Myr after cap carbonate deposition. Here we provide biogeochemical, sedimentological and petrographic evidence suggesting that the carbonate facies from the Doushantuo with extreme carbon isotope signals are consequences of syndepositional hydrocarbon seepage, general increased microbial activity and hinterland weathering, which were active at the time approximately corresponding to the limestone levels at the top of the cap carbonate. The abundant thrombolytic and stromatolitic structures in the lower, and more prominently in the upper levels of the cap carbonates exhibit well preserved microbial mats, which often mineralised in distinct and complex framboid pyrite and Ca-phosphate laminae associated with very characteristic "Yellow Calcites" (YC). Those early cements which bear the most light carbon isotope signals are also enriched by organic carbon (Raman data). The abundant framboid pyrites are a result of a strong microbial sulphate reduction which also caused a high carbonate alkalinity. The high sulphate concentration during times of carbonate precipitation is also documented by early barite precipitates. First biomarker analyses from the lower parts of the Doushantuo cap carbonates have shown signatures of archaea (biphytanes) and anaerobic bacteria (i/ai-alkanes) in high abundance and low pristane and phytane concentrations, which indicate a low content of phototrophs. All analyses and observations made so far demonstrate that complex microbial metabolic activities were key processes during the formation of the Marinoan Doushantuo cap carbonates and probably also of the Sturtian laminated cap carbonates from Namibia (Rasthof cap carbonates) which were analysed for comparison. High sulphate concentrations and methane had obviously key functions in the microbial metabolic cycles. Methane was potentially produced by methanogenesis, but may have also resulted from collapsing methane hydrates during deglaciation processes. The high sulphate input was probably caused by strong hinterland weathering processes, together with large amount of divalent cations like Ca^{2+}, Sr^{2+}, and Mg^{2+}. Breakdown of inhibition potential of microbial exopolymers (EPS), which functioning in living microbial mat to avoid fast mineralisation caused by heterotrophic microbes, provided nucleation sites for various mineral precipitates which favoured the formation of microbialites within cap carbonates.

S3 – New Ediacara-type organisms from black laminated microbial carbonates of the Shibantan Member of the Three Gorges Area (Dengying Formation, Hubei, China)

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Generally Ediacara organisms are found in siliciclastic facies. The only exceptions known so far are organisms from the Khatyspyt Formation in Siberia and from the here presented Shibantan Member of the Huangling anticline. The latter consists of black laminated limestones, formed by microbial mats. The carbonates were occasionally interrupted by tempestites indicating a shallow subtidal environment. Traces of the microbial mats are often seen on the bedding surfaces and resemble vendotaenid filaments. However, these remains exhibit disrupted and shrunken biofilms. Sometimes horizontal trace fossils occur below the microbial mats. These new Ediacara-type organisms are tightly associated to microbial mats. Specimens are more or less circular and are with diameters up to 60 cm relatively large. The best preserved one demonstrates a fine circular ribbing and a prominent outer margin. Other fossils share the same type of margin structure but have a more flat central part with few ribs only. The new types do not show the vendobiont quilt pattern. All observed specimens show conspicuous traces on the bedding surfaces, caused by moving, feeding or shrinkage. Biomarker analyses show a pristane/phytane ratio of 0.93 suggesting that organic matter was deposited in an anoxic marine environment. A marine origin is further supported by a low C30 sterane index of 0.09 and a sterane/hopane ratio of 1.3. 3-methylated and 2-methylated hopanes were identified, which proof a methanotrophic and cyanobacterial source. Gammacerane was also identified suggesting the presence of ciliates at the sediment/water interface.

S5 – Advances in Antarctic Neogene radiolarian high-resolution stratigraphy

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Antarctic Neogene sediments are a key archive to understand major climatic and paleoceanographic events such as ice sheet growth during the middle Miocene, low-latitude upwelling system development during the late Miocene, Messinian events, early Pliocene warming and late Pleistocene glaciations. However, the study of these events are hindered by the lack of a robust geochronologic framework, which is caused by the absence of carbonate microfossils in these sediments, widespread hiatuses and rapid changes in sedimentation rate: age model uncertainties are commonly higher than 1 myrs and thus prevent correlation at the needed resolution.

In addition to the more widely employed diatoms, Antarctic Neogene sediments contain abundant well preserved radiolarians. These faunas are diverse, evolve rapidly and offer in principle a major resource for improved biostratigraphy and thus improved geochronology. However, studies to date have employed only a small fraction of the fauna and the available biostratigraphic resolution is only moderate.

In this study, we collected quantitative, full fauna data from samples from several Antarctic late Miocene – early Pliocene sections. After careful outlier identification (samples with large number of anomalous occurences, species with inconsistent ranges, etc) and a stratigraphical analysis using the CONOP method (Constrained Optimization), we show here that ca 100 events can be used to correlate late Miocene – early Pliocene sections (vs ca 20 in the current biostratigraphy).

Together with the ca 80 reliable diatom events (newly) available for the same time interval in the Southern Ocean, we now have the tools to substantially improve Antarctic Neogene chronology and create new opportunities for paleoceanographic research.

S2 – Macroevolutionary patterns in Antarctic Neogene Radiolaria

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The deep-sea Cenozoic planktonic microfossil record has the unique characteristics of continuously well-preserved populations of most species, with virtually unlimited sample size and therefore constitutes, in principle, a major resource for macroevolutionary research. Antarctic Neogene radiolarians in particular, are diverse, abundant, consistently well-preserved and evolved rapidly. This fauna is, in theory, a near-perfect testing ground for paleodiversity reconstructions.

In this study we determined the diversity history of these faunas from a new quantitative, taxonomically-complete dataset from Neogene and Quaternary sections at several Antarctic sites. The pattern retrieved by our whole-fauna dataset shows a significant, largely extinction-free ecological change in faunal composition and decrease in the evenness of species' abundances during the Late Miocene, followed 3 My later, at around 5 Ma, by a significant drop in diversity. We tentatively associate this ecological event with a synchronic, regional change in the composition of the primary producers, but as yet cannot identify any environmental changes associated with the later extinction.

Further, our whole-fauna diversity history was compared to diversity computed from much less complete, biostratigraphically oriented studies of species' occurrences, compiled in the Neptune database and reconstructed by using subsampling methodologies. Comparison of our whole-fauna and subsampling-reconstructed diversity patterns show that the first order trends are the same in both, suggesting that to some degree, such literature compilations can be used to explore diversity history of plankton. However, our results also highlight substantial errors and distortions in the reconstructed diversity that make it poorly suited to more detailed studies (e.g., for comparison of diversity history to paleoenvironmental history). We conclude that detailed studies of plankton diversity, and particularly those attempting to understand the relation between diversity and paleoceanographic change, should be based on taxonomically comprehensive, quantitative data.

S23 – NaTourDidakt – Vermittlung paläobiologischer Inhalte als Dienstleistung

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NaTourWissen hat es sich zur Aufgabe gemacht, die komplexen Inhalte naturwissenschaftlicher und dabei auch paläobiologischer Erkenntnisse mit Hilfe geeigneter didaktischer Angebote leicht verständlich zu vermitteln. Der aktuelle Wissensstand wird spannend und unterhaltsam aufgearbeitet und in dieser Form an touristische Gäste und Seminarteilnehmer mit und ohne Vorbildung

weitergegeben. NaTourWissen fungiert dabei ähnlich wie Museen als Vermittler zwischen Forschung und interessierter Öffentlichkeit. Durch die Angebote von NaTourWissen kann man Naturwissenschaft hautnah miterleben. Kleinen Museen mit Naturhistorischen Sammlungen und Einrichtungen des Natur- und Geotourismus (Geotope, Natur- und Geoparks) kann NaTourWissen spezielle Angebote als Dienstleister im Bereich der kombinierten Natur- und Geodidaktik anbieten. Diese Einrichtungen werden bei der Umsetzung von einzelnen naturhistorischen Projekten beraten und bei der Schulung von didaktischem Personal unterstützt. Zusammen mit Partnern können bei der Konzipierung und Ausgestaltung von Ausstellungen, Postern, Infotafeln, Lehrpfaden und Themenwegen überall in Deutschland preislich und inhaltlich angemessene und zeitgemäße Lösungen gefunden werden. Natur- und heimatkundliche Vorträge, Seminare und thematische Workshops für Erwachsene und Schüler werden von NaTourWissen ebenfalls genutzt, um u. a. paläobiologische Zusammenhänge an bestimmte Zielgruppen sinnvoll zu vermitteln. Modernes und gleichzeitig ansprechendes didaktisches Bildmaterial macht nicht nur Inhalte leichter verständlich, sondern steigert auch den Unterhaltungswert einer Veranstaltung. Wird Wissen anschaulich und gleichzeitig unterhaltsam angeboten, sind die Chancen, dass das vermittelte Wissen nicht nur verstanden, sondern auch behalten wird um ein Vielfaches größer.

S23 – Das Hessische Landesmuseum Darmstadt – Geschichte und Neukonzeption

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Die Ursprünge des heutigen Hessischen Landesmuseums Darmstadt lassen sich bis zum Großherzoglichen Museum, welches von Landgraf Ludwig X. von Hessen-Darmstadt (1753-1830; seit 1806 Großherzog Ludewig I.) begründet wurde, zurückverfolgen. Letzterer ließ 1820 verkünden, dass die Bestände des Museums sowie die der alten Hofbibliothek auch nach seinem Tod der Öffentlichkeit zugänglich gemacht werden sollen.

Zuerst wurde seine Sammlung im alten Residenzschloss, welches zu Beginn des 19. Jahrhunderts ausgebaut wurde, ausgestellt. Kurz darauf (1834) wurde die großherzogliche Stiftung dem Ministerium des Inneren unterstellt.

Aufgrund kontinuierlicher Erweiterungen der kunst- und naturwissenschaftlichen Sammlungen reichten die Räumlichkeiten bald nicht mehr aus. Anträge für einen Neubau wurden seit 1865 mehrfach in den Landtag eingebracht, jedoch erst 1891 erfolgte die öffentliche Ausschreibung eines Wettbewerbs für ein neues Museumsgebäude. Schließlich erhielt Alfred Messel (1853-1909) die Zusage. Der Rohbau wurde 1902 vollendet; vier Jahre später (1906) fand die Eröffnung des neuen Gebäudes statt. Die neuen Ausstellungen bestanden aus einer Gemäldegalerie, einem Kupferstichkabinett, Sammlungen von Altertümern, Gipsabgüssen sowie der zoologischen und der geologisch-mineralogischen Abteilung.

Änderungen am Gebäude wurden in der 1930ern und nach der schweren Beschädigung 1944 sowie in den späten 1960ern notwendig. Hier wurden unter anderem Fenster und Durchgänge zugemauert um Ausstellungsflächen an den Wänden zu gewinnen. Diese neuzeitlichen Veränderungen an der historischen Bausubstanz werden bei der Sanierung des Gebäudes seit 2008 rückgängig gemacht. Gleichzeitig wird Rücksicht auf die Erwartungen und Bedürfnisse der Museumsbesucher genommen.

Im Vordergrund des Konzepts stehen besondere Originalobjekte, die in einen thematischen Zusammenhang gebracht werden, unter anderem mit Hilfe moderner Medien. Dabei wird auf eine übersichtliche Besucherführung Wert gelegt, die durch zahlreiche Umbauten im letzten Jahrhundert zuletzt nicht mehr gegeben war. Überdies soll im neuen Konzept die Entwicklung und Vielfalt aller Sammlungen, deren Bestand sich im Laufe der Zeit durch Schenkungen, An- und Verkäufe sowie Verlusten maßgeblich verändert hatte, dargestellt werden.

In der zoologischen Abteilung steht der Begriff Wandel im Vordergrund, sowohl im Rahmen von Forschung und Geschichte, als auch in der Natur. Die früheren Dioramen, von Alfred Messel und dem damaligen Leiter der Abteilung Gottlieb von Koch konzipiert, wurden detailgetreu restauriert und in den ursprünglichen Zustand zurückversetzt. Als thematisches Bindeglied zur Paläontologie wird die Evolution der Hominiden dargestellt. Die Gestaltung des Ausstellungsbereiches Erdgeschichte wird ebenfalls auf das Thema Wandel fokussiert, wobei einerseits geologische Prozesse thematisiert werden, zum anderen anhand paläontologischer Objekte aufgezeigt wird, dass es keine Konstanz in der Natur gibt. Ein Schwerpunkt der neuen Ausstellungen werden tertiärzeitliche Fossillagerstätten sein, insbesondere die Grube Messel. Dieser regionale Schwerpunkt wird auch in der neu überarbeiteten Mineralienausstellung sichtbar, wo zum Beispiel Minerale aus dem Odenwald gezeigt werden.

Die neuen Ausstellungen im Hessischen Landesmuseum Darmstadt, welche 2013 eröffnet werden sollen, stellen somit neue und modern dargestellte Sammlungsschwerpunkte in einem historischen Bau dar.

S9 – Microstructures of modern sea pen axes – a tool for the systematics of fossil pennatulaceans (Octocorallia)

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The pennatulaceans are considered to be a very distinct and greatly specialized group of octocorallian cnidarians. Since they are largely composed of soft tissue, the systematics of modern sea pens (Octocorallia: Pennatulacea) are mostly based on soft-part morphology, such as the arrangement of the secondary polyps around the rachis. Among the only hard parts (an axial rod and various sclerites), both present in most species, only the sclerites have been employed as systematic traits. However, both types of hard parts, especially the calcareous axial rod, are the only remnants of fossil pennatulacean specimens.

Fossil sea pens, the earliest specimens deriving from Late Cretaceous sediments, have therefore mostly been placed in one collective genus: *Graphularia* Milne Edwards & Haime, 1850.

A study of hard-part morphology, using 20 modern sea pen species from 10 of the 14 valid families, has shown that the microstructure of the axial rod is relatively consistent within one genus, whereas the cross section may vary between the distal ends of the rachis and the peduncle. Using field emission scanning electron microscopy, the microstructures of at least nine fossil species previously placed within the genus *Graphularia* have been studied. By comparing the microstructure of fossil and recent sea pen specimens, similarities have been observed, allowing a placement of fossil species close to modern genera and therefore also within modern families.

The microstructures of specimens from various families (including representatives from several genera) are presented here, demonstrating the value of these as a systematic trait.

This study, along with further research on the microstructure of modern and fossil sea pens using a larger number of specimens to include all modern families featuring an axial rod and to account for interspecies and intergenus variations, will assist the long-term goal of revising fossil pennatulacean systematics and phylogeny. This will also enable conclusions to be made on the paleoecology and former mode of life of the "nearly" neglected sea pens.

S20 – Neogene rise and decline of African tragulids (Artiodactyla, Ruminantia): possible selection related to digestive innovations within Ruminantia

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Modern African mammalian biogeography is largely characterised by a diverse ruminant fauna comprising mainly members of the family Bovidae (cattle, antelopes, goats), which belongs to the infraorder Pecora (ruminants with cranial appendages). Another African representative of Ruminantia is the African water chevrotain, which is endemic to West and Central Africa and confined to closed-canopy, moist tropical lowland forest, where sufficient supply for its frugivore dietary adaptation is provided. It is the only African species of the family Tragulidae, a group of small-sized ruminants including the smallest living hoofed mammal. Based on a suite of plesiomorphic characters, tragulids are considered the most basal crown ruminants, the only extant representatives of the once diverse infraorder Tragulina.

The fossil record documents the arrival of tragulids in Africa in the Early Miocene, with a major diversification during the Early / Middle Miocene. During this time, African tragulids were much more widely distributed, exhibited a larger range of body size, habitats and dietary adaptations, along with common sympatric occurrences of several species. The peak of their diversity is recorded from the Early / Middle Miocene transition followed by a severe decline in species numbers from the Middle Miocene onwards which overlaps with the initial diversification of Pecora, and promotes the idea of a selective advantage of pecorans over tragulids.

The comparison of living pecorans and tragulids offers a plausible example of competitive displacement due to a simple, morphophysiological 'innovation' in their digestive tract. All ruminants share a multi-compartment forestomach complex with the major peculiarity of a sorting mechanism, which ensures the selective retention of large particles for further digestion and rumination. This sorting mechanism facilitates a rather unique digestive efficiency, due to the extreme particle size reduction it facilitates in the course of rumination.

Whereas tragulid forestomach anatomy (with only two compartments) conserves an earlier developmental stage of the digestive tract in ruminant evolution, the pecoran forestomach includes a third compartment, the omasum, which increases not only the efficiency of the sorting mechanism, but also of the harvest of bacteria from the rumen. This difference in the overall efficiency of the forestomach may have led to tragulids losing out in a competition for dietary resources in a context of climate-

related spread of open habitats. Their demise occurs contemporaneously with the initial major diversification of pecorans. The omasum, a hallmark of the pecorans, and especially developed in the most recently radiated bovids, may well be the decisive innovation that sets the ruminant digestive strategy apart from that of other herbivores. Tragulids today survive only in relict forested areas with resources to support a year-round frugivorous diet, a niche where a pecoran's advantage might not be as pronounced as on grass or browse-dominated diets.

S2 – Species richness, functional diversity and the selection of communities

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Species history, and hence Phanerozoic richness, is attributable to stochasticity, microevolution and macroevolution. The history of any higher-level ecological unit is not merely the sum of species histories, however, but rather the feedback among species histories, the number of species in the unit, and interspecific interactions. For example, how a community responds during times of environmental crisis depends on species richness and the manner in which that richness is partitioned according to ecological function. Reciprocally, the resistance dynamics of a community will affect the responses of individual species. The result is a feedback between levels of organization, with species properties determining how a community will respond during environmental change, and that response in turn imposing selection on species.

Selection of species by community dynamics is, however, generally negligible for two reasons. First, community interaction models support the variation of interaction patterns without an alteration of dynamics, given stability of functional diversity. Second, communities that persist on geological timescales are finely-tuned products of selection acting on the community's biotic interactions. Selection imposed by community structure becomes effective during and immediately following episodes when community structure changes significantly, e.g. mass extinctions or biotic interchanges. The composition and partitioning of ecological function within the community are altered by taxon extinction, diversification of survivors, or taxon immigration. Community structure and dynamics are driven during those episodes by the evolution of species properties. The result, however, can be communities with lowered resistance to continued disturbance. Changes at the level of functional configuration that then reverse or improve community states will be favoured, regardless of whether those changes are unfavourable to the survival of individual taxa. The result is either a return to pre-crisis community configuration, or a new type of community. There are several implications of this process. First, delays of biotic recovery are not due to time taken to re-evolve interspecific relationship, but rather the time required for community-level selection to eliminate unfavourable patterns of functional diversity. Second, community and ecosystem-level selection can operate counter to species-level selection. And finally, ecological systems at levels of organization above those of species populations are subject to, and the product of, selection acting at those levels.

Patterns of historical biodiversity are therefore products of evolution at the level of species coupled with selection at levels representing sets of interacting species and the history of abiotic contingencies. The study of biodiversity in the fossil record is dominated by documentations of taxon richness, identification of intervals of changes in richness, and the search for biases in the geological record. To understand the history of biodiversity, however, we need theory to explain the parallel history of the higher-level ecological systems into which richness is organized, namely communities and ecosystems.

S21 – Anatomically preserved calamitaleans from the Permian of Tocantins (Parnaíba Basin, NE Brazil) exhibit growth form diversity

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Arboreal sphenopsids were not only major constituents of Pennsylvanian and Permian wetland ecosystems, but during that time they also attained their maximum diversity. Along with various ferns, lycophytes, pteridosperms and other gymnosperms calamite remains dominate a large number of fossil plant assemblages in both sedimentary and volcanic environments.

Northern Tocantins, Brazil, represents an outstanding fossil lagerstätte offering large quantities of petrified trees. The latter come from different lithofacies of a cyclic alluvial succession of the Permian (Motuca Formation, SW Parnaíba Basin). The three-dimensional preservation, which is offered by siliceous petrifactions provides the opportunity to study, as well as gross morphology, the anatomy and internal organisation of plant tissues, as well as taphonomical and ecological aspects.

Whereas studies on petrified calamitean trunks and their internal anatomy can be traced back nearly two centuries, detailed examinations providing crucial knowledge of both anatomical and branching variation remained rare, like the post-Carboniferous record in general. Recently, based on finds from Tocantins sizable tree trunks have been investigated and resulted in much additional data. Advances in the study of these Permian forms demonstrated major peculiarities as compared to most other fossil calamites, and drew into question their detailed growth strategy, which remains unsatisfactorily understood. Our observations provided striking similarities of calamitaleans from the Southern and Northern Hemispheres and confirmed new results recently obtained from the type locality Chemnitz, Germany. We challenge the view of many textbooks that calamitaleans are typically characterized by underground rhizome systems and aerial upright stems. For the first time we excavated stems that still show their roots attached. According to our new finds calamitaleans are individual tree trunks that have adventitious woody roots of different size anchoring the trunks in the soil. Vegetative axes include a central pith or cavity and can have considerable secondary growth. Different forms of branching have been recognised and resulted in new reconstructions. As developmental changes in calamitaleans were for many years underestimated, we now realise greater growth form diversity among this anatomical conservative plant group.

One of the calamitaleans recently characterised by its anatomy and branching is *Arthropitys isoramis* n. sp. The stem consists of central pith/cavity with primary and secondary vascular tissues. Branching is very regular at every node. Branch traces of leafy twigs alternate in successive nodes, and lie on the top of each other at every second node. Usually 4 branch traces (rarely 3) occur per node in juvenile axes. Pith is circular and surrounded by primary xylem strands with clearly developed carinal canals surrounded by small metaxylem elements. Secondary body shows division into interfascicular rays and fascicular wedges.Secondary xylem tracheids show reticulate secondary wall thickenings and multiseriate pits on their radial walls.

S21 – Medullosa – eine paläozoische Gymnospermengattung mit Wuchsformenvielfalt

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Die Medullosen gehören immer noch zu den rätselhaftesten Pflanzenfossilien des Rotliegend. Es waren Samenpflanzen mit farnartigen Blättern – die größten und stattlichsten unter den Pteridospermen. Ihre Stammkonstruktion vereint mehrere Leitbündel, die einen zentralen Markraum erfüllen bzw. flankieren und jedes für sich sekundäres Dickenwachstum aufweisen. Ihnen werden riesige Gabelwedel vom *Neuropteris*- und *Alethopteris*-Typ zugeordnet, die ihrerseits an *Myeloxylon*-Blattstielen sitzen. Diese sind von zahlreichen Einzelleitbündeln und Sklerenchymsträngen durchzogen. Die weiblichen Fruktifikationen, radiärsymmetrische, 1 bis 10 cm große Samenanlagen ohne Cupula sind genauso bekannt wie die männlichen synangiaten Pollenorgane mit unzähligen, großen, monoleten Präpollen. Bereits nach der Anatomie der Stämme sind mehrere natürliche Gruppen zu unterscheiden, doch welche Beblätterungsformen und Fruktifikationsorgane zu welcher Pflanze gehören, ist auch fast 200 Jahre nach ihrer Erstbeschreibung unklar. Selbst die Wuchsformen, die eine enorme Vielfalt andeuten, fanden bislang kaum ihren Niederschlag in den Rekonstruktionen.

Von dort, wo einst die Wiege ihrer Erforschung stand, dem locus typicus Chemnitz, liegen jetzt neue Funde vor, die neue Organzusammenhänge zeigen. Ein terminaler Stammabschnitt mit zwei Wedeletagen wurde während der Eruption des Zeisigwald-Tuffs (290,6 ± 1,8 Ma) abgeknickt und kopfüber in Pyroklastite eingebettet. Die Stammanatomie dieses Fundes zeigt zahlreiche, sehr regelmäßig, nahezu äquidistant angeordnete Leitbündel. Dieses Muster ist bei den bislang beschriebenen Formen unbekannt. Da jedoch wenig über die ontogenetische Entwicklung der Leitbündelarchitektur der beschriebenen Formen bekannt ist, kann derzeit noch nicht entschieden werden, ob es sich bei dem neuen Fund um eine neue Art handelt oder um eine Stammposition, die von den bekannten Formen noch nicht vorlag. Die Beblätterung ist *Alethopteris schneideri* zuzuordnen, einer für das europäische Rotliegend typischen und weit verbreiteten Pteridospermenbeblätterung. Ferner hat die Wissenschaftliche Grabung des Museums für Naturkunde (2008-11) auch Zweige geliefert mit männlichen Fruktifikationsorganen, die in Kenntnis der gesamten fossilen Flora an der Fundstelle den Medullosen zugeordnet werden.

Die Medullosen bleiben Synonym für ein natürliches Experiment der Kombination, Optimierung und Anpassung von Stelentypen, Wuchsformen und Vermehrungsstrategien an die sich allmählich verändernden Umweltbedingungen und Lebensräume im ausgehenden Paläophytikum. Die Funde aus dem Unterrotliegend sind die letzten von dieser Pflanzengruppe, bevor sie im Laufe des Perms ausstarb – möglicherweise eine Folge der verschwindenden Moorbiotope, ihr Lebensraum über Jahrmillionen.

S1 – The dynamics driving plate tectonics and continental drift: why a close reading of Wegener is always rewarding

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Alfred Wegener's insightful summary of geological observations together with conjectures regarding possible causes and consequences of continental drift starting with his first publication (Wegener 1912 – "*Die Entstehung der Kontinente*" in Petermanns Geographische Mitteilungen) is a truly remarkable example of synthesis, probably unmatched in the Earth Sciences, except perhaps by his own book-length treatises in 1915-1929. Many of Wegener's most vociferous critics drew attention to the absence of a driving mechanism for continental drift, despite Wegener's own tentative discussions of possible driving forces together with his explicit statements: "The Newton of drift theory has not yet appeared" or in 1912 "The question of which forces cause the … horizontal displacements … cannot be passed over although I consider it premature". With the advent of plate tectonics, the general consensus view of plate driving forces is that the Earth behaves as a top-down driven convective system in which subduction of cold lithosphere dominate plate driving forces, and that all other forces are orders of magnitude less important. Here we argue that this consensus view itself needs reappraisal and that whole mantle convective forces contribute driving forces of the same order of magnitude to the plate movement. Empirically, following Wegener's example, we show that the East Pacific Rise (EPR) over the past 83 Ma is characterized by very limited ridge-perpendicular motions and hence the position of the EPR has not migrated E-W relative to the deep mantle over this interval. This absence of lateral migration is incompatible with expectations of top-down convection, but is compatible with mantle flow calculations highlighting whole mantle convective flows beneath the EPR, significant stability of these flows over time, and asymmetric mantle tractions comparable with observed asymmetric spreading, among other results. Our flow calculations are compatible with estimates of core-mantle boundary heat flux of > 15 TW (Pozzo et al., 2012, Nature, 485, p. 355) associated with a significant buoyancy flux at the base of the mantle, not included in the consensus view of plate driving forces. As true of many aspects, Wegener once again was prescient while citing the work of others in stating: "In considering earth's surface … there is no mistaking that the split-up of Gondwanaland and also that of the former Europe and Asia, can be conceived as the effect of such sima circulation" (1966, p. 178). And further: "Continental drift, faults and compression, earthquakes, volcanicity, transgression cycles and polar wandering are undoubtedly connected causally on a grand scale". It is our view that the grand scale that unites these among other aspects of earth dynamics reflects the manifestation of the full coupling of a bottom-up and top-down driven convective system with plate tectonics and continental drift as natural consequences.

S25 – The inner ear of *Leptictidium auderiense* (Leptictida, Mammalia) – a key to the reconstruction of leptictid locomotion

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The semicircular canals of the inner ear are involved in detecting angular acceleration of the head. It is well known from former studies that the size and shape of the semicircular canals, here represented by the bony labyrinth of the inner ear, correlate with agility and body mass. Thus, morphometry of the bony labyrinth can be used as a proxy to elucidate the type of locomotion in fossil mammals.

Leptictida for instance, are extinct basal insectivorous placentals comprising species with highly specialized postcranial features. Among these, *Leptictidium* from the middle Eocene of Messel (Germany) has been considered to be very agile because of its very short forelimbs and extremely elongated hind limbs and tail. However, it is still debated if *Leptictidium* showed a bipedal running or a bipedal saltatory locomotion.

Thanks to a recently discovered specimen we provide here the first insight into the inner ear anatomy and morphometry of *Leptictidium auderiense*, one of three *Leptictidium* species found in Messel. Using high resolution computed tomography scans, the 3D morphology and morphometry of the bony labyrinth in *Leptictidium auderiense* were compared with those of selected specimens of North American Leptictida, such as *Leptictis dakotensis*, which is supposed to be mainly quadrupedal.

The general morphology of the bony labyrinth reveals that both species have a prominent secondary crus commune, which is a primitive mammalian character. In *Leptictidium* the cochlea has almost 2 turns and lacks a secondary bony lamina. In contrast *Leptictis* shows 2.25 cochlear turns and possesses a short but distinct secondary bony lamina. The semicircular canals are thin and prominently arcuated in both taxa, but are relatively

larger in *Leptictidium* than in *Leptictis*. Furthermore, the mean size of the radii of their semicircular canals was plotted against the geometric mean of their body mass in a regression analysis taken from the literature and comprising 210 therian species. It appears that *Leptictidium* clusters with other highly agile mammals and has much larger semicircular canals than most similar sized species. Conversely, *Leptictis* plots below the regression line closer to slow moving species. Concurrently, we calculated the agility scores of their semicircular canals. The agility scores of *Leptictidium* range from 4.5 to 5.5 and indicate a medium to medium-fast moving animal. The highest end of this interval falls into the range of extant saltatory mammals, which would support the hypothesized saltatory locomotion in *Leptictidium*. Conversely, *Leptictis* shows a significantly lower agility score interval (3.5-3.7), which refers to a medium-slow to medium agility. The scores of most extant mammals, displaying more general types of locomotion such as terrestrial, cursorial, scansorial, arboreal, and semiaquatic, are situated within this interval.

S18 – Neuigkeiten aus der Bernsteinforschung – Neue Fundstellen, neue Methoden, offene Fragen

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Die Fossilüberlieferung von terrestrischen Ökosystemen ist im Gegensatz zu marinen Fossilvorkommen in hohem Maße an besondere Erhaltungsbedingungen geknüpft. Hierzu zählen etwa Seeablagerungen, wie im Fall des Alttertiärs von Messel, küstennahe marine Räume, wie z. B. das Karbon von Mazon Creek, oder fossile Harze, die als Kopal und Bernstein aus einer Vielzahl von Lagerstätten weltweit bekannt sind. Obwohl die ältesten Fossileinschlüsse erst kürzlich in triassischem Bernstein aus den Dolomiten entdeckt wurden, liegen die ältesten, wirklich fossilreichen Bernsteinvorkommen aus dem Libanon vor und sind ca. 135 Millionen Jahre alt. Die prominenteste Lagerstätte, der Baltische Bernstein, wird dagegen in das Eozän datiert. Mit bislang über 2000 beschriebenen Arten ist der Baltische Bernstein zugleich die systematisch am besten erfasste Fossillagerstätte überhaupt. Trotz dieser immensen Vielfalt ist der Formenreichtum der klassischen Bernsteinvorkommen, zu denen auch der Dominikanische und Mexikanische Bernstein zu rechnen sind, bis heute nicht erschöpft, wie zahlreiche Neubeschreibungen zeigen. Gerade in den letzten Jahren haben auch neue Fundstellen für Aufsehen gesorgt. Dazu zählen kleinere Vorkommen wie etwa aus dem Miozän von Peru oder der Kreide von Äthiopien, aber auch sehr umfangreiche bernsteinführende Ablagerungen, die aus dem unteren Eozän von Indien oder der Kreide von Frankreich beschrieben worden sind. Für die wissenschaftliche Auswertung von Bernsteinlagerstätten sind aber nicht nur Neufunde von Bedeutung, sondern auch neue Untersuchungsmethoden haben zu erheblichen Fortschritten geführt. Allen voran ist hier die hochauflösende Synchroton Röntgenanalyse zu nennen sowie die Untersuchung von Einschlüssen mit Hilfe von Mikro-CT Scannern und Laser Scanning Mikroskopie. So hilfreich diese neuen Methoden für die Bernsteinforschung auch sind, so gibt es nach wie vor eine Vielzahl von offenen Fragen, die zum Teil nur mit Hilfe neuer konzeptioneller Ansätze beantwortet werden können. So ist bis heute z. B. nicht bekannt, welche diagenetischen Prozesse die Erhaltung von Weichgeweben (Muskeln, Nerven etc.) bis hin zu subzellulären Details ermöglichen. Auch biostratinomische Faktoren, welche die Zusammensetzung von Bernsteinfaunen erheblich beeinflussen, bedürfen weiterer Untersuchungen. Im größeren Maßstab sind es vor allem ökosystemare Analysen und überregionale Vergleiche, bei denen erheblicher Forschungsbedarf besteht. Hier könnten Rekonstruktionen der ehemaligen Gildenstruktur und der ökologischen Räume bedeutende Fortschritte liefern.

S5 – The revival of late Mesozoic non-marine ostracod biostratigraphy - Breaking conceptual barriers

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Cretaceous biostratigraphy as based on non-marine ostracods has a long tradition, particularly with respect to the so-called “Purbeck-Wealden interval” (uppermost Tithonian to Barremian/lowermost Aptian in Europe), also resulting from the fact that non-marine ostracods underwent an explosive evolutionary expansion in non-marine environments during this interval. While ostracods are definitely the most useful biostratigraphic tool in (Lower) Cretaceous non-marine successions, their interpretation remains difficult and controversial, and their biostratigraphic application has always been affiliated with considerable problems and limitations especially on supraregional (i.e., inter-basinal) to global scales.

Crucial to a broader, supraregional approach to (Late Jurassic–) Cretaceous non-marine ostracod biostratigraphy, is an appreciation of the fact that certain groups are

not restricted to individual water bodies or smaller geographic regions in their distribution and dispersal. Today, whole living specimens or their eggs can be transported passively by larger animals or wind over long distances, crossing migration barriers – and non-marine ostracods are considered to have been already able to do so by the Late Jurassic. This wide passive dispersal ability is a key consideration in the supraregional biostratigraphic utility of these ostracods.

Attempts at supraregional correlation of non-marine deposits have to deal with two major issues: the application of taxonomy and the palaeoenvironmental context. New approaches and methods as well as modern insights into ostracod palaeobiology and palaeobiogeography assist the process of taxonomic revision. It turns out that much of the morphological variability is a result of local environmental changes – or environmental differences between separate localities – rather than sequential evolutionary changes. This means that correlations based on the short ranges of such taxa are likely to be spurious. There are different ways of handling the morphological variability exhibited by these ostracods, in part with taxonomies specifically adjusted to the respective application. The resulting upgraded and integrated taxonomy in combination with the appreciation of a supraregional dispersal potential and wide distribution of the respective ostracods facilitates their supraregional biostratigraphic application, and improves their utility as to palaeoenvironmental analysis. This way, the traditionally presumed drawbacks as to the biostratigraphic application of non-marine ostracods, i.e., strong endemism and facies control, can be successfully dealt with in many cases.

It is, thus, not the question anymore whether inter-basinal to inter-continental correlations are possible or not. The new guiding principle concerning late Mesozoic non-marine ostracod biostratigraphy is rather to take these facts for granted and develop a network of supraregional correlations (i.e., stratigraphic ties) at the interim cost of lesser accuracy, then followed by the integration of these with other chronostratigraphical and geochronologic methods on regional to global scale to improve the resolution. We are approaching a new period of the fundamental reinterpretation of the basics of Cretaceous non-marine ostracod biostratigraphy and its practical implementation.

S4 – Die Verwendung der LA-ICP-MS zur geochemischen Analyse von Rudistenschalen aus der Oberkreide von Chiapas, Mexiko

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Die Haupt- und Spurenelement-Verteilung mittels LA- ICP-MS wurde an sechs Rudistenschalen der Gattung *Titanosarcolites* sp. aus der Oberkreide in Mexiko analysiert. Die gemessenen Hauptelemente schließen Mg, Mn, Fe, Al und Si ein, während die analysierten Spurenelemente Sr, Ba, Cu, Ni, Co, V, Cr, Rb, Ti, Zr, Mo, Hf, Sn, Sb sowie die Seltenen Erden umfaßten. Die Hauptelementanalyse deutet auf eine Niedrig-Mg-Kalzit-Mineralogie für die äußere Schale hin. Die geringen Gehalte von Mn und Fe lassen auf eine gute Erhaltung, frei von diagenetischen Effekten schließen. Der niedrige, bzw. nicht vorhandene Gehalt an Si und Al sind Hinweise auf ein küstenfernes Milieu, was auch anhand der Spurenelemente Rb, Zr, Ti und Hf bestätigt werden konnte. In der inneren Schale sind lokale Sr-Anreicherungen zu beobachten. Diese können Spuren der inneren aragonitischen Schale darstellen. Die Konzentrationen von Sb, Sn, V, Cr, Ba und Ni zeigen Variationen zwischen den verschiedenen Schalen. Jedoch sind sie in allen Schalen vorhanden, was auf biologische Prozesse hindeuten könnte. Das gleiche gilt auch für Mo, Cu und Co. Diese Elemente sind allerdings ein sicherer Hinweis auf den Stoffwechsel der Rudisten, da ähnliche Anreicherungen bei rezenten Bivalven zu beobachten sind. Eine Anreicherung an Seltenen Erden konnte nicht beobachtet werden. Dieses Projekt ist von besonderer Bedeutung, da LA-ICP-MS bisher nie für geochemische Analysen in Rudisten angewendet wurde.

S9 – Embryos in Deep Time – Palaeontology and the study of the evolution of vertebrate biological development

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If the expanded evolutionary synthesis places development as a key subject, then the role of palaeontology to address developmental evolution becomes a central issue. Palaeohistology and the occasional embryos or growth series provide means of examination of what is otherwise rare: the direct study of development in fossil vertebrates. A web-database provides a bibliographic listing covering all major groups of vertebrates (www.developmentalpalaeontology.net). Fossil phenotypes provide an indirect but rich source of data for developmental evolution. Collaborative works in my lab provide examples of dif-

ferent approaches. The resolution of the homologies of the interparietal bone and its dual embryonic tissue origin would not be possible without early synapsid (stem-mammals) data. The study of palaeohistology in fossil deer demonstrates how gigantic and dwarf forms grew. Fossils can expand the morphospace of a clade which otherwise would be considered to be biased negatively by some developmental pattern of that clade. Examples can be found in the size and dental morphological range of fossil marsupials. Studies of development also provide models and predictions which serve to interpret the fossil record. This is exemplified by the study of the potential molecular bases for the morphological diversification of a ray-finned fish from the middle Triassic of Switzerland. Another example is the application of the 'inhibitory cascade model' to predict molar proportions and its examination in a large radiation of extinct and endemic ungulate mammals from South America. Finally, palaeontology together with comparative morphology can provide the questions that developmental studies should address. This is exemplified by the investigation of the apparent extra-digit in talpid moles among mammals. The partial preservation of fossils and the impossibility of performing experiments on them put major limits on what can be achieved in developmental palaeontology. But the direct evidence fossils provide of development in geological time make them a central subject of an expanded evolutionary synthesis.

Public lecture - Die Biologie der sauropoden Dinosaurier: Die Evolution des Gigantismus

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Unendlich langer Hals, winziger Kopf und riesengroß - das waren die sauropoden Dinosaurier, die größten Landtiere der Erdgeschichte. Das Museum für Naturkunde Berlin zeigt in seinem weltberühmten Sauriersaal die Originalskelette der Sauropoden *Brachiosaurus brancai* und *Dicraeosaurus hansemanni* aus den Tendaguruschichten (Jura von Tanzania) und den Abguss des *Diplodocus carnegii* aus der Morrison-Formation (Jura der USA). Heutige Elefanten wirken wie Zwerge im Vergleich mit mittelgroßen (z.B. *Brachiosaurus*) und großen Sauropoden, für die Lebendgewichte von 50 bis 80 Tonnen und eine Länge von bis zu 40 m rekonstruiert werden. Aus evolutionsbiologischer Sicht stellt sich die Frage, wie die Sauropoden der Jura- und Kreidezeit derartige Dimensionen erreichen konnten und warum die heutigen landbewohnenden Säugetiere so viel kleiner blieben. Um sie beantworten zu können, ist paläobiologische Forschung nötig, also der Versuch, die Sauropoden als lebende Tiere zu verstehen.

Transdiszplinäre Untersuchungen einer von der DFG geförderten Forschergruppe sind einer Erklärung näher gekommen. Nicht ein einziger biologischer Faktor, sondern das komplexe Zusammenspiel evolutiver Innovation mit ererbten Primitivmerkmalen ermöglichte den Gigantismus der Sauropoden. Der bei manchen Arten über 10 m lange Hals funktionierte wie ein Kranausleger, mit dem das Tier ohne viel Energieaufwand in einem großen Gebiet in möglichst kurzer Zeit möglichst viel Pflanzennahrung abbeißen konnte. Gekaut wurde nicht, denn das hätte Zeit gekostet und würde einen relativ großen Kopf bedingen, der nicht auf einem langen Hals getragen werden könnte. Für die Evolution des langen Halses war auch ein vogelähnliches Atmungssystem entscheidend, da es einerseits den extremen Leichtbau der Halswirbelsäule durch Pneumatisierung ermöglichte und andererseits das von der extrem langen Luftröhre verursachte Totraumproblem löste.

Ein weiteres Vogelmerkmal, das Eierlegen, sowie eine hohe Grundstoffwechselrate, waren ebenfalls Voraussetzungen für den Riesenwuchs der sauropoden Dinosaurier. Da mit der evolutiven Zunahme der Körpergröße die Eier der Sauropoden wie auch anderer Dinosaurier relativ immer kleiner wurden (Eier können nicht beliebig groß werden), kompensierten die Sauropoden dies durch eine hohe Zahl von Eiern. Modellrechnungen zeigen, dass diese hohen Reproduktionsraten die Sauropoden weniger anfällig für Hintergrund-Aussterben machten als große Säugetiere. Damit kamen Sauropoden mit geringeren Populationsdichten aus, was wiederum größere Einzeltiere erlaubte. Eine hohe Grundstoffwechselrate ist deshalb eine Voraussetzung für Gigantismus, weil nur sie eine hohe Wachstumsrate der Jungtiere ermöglichte, die das Überleben bis zur Geschlechtsreife ermöglichte.

Der Vergleich von Dinosauriern mit Säugetieren lässt so erkennen, welche Eigenschaften, wie z.B. das Kauen und die Fortpflanzungsweise, die Körpergröße begrenzen können.

S16 – Sauropod herbivory: how nutrition played a role in gigantism (or not)

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It had long been thought that the Mesozoic flora offered very little in regard to nutrition to the herbivorous dinosaurs. However, we now know based on fermentation studies on the nearest living relatives of the Mesozoic plant world that some plant groups offer as much as or even more energy than grass, which is the prime fodder of herbivores today. Recent cropping experiments also show

that gymnosperm trees offer foliage biomass than broad-leaved trees. Among Mesozoic ecosytems, the Morrison Formation is of special interest because of the great abundance and diversity of sauropods and other dinosaurs it has yielded. It follows that the vegetation growing in the Western Interior of North America during Late Jurassic times must have supported heavy herbivory by the gigantic plant-eating reptiles that lived there then. Yet, it is still unclear what sorts of plant communities dominated the landscape and would have thus provided fodder for the vast numbers of herbivores in this widespread area. It has been estimated, for example, that a 70-ton sauropod with the scaled-up energy requirement of a modern elephant would have needed a daily intake from 237 to 394 kg of dry plant matter, depending on food quality; this equals 1000 to 2000 kg of fresh material daily. Previous reconstructions of the Morrison vegetation have ranged from open "fern prairies" to semi-arid "savanna-like" vegetation, hypothetical habitats in which trees are restricted in quantity and distribution, despite the abundance of fossil wood and huge logs in Morrison sediments and the common co-occurrence of wood and dinosaur bone. Recent discoveries of several new species of fossil conifer cones in Utah, Wyoming, and Colorado offer evidence for a re-evaluation of the Morrison flora and suggest that it was dominated by a diversity of forest-forming trees. This is supported by pollen samples taken throughout the Morrison, from Montana to New Mexico, that also indicate a conifer-dominated vegetation. New collections of fossil leaf floras from Montana and Colorado document moisture-loving ferns and fern allies in locally mesic or even hydric environments. Widespread conifer forests and fern wetlands, as interpreted from these multiple lines of new evidence, would have provided more extensive sources of fodder than a semi-arid or mostly treeless vegetation. With regard to the nutritional analysis of the nearest living relatives of the Mesozoic flora, a steady diet of araucarian and other conifer foliage, horsetail shoots, and some mesic ferns would have served the daily dietary requirements of the sauropods well, supporting their need for high energy intake for rapid growth and maintenance of their huge sizes.

S3 – Organic compounds and conditioning films within deep rock fractures (Äspö Hard Rock Laboratory, Sweden)

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The Äspö Hard Rock Laboratory (HRL) is a tunnel in southeast Sweden excavated as a study site of the Swedish nuclear waste disposal program (SKB Svensk Kärnbränslehantering AB). The tunnel is located underneath the island of Äspö which is part of the Precambrian bedrock belonging to the 1.6 – 3.1 Ga old Fennoscandian Shield. The dominating rocks are 1.8 Ga old post-orogenic granites to quartz-monzodiorites which exhibit numerous mineralized fractures consisting mainly of quartz, calcite, fluorite and/or epidote. Formation and reactivation of the fractures, as well as related mineral precipitation are connected to at least four different orogenies between 1.75 Ga and 0.4 Ga. The fracture mineralization consists of six different parageneses, characterized by varying formation temperatures ranging from early hydrothermal conditions to low temperature conditions of recent times. After an initial oxic period, the fracture zones remained anoxic, which was supposed to be controlled by microbial activity. The presence of microorganisms in the deep biosphere is usually suggested to depend on associated aquifer systems. The contact of the solid rock surfaces with aqueous solutions leads to the formation of conditioning films, needed for balancing negative charges enabling the attachment of microorganisms to the surface. During the development of a conditioning film a number of organic compounds are involved.

Here we present results obtained in fracture fillings of both main rock types of the island of Äspö with the objective of revealing their possible organic content in order to search for traces of recent and fossil life in deep rock fractures.

Various analyzes with Raman spectroscopy, HPLC and HPAE-PAD applied to a granitic sample revealed numerous different organic molecules. These molecules could be classified into main building-blocks of organic matter, e.g. lipids, saccharides, amino acids and nucleic acids. They could be obtained from fine calcitic fractures within the main epidote fracture. Comparable data were obtained from a dioritic sample containing epidote and calcite as fracture cements. In order to validate the observed data, additional analyzes of water samples obtained from open fractures close to the drilling sites were performed. The results demonstrate excellent coincidences especially in the amino acid content showing a dominance of phenylalanine and proline. Both amino acids occur in the D-configuration with a visible racemic mixture of ca. 50% between D- and L-configuration for phenylalanine. It is supposed that most of the preserved organic matter is related with thin conditioning films which could form due to post-glacial reactivation of the fracture system in the Late Pleistocene. Extracted bacterial and fungal DNA from the granite and a second diorite clearly show still active microbial activity in fracture micro-niches.

S16 – Quantitative interpretation of tracks using soil mechanical concepts

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Ever since the first giant bones of sauropods were found scientists worldwide investigate the development of gigantism and the lifestyle of these enormous animals. Analysis and interpretation of sauropod gigantism is essential for understanding the evolutionary constraints and their consequences on the development of the earth's geological and biological history. Quantitative information on the sauropods' weight is, among other attributes, of major interest.

In many localities worldwide dinosaurs left their tracks in sediments, which can today be observed to date as fossil footprints. Based on the geometry of those footprints and using soil mechanical approaches the stress state applied to the subsoil by the dinosaurs via its foot may be reverse-calculated using inverse analysis. The geometry of the footprint (i.e. vertical displacements) is strongly influenced by the stress applied and the characteristics of the subsoil. The value of the applied stress depends on the dinosaur's weight (i.e. static component) as well as on the acceleration the dinosaurs foot received when coming into contact with the subsoil (i.e. dynamic component). Biomechanical aspects have to be taken into account when dealing with this problem.

Therefore, the aim of the present investigation is to apply and to verify a soil mechanical concept to predict the weight of an extant, living animal, to validate the engineering methods. Based on the footprint geometry and the soil mechanical properties of the subsoil the Finite Element Method (FEM) is adopted to achieve this aim.
Certain similarities may be found between sauropods and elephants locomotion. Thus in this study an elephant with known weight is walking on a prepared sand bed to produce footprints. The geometry (i.e. vertical displacements) of the footprint is used to reverse-calculate the elephants weight. The following work steps are performed:
- The footprints are scanned using Laser Scanners to derive 3D geometry diagrams of deformation.
- Experimental investigations are carried out to determine soil parameters needed as input values for the numerical simulation.
- Locomotion sequences of the elephant walk are studied in detail by Digital Image Correlation (DIC) method.
- Inverse Analysis using numerical simulation by FEM code PLAXIS including Hardening Soil Model (i.e. stress dependent stiffness values are taken into account) is carried out.

The predicted weight of the elephant and the estimated weight of the elephant derived via numerical simulation are compared. We summarize the outcome with regard to the influence of dynamic components (arising from the forward speed) and several weight distributions during the elephant walk. As a result we discuss the applicability of the above introduced soil mechanical concept for the prediction of sauropods weight by inverse analysis.

S25 – A remarkable carpal construction in *Prosantorhinus germanicus* (Rhinocerotidae, Mammalia) from Sandelzhausen (Bavaria, Germany)

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The famous Miocene locality Sandelzhausen has an age of around 16 Ma and belongs stratigraphically to the Neogene mammal zone MN5 respectively the upper freshwater molasse. The highly diverse fossil assemblage consists of plants, invertebrates and vertebrates with a dominance of mammals. Within the large number of specimens the remains can mainly be assigned to rhinos. Among the first findings in 1959 was a well-preserved rhino lower jaw. Within the excavation history of two large periods the number of teeth, skulls and postcranial remains of three different rhino taxa grew to a tremendous size (e.g., more than 1800 teeth). The largest and rarest species is *Lartetotherium sansaniense*. A second species is *Plesiaceratherium fahlbuschi* of which Sandelzhausen provided the type specimen. *Prosantorhinus germanicus* is the third species and most numerous in remains. Compared to the other species this rhino has relatively short limbs and the whole posture is reconstructed as hippo-like. Following this and supported by findings from limnic sediments, the members of the whole tribe (Teleoceratini) are very often described as semi-aquatic in their mode of life. A large project focuses on the postcranial skeleton to answer the question if adaptations are visible to support such a semi-aquatic mode of life hypothesis. A first look at the carpal bones reveals two different morphotypes of the intermedium and the carpale IV. Some of these two bones are showing a palmar located contact facet. Such a palmar articulation has not been observed in the other species from Sandelzhausen or their extant relatives. The intermedium is the carpal bone between the ulnare and the radiale in the proximal row of carpals, and the carpale IV belongs to the distal row of carpals. A palmar contact facet between intermedium and carpale IV would mean a restriction of movement between the proximal and distal row of carpals. In cursorial ungulates a movement restriction shows an adaptation to a higher speed or to a difficult habitat (e.g., mountainous regions), and therefore reduces the danger of injuries. This restricted carpal movement would point to a more cursorial locomotion in *Prosantorhinus germanicus* which would be in contrast to the

predicted semi-aquatic mode of life. Another interpretation lies within an extreme form of sexual dimorphism. Since male rhinos are much heavier than females, the restricted carpal movement may have supported the larger body weight and prevented injuries of the forelimb. Further investigations are needed to shed more light on the ecology of these fossil rhinos.

S1 – The role of hot spots in the break-up of Pangaea and the opening of the Atlantic Ocean

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It is generally acknowledged that mantle plumes played a significant role in the process of fragmentation of the Pangaea supercontinent during late Triassic – early Cretaceous times, although the importance of their contribution is often underestimated. I show that long-lived thermal anomalies in the mantle not only triggered the break-up of central Pangaea but also influenced considerably the tectonic evolution of the Atlantic Ocean from the Early Jurassic onward.

A major point of controversy in modern geology is the role of far-field and "active" forces for rift initiation. Most authors distinguish two end-members in modelling of continental break-up: active rifting, associated with asthenosphere upwelling due to thermal or compositional anomalies (mantle plumes), or passive rifting associated with a regional tensional stress field. Although people generally agree that both mechanisms may contribute to the onset of rifting, it is still unclear if active rifting by itself can drive the rupture of continents. A common line of thought assumes that the lithosphere only breaks passively, although this process may in turn destabilize the lower lithosphere, leading to small-scale convective upwelling of asthenosphere, thereby active rifting may only take place in the late syn-rift or post-rift phase.

The possibility that active rifting represents a viable mechanism for the break-up of a continent is suggested from the observation that active spreading pulses along mid-ocean ridges often cause deformation in the nearby continental margins. These phenomena were first described by Bott in the 1990's, who showed that anomalous hot and low-density upper mantle zones beneath oceanic ridges, forming ocean floor swells, determine a substantial increase in the compressional deviatoric stress field in the oceanic area and in the adjacent continental margins (up to 90 MPa). The existence of post-break-up contractional deformation along passive margins, associated with horizontal compression, has been discussed in many papers, in particular for the northern and central Atlantic regions during the Cenozoic. For instance, I have recently showed that the inversion of the Mesozoic rift structures of the Atlas region, leading to the formation of the Atlas orogen, occurred during the Oligocene – early Miocene and was accompanied by higher spreading rates in the central Atlantic, possibly driven by the Azores mantle plume. Similarly, it was suggested that the rapid northward motion of India during the late Cretaceous – Eocene was driven by the force exerted by the Reunion plume head.

I will outline a new paradigm for the driving forces of plate tectonics, in which divergent flows in the asthenosphere, associated with mantle heterogeneities, are driving mechanisms as well. In this model plates are moved by the combined action of drag stresses exerted on the base of the lithosphere and far-field boundary forces (slab pull and ridge push).

S6 – The rise of Mesozoic marine reptiles and a review of the developmental record

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Today, the percentage of marine reptiles among the total sauropsid species richness is very low, with only 90 out of ca. 20,000 (0.45 %) living in the oceans. Among the five different lineages (turtles, sea snakes, crocodylians, iguana, and birds, of which the latter three are predominantly semi-aquatic) only the sea snakes (Hydrophiidae) are speciose. In contrast, in the Mesozoic the oceans were inhabited by an immense diversity of secondary marine reptiles, including ichthyosaurs, mosasaurs and sauropterygians, all three successful radiations. With their appearance in the fossil record shortly after the most catastrophic mass extinction event in Earth history, the sauropterygians and ichthyosaurs quickly radiated and evolved diverse morphologies, ecologies and life histories. Besides the anatomical study of adaptation to the aquatic environment, it is becoming increasingly important to also look at the physiological, metabolic and life history aspects the organisms experienced. These aspects can be addressed for example with bone histological studies. One key aspect to elucidate phylogenetic relationships and functional constraints is the study of how the early development of the different organisms is affected by the profound changes in environment. Do juveniles have similar lifestyles as the adults? Do they occupy the same or different habitats?

Can the adults still go on land for oviposition or do they have to become obligate (ovo-)viviparous? What are the functional constraints acting upon the small bodies of juveniles in comparison to the adult individuals?

A comprehensive literature review of ontogeny- and bone histology-related papers resulted in the composition of a database (http://www.developmental-palaeontology.net) of developmental evidence in the fossil record. There are 50 morphological and 60 histological entries just for Sauropterygia alone. Ongoing histological sampling such as long bone histology of placodonts, sister group to all remaining sauropterygians will further increase the knowledge of the life history data of these animals. The first examination of the sectioned bones shows that even this small group is already quite heterogeneous, maybe reflecting habitat preference in the microstructures. Furthermore, discovery of a juvenile skull of a basal sauropterygian sheds light not only on the origins of the group but also on the anatomical changes that took place postnatally in these animals. From isolated finds, over more complete fossilised growth series to histological sections which provide insight into an individual's growth record, comparison with extant taxa enables the study of evolutionary processes like sequence or growth heterochrony in fossils, aspects of development which are otherwise barred to palaeontologists.

S24 – On the evolution of the Late Cretaceous sea-urchin *Micraster* – The tale of the *Micraster*-evolution

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The Late Cretaceous echinoid genus *Micraster* is one of the most famous examples of a continuous evolutionary lineage in invertebrates. Since the late 19th century, the transformation of certain morphologies of the test (e.g., ornamentation of the paired petals, the periplastronal region) in successive stratigraphic intervals has been interpreted to be driven by gradual evolutionary changes. This has been demonstrated by several authors. However, only few stratigraphically well-constrained data are available, describing the temporal distribution of the evolutionary states of the ambulacralia. Furthermore, previous work considered exclusively populations from lithologically monotonous nannofossil limestones of cool temperate regions. Here we present new data on the temporal morphological changes of the paired petals and the periplastronal area for the upper Turonian to lower Coniacian interval from warm temperate regions with heterolithic ramp deposits (Cantabria, northern Spain).

The deviations between populations from different facies realms are most obvious in the temporal appearance of morphologies: abundance peaks in "advanced" states occur earlier in northern Spain than in southern England. The temporal occurrence pattern of these states are very divergent, predominately monophenotypic in successive intervals in the Chalk facies (southern England), whilst polyphenotypic populations in the heterolithic facies are found in each stratigraphic interval. Additional, "evolved" states were already present in "primitive" species of *Micraster* (*M. leskei*) in populations of northern Spain, which is in contradiction to previously published works.

We conclude that an involvement of plastic responses to environmental cues is a more plausible explanation of the observed patterns than evolutionary (genetic) induced changes in the morphological states of the ambulacral zones of *Micraster*. Thus, the species concept in this genus, based on progression of distinct characteristics (i.e., ambulacral ornamentation) within certain successive stratigraphic intervals, has to fail in the upper Turonian/lower Coniacian. According to the here presented outcome, the evolution of *Micraster* is not an example for a continuous evolutionary lineage as interpreted by previous workers. Further, it follows that the evolution of *Micraster* has to be revised carefully. Therefore it is inevitable to include larger populations of different palaeoenvironmental settings in further studies.

S18 – Arthropods in Triassic amber

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The fossil record of amber occurrences begins in the Carboniferous, ca. 320 million years ago. Until now, the oldest inclusions of terrestrial arthropods in fossil resins have been ca. 130 million years in age, coeval with the onset in secretion of large masses of resin in the Early Cretaceous. However, we report here the recent discovery of the largest and most promising pre-Cretaceous amber deposit to date, in Carnian (Late Triassic) strata from the Italian Dolomites. Initial research revealed a plethora of delicately preserved microorganisms inside minute ca. 230 million-year-old amber drops from this locality. Subsequent screening of about 70,000 amber drops has since revealed the oldest arthropods preserved in any amber: a nematoceran fly (Diptera) and two species of eriophyoid mites (Acari). The midge is fragmentary and consists of a partial head with portions of some appendages, an antenna, and a portion of the thorax with remnants of at least four legs. This fossil is considered either a nematoceran or a basal Brachycera representative. The inclusions of the eriophyoid mites represent the only definitive pre-Cenozoic fossils of this group and possess very distinct morphologies. One mite is elongate and vermiform and shows bizarre feeding structures, while the other is fusiform, more compact and possesses more integrated mouthparts. Vermiform mites generally live in sequestered spaces (sheaths, galls, buds) that protect them from desiccation, while a fusiform body correlates with a vagrant lifestyle on exposed surfaces of plants. The amber was formed on the leaf surfaces of the source trees, which can be assigned to the extinct conifer family Cheirolepidiaceae. It is therefore likely that the fossilized mites were either sheath dwellers or surface vagrants feeding on this foliage. Eriophyoidea are one of the most specialized and species-rich lineages of phytophagous arthropods and comprise at least 3,500 Recent species, 97% of which feed on angiosperms. The Triassic fossils document that the loss of the third and fourth pairs of legs is an ancestral state, and confirm conifer feeding as an ancestral trait. Further recovery of inclusions in Carnian amber from the Dolomites is promising and will have profound implications for understanding the ancientness and evolution of terrestrial arthropod lineages.

S24 – Late Pleistocene palaeolimnology of the megalake Palaeo-Makgadikgadi (Kalahari, Botswana) inferred from diatom assemblages

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The middle and northern Kalahari feature a palaeo-lacustrine system spanning ~70,000 km2. The lacustrine development is evidenced by palaeo-shorelines of five major structural depressions which have been formed under the tectonic control of the south-western branch of the East African Rift System. Geomorphological studies have shown that during the last ~300 ka at least seven lake high stands at *c.* 935 to 946 m a.s.l. occurred probably having interconnected different lake basins to vast sheets of water. Such megalake phases have been termed Lake Palaeo-Makgadikgadi referring to the Makgadikgadi Basin, the by far largest (*c.* 37,000 km2) and deepest (*c.* 50 m) basin of the lacustrine system. The limnological parameters of Lake Palaeo-Makgadikgadi, such as salinity and pH, are still unknown. We studied a geological section in the Boteti River gorge at Gidikwe Ridge, which is a palaeo-shoreline system bounding the Makgadikgadi Basin to the west, and found a 30 cm thick bank of lacustrine, diatom-rich sediments deposited at *c.* 935 m a.s.l. and thus during a lake high stand. The sediments were OSL dated to 105 to 75 ka. Sixty samples were extracted in 0.5 cm steps and processed for diatom analysis. *C.* 500 valves per sample were counted and 50 different species identified. In average 20 to 30 mainly benthic species were identified per sample. Seven species occurred continuously throughout the section. The frequency of the four taxa *Pseudostaurosira brevistriata*, *Rhopalodia gibberula*, *Cyclotella meneghiniana*, and *Mastogloia elliptica* ranges between 64-88%. *P. brevistriata* and *R. gibberula* are dominant with 44-77%. The diatom assemblages indicate a relatively stable lake phase at *c.* 936-938 m a.s.l., featuring a shallow water, low saline, alkaline environment. Additional palaeoenvironmental information is expected from the oxygen isotope compositions of diatom valves which are currently analysed.

S16 – Paleobiological implications of semicircular canal dimensions in Sauropoda

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In vertebrates the vestibular system is the sensory system that contributes information about balance and movement. The vestibular system, which consists of the semicircular canals (SCC) and the vestibule, is located within the bony labyrinth of the inner ear. The size of the SCC determines their sensitivity, and extant vertebrates of similar body size and lifestyle have similar-sized semicircular canals. This suggests that SCC dimensions may be paleobiologically informative in the largest terrestrial animals ever, the sauropod dinosaurs. Not only did sauropods surpass extant terrestrial animals by an order of magnitude in body mass, but the neck of some sauropods is more than three times longer than that of the giraffe. The small head on this long neck must have experienced very fast angular accelerations, even during slow movements of the neck, which raises the question of how the vestibular system of sauropods could cope with the fast angular acceleration.

Using μCT data and 3D reconstruction software, we visualized the vestibular system and the SCC and quantified SCC dimensions of representatives of most major sauropod clades (*Spinophorosaurus, Nigersaurus, Apatosaurus, Diplodocus, Europasaurus, Brachiosaurus*) and a basal sauropodomorph (*Plateosaurus*). SCC size in relation to estimated body mass indicates apomorphic vestibular proportions. Specifically and contrary to previous suggestions that semicircular canals in all sauropods were rather small, this holds true only for basal neosauropoda (*Spinophorosaurus*) and Diplodocoidea (*Nigersaurus, Apatosaurus, Diplodocus*), while basal macronarian sauropods (*Europasaurus* and *Brachiosaurus*) had average-sized semicircular canals like in *Plateosaurus*. Furthermore, all studied sauropods had disproportionally large anterior SCC but disproportionally small and thick lateral SCC.

Because no direct parallels between Sauropoda and extant species exist in SCC dimensions and proportions, this size discrepancy between the three SCC likely reflects the great body mass and extremely long neck of sauropods. We hypothesize that it was particularly the high angular acceleration experienced by the head during neck movement that is responsible for the peculiarities of sauropod SCC dimensions. The differences between different sauropod taxa in absolute canal size and proportions also suggest different behavioral strategies such as low-browsing vs. high-browsing.

These results will not only provide a better understanding of sauropod feeding strategies as well as head and neck movements but also have implications for the ongoing controversy about neck posture in sauropods.

S25 – Oldest known potamolepid freshwater sponges (Demospongiae) from the Early Permian Döhlen Basin, Germany

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The oldest freshwater sponges known to date are isolated spiculites from the latest Pennsylvanian Stephanian B of the French Massif Central as well as the latest Pennsylvanian Stephanian C and Early Permian Lower Rotliegend of the Saar-Nahe Basin, SW Germany. The so far oldest pre-Cenozoic record of completely preserved freshwater sponges is from Late Jurassic and Early Cretaceous strata in the USA and Argentina, respectively. We report on recently discovered fossil freshwater sponges from the Early Permian Lower Rotliegend of the Doehlen Basin in Saxony, eastern Germany. The silicified remains occur on top of a chert layer in lacustrine limestones of the Niederhäslich Formation (Sakmarian), which is well known for its tetrapod fauna and unusual chlorophycean flora (dasycladaceans, udoteaceans). Our finds include silicified sponge bodies with pinacoderm, strongyles, gemmules, gemmuloscleres, and gemmulopavements, complex parts of skeletons, and choanosomale skeletons. Microscleres have not been observed. On this base the remains are assigned to Potamophloios n. sp. of the family Potamolepidae. They represent not only the oldest known completely preserved freshwater sponge skeletons and the oldest record of gemmules of freshwater sponges, but also the oldest record of the family Potamolepidae which was hitherto only known from the Miocene to Recent.

Immigration into the Permian lake has presumably taken place in the form of dry resistant gemmules transported by wind or semi-aquatic animals such as larger insects or tetrapods.

Recent Potamolepidae limited to East Africa and South America may represent only relicts of a once Pangaean-wide distributed group of freshwater sponges.

S13 – Finding localities of the Triassic "Lizard fish" *Saurichthys* in Germany

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Due to the characteristic elongated head with long, obliquely striated jaws and the long and slender body with reduced squamation and specialized scales and fins, even fragments of the fossil actinopterygian *Saurichthys*

are easily identifiable at generic level. Isolated conical teeth with distinctly striated shafts and smooth enamel caps have also long been regarded diagnostic, but this evidence is questionable.

Although our knowledge of *Saurichthys* mostly relies on specimens from Early Triassic sediments of Spitsbergen, Madagascar and Canada and from Middle and Late Triassic rocks of Switzerland and Italy, many historically important finds come from the German Buntsandstein, Muschelkalk, and Keuper. As early as in 1710, the first *Saurichthys* skulls were pictured in M.D.S. Büttner's book on signs and witnesses of the Flood in the district of Querfurt (Saxony-Anhalt), however with no description or attempt of attribution. In 1834, Louis Agassiz established the genus *Saurichthys*, basing it on a fragment from the upper Muschelkalk (Ladinian) of Bayreuth-Laineck (Francony). Solely cranial material, including a nearly complete, ca. 20 cm long skull, has been collected in those quarries; it has long been a problem for the understanding of the genus *Saurichthys* that the body of its type species *S. apicalis* is unknown.

Another type of skulls from Middle Muschelkalk (Anisian) near Jena (Thuringia) is known as *S. tenuirostris*. They are comparatively small (less than 10 cm in length) and narrow and the skull roofing bones are covered with fine tubercles. Again, no associated postcranial material is found. Similar skulls occur at several localities in Thuringia and Saxony-Anhalt, and a find from the Röt (Upper Buntsandstein, early Anisian) of Jena-Göschwitz has also been reported under this name.

Skulls and jaws of *Saurichthys* different in shape and ornamentation have been described from the Röt and Middle Muschelkalk of Rüdersdorf (Brandenburg). A three-dimensionally preserved skull and several recently discovered complete, about 20 cm long individuals accumulated on few bedding planes provide good material for future study. Middle Muschelkalk of Lower Saxony also yields saurichthyid skull fragments.

Numerous very small (<10 cm) complete specimens, isolated skulls and fragments have been collected in the Röt of Hammelburg and Münnerstadt (Franconia). They belong to the smallest saurichthyids known and, whether juveniles or not, probably represent two or more new species.

A fragmentary upper jaw from Lower Keuper (late Ladinian) of Altenmünster (Franconia) has been described as *S. gypsophilus*. Jaw fragments referable to *Saurichthys* also occur in the Lower Keuper of Baden-Württemberg. Finally, incomplete skulls found in the Lehrbergschichten of Stuttgart (Middle Keuper, early Carnian) are known as *S. irregularis*.

The fragmentary preservation of most German *Saurichthys* remains is explained by the contrast between the large, massive, heavily ossified head and the elongate body with reduced squamation. Under highly energetic conditions of the shallow epicontinental Muschelkalk sea, the skulls were detached, further fragmented and subsequently buried, whereas bodies got completely destroyed.

S25 – The Leviathaniidae – the largest pre-Cenozoic gastropods

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The Middle Tithonian to Berriasian carbonates of the Alpine-Carpathian northern Tethys margin yield giant, up to 40 cm high gastropods, which are assigned to the genus *Leviathania* Pčelintzev. These snails formed dense populations in the wide-spread, highly productive lagoonal environments situated on the carbonate platforms of Ernstbrunn (Austria), Mikulov, Štramberk (both Czech Republic), and Niżniów (Ukraine). Despite their eye-catching size and morphology, these gastropods have been treated as Purpurinidae Zittel or Purpuroideidae Guzhov to date. However, a separation from these families is obvious based on the phaneromphalous umbilicus, weak sculpture and large size of *Leviathania*. Therefore, the new family Leviathaniidae was established by the authors and tentatively assigned to the order Littorinimorpha Golikov & Starobogatov. Currently, the family comprises a single well defined genus with several species, which suggest an origin of *Leviathania* during the Kimmeridgian, when it is known from northern Germany. During the latest Jurassic, the family was distributed along the northern Tethys shelf, from Austria in the west to the Ukraine in the east. During the Early Cretaceous, the family spread from Spain and France via Switzerland as far east as the Caucasus. The species currently assigned to the family Leviathaniidae seem to have been characteristic members of the benthic assemblages of the tropical lagoons of the northern Tethys shelf. They were less frequent in reefal settings but rather preferred mobile bioclastic sediment. In modern gastropods, the population densities and the impressive shell-size of *Leviathania* are comparable only with those of the stromboidean gastropods, e.g. the queen conch *Lobatus gigas* (Linnaeus) from the Caribbean Sea. Therefore, we tentatively suggest a comparable herbivorous/omnivorous life style for the Leviathaniidae. Last but not least, the Leviathaniidae comprise the largest pre-Cenozoic gastropods, represented by a yet unnamed gigantic *Leviathania* species from the latest Tithonian or early Berriasian of Ukraine.

S2 – Bivalve ecology drives biodiversity – early rudist "reefs" on Tithonian-Berriasian carbonate platforms

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The Hippuritida, commonly known as rudist bivalves, evolved at around the Middle to Late Jurassic transition and persisted until the end of the Cretaceous. Very soon in their evolution the rudists, namely their two basal families, the Epidiceratidae and Diceratidae, formed densely grown clusters – the forerunners of the expansive rudist reefs of the Late Cretaceous. Unlike coral reefs, these rudist build-ups are characterised by a remarkably low biodiversity both of constructors and reef dwellers. In contrast, the Tithonian-Berriasian carbonate platforms of the northern Tethys margin are well-known for their extraordinary species richness, which was promoted by a complex environmental patchwork of fringing ooid bars, scleractinian patch reefs, and lagoonal habitats. Identified as the cradle of the modern crab fauna, these environments, in particular the Ernstbrunn-Pavlov Platform of NE Austria and SE Czech Republic and the Štramberk Platform of NE Czech Republic, also hosted an extraordinary high number of bivalve, gastropod, and other benthic invertebrate species. This is however not true for the immediate vicinity of the Epidiceratidae. These bivalves – often also found as reef associates – grew to patch reefs of several decimetres in height and extent in favourable settings. Individuals of different rudist species attached to various substrates as well as to each other by cementing of their lower valves. Despite their presence in the near vicinity, however, the numerous other cementing organisms, e.g., scleractinians, coralline sponges, or oysters, are never found attached to the shell of a living rudist. Likewise, byssally attached bivalves, grazing gastropods, and other dwellers were virtually absent from the epidiceratid patch reefs. Based on exceptional samples from the Ernstbrunn Limestone of Lower Austria, the present study investigates the ecology of these early Hippuritida trying to shed light on the causes of depleted biodiversity in their ambit.

S6 – Developmental evolution of early tetrapods: a diversity of life histories

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The origin of tetrapods has traditionally been studied with the focus on adults. Yet as modern amphibians exemplify, life cycles are often complex and it requires understanding of the whole ontogeny to analyze the evolutionary history of a clade. The integration of ontogenetic and paleoecological data from the fossil record permits a new perspective on early tetrapod evolution, revealing adaptive strategies behind life cycles. This is the study of life history evolution, which in recent years has come into reach of paleontology, after developmental data of Paleozoic and Mesozoic amphibians have been analyzed. According to these findings, life histories of early tetrapods were diverse and often complex, with metamorphosis and neoteny (the typical traits of modern amphibians) having emerged only late within the amphibian lineage. Although ancient tetrapod life cycles were mostly uniphasic, they were more flexible than those of salamanders and frogs in some respects.

S20 – The Turkana Basin (N. Kenya) in the Plio-Pleistocene: cradle or sink of molluscs?

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The Turkana Basin between Kenya and Ethiopia is famous for the large number of hominid fossils recovered from the Pliocene and Pleistocene sediments around present-day Lake Turkana. Since the earliest discoveries of hominid fossils along the eastern shore of Lake Turkana in the early 1970s, more than 200 hominid specimens of at least seven distinct species have been discovered. Along with the hominids, fossils of many other taxa have been reported from the Turkana Basin including molluscs. These mollusc successions became famous when they were suggested to represent an ideal documentation for the punctuated equilibrium model of evolution.

During our work we focussed on a thorough revision of the diversity and disparity pattern of freshwater molluscs in the palaeolake Lorenyang (upper Burgi and KBS Members), based on new in situ bulk collection of the fossils in their stratigraphic and sedimentologic contexts, in order to better understand the reported faunal changes. One aspect of the study was the biogeographic relationships of the molluscs of the Turkana Basin. In the case that the Turkana Basin actually represents an evolutionary hotspot for molluscs in the Plio-Pleistocene, the developments in the basin should have a significant impact on the malacofauna composition of East Africa today.

According to our assessment, we consider 24 species as validly occurring in the upper Burgi and KBS Members. Two-thirds of these species (n=16) are also found outside the Turkana Basin. Only eight species are restricted to the Turkana Basin and seven of these are only known from the fossil record of the upper Burgi and KBS Members. The majority of the 16 cosmopolitan species are today known from the Nile River. This reflects connections of the catchment areas of the Nile River and the Omo River

(main tributary of Lake Turkana today) in the Ethiopian Highlands. It also reflects elements of the Jurassic-Paleogene Central African Rift System, which influenced biogeographic and sedimentary patterns in the Turkana Basin until the Middle Pleistocene.

Combining all the evidence, the fossil malacofauna of the Turkana Basin is mainly a mixture of so called Nilotic elements and some exotic elements. Accordingly, the basin itself is more a sink than a cradle of molluscs. This is even more true when considering the modern Lake Turkana, as its high alkalinity renders it a very unsuitable habitat for molluscs in which only a few species are able to survive. Although Lake Turkana sits at an intersection of East African malacofauna provinces, the alkaline water and arid conditions of the lake environment make it an effective barrier for the exchange of mollusc faunas today.

S25 – Like a BEAGLE's second voyage: bryozoans in collections

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The young Charles Darwin dedicated his very first scientific study to bryozoans (1827). Several decades later, Darwin was dealing again with bryozoans in his "Origin of Species". His collection, deriving from the voyage of the H.M.S. *Beagle*, is today kept in the NHM in London. It goes without saying that such objects are rated as cultural heritage, and we are obligated to preserve them for future generations to admire.

Aside from the heritage aspect (1), additional fields of relevance for bryozoan specimens in museums are outlined (2-6), using examples mainly from collections of the Natural History Museum, London, and the Senckenberg Research Institute, Frankfurt/M.:

(2) Museum collections of bryozoans contain many undiscovered or poorly known species;

(3) Recent developments in biodiversity and environmental research have highlighted the greater importance of museum collections, with researchers acknowledging that these libraries of biodiversity are largely under-exploited sources of key information about the conservation of species;

(4) Describing newly acquired bryozoan specimens from almost unexplored areas, such as Red Sea shoreline of the Kingdom of Saudi Arabia or the deep sea, is extending bryozoan databases;

(5) Sometimes, the old fashioned style of illustrating types in earlier publications precludes their reliable use in species identification. In many species, classification is in urgent need of updating;

(6) The modern Bryozoa fauna has been established since the Cenomanian, and been subjected e.g. to periods of mass extinctions, and changes in sea water chemistry and climate. Once we know what caused bryozoan diversification in the Late Cretaceous, we could make comparisons with the modern fauna. Establishing bryozoans as a model system for exploring tempo and mode of morphological evolution in the marine fossil record requires well sorted paleontological collections.

Frequently under-valued, often under-funded and in some cases considered disposable, natural history collections of bryozoans are unique databases giving a perspective through time and space, thereby illustrating the need to raise public awareness of minority groups, such as the Bryozoa.

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S25 – Diversity of *Aspidorhynchus* Agassiz, 1833 (Neopterygii, Aspidorhynchiformes) in the Solnhofen limestones, Germany

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The genus *Aspidorhynchus* belongs to the family Aspidorhynchidae, a group of Mesozoic actinopterygian fishes. Seven species of *Aspidorhynchus* are currently recognized worldwide.

In the Solnhofen limestones of southern Germany, only two species of *Aspidorhynchus* (*A. acutirostris* and *A. sanzenbacheri*) have been accepted as valid. During the study of *A. acutirostris*, the type species of the genus, we found significant morphological variation among the specimens referred to this species, particularly in the ornamentation of the flank scales.

After thorough revision of several type and referred specimens, we have identified four different species of *Aspidorhynchus* in the Solnhofen Archipelago, corresponding to the already available nominal species *A. acutirostris*, *A. ornatissimus*, *A. obtusirostris* and *A. sanzenbacheri*. In addition to the strong differences in the ornamentation of the scales, these species differ in the

shape of the premaxilla, the shape and dentition of the predentary, the ornamentation of the skull roof bones and the shape of the basal fulcra of the caudal fin.

In addition to these important taxonomic results, we found several morphological features previously unknown for this genus. Aspidorhynchids, for example, have been characterized by the absence of an interoperculum among other features. An antorbital has never been described in Aspidorhynchids. However, both the interoperculum and the antorbital are present in *Aspidorhynchus*.

Aspidorhynchus shows close morphological similarity with other non-teleostean neopterygians, indicating a more basal systematic position than previously thought. A monographic anatomical revision of *A. acutirostris*, currently in preparation by the authors, will certainly help in solving the systematic position of these fishes, which is still controversial.

S5 – Foraminiferenfauna, Sedimentologie, Geochemie und paläoozeanographische Entwicklung an der Eozän/Oligozän-Wende in der Bohrung Loburg 1/90 (Sachsen-Anhalt)

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Die Bohrung Loburg 1/90 (Sachsen-Anhalt) Iiegt am Südrand des paläogenen Nordseebeckens und durchteuft unter anderem die Eozän-Oligozän-Grenzschichten. In den Ietzten Jahren wurden vor allem die Obere Schönewalde-Formation (hier = OS, Ober-Eozän, Priabonium) und die Rupel-Formation (hier = R, Unter-Oligozän, Rupelium) umfassend bearbeitet.

Ober-Eozän: Die OS (25m, NP21-?22, Dn12c, E14-16, O1) beginnt mit einem Trangressionskonglomerat, gefolgt von sandigen und tonigen Abschnitten. Anfangs dominiert Glaukonit, gefolgt von Quarz und danach Pyrit und Glimmer (reduzierende Bedingungen). Viel schwefelhaltiges Corg und hohe C/N-Werte (bis >45) weisen auf terrestrischen Einfluss hin. lm oberen, kalkreicheren Abschnitt sinken die C/N-Werte auf etwa 15.

Die OS endet an einer weit verbreiteten Erosionsdiskordanz. Die Eozän/Oligozän-Grenze Iiegt offensichtlich in der oberen OS. Die kalkige Foraminiferenfauna insgesamt zeigt hier noch deutliche Beziehungen zur Tethys. Die nachfolgende Lücke umfasst den höheren Abschnitt der NP22, eventuell der D12nc, sicher aber einen Teil der Dn13 und den höheren Abschnitt der O1.

Unter-Oligozän: Die Erosion des R 1 greift infolge tektonischer Bewegungen auf unterschiedlich alte Abschnitte der OS über. In den Hiatus fällt eine Verschiebung der Sauerstoff- (positiv, 1,2 ‰) und Kohlenstoffisotope (negativ, etwa 0,5 ‰). Diese Verschiebung könnte dem Oi-1-Event entsprechen (je nach stratigraphischer Einordnung, NP21 oder 22). Die Verschiebung in Loburg ist in jedem Falle z.T. mit einem Temperaturrückgang verbunden (etwa 3º C), verursacht durch die Unterbrechung der Verbindung zwischen Nordseebecken und Tethys, sie ließe sich aber teilweise auch durch Salinitätsunterschiede zwischen OS und Rupel-Fm. oder eventuell die antarktische Vereisung erklären.

Der über der Erosionslücke folgende sandige R 1 lässt sich nur durch Dinoflagellaten datieren (D 13). Der R 2 (D14na, NP23, O2) zeigt eine kurzfristige transgressive Phase mit Quarz und Glaukonit sowie niedrigen δ18O-Werten und eine länger andauernde Phase mit reduzierenden Bedingungen. Siderit-reiche Lagen mit niedrigen δ13C- und hohen C/N-Werten Iassen auf vorübergehende terrestrische Einflüsse schließen. Im oberen Abschnitt zeigen Bolivinen-reiche Phasen mit niedrigen δ13C-Werten Auftrieb an. In der Foraminiferenfauna fehlen nun die „Tethys"-Arten. Der R 2 geht durch Abnahme der Foraminiferenfauna sowie des Kalk- und Pyritgehaltes kontinuierlich in den R 3 (D14na, NP23, O2) über, es dominiert Quarz. Der C/N-Index erreicht nicht mehr die hohen Werte des R 2, Anzeichen von terrestrischem Einfluss fehlen. In der spärlichen Foraminiferenfauna dominieren *Glomospira, Ammodiscus, Bathysiphon* und *Recurvoides*. Diese Assoziation könnte auf einen Anstieg der CCD hinweisen, wahrscheinlicher ist auf dem Schelf aber eine erhöhte Sauerstoffversorgung durch intensivierte Strömung, verbunden mit einer verstärkten Kalklösung. Der R 4 (NP 23-24, (Dn14a)-Dn 14b, O3-4) setzt relativ unvermittelt mit erhöhten Kalkgehalten und Foraminiferenzahlen ein. Im unteren Abschnitt dominiert Pyrit, später Quarz. Die C/N-Werte liegen zwischen 10 und 15; hohe Werte wie im R 2 fehlen. lnsgesamt zeigt der R 4 gegenüber dem R 2 ausgeglichenere Verhältnisse, organische Substanz wird zunehmend abgebaut.

S26 – Funktionsweise prätribosphenischer Gebisstypen

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Die ursprünglich orthale Kieferbewegung der Tetrapoda wurde im Laufe der Evolution der Säugetiere zu verschiedenen Kaubewegungen abgeändert. In Kombination mit der Entwicklung der hochpräzisen Okklusion von Ober- und Unterkieferbezahnung entstanden neben der Fähigkeit zur effektiveren Nahrungszerkleinerung auch komplexe Gebissformen. Als klassisches Beispiel zur Erschließung eines breiteren Nahrungsspektrums gilt

der tribosphenische Molar, der durch die Ausnutzung einer transversalen Kieferbewegung zusätzlich zu der ursprünglich stechend-schneidenden eine reibende Funktion ermöglicht. Noch bevor dieser auftrat, wurden bereits im Mesozoikum innerhalb der Mammaliamorpha und frühen Mammalia unterschiedliche Mastikationstypen zur effizienteren Nahrungszerkleinerung entwickelt. Striationsanalysen, moderne Mikro-Computertomographie, sowie virtuelle Simulationen von Mastikationszyklen tragen zur Klärung der Funktionsweise der prätribosphenischen Molarentypen bei. Der „Occlusal Fingerprint Analyser" (OFA) ermöglicht die Visualisierung von Mastikationszyklen fossiler Gebisse und über die Detektion von Kollisionsflächen zwischen Ober- und Unterkiefer lässt sich deren Effizienz erstmals quantifizieren.

Dryolestida, Docodonta und Triconodonta weisen einen transversalen Kauweg (buccal nach lingual) auf, während Tritylodontia und Multituberculata durch einen palinalen Kauweg (mesial nach distal) charakterisiert sind. Beim Mastikationsvorgang der Dryolestida treten während der Okklusion die Trigonide der unteren Molaren in die dreieckigen Zwischenräume zwischen den oberen Molaren. Die spitzen Zahnhöcker haben eine stechend-quetschende Funktion, während die scharfen Scherkantenpaare als Schneidewerkzeug genutzt werden, um beispielsweise harte Exoskelette von Insekten zu zerteilen. Teile der Nahrung werden entlang der Hauptscherfläche in der nach buccal abfallenden Hypoflexidrinne zerschert, aufgrund einer fehlenden buccalen Begrenzung entfällt die reibend-quetschende Komponente. Die Kollisionsdetektionen zeigen, dass diese Rinne bei der Nahrungszerkleinerung der Dryolestida eine bedeutende Rolle spielt, während die homologe Struktur bei den Tribosphenida nur von untergeordneter Bedeutung ist. Bei den Dryolestida endet der Kauzyklus mit der zentralen Okklusion, während sich daran bei den Tribosphenida eine reibende Phase anschließt. Unterschiedlich gerichtete Striationen weisen darauf hin, dass der Kauzyklus der Dryolestida dennoch zweiphasig ist. Im Vergleich zu den insektivoren Dryolestida zeigen die herbivoren Tritylodontia und Multituberculata mit palinaler Kaubewegung eine ganz andere Molarenmorphologie. Beide Gruppen haben Oberkiefermolaren mit drei parallelen Reihen eng stehender Höcker, in welche die zwei Höckerreihen der Unterkiefermolaren hineingreifen. Trotz gleicher Kieferbewegungsrichtung und ähnlicher Morphologie weisen Tritylodontia und Multituberculata verschiedene Zerkleinerungsstrategien auf. Während die Tritylodontia sehr steile Höcker mit deutlich ausgeprägten Scherkantenpaaren besitzen, haben die Multituberculata eher abgerundete Höcker. Striationsanalysen zeigen bei beiden, dass die Kaubewegung streng mesial-distal gerichtet gewesen sein muss. Die pflanzliche Nahrung wird bei den Tritylodontia entlang der steilen, hintereinander geschalteten Scherkantenpaare zerschnitten. Bei den Multituberculata werden dagegen eingeklemmte Nahrungspartikel zwischen den großen Scherflächen zerschert und in der Rinne der unteren Molaren zerquetscht.

Die virtuelle Rekonstruktion von Mastikationszyklen ermöglicht sowohl eine Analyse der Effizienz der Nahrungszerkleinerung als auch Rückschlüsse auf die Beschaffenheit der Nahrung fossiler Taxa. Funktionalität der Zähne und Gebisse können unabhängig von zusätzlichen Informationen, wie etwa Schädelform oder überliefertem Mageninhalt, erfasst und verglichen werden.

S14 – The palaeoenvironment at the transition from piscine to tetrapod sarcopterygians

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The transition from piscine to tetrapod sarcopterygians is now accepted to have occurred in a coastal marine environment, whereas for most of the last century a transition in freshwater palaeoenvironment was proposed and accepted. An origin of tetrapods in a freshwater palaeoenvironment cannot be explained physiologically, as has been shown fifty years ago by comparison with extant fishes. Like the piscine sarcopterygians the first tetrapods were also living in coastal marine to brackish environment. That brings up the question when early tetrapods lost the tolerance to salty marine environments. A cladistic approach may be the way to investigate this problem, as this method was also used to reach the conclusion that the fish/tetrapod transition occurred in a coastal marine environment. The mapping of the palaeoenvironment on an early tetrapods phylogeny suggests that even the earliest amniotes may have been tolerant of salty water as now indicated by the reinterpretation of the Joggins fossil locality as coastal marine environment.

S17 – Variability in tooth wear indicates attritional wear – implications from feeding experiments with lagomorphs

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Dental microwear and 3D surface texture analysis are useful in reconstructing herbivore diets, with scratches usually interpreted as indicators of grass dominated diets and pits as indicators of browsing. We conducted feeding experiments on a captive population of 32 rabbits (*Oryctolagus cuniculus*) over a period of 25 weeks using four different pelleted diets (lucerne, lucerne & oats, grass & oats, grass). The lowest silica content was measured in the lucerne and the highest in the grass diet. After extended exposure to each diet dental castings were made of the rabbit's lower molars. Occlusal surfaces were then investigated using dental microwear and 3D areal surface texture analysis. In terms of classical microwear, we found our hypothesis supported, as the grass group showed a high proportion of (long) "scratches" and the lucerne group a high proportion of "pits". Regardless the uniform diets, variability of microwear and surface textures increased with lower silica content. A high variability in microwear and texture analysis thus need not represent dietary diversity, but can also be related to a uniform, low-abrasion diet. In other words, the uniformity or variability of microwear/texture analysis results may be associated to the degree of abrasion and attrition.

S2 – Evolution of ecological traits along a latitudinal transect in Chilean mollusks since the Miocene

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Studies throughout the last two decades have shown an inversion of the latitudinal diversity gradient in marine mollusks south of 42°S off the coast of Chile. More recent studies dated its origin to the younger Quaternary. Until now these studies have generally focused on diversity. Combining databases of fossil and extant molluscs provided by earlier studies on the latitudinal diversity gradient a new database is created. By adding ecological characteristics to the species this work unravels the trends in ecological traits and their origins. This shows a trend-inversion induced by a shift in the Humboldt Current System due to Andean uplift during the late Miocene. This change in oceanographic patterns led to a cooling of the South Pacific off Chile severely affecting species of high trophic levels. The Miocene fauna, dominated by epifaunal predators, is succeeded by a post-extinction fauna during the Pliocene-early Pleistocene leading to today's more balanced faunal composition. After excluding the biased record of hard substrate dwelling species further research shows that although gastropods are the main contributor to the trend-inversion. Each family seems to have its own latitudinal ecology pattern. Finally, the quality of the data is analyzed revealing possible sampling bias in parasitic gastropods.

S3 – New insights into the classification of desma-bearing demosponges ('Lithistida') – A combined molecular and morphological study

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Lithistid sponges, a polyphyletic group within demosponges, share a rock-like skeleton of irregularly articulated siliceous spicules (desmas) with a high fossilization potential, and provide the richest fossil record among demosponges. Although strong indication for polyphyly of lithistids exists, they are frequently still assigned to a taxon "Lithistida", while their exact taxonomic classification is still under debate. Unraveling the taxonomic relationships within this group, as well as in respect to other demosponges, is important to obtain a deeper understanding of demosponge evolution. This study therefore aimed to comprehensively analyze the phylogeny of lithistid sponges using a molecular paleobiological approach and evaluate existing phylogenetic hypotheses based primarily on morphological traits as well as to reconstruct the evolution of spicule morphology within lithistid sponges. We used unlinked mitochondrial protein-coding and nuclear ribosomal markers in addition to a newly constructed morphological character data matrix for our analyses.

Our results confirm most of the previous molecular results on lithistid sponge phylogeny, but also provide new insights into the relationships within lithistid sponges, which are sometimes conflicting previous morphological hypotheses. Our results assign at least 8 out of 13 families to the Astrophorida and we additionally suggest that three other families (Scleritodermidae, Siphonidiidae and Azoricidae) show affinities to Tetractinellida. Relationships of the polyphyletic lithistid family Desmanthidae to halichondrid sponges as well as the sister group relationship of the monotypic family Vetulinidae to freshwater sponges (Spongillina) is further supported. Preliminary results on the evolution of spicules indicate that desma

spicules got lost several times independently in different sponge orders, which could explain the conflicts observed between morphological and molecular classification.

S25 – 'Septal compass' and 'septal formula' – a new method for phylogenetic investigations of the ear region in sciuromorphs (Rodentia, Mammalia)

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In the last century, morphological investigations of the ear region in rodents were focussing on the three auditory ossicles or the bony labyrinth with the inner ear. Pneumatization of the tympanic and mastoid region but also the bony septa in the recessus epitympanicus and the cavum tympani were described, but their phylogenetic value was not realized. In this study, the 'septal compass' is developed for illustrating the characteristic internal anatomy of the ear region. Therefore, 'primary' and 'secondary septa' are distinguished, depending on their spatial direction and position in the recessus epitympanicus and the cavum tympani. Supplementary to the compass, the 'septal formula' allows a numeric description of this anatomy and is used in a similar way to the 'dental formula'. Applying the compass and the formula on the ear region of sciuromorphs, a group of rodents composed of sciurids, glirids and *Aplodontia rufa* in which phylogenetic relationships based on morphological data are not consistent, remarkable anatomical differences are observed. In sciurids, ventrally and dorsally laying 'primary' and 'secondary septa' are formed. Glirids do not possess any septa in the recessus epitympanicus, but show additionally sinuses in posteromedial direction. The ear region of *Aplodontia rufa* is quite different, whereby a network of bony septa is observed, also seen in one of the oldest known rodents, *Ischyromys typus*. Therefore a bony network can be postulated as a ground plan character of sciuromorphs, which has been reduced in different ways in glirids and sciurids. For further investigations of the internal anatomy of the ear region in rodents, the 'septal compass' and the 'septal formula' are particularly suitable for illustrating phylogenetic issues.

S17 – Function and wear in the dentition of the common opossum (*Didelphis marsupialis*)

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Extant marsupial *Didelphis marsupialis* can be used as a comparative model for basal Mesozoic Theria because of its plesiomorphic dentition. The tribosphenic molars of *D. marsupialis* closely resemble that of Late Cretaceous metatherians such as *Alphadon*, and therefore can be considered as a model for the understanding of the chewing cycle of basal therians. The function of the dentition of *D. marsupialis* was analyzed based on high resolution 3D-models of the molars, applying the Occlusal Fingerprint Analyser (OFA) software, to virtually reconstruct the chewing cycle. It demonstrates the combination of the two basal functions in the tribosphenic molar: cutting and shearing between trigon and trigonid and grinding between protocone and talonid.

Successive progress of dental wear was studied at molar rows of about 60 specimens of different ages (juvenile, adult, senile) from South and Middle America. Five categories of dental wear stages were distinguished. The loss of dental material during the lifespan is a result of apical wear and the formation of functional facets. In the first three wear stages studied, apical wear corresponds to increasing facet areas. Afterwards, in stages four and five, facets become smaller with progressing apical wear of the cusps. This process can result in the complete destruction of the tooth crown. The wear stages in a tooth row decrease from the first to the fourth molar, corresponding to the succession of tooth eruption.

The comparison of tooth rows revealed individual differences in wear patterns expressed through the gradient of wear between first and last molars, mode of abrasion, varying formation of facets and preferred e sides of mastication. In one-third of the individuals areas of exposed dentine at the lingual sides of the molars were observed. They occur more often in upper than in lower molars and cannot be attributed to any dental antagonistic tooth contact. The development of these facets is probably related to the interaction of the tongue and food particles.

The species of *Didelphis* are characterized as opportunistic and omnivorous, feeding mostly on fruits, seeds, leafs and grass, insects, other arthropods and earthworms. Vertebrates up to the size of a chicken or rabbit are documented as a common diet. The diversity in the individual wear patterns in *Didelphis marsupialis* reflects the wide range of habitats occupied and various nutriment ingested by this species.

S17 – Mastication in *Diacodexis* and other primitive Artiodactyla

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The masticatory cycle of most modern selenodont artiodactyls is relatively uniform and derived with a one-phased power stroke and no centric occlusion. Their teeth, equipped with many sharp enamel edges, are ideal tools for cutting, shearing and grinding fibrous, plant food. The dentition of *Diacodexis*, the first known artiodactyl, is distinctly different in morphology and function compared to the selenodont dentition of modern species. Therefore the masticatory cycle of *Diacodexis* was investigated, in order to understand the evolution of the tooth pattern and the linked functional differences in mastication among the artiodactyls.

Diacodexis occurs in the Lowest Eocene and has a primitive bunodont dentition with triangular upper molars and six cusped lower molars. In contrast to most other artiodactyls it has only three main cusps and no hypocone. The orientation of enamel facets and the direction of striations on their surface allowed the reconstruction of the masticatory cycle. The results show a two-phase cycle, with Phase I and Phase II separated by centric occlusion. It combines a cutting function in Phase I and a crushing function during centric occlusion and Phase II. Investigations based on digital 3D models of dentitions of *Diacodexis* show a higher amount of facets that are developed during the cutting function. Thus, it can be concluded that the proportion of leaves in the diet was relatively higher than the proportion of fruits, seeds or nuts.

With the diversification of the artiodactyls during the Eocene more derived bunodont, bunoselenodont or selenodont dentitions with differences in crown morphology and cusp pattern were developed. In contrast to *Diacodexis*, they all have a hypocone in common. In order to understand the associated differences in function and mastication, the dental morphology and masticatory cycle of some primitive artiodactyls were investigated. So the enamel facets and striations of the five cusped bunoselenodont upper molars of *Microbunodon* (Anthracotheriidae) indicate a power stroke consisting of Phase I and Phase II, separated by centric occlusion. The Oreodontoidea, including the basal bunoselenodont *Agriochoerus* (Agriochoeridae), and the more derived selenodont Merycoidodontidae, show no Phase II facets and the striations indicate a consistent direction of movement. However, manipulation of jaws suggests that there is a disruption of the movement after centric occlusion, although there is no remarkable change in direction. In contrast, there is a consistent moving direction during the power stroke without disruptions in *Caenomeryx*, a selenodont species belonging to the European endemic Cainotheriidae. Hence, the crown morphology of selenodont molars seems to induce a consistent direction of movement during the power stroke and the basal selenodont species characterize the transition from a two-phased masticatory cycle in primitive species to a one-phased cycle in modern selenodonts.

S1 – Introduction

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In 1912, 100 years ago, Alfred Wegener first published his revolutionary theory of continental drift. Though the idea lay largely dormant for fifty years, in the mid-1960's it was embraced by the geophysical and geological community and since that time has revolutionized the way we think about the Earth. In many respects Alfred Wegener was one of the first "Earth System" scientists. His interests were multi-disciplinary and his attempts to understand the processes that interlinked geology, climatology and paleontology were decades ahead of his time. In this symposium we will hear from a few of the intellectual descendants of Alfred Wegener, and get a glimpse of how his vision of the Earth has transformed our understanding of the history of the Earth and the interlinked processes that have shaped our planet.

S1 – Continental drift: the idea that changed the world

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I briefly review some of the highlights of the PALEOMAP Project. These include the 1) PALEOMAP PaleoAtlas for ArcGIS, 2) the app for the iphone/iPod called "Ancient Earth", 3) the Global Geology website, and 4) the Earth System Archive Project.

The PALEOMAP PaleoAtlas for ArcGIS comprises 52 paleogeographic maps organized into 6 volumes (Cenozoic, Cretaceous, Jurassic&Triassic, Late Paleozoic, Early Paleozoic, & Neoproterozoic). The information for each paleogeographic map is organized in a hierarchy of feature layers. The eight principal feature groups are: graticule, modern features, lithology, plate tectonics, paleorivers & drainage, paleocliamte, paleogeograghy, and paleogeography. The PALEOMAP PaleoAtlas has become an industry-standard source of information about the evolution of the Earth System.

The paleoglobes in Ancient Earth: Breakup of Pangea are taken directly from the maps in the PALEOMAP PaleoAtlas. Using this interactive app for the iPad/iPhone users can view the ancient Earth from any point-of-view. By scrolling the timescale along the bottom of the app window, users can animate the

motions of the continents and oceans backwards and forward through time. In the next release of Ancient Earth, users will be able to plot modern data and track the positions of the information back through time.

The Global Geology Website (www.globalgeology.com) is both an archive of stratigraphic information and a portal to the geology of the world. Like a cross between Google Maps and Wikipedia, globalgeology.com, uses a geological map of the world (1:10,000,000) as an interface to help users locate and enter geological information. The bulk of the information, however, comes from the worldwide community of geologists, and like Wikipedia, the global geology website is an editable, community effort. A new feature of the global geology website is teh ability to plot geological data for selected time intervals on downloadable "Google Earth"-style kmz files.

The Earth System Archive (ESA) Project is a joint with Thomas L. Moore (PaleoTerra, Bolingbrook, Illinois). The Earth System Archive is a software and GIS data package that provides paleoenvironmental information about the Earth's surface during the last 600 million years. The Earth System Archive is built upon 31 paleoclimatic and paleogeographic simulations of the GANDOLPH project. For each of these time intervals the user will be able to map out more than 40 environmental variables. The user will also be able to and track the changing value of any of these environmental variables at any location on Earth, back through time.

S11 – Paleoenvironmental significance of ferromanganese stromatolites in the early Cambrian of the Lesser Karatau Range, Kazakhstan

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The Lesser Karatau Range of southern Kazakhstan exposes Ediacaran to Cambrian strata deposited in low-latitude shelf settings, comprising mixed volcanic-arc-derived siliciclastics, cherts, phosphorites and platform carbonates. Despite intense tectonization and weathering in this area, these rocks retain a geochemical signature typical of open marine waters as evidenced by REE patterns. Remarkably, an early Cambrian regressive sequence is capped by a thin, discontinuous yet regionally widespread horizon of ferromanganese-rich carbonate stromatolites. The morphology of coalescent cm to dm high stromatolitic columns and their preservation in channel fills suggests that their growth was limited by a very shallow water depth and frequent drying phases, whereas episodes of higher hydrodynamic regime resulted in the formation of centimetric oncoids. Non-biolaminated sediments within this unit are limited to grey sparitised carbonates, usually trapped in crevices between stromatolitic digits where they preserve a low-diversity assemblage of phosphatized early Cambrian small shelly fossils. Taken altogether, these elements are evidence for a coastal, nutrient-rich, open marine habitat subject to temporary drying and high energy currents, profusely settled by microbial communities and hardened consumers.

Although biogenic accumulation of Fe-Mn has been documented in the geological record, most ferromanganese-rich sediments can be attributed either to bio-mediated early diagenesis in dysoxic environments or to hydrothermal and supergene processes. Our elemental analyses of early Cambrian stromatolites of southern Kazakhstan do not show evidence for dysoxic diagenesis and little to no influence of hydrothermal fluids. Conversely, the low Mn-Fe ratio of sparitized stromatolitic columns as well as the prevalent concentration of iron oxi-hydroxides in high-porosity horizons lend support to the hypothesis of an early supergene enrichment under oxic conditions. According to this model, Fe- and Mn-rich meteoric water derived from weathered landmasses circulated preferentially in permeable stromatolitic carbonates. The high porosity, organic matter content and repeated subaerial exposure of biogenic sediments were all conducive to the long-term fixation of metal ions in carbonates and oxi-hydroxides, by inducing Eh and pH fluctuations in the subsurface microenvironment. Besides its economic value, such a ferromanganese deposit thus provides a unique example of interaction between a still microbe-dominated ecosystem and its sedimentary environment.

S9 – Jurassic spiders

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Spiders are rare fossils, especially in rocks older than the early Cretaceous, which is the age of the earliest amber with biological inclusions. Nevertheless, a few examples of Fossil-Lagerstätten are known from the Jurassic period, and these include fossil spiders which elucidate aspects of spider evolution. In this talk I briefly review the fossil record of Jurassic spiders before concentrating on the Orbiculariae from this time period. The male of *Nephila jurassica* Selden, Shih & Ren, 2011 has been discovered, and it sheds a most interesting light on the evolution of sexual size dimorphism and the timing of the loss of the cribellum in orbweavers. In addition, the first Jurassic spider ever described, *Juraraneus rasnitsyni*

Eskov, 1984, a male orbweaver, has been restudied, and this specimen, too, adds interest to the story.

S1 – Pangaean Games 2012

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The Pangaean Games were inaugurated in 1650 by Bernhard Varen (Varenius) when he suggested that the Americas were torn from the old world. A second game was not held until 1858 by Antonio Snider-Pellegrini, encouraged by von Humboldt's "Atlantic Valley", when he noticed that the coal belts of Europe continued into North America. Wegener initially created half a Pangaea (1915), subsequently a full one (1922), but committed the double sin of claiming an Eocene to Plio-Pleistocene age for the Atlantic Ocean and distorting those parts of the circum-Atlantic continents that had been undeformed since the beginning of the richly fossiliferous deposits. Argand left Gondwana-Land rigid but noticed that grouping of rigid continents around the Atlantic left a huge gap in the belly of Pangaea. That he found unacceptable, largely because of his geosynclinal bias, and filled, following Wegener, a good portion of it by more than doubling the length of India through an appendage that he thought now partly resided under Tibet and partly seen piled up in the Himalaya. No later reconstruction improved substantially anything that Argand had done, until Ted Irving shattered the complacency of the geologists in 1977 by pointing out that Argand's Pangaea was incompatible with the palaeomagnetic evidence. Morel and Irving showed in 1981 that the polar wander paths of Permian Laurasia and Gondwana-Land could not be fitted if the newest version of the Wegener-Argandian Pangaea (Pangaea A) is accepted. They instead suggested a Pangaea B, in which the northern part of South America, instead of the western bulge of Africa, originally was apposed against the Appalachian margin of North America. Alan Smith and his co-workers invented in 1980 even a Pangaea C, in which Gondwana-Land was shoved even farther to the NE with respect to Laurasia, although it violated so much geological data that it had to be dropped from further consideration.

Geologists had been happy with Pangaea A and the palaeomagneticians have spent heroic efforts not to destroy that happiness. However, observations by geologists have recently suggested that not all can be well with the Pangaea A family. First and foremost, the Hercynian chain in Europe has an unacceptable geometry if it is simply pulled back concertina-style to reconstruct its pre-collisional geometry. Secondly, too much right-lateral strike slip with displacements exceeding 1000 km, mostly of late Carboniferous to Triassic age, has been found right along the Hercynian remnants. Thirdly, a recently-found therapsid of mid-Permian age, *Pampaphoneus biccai*, could have come to its present Brasilian abode without having to be an alpinist, if it moved from European Russia, where it had originated, following a route in Pangaea B.

Moreover, if considerable collision-related escape is allowed within the main Hercynian body and the Pyrenean deformation and metamorphism are ascribed to related keirogeny, the Iberian oroclines and the enigmatic "foreland orogen" of the Pyrenees, are more easily explained than by postulating simplistic past "stress-fields" based on preferred Pangaea reconstructions. As of 2012, nothing geological seems to oppose Pangaea B. As the palaeomagnetic are still inconclusive, it might be possible to allow Pangaea B the winner's laurels for this year.

S1 – The Great Ordovician Biodiversification in the context of Lower Palaeozoic palaeo(bio)geographies

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The Ordovician Period experienced a truly massive rise in marine biodiversity accompanied by an increase in the biocomplexity of marine life marking 'The Great Ordovician Biodiversification Event' as one of the two most significant radiation events in the history of marine life. The unusual environments of the Ordovician Period were associated with extensive, epicontinental seas developed during sea-level high stands, driven by a waning but extended greenhouse climate, flat seafloors and restricted land areas; these were probably represented by occasional, emergent archipelagos. Sea levels were most probably the highest of the Palaeozoic and possibly the highest of the entire Phanerozoic; there are no modern analogues to the epicontinental seas of the Ordovician Period. Magmatic and tectonic activity was intense and persistent associated with rapid plate movements and widespread volcanic activity. Island arcs and mountain belts provided sources for clastic sediment in competition with the carbonate belts associated with the platforms on most of the continents. The continents were widely dispersed driving provincialism of most fossil groups. Such biogeographical differentiation was extreme, affecting plankton, nekton and benthos, and climatic zonation, particularly in the southern hemisphere, where most of the continental plates had accumulated, was pronounced. Here we present a series of new biogeographical maps that docu-

ment the Great Ordovician Biodiversification Event in the context of Lower Palaeozoic palaeogeographies.

S3 – Study on a fossil nautiloid – surprising insights

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The Buckhorn Asphalt Quarry in Oklahoma, USA, yields a Desmoinesian (Upper Carboniferous) faunal assemblage of outstanding preservation caused by synsedimentary or contemporary impregnation of sediments and fauna with hydrocarbons. These hydrocarbons prevented diagenetic processes to a high degree. The faunal assemblage evolved in a (sub)tropical shallow marine setting and is, with more that 160 reported species, one of the most diverse Paleozoic faunas known to date. The succession is strongly dominated by mollusks, i.e., gastropods, cephalopods, and bivalves, accompanied by e.g., fusulinids, ostracods, echinoderms, and bryozoans. The sediments are mainly mixed siliciclastic-carbonatic and exhibit a single cycle of trans- and regression, with cephalopod-dominated sediments ("cephalopod coquina") representing the deepest marine deposits.

Two cephalopod shell remains from the cephalopod coquina were selected for a detailed isotope study (O, C). One shell remain derives from a so far unidentified specimen, the second one from an orthoconic nautiloid which was tentatively assigned to *Hebetorthoceras unicamera*. *Hebetorthoceras* is characterized by preservation of two chambers of the phragmocone with nicely preserved cameral and siphuncular deposits. Before samples were prepared the shell remains were intensively studied by using SEM, EDX, XRD-GADDS, and by a series of thin sections. As expected, original shell microstructure and material were still preserved accompanied by parts influenced by diagenetic alteration. Anyhow, both altered and unaltered shell material and both cameral deposits and shells were sampled with high resolution. Primary isotope signals were used to calculate local paleotemperatures (unidentified remain: 28-31°C; *Hebetorthoceras*: 14-15°C) for the sea covering the area of the Buckhorn Asphalt Quarry. Samples exhibiting diagenetic alteration were used to reconstruct diagenetic pathways within the cephalopod remains. So far so good, if there weren't two distinct oval marks on the outside of *Hebetorthoceras* and the rather abnormal formation and mineralogy of the cameral deposits of this specific specimen. In a subsequent study both the oval marks and the cameral deposits were examined and it turned out that a) *Hebetorthoceras* was victim of a predator, b) this attack was sublethal, c) the specimen was able to precipitate further cameral deposits after the assault, d) it precipitated high magnesium-calcitic cameral deposits during lifetime, and e) the HMC was not a reaction to the heavy injury caused by the attack, but was even formed before.

S18 – The what and why of amber: attempting to understand the relationship between resin production and amber deposits

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Amber, a fossilised cross-polymerised plant resin, is a valuable source of information for palaeobiologists. Amber is relatively rare in the fossil record, but at certain points in earth history, there are remarkably large deposits found, often in numerous localities worldwide. The most notable deposits are from the Late Triassic, the Early and mid Cretaceous and the Eocene to Miocene. The causes of these extremely unusual deposits are not clearly understood and there are several theories to possibly explain these extensive outpourings of fossil resin. There are two key questions surrounding amber: which plants produced the resin that became fossilised as amber; and why did they produce such quantities? Through numerous careful chemical studies, we can answer the question of which plants produced the resins in most cases. It is clear that amber, particularly the older fossil resins, was predominantly produced by coniferous trees, with much smaller quantities being produced by angiosperms, although the parent plants of some ambers are still unknown. In this study we start to try to address the question of why some conifers in their natural environment produce large quantities of resin. Here we show results from an initial study on modern highly resinous conifers to at least understand and test some reasons for resin production. Modern conifers that produce only moderate amounts of non cross-polymerising resin today (e.g. Pinaceae) were ignored for the purposes of this ecological study. This study instead, focuses on the highly resinous Araucariaceae family of conifers since the resin of extant Araucariaceae members appears to have chemical similarities to the fossil resins found from numerous different localities and geological ages. We concentrate on two of the two genera: *Agathis* Salisbury and *Araucaria* Jussieu. These genera are now restricted predominantly to the Pacific region and the southern hemisphere. We tested several different hypotheses of resin production reasons in the natural environ-

ment. In New Zealand both extant and in situ subfossil *Agathis* resins were observed and collected for further analysis. Healthy and diseased/dying trees of the New Zealand Kauri, *Agathis australis* (D. Don) Loudon, were compared for resin production type and sites to aid examination of whether disease hypotheses of large resin secretion could be supported. The New Zealand subfossil 'swamp' resin/copal was used to help examine the appropriateness of 'disaster' hypotheses. In New Caledonia, the modern centre of diversity for these conifers, *Agathis* and *Araucaria* species were examined to test different ideas of resin production. Hypotheses tested included resin production in response to insect damage (*Araucaria humboldtensis* Buchh.), mechanical damage [*Agathis ovata* (Moore ex Vieill.) Warb., *Araucaria columnaris* (G. Forst.) Hook.] and fire (*Araucaria columnaris*).

S14 – *Ophiacodon* long bone histology: testing the Brinkman hypothesis

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The validity of species in a genus that only differ in size has always come into question. Histological analysis is one of the most definitive methods of species determination based on ontogenetic stages by examining the histology of the diaphyseal mid-shaft of long bones, usually femora or humeri. This area is known to contain the best record of growth. In non-therapsid synapsids ("pelycosaurs"), some species have been identified solely on the basis of size regardless of the degree of ossification observed in the epiphysis. Brinkman (1988) attempted to overcome this problem by establishing size-independent morphological criteria on putative growth series of pelycosaurs including *Ophiacodon*. Based on the degree of ossification of the epiphyses and the development of specific anatomical structures, he subdivided the putative growth series into five stages. Here we test his hypothesis of a growth series using histological indicators. The growth series comes from the Rattlesnake Canyon locality (Nocona Formation, Lower Permian) in Archer County, Texas, USA. We conclude that the histology of the *Ophiacodon* humerus growth series of Brinkman does support his morphological ontogenetic stages that were assigned to those specimens. The general histology of the humeri consists of a cortical bone matrix made up of parallel-fibered and woven bone and is highly vascularized by radial canals and radially arranged longitudinal with varying degrees of lamellar bone infilling. This gives the cortex a "spoked bicycle wheel" appearance. The medullary cavity is filled with a network of trabecular bone. The largest humerus, assigned to stage five by Brinkman, contains within the outer most cortex an external fundamental system (EFS) and a sharp decrease in vascularization. This unequivocally indicates that the animal had surpassed sexual maturity. However, the time represented by the EFS is unknown. The smallest humerus examined was determined by Brinkman to be a stage two and its histology preserves the neonatal line in the deep cortex. This is an indicator of the time when the animal presumably hatched, and is the boundary between original embryonic bone and tissue deposited postnatally. The histology and vascularization of the cortex is very similar to that seen in *Dimetrodon natalis* and, surprisingly, basal sauropterygians. This tissue has been named incipient fibro-lamellar bone. It is the precursor to the true fibrolamellar bone seen later in therapsids and mammals.

S12 – Tempo of the end-Permian mass extinction

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The end-Permian mass extinction has been universally documented as the biggest extinction during the Phanerozoic and resulted in the extinction of 95% marine species and 75% terrestrial species. In the immediate aftermath the marine ecosystem was prevailed by microbial and monotonous communities dominated by disaster taxa, and the whole recovery to the pre-extinction level took more than 5 million years. Although it is the most intensively-studied event, its causes and patterns remain contentious yet. It has been documented that the end-Permian mass extinction was a protracted event beginning from the end-Guadalupian about 8 million years before the end of Permian. By contrast, some others suggested that this event happened within a very short time beginning just before the Permian-Triassic boundary. In order to constrain the timing, and ultimately the causes of this event, we collected a suite of geochronologic, isotopic and biostratigraphic data based on a number of well-preserved Permian-Triassic sections in South China and the peri-Gondwanan region. High-precision U-Pb dating based on 29 volcanic ash layers and biodiversity pattern pooled occurrence data of 4500 species in a large geographic area reveal that the extinction interval was less than 200,000 years, and the extinction peak occurred just before 252.28+/-0.08 Ma and coincided with a ^{13}C excursion of

about -5‰. It was synchronous in marine and terrestrial realms; associated charcoal-rich and soot-bearing layers indicate widespread wildfires on land. The end-Guadalupian biological crisis was another less pronounced event separated by a high-diversity interval more than 7 millions years long from the end-Permian mass extinction.

Plenary – Fossils, genes, and the origin of novelties: examples from vertebrate appendages

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The tree of life serves as a backbone to integrate experimental data from living organisms with expeditionary and morphological data from the fossil record. At issue is the question: how do morphological novelties arise and what are the sequence of genetic, morphological, and ecological changes involved with them. Morphological data from both fossil and extant sarcopterygians reveals the key stages in the transformation of fins into limbs. However, because taxa with critical intermediate morphological are extinct, a number different fish have served as proxies to constrain developmental characters on the tree. The tetrapod limb has a number of novelties including digits, a purely endochondral skeleton, a distinctive mesopodial arrangement with derived genetic mechanisms that pattern these features. Key among these genetic factors are those that are involved with the outgrowth and patterning of distal limb segments. One class of genes, the Hox genes of the A and D paralogue groups have seen the most study in limb patterning and evolution. Genetic manipulation of mice and chicks have revealed that the distal limb segment, the autopod, is patterned by novel late acting late phase of Hox gene expression. Initial studies of zebrafish fin development suggested that this late phase is not present in fins. Later work described putative late phase activity in sharks, paddlefish, and zebrafish. Studies of expression however are far from definitive: critical evidence for genetic antecedents must lie in the regulatory elements that drive these patterns. Recent work reveals a complex landscape of interacting regulatory elements, several of which have antecedents in fish. Indeed transgenic analysis of these elements reveals the capacities to drive expression in the autopod of tetrapods was present in teleosts and sharks. The emerging picture is that the distal limb segment is a plesiomorphic trait of fins, but that the digital apparatus is a tetrapod novelty. Interestingly, new data from fossils and extant creatures reveals that the hind appendage may have played a more important role in the transition than currently thought. While the missing data from the fossil record has long been a source of concern, integrative analyses reveal that the developmental and genetic records are limited by a fragmentary record: despite advances in genomic technologies major gaps remain in our knowledge of sequenced genomes and the developmental biology of non-model organisms remains relatively poorly sampled. The coming years should witness dramatic new discoveries as gaps in our knowledge of fossil and extant creatures are filled.

S25 – A reanalysis of the Upper Triassic diapsid *Elachistosuchus huenei* by X-ray micro-computed tomography

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The enigmatic reptile *Elachistosuchus huenei* from the Upper Triassic (Norian) of Germany has been considered as both a pseudosuchian archosaur due to the presence of an ‘antorbital fenestra’ and as a sphenodontid lepidosaur because of its ‘acrodont’ tooth implantation. As it bears many plesiomorphic characters and because part of the material is still encased in matrix and too fragile to be further prepared, it has been largely ignored in the recent literature and, as a consequence, its exact taxonomic assignment remains unresolved. Parts of the holotype and assigned materials were scanned using high-resolution micro-computed tomography in an attempt to shed new light on its morphology and on its phylogenetic relationships. Preliminary results revealed internal structures of the skull and palate, and new elements hidden within the matrix. One of the most striking features recovered is the presence of very well-developed medial processes in the frontals that meet at the midline and form a tube-like structure, which is reported for both basal lepidosauromorphs and archosauriforms, but in a more subtle state. However, information on the presence and distribution of this character among basal taxa of both clades is still very scarce. The presence of a lacrimal bone, although reduced, and tooth implantation of sub-thecodont type do not support a sphenodontian classification. An antorbital fenestra is not confirmed, and the preservation of the posterior ramus of the jugal indicates that the lower temporal fenestra was partially open. Palatines, pterygoids and vomers bear a shagreen of denticles without any identifiable order and the lower jaw might lack a splenial bone. The latter characters are more commonly found in derived neodiapsids, accounting for a not so basal position of this taxon. CT scans also revealed an unidentified long bone, partially articulated concealed clavicles and an elongate T-shaped, broad-plated interclavicle, a morphology not usually found in more derived clades of eosuchians. The centra

of the vertebrae are oval in cross section, and the pedicels connecting them to the neural arch are not straight, but round instead. In addition to the type specimen a juvenile, dorsoventrally flattened skull was found, whose parietals are not entirely ossified, showing a large dorsal fontanelle. The morphology of its jugals also indicates the presence of an incomplete lower temporal bar. Our new study suggests that the puzzling Elachistosuchus may well represent a late surviving neodiapsid, or a basal eosuchian taxon, and that it has great potential to provide new information on the phylogeny and early evolution of Diapsida.

S25 – Dreidimensionale photogrammetrische Modelle von Fährten von Dinosauriern aus der Unterkreide (Berrias) von Münchehagen, Niedersachsen

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Spurenfossilien sind von besonderem Interesse, da sie grundsätzlich andere Informationen liefern als Körperfossilien. Wo Knochen nur Rückschlüsse auf die Anatomie des Tieres zulassen, eröffnen Spurenfossilien die Möglichkeit eine Aussage über die Morphologie von Händen und Füßen zu machen, andererseits können aber auch Vermutungen über Verhalten, Ökologie und Evolution geäußert werden.

In der folgenden Arbeit werden tridactyle Dinosaurierfußspuren aus der Unterkreide (Berrias, Wealden Hauptsandstein) untersucht. Sie stammen aus dem noch aktiven Steinbruch Wessling in Münchehagen, Niedersachsen.

Mit Hilfe der dreidimensionalen Darstellung am Computer wurde die untersuchte Fährte auf Beschaffenheit und auffällige Merkmale untersucht, wie zum Beispiel eine verkrümmte Zehe III am rechten Fuß. Eine Frage war, ob sich die dreidimensionalen Modelle auch objektiv vermessen lassen. Vermessen werden die Abdrücke in Fußlänge und –weite, so wie die Doppelschrittlänge eines Fußes. Damit soll die Hüfthöhe, Gangart und Geschwindigkeit des Spurenverursachers berechnet werden. Die Berechnungen erfolgen nach den Formeln von Alexander und Thulborn.

Als Datenbasis für die Analyse dienen Fotos der Spuren, die aus verschiedenen Blickwinkeln aufgenommen wurden. Diese Bilder werden mit einem photogrammetrischen Programm (Agisoft Photo Scan) bearbeitet und in ein dreidimensionales Modell umgewandelt. Die weitere Analyse findet an einem Computerprogramm zu Bildsynthese, Rhinozeros 4.0, statt. Dabei wird eine Nullebene durch die dreidimensionalen Fährten gelegt, um zu gewährleisten, dass alle Spuren in derselben Art und Weise vermessen werden.

S4 – The phosphate nodules associated to skeletons of the Triassic temnospondyl *Plagiosuchus pustuliferus* – biogenic versus diagenetic origin?

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Small phosphatic nodules have been observed associated to osteoderms and gastral scales of the temnospondyl *Plagiosuchus pustuliferus* from numerous Triassic localities in Württemberg and Thuringia, and occur in a range of different sedimentary facies. The nodules have been considered as components of the integumentary skeleton because of their association to the dermal bones and have been regarded a peculiar feature of *Plagiosuchus*. In contrast to osteoderms and scales, the nodules have never been studied in detail.

We present here the first petrographic and isotopic ($\delta^{13}C$ and $\delta^{18}O$) analyses of the nodules in order to investigate their structure, composition, development and taphonomic context with the other associated fossil remains from *Plagiosuchus* and other organisms. Two specimens from the Middle Triassic (Ladinian) of two localities in Baden-Württemberg were studied. The nodules from both localities are similar in composition and structure despite the differences in sedimentary facies.

The most complete and complex nodules (about 2 mm in maximal dimension) present a central region or nucleus composed by the association of globules, similar to the peloidal patterns. From the nucleus to the periphery of the nodule, stacked globules and hemispheroids are deposited centrifugally forming a columnar and branching pattern similar to that described in phosphate microstromatolites and micro-oncoids.

Microbial filaments appear in the complete nodule, from the nucleus to the most superficial layers. Most of the filaments in each globule are relatively short and branched, which are common features of fungi and filamentous bacteria (e.g., actinomycete-like organisms).

The nodules consist of carbonate-fluorapatite as confirmed by XRD analysis. Trace elements are rather homogeneously distributed across a nodule cross-section. Carbon and oxygen isotope compositions of different nodules from one individual have similar values of $\delta^{13}C$ = -7.6±0.1 and $\delta^{18}O_{PO4}$ = 17±0.6‰ (n=6) are not differing much from values of a bone and scale specimen of the same individual analyzed.

The evidence of nodules penetrating into fragmentary gastral scales of *Plagiosuchus* support the hypothesis

that the microbial degradation of bone provided the phosphate and calcium for the precipitation of carbonate-fluorapatite. The microorganisms likely degraded the collagen of the bone and dissolved the apatite. The microbial boring produced special microenvironments where the rapid increase of the phosphate solution concentrations led to the precipitation of carbonate-fluorapatite around the microbial filaments.

In conclusion, our analyses indicate that the nodules are probably not dermal elements of *Plagiosuchus* (e.g. they lack osteocytes or vascularisation structures typical for most bony tissues) but seem rather the result of authigenic precipitation of carbonate-fluorapatite *in situ*, in between the skeletal remains of *Plagiosuchus* with the mediation of filamentous microorganisms. The microbial decomposition of bone and consequently the formation of nodules, probably occurred very early after the death of the temnospondyls.

S18 – Taphonomy of the Mexican amber

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Several important aspects have to be considered when investigating the evolution of paleodiversity in tropical realms such as the impact of taphonomic processes on the fossilization of major parts of a paleoecosystem. Knowing which information is lost or conserved under specific fossilization conditions is essential for interpreting the structure and organization of the former faunal composition in a particular ecological system. In the present work the extant fauna from *Hymenaea courbaril* L. and the fossil fauna from *H. mexicana* Poinar & Brown were investigated. *Hymenaea courbaril* is the closest related tree in Central America to the Mexican amber producing tree *H. mexicana*. Three collection trips to a mangrove region located at the Pacific coast of southern Mexico were conducted with the aim to find out which entomological trap is the most similar to the amber. The specific site was chosen because floral composition, climate and geographic location are very similar to the former Mexican amber forest. These empirical findings answer key questions about taphonomic biases and filters of resin-related fossilization processes of the former living Miocene Mexican fauna.

S20 – Investigating the fossil record of extant African wild pigs (*Potamochoerus*, *Hylochoerus*, and *Phacochoerus*): A geometric morphometric approach

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Wild pigs (Suinae) are represented by five extant species (three genera *Potamochoerus*, *Hylochoerus*, and *Phacochoerus*) in sub-saharan Africa, where they occupy omnivorous and herbivorous ecological niches. Very little is known about the origin of these modern taxa and their precise relationships to the extinct genera *Kolpochoerus* and *Metridiochoerus*. To revise the fossil record of the modern genera, I used both comparative anatomy and quantitative analyses of cranio-mandibular and dental remains based on geometric morphometric methods of shape analysis on a large sample of modern suines (n=150), as well as fossil suines from Plio-Pleistocene sites of eastern Africa. I digitized 3D landmarks on the skulls using a Microscribe G2X, and 2D semi-landmarks and landmarks on the outline of molar teeth in occlusal views. Landmark and semi-landmark data were treated using Generalized Procrustes analysis and were then subjected to Principal Components Analysis in order to assess inter- and intraspecific variation. Based on the new taxonomic revision and phylogenetic analysis, a general framework of African suine biogeography is presented and potential dispersal events are discussed. Results obtained indicate that *Potamochoerus* has no undisputed record in Africa prior to the late Pleistocene. This absence of *Potamochoerus* from the Pliocene and part of the Pleistocene in Africa could be an artifact of the fossil record, or it could suggest a dispersal from Eurasia during the Pleistocene, simultaneously to or after the demise of similarly omnivorous species of *Kolpochoerus* in Africa. This is supported by the presence in Spain of the species *Po. magnus* in deposits dating back to 2 Ma. In contrast, evolutionary histories of *Hylochoerus* and *Phacochoerus* are deeply rooted in Africa. Similarities in cranio-mandibular and dental morphologies indicate that they are nested within the African genera *Kolpochoerus* and *Metridiochoerus*, respectively. The earliest evidence in Africa is ca. 5 Ma for *Kolpochoerus*, and ca. 3.4 Ma for *Metridiochoerus*. Along with the absence of potential African ancestors, this suggests either one or two different dispersals from Eurasia, followed by diversification. *Hylochoerus* likely evolved from a *Kolpochoerus majus*-like ancestor. The latter species is known only from eastern African Pleistocene deposits, and like the modern *Hylochoerus*, was probably a stenotopic species. On the contrary, *Phacochoerus* and its putative ancestor *Metridiochoerus modestus* were graz-

ers adapted to open environments and were always very widespread geographically. Dispersals from Africa to Eurasia during the Pleistocene include the species *Kolpochoerus olduvaiensis* and *Phacochoerus* sp. Both taxa were grazers, and reached the Levant probably at different times. Overall, between two and three dispersals from Eurasia to Africa took place during the Neogene and gave rise to the modern assemblage of sub-saharan suines. Dispersals from Africa to Eurasia were limited to the Levant area and were not followed by diversification.

S22 – Cretaceous terrestrial climates and vegetation: data, models and speculation

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The Cretaceous was a time of transition from the Mesophytic world to the one we are familiar with now, characterized by the establishment of flowering plants as a global influence on terrestrial ecosystem structure and composition. The earliest recognized Cretaceous angiosperms are aquatic but by the mid Cretaceous flowering plants had spread from pole to pole as herbs, shrubs, trees and vines, and evolved complex floral structures indicative of a close interdependence with biotic pollinators. This evolutionary radiation took place not in the aftermath of some great extinction event but was, as is common in the plant world, the result of innovation. However, several Mesozoic plant groups simultaneously evolved features characteristic of 'angiospermy', and this, coupled with building evidence for widespread reticulate evolution, heterobathmy and the isolated organ nature of the plant fossil record complicates the use of cladistics to understand angiosperm evolutionary relationships. Once angiosperm-rich communities became established in mid Late Cretaceous times flowering plant invasion of older Mesophytic communities appears to have been not 'species by species' but by wholesale community replacement. Disturbed environments were preferentially invaded by flowering plants while more stable mire communities appear to have been the last to be infiltrated.

The concurrent evolution of angiosperm-like features in a diversity of plant groups suggests an all-pervasive environmental selective pressure favouring such features. Our understanding of the terrestrial climates under which these changes took place is informed by a variety of proxies including those that are plant-based. Comprehensive multiproxy-based mapping of Cretaceous climate shows cool, but not cold, humid poles, warm temperate humid mid-latitudes and predominantly seasonally arid conditions in the tropics. Areas that could have supported tropical ever-wet systems are limited compared to those of the present day and restricted to those with adjacent moisture sources. While climate models are sometimes able to reproduce these general patterns they consistently fail to reproduce the shallowness of the latitudinal temperature gradient and overestimate the annual range of temperature in continental interiors. A lack of understanding of the hydrological cycle in global 'hothouse' climates appears to be at the heart of this failure.

Although models clearly have limitations regarding the Cretaceous they do support the presence of a near permanent Arctic cloud cap, a weak N. polar high, and high precipitation – all features previously interpreted from the abundant Arctic palaeobotanical record. In the Antarctic the lack of a warm ocean, as now, suggests a different regime. The waxing and waning of a perched Antarctic Greenland sized ice cap explains observed eustatic sea level fluctuations on Milankovitch time scales while annual warming and cooling of the land mass could have generated seasonal variations in wind and precipitation patterns that can be classed as monsoonal.

S14 – Die sphenacodonten Pelycosaurier Europas

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Sphenacodontia als die unmittelbare Stammgruppe der Therapsida sind im frühen Perm sowohl in Nordamerika als auch in Europa verbreitet. Ihre fortschrittlicheren Vertreter, die Sphenacodontidae, sind auf beiden Kontinenten bereits im ausgehenden Karbon nachgewiesen. Aus Europa sind im Pennsylvanian *Macromerion* und *Cryptovenator*, im frühen Perm *Neosaurus*, „*Sphenacodon britannicus*" und *Dimetrodon teutonis* bekannt, von denen bis auf den letztgenannten nur je ein Kieferfragment vorliegt. Der Befund ist gegenüber Nordamerika mäßig divers und äußerst sporadisch.

Die primitiveren und paraphyletischen Haptodontiden fehlen im europäischen Karbon, sind dagegen aber im Perm hoch divers, mit bis zu acht unterscheidbaren Taxa gegenüber zwei(?) amerikanischen. Die transkontinentale Ähnlichkeit der Faunen ist demnach nur eingeschränkt zu postulieren, wie es auch diverse andere Gruppen belegen (Edaphosauridae, Captorhinomorpha, etc.). Demgegenüber ist zu fragen, ob nicht eine aufschlussbedingte Verzerrung dieses Bild erzeugt. Die europäischen Funde stammen zumeist aus lakustrinen Ablagerungen, während die voll terrestrischen Rotsedimente vielfach noch keine größeren Knochenfunde offenbarten.

Eine derzeit in Arbeit befindliche Revision der Haptodontiden widmet sich zunächst den europäischen Ver-

tretern. Da die Gruppe ohnehin selten ist, scheint eine generalisierende Charakteristik schwierig. Möglicherweise sind ihre biologischen Merkmale sehr divers, wie allein schon ihr Größenspektrum andeutet. Ein einzelner Humerus aus der thüringischen Manebach-Formation hat voll ossifizierte Gelenkfortsätze und dürfte damit von einem adulten Tier stammen, das ca. 90 cm lang war. „*Haptodus grandis*“ (England) ist mit schätzungsweise 1,8 m Körperlänge den Sphenacodontiden vergleichbar und kommt als Gipfelraubtier in Frage. Das gemeinsame Auftreten mit dem wenig größeren „*Sphenacodon britannicus*“ spricht gegen eine prinzipielle Trennung der beiden Typen nach Habitaten.

Pantelosaurus und *Palaeohatteria* aus dem Döhlen-Becken stellen eine mögliche Wachstumsreihe dar. Ihre ökologische Rolle könnte ontogenetisch wechseln, da ein ausschließlich juveniler Befund aus Feuchthabitaten vorliegt und bei Adulten ein exzeptionelles Vordringen ins Becken diskutiert werden kann. Für beide Stadien sind Indizien für Gruppenverhalten vorhanden.

Weitere Neudokumentationen geben Einsicht in eine höhere Diversität der europäischen Sphenacodontier. *Callibrachion* aus dem Autun-Becken zeigt gleichermaßen Merkmale von Haptodontiden wie Sphenacodontiden und dürfte das Jungtier einer großwüchsigen Art sein. Der Holotyp von *Haptodus baylei* derselben Herkunft ist ebenfalls juvenil und wird taxonomisch wie ökologisch mit *Palaeohatteria* verglichen. Die Klassifikation von *Datheosaurus* (Innersudetische Senke) als Sphenacodontier muss angezweifelt werden.

S25 – The Second Evolution - Life reconstructions through the ages

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The visual life reconstruction of fossil organisms, as well as entire palaeo-ecosystems, not only educates the general public but also provides the scientific community with a summary of the current state of knowledge. This may also include working hypotheses for still unproven aspects. New discoveries and ongoing biological insights are a prime motivating force for the continuous and necessary revision of palaeontological perceptions.

Incorporated within these paradigm shifts, whole groups show a kind of ‘second evolution’ concerning their reconstruction. This history of science archive keeps a record of those models favored or opposed at one time. It helps to reflect from a broader perspective, that even modern research is subject to a Zeitgeist that is to be challenged. Additionally, it reveals the interaction of primary research and reconstructions stimulating – or hindering – one another whenever standardized images are unquestioningly passed along. Thus, the best realized reconstruction of fossil organisms as living creatures is meaningful for understanding evolution, physiology, and primarily palaeoecology. Therefore reconstruction history participates in the core concern of palaeontology: environmental history.

The first milestone of reconstruction history was the transition from a rather mythological imagination to systematic science during the late 17th century. It was much later, around 1970, that the ‘dinosaur renaissance’ updated many fossil vertebrate reconstructions. In recent times excavations have given further cause for rethinking, as in pilose pterosaurs and Urvögel from Yixian. As progress is made, specific nuanced questions arise while basic questions become somewhat rare.

Among the classic cases of historical ‘scientific evolution’ is *Iguanodon*. This second oldest dinosaur to be diagnosed (in 1825) was first reconstructed as a giant arboreal lizard, then as a bear-like crocodile. The finding of complete skeletons then revealed the true shape, and ultimately the outdated kangaroo-like posture was rejected. Dinosaurs are especially affected by this revisionary process, as they were highly advanced, resulting in a higher interpretability. Other vertebrates are plesiomorphic, or can be compared to extant taxa. Invertebrates are mostly defined by their preserved exoskeletons. *Anomalocaris*, once assumed to be three separate invertebrate taxa, illustrates another significant historical development in reconstructing past life. A similar re-evaluation exists today for *Palaeoxyris*, which has changed from being thought of as a putative inflorescence to now being considered the egg-capsule of Chondrichthyes.

Applying traditional and new methods, paleontological research needs to undertake further efforts, although the complete closure of outdated perceptions is never to be realized. Many groups are still under-estimated, just like the Victorian reconstruction once ‘repressed’ the consideration of dinosaurs as being advanced animals. At times even unconventional ideas can be daringly proposed to describe creatures in a more modern way. Finally, a well-founded reconstruction process can raise questions scientists have never been aware of before.

S17 – Biomechanical aspects of the incisor action of Recent and fossil castorids

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Beavers are well known for cutting trees in order to use them for construction purposes and for food. It has been described how they proceed but little is known about functional and biomechanical aspects of this action. Even less is known about the wood cutting abilities of fossil beavers. Cut wood chips have so far been associated with *Castor* and *Dipoides*. In our study we focus on the biomechanics of cutting and gnawing wood of *Castor fiber*. Its incisors show a smooth and nearly flat (lower incisors) or slightly curved (upper incisor) enamel surface and a flat chisel-shaped tip. Usually upper and lower incisors show different macroscopic wear: the lower ones have a longer wear facet tapering gradually to the end, whereas the upper ones have a shorter wear facet ending more abruptly in a ledge or few steps.

It can be assumed that the geometry of the incisors and the maximal gapeing constrain the maximal diameter of trees that can be cut. It can also be assumed that the form of the incisor cutting blade determines the cutting force after initial contact and the maximal wood hardness that can be used. It would also determine the geometry of the wood chips. In the calculated cutting force diagrams: Cutting forces versus penetration depth of the sharp enamel cutting edges of the lower incisors we show the influence of width and thickness of the collected chips. The calculation method was validated by experiments.

We study whether differences in incisor overall form, the shape of the tip, the curvature of the cutting blade, the smoothness of the enamel face and form of dentine wear facet are related to differences in tooth use and biomechanics or to phylogenetic constraints.

Here we focus on the form and function of the incisors of the Castoridae and their biomechanical profiles. For *Castor* the calculations show that the cutting force increases slowly and not abruptly which is well in accordance to physiological requirements of the musculature. A survey of the incisors of fossil beavers was performed indicating few other types: Enamel surface: smooth or slightly to strongly ridged (*Anchitheriomys*, *Castoroides*); flat (*Chalicomys* or slightly to strongly convex or rounded (*Steneofiber*, *Castoroides*); incisor tip: flat and chisel shaped or pointed either symmetrically in the middle or asymmetrically more to the sagittal plane (*Dipoides*, *Castoroides*). Incisors with different shape show different biomechanical profiles.

S6 – Embryonic bone and eggshell histology of prosauropods(?) from the Lower Jurassic Lufeng Formation, Yunnan, China

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The Lower Lufeng Formation (Hettangian-Sinemurian) has yielded a rich sauropodomorph and theropod dinosaur fauna. Recently, very small sized skeletal elements and eggshell fragments were collected from a thin layer, near the classic DaWa *Lufengosaurus* locality. Overall anatomy of the vertebrae and longbones strongly resembles that of *Massospondylus* embryos from the Lower Jurassic Elliot Fm. from South Africa. *Lufengosaurus* is the most common dinosaur in the region, however, a direct affinity cannot be concluded at this point. We sectioned three dorsal vertebrae. The smallest and largest were cut saggitally, the middle-sized specimen transversally. In the saggital plane, a distinct canal penetrating the length of the vertebral centrum is visible. The vertebrae show different stages of closure of this canal in the epiphyseal region, indicating this is the *chorda dorsalis*. The epihyses consist mostly of calcified cartilage which is perturbated by large erosion cavities of medullary origin. In some of these erosion cavities, small strips of endochondral (or replacement) bone have been deposited along the edges. The diaphyseal region of the vertebrae shows the intial stage of periosteal bone deposition. The deposited periosteal bone is highly cancellous, with numerous primary vascular spaces, indicative of fast growth (‘embryonic bone’). In the transverse plane, the *chorda dorsalis* is visible as a large cavity in the vertebral centrum. The cavity is surrounded by a layer of periosteal bone, which also shows a high porosity. In the most dorsal region of the vertebral centrum, directly below the *chorda dorsalis*, large erosion cavities are visible. These probably followed the resorption of the cartilage precursor of the vertebra. Small patches of calcified cartilage are still visible in this region. A concave bony structure that contained the neural canal, extends dorsally from the notochordal canal. A small handpiece with numerous eggshell fragments was sectioned radially. The eggshell fragments are extremely thin (~120µm), similar to those of *Massospondylus*, and consist of two layers (each ~60µm). The lower layer shows a platelike fibrillar microstructure. This is the Membrana Testacea. The second layer is the mammillary layer, which has eggshell units composed of calcitic wedges, that form a typical fan-like structure. Occurrence of these eggshells and embryonic bones of different developmental stages in one single bonebed suggest the DaWa bonebed may represent a flooded nesting site.

S11 – Cambrian graptolites (Pterobranchia) and the origin of colonial organization in metazoans

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The origin and early evolution of the Pterobranchia as colonial organisms, secreting a characteristic housing from organic material, is still unknown. The main reason for the poor record appears to be the difficulty in identifying them unanimously in many of the famous Cambrian fossil lagerstätten. Pterobranchia likely existed during the Cambrian bioradiation, but a reliable and diverse record is known only from the Paibian of the Furongian Series onwards.

The pterobranch colonies consist of the organic housing or tubaria, secreted from a scleroproteic material and the soft-bodied zooids. Of these, only the tubaria are preserved in the fossil record. The anatomy of the zooids is known only from the few surviving members of the extant genera *Rhabdopleura* and *Cephalodiscus*.

Pterobranch colonies may easily be misidentified as algae and vice versa in cases in which no details of the construction of their tubaria is available. A number of taxa originally described as graptolites have been re-assigned to algal groups lately, mostly to the dasycladaceans. Maletz et al. (2005) discussed a single specimen of the Cambrian Series 3 taxon ?*Cephalodiscus* sp. from the Wheeler Shale of Utah. The authors provided convincing evidence of fusellar construction of the specimen through SEM-BSE investigations. Further material of the same taxon from the Wheeler Shale, Spence Shale and Marjum formations of Utah have been identified in the past as the Cambrian alga *Yuknessia simplex* Walcott. These also show fusellar construction and have to be identified as early pterobranchs.

The type material of *Yuknessia simplex* from the Burgess Shale of British Columbia is identical in outline to the Utah specimens, but does not show the particular fusellar construction. Elemental analysis of the composition of specimens of the genera *Dalyia* and *Yuknessia*, both previousely described as eukaryotic algae, revealed that the Burgess Shale material consists largely of clay minerals. No original organic material is preserved in these specimens. The clay minerals can be interpreted as diagenetic minerals indicative of the tectonic distortion of the Burgess Shale, while the original organic material may have been lost through diagenetic and weathering processes.

Yuknessia is recognized as one of the earliest known pterobranch hemichordates in the Drumian of the Cambrian Series 3. The identification of the Burgess Shale taxa *Yuknessia* and possibly *Dalyia* and the genus *Malongitubus* from the Chinese Chengjiang fossil lagerstätte as Cambrian pterobranchs questions the common recognition of branched carbonaceous remains as algae. It also sheds light on the complex development of the Cambrian food chains and the lack of eukaryotic algae as major primary producers in the early Cambrian ecosystems. It appears remarkable to note that early animal communities were trophically not based on eukaryotic, photic primary producers, but rather on organic detritus and bacterial remains.

S15 – A multi-element histological analysis of the Jurassic tyrannosauroid *Guanlong wucaii*

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While knowledge of skeletal development in Cretaceous coelurosaurs continues to grow, relatively little is known about ontogeny in their Jurassic counterparts. The basal tyrannosauroid *Guanlong wucaii* from the Upper Jurassic part of the Shishugou formation of Xinjiang, P.R.C. is known from two penecontemporaneously fossilized individuals of differing size and ontogenetic maturity. We produced histological sections from core samples of the right humerus, femur, and tibia from the larger holotype specimen (IVPP V14531), as well as whole-element sections from the humerus, femur, tibia, and fibula of the smaller referred specimen (IVPP V14532).

Both individuals exhibit fibro-lamellar bone in all examined elements, similar to other coelurosaurs. The relative frequency of longitudinally oriented primary osteons increases approaching the periosteal surfaces of hindlimb elements in both specimens, consistent with a slowed rate of growth. An external fundamental system (EFS) is present in hindlimb elements of the larger individual with varying numbers of LAGs in each, but no EFS is visible in the humerus, perhaps indicating significant allometric change in limb proportions during ontogeny.

Several features indicate substantial lateral migration and remodeling of the fibula and relative stationarity of the tibial medullary cavity during ontogeny: (1) a marked lack of concentricity of growth lines in the fibula; (2) greatest cortical thickness between fibular LAGs laterally and least medially; (3) numerous secondary osteons and large erosion rooms in the medial region of fibular cortex; and (4), the presence of extensive endosteal lamellar bone in the tibia but not the fibula, with little evidence of perimedullary Haversian systems, Howship's lacunae, or resorption lines. Similar patterns of fibular remodeling and migration, and/or tibial stationarity are present in Cretaceous tyrannosaurids (e.g., *Tyrannosaurus*, *Tarbosaurus*, *Gorgosaurus*) and basal tetanurans (e.g., *Allosaurus*, *Acrocanthosaurus*). These findings point to phylogenetically conserved histological patterns, reveal potential biases associated with age and growth rate estimates derived from fibulae, and emphasize the utility of multi-element histological studies for accurate ontogenetic assessment.

We used three-dimensional stereological methods to estimate osteocyte lacunar volume in Guanlong. Similar and often identical ($p < .05$) mean lacunar volumes

and volume distributions were recovered between elements and individuals when controlling for tissue type, but differing mean volumes and volume distributions were found between tissue types within a single element. We performed the same measurements on histological sections from the Jurassic ceratopsian *Yinlong downsi* and the Cretaceous ornithopod *Jeholosaurus shangyuanensis* to confirm our findings. These results suggest non-uniformity in osteocyte morphology between tissue types and cast doubt on previous estimates of genome size and architecture in fossil tetrapods based on non-discriminant, two-dimensional measurements of osteocyte lacunar volume.

S25 – Ein Problematicum aus der Unteren Gosau-Subgruppe von Brandenberg (Tirol, Nördliche Kalkalpen, Österreich)

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Der Raum Brandenberg im Bezirk Kufstein (Tirol, Österreich) ist bekannt für seine oberkretazischen Gosau-Sedimente. Es handelt sich hierbei um marine Flachwasserkarbonate der sogenannten Unteren Gosau-Subgruppe (Oberes Turonium bis Coniacium), die durch terrestrische bis tief neritische Ablagerungen gekennzeichnet ist. Diese wurden im Zuge einer Transgression abgelagert. Typischerweise ist die Biodiversität in Gesteinen dieser Subgruppe relativ niedrig. Die Auswertung der Gesteine im Arbeitsgebiet hingegen ergab eine sehr hohe Biodiversität enthaltener fossiler Taxa, die, soweit bekannt, eine Besonderheit darstellt.

Aus der paläoökologischen Interpretation und Mikrofaziesanalyse der Gesteine der Unteren Gosau-Subgruppe von Brandenberg lässt sich ableiten:

Es handelt sich um Reste eines marinen Flachwasserenvironments, welches durch Fleckenriffe, bestehend aus Korallen, Rudisten und anderen Riffbildnern, geprägt war. Regelmäßige Hochenergieevents verhinderten den Aufbau größerer Riffkörper.

Stürme und angesichts der hohen tektonischen Aktivität im Raum der jungen Alpen im besagten Zeitraum auch möglicherweise Seebeben und Tsunamis wären als mögliche Verursacher denkbar. Somit waren die Riffbildner einem ständigen Zyklus aus Aufbau und Zerstörung unterworfen.

Im Zuge der faziellen Bearbeitung fanden sich auffällige Bioklasten, welche bis dato keiner bekannten Großgruppe zugeordnet werden konnten. Diese ca. 800 µ großen, vermutlich ursprünglich röhrenförmigen Strukturen weisen einen komplizierten Wandbau auf.

S11 – Sedimentary environment of the Precambrian-Cambrian transition in the Meishucun area, Yunnan, South China

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The Meishucun section, part of the Kunyang mining area of eastern Yunnan, is a classical Precambrian-Cambrian (Pc-C) boundary section and had been investigated as a potential Pc-C GSSP stratotype. Its paleontology, stable-isotope geochemistry and (to a lesser degree) chronostratigraphy are well known; however, the precise location of the Pc-C contact in this carbonate-rich, condensed section is still debated. Even though the section has the potential to contribute to our understanding of environmental changes across the Pc-C boundary, sedimentary and paleoecological studies have not been completed.

The Meishucun section, part of the tropical Cambrian Yangtze Platform, exposes basal Cambrian, abundantly SSF-bearing granular phosphorites which overlie late Ediacaran platform dolostones (Dengying Formation) with erosive contact. The lower part of the section is dominated by well-bedded, light-colored dolograinstones and cherty biolaminated dolobindstones; cross-bedding indicates a depositional environment above wave base. Randomly oriented "bird-foot" fractures in the dolostone a few millimeters to several decimeters in length and marked by FeOx-minerals may be related to paleoweathering and occasional exposure in tidal flats. Fields of small (up to 3 cm high) but widespread, dolomitized, partially phosphatized, columnar-branching stromatolites (cf. "*Microstylus perplexus*") and regularly spaced domal laminations are best documented from the uppermost, well-exposed carbonate bedding plane. Stromatolites grew adjacent to and within sediments composed of sub-rounded, coarse-grained sandstone; common ghost crystals after gypsum occur in the stromatolites. Wedge- and bowl-shaped erosive depressions up to several decimeters deep in the topmost dolomites beds, commonly filled by polymict sandy phosphate-, chert-, and quartz-clast conglomerate, mark at least one but possibly several karsted surfaces. The carbonates are overlain by thick bedded, SSF-bearing, coarse-grained, dolomitic and siliceous phosgrainstones and phosrudstones which are separated by a volcanic tuff ("unit 5") dated at 535.2 ± 1.7 Ma (Zhu et al. 2009).

The duration of the exposure and the age of the base-lowering event are thus poorly constrained. If the Precambrian-Cambrian boundary, assumed to be 542 Ma in age, is placed at the first appearance of SSF in the basal Zhongycun Mb. (note previously the FAD of small skeletal fauna was erroneously placed in the uppermost member of Dengying Fm., called Marker A) of the Meishucun section, then Meishucun units 1 and 2 represent the Neoprotero-

zoic carbonate platform carbonates with a major environmental change at the Pc-C boundary. The significant base-lowering event generating the erosive contact described here and followed by the extensive reworking of P-rich sediment in an oxic environment is then early Cambrian in age but predates 535.2 ± 1.7 Ma. The observation of earliest Cambrian sea level fluctuations is consistent with observations from other sections in South China.

S4 – Late Holocene marine climate archives from archaeological shells

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Proxy records reconstructing marine climatic conditions during the Medieval Climate Anomaly (MCA; ~900-1350 AD) and Little Ice Age (LIA; ~1350-1850) are strongly biased towards decadal to annual resolution and summer/growing seasons. Here we present new archives of seasonal variability in North Atlantic sea surface temperature (SST) from shells of the European limpet, *Patella vulgata*, which accumulated in Viking and medieval shell and fish middens at Quoygrew on Westray, Orkney. SST was reconstructed at submonthly resolution using oxygen isotope ratios preserved in shells from the 12th and mid 15th centuries (MCA and LIA, respectively). MCA shells recorded warmer summers and colder winters by ~2 degrees C relative to the late 20th Century (1961-1990). Therefore, seasonality was higher during the MCA relative to the late 20th century. Without the benefit of seasonal resolution, SST averaged from shell time series would be weighted toward the fast-growing summer season, resulting in the conclusion that the early MCA was warmer than the late 20th century by ~1°C. This conclusion is broadly true for the summer season, but not true for the winter season. Higher seasonality and cooler winters during early medieval times may result from a weakened North Atlantic Oscillation index. We will test the hypothesis that LIA shells have cooler summers and winters relative to the MCA shells and late 20th century. Our findings provide a new test for the accuracy of seasonal amplitudes resulting from paleoclimate model experiments.

S12 – Facies development and biodiversity of the Early to Middle Devonian shallow marine sequence of the central Carnic Alps (Austria-Italy)

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The Early to Middle Devonian shallow marine sequence of the central Carnic Alps is best exposed between Mount Seewarte some few hundred meters south of Lake Wolayer (Austria) and Forcella Monumenz near Cima Plotta (Italy). It consists of the neritic Rauchkofel Limestone (Lochkovian to Pragian) at the base of Mount Seewarte which is followed by the Hohe Warte Lst (Pragian), Seewarte Lst (Pragian to Emsian?), Lambertenghi Lst (Emsian?), Spinotti Lst including the *Amphipora* Lst at its top (Eifelian to Givetian), and the Kellergrat Reef Lst (Givetian to Frasnian?).

In general the sequence starts with some few lithoclastic horizons and crinoidal limestones (organisms: brachiopods, gastropods, echinoderms, conodonts) followed by a short interval of dark gray nodular lst bearing phosphatic shells of *Opsiconidion* and some few conodonts in the Lochkovian, and well-bedded crinoidal grainstones and a thick unit of massive bright gray frame- and rudstones (dominating skeletal components: calcareous algae, stromatoporoids, tabulate and rugose corals) during the Pragian. These units are succeeded by laminated dark gray to black limestones that are rich in algae, bryozoans, ostracodes and large specimens of gastropods and interpreted as lagoonal deposits. Above deposited are a series of loferite cycles that consist of dolomitized microbial laminites, some levels of birds-eye limestone, rimmed-grain grainstones, oncoidal limestone intervals, and some few palaeosol horizons. Within grainstone beds abundant high trochospiral gastropods, brachiopods, bivalves, ostracodes, small solitary rugose corals and some stromatoporoid colonies are observed. Overlying these cyclically deposited sediments another unit of massive bright gray limestones exposes mainly small bioherms of tabulate and rugose corals at its base, a relatively thick horizon dominated by stromatoporoids in the middle and peritidal sediments such as birds-eye limestone and microbial laminites that are followed by intervals of *Amphipora* biostroms towards the top of the formation. At Forcella Monumenz close to the top of the Spinotti Limestone a brachiopod horizon mainly consisting of specimens assigned to *Stringocephalus burtini* occurs. The interval dominated by *Amphipora* is overlain by reef deposits of the Kellergrat Lst that is rich in solitary rugose corals, tabulates, single, up to half a meter large stromatoporoid colonies, echinoderms and brachiopods. Conodonts derived from crinoidal debris layers intercalated between 10-20 cm thick frame- and rudstone-layers of this unit exposed at the abandoned quarry near Val di Collina indicate a Givetian age. – This is a contribution to FWF P23775-B17 and IGCP 596.

S5 – Zwei Radiolarienzonen der mittleren Kreide von Costa Rica

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Die hier beschriebenen Radiolarien-führenden Gesteine, die in den chaotischen Brekzienfolgen des Nicoya-Komplexes vorkommen, stammen vom Oberlauf des Rio Potrero Grande, Halbinsel Santa Elena im Norden von Costa Rica. Schmidt-Effing (1980) beschrieb schon 23 Radiolarienarten aus diesen Gesteinen, die damals zwischen Ober-Alb und Turon (Cenoman am wahrscheinlichsten) eingestuft wurden. Die heutige Überprüfung dieser Radiolarienfaunen zeigt, dass sie im wesentlichen in zwei Radiolarienzonen (Faunenzonen) unterteilt werden, d.h. die Zone *Cryptamphorella clivosa*-Fauna (Apt) und die Zone *Holocryptocanium barbui*-Fauna (?Ober-Alb/Cenoman).

Die *Cryptamphorella clivosa*-Fauna ist durch das häufige Auftreten von *Cryptamphorella clivosa* (Aliev, 1967) gekennzeichnet, und sie enthält die folgenden, stratigraphisch wichtigen Arten: *Sphaerostylus squinaboli* (Tan, 1927); *Pseudodictyomitra leptoconica* (Foreman, 1973); *Pseudodictyomitra lodogaensis* Pessagno, 1977; *Xitus elegans* (Squinabol, 1903); *Dictyomitra pseudoscalaris* Tan, 1927; *Thanarla pacifica* Nakaseko & Nishimura, 1981; *Thanarla brouweri* (Tan, 1927); *Thanarla lacrimula* (Foreman, 1973); *Stichocapsa orca* (Foreman, 1975); *Stichocapsa uterculus* (Parona, 1890); *Hiscocapsa grutterinki* (Tan, 1927). Diese Radiolarienarten zeigen deutlich ein aptisches Alter.

Die *Holocryptocanium barbui*-Fauna durch ein reiches Artenspektrum charakterisiert, und insbesondere ist das Auftreten von einer sphärischen Nassellarie, *Holocryptocanium barbui* Dumitrica, 1970, auffallend. Diese Fauna enthält die folgenden stratigraphisch wichtigen Arten: *Holocryptocanium tuberculatum* Dumitrica, 1970; *Pseudodictyomitra pseudomacrocephala* (Squinabol, 1903); *Novixitus weyli* Schmidt-Effing, 1980; *Obesacapsula costarricensis* Schmidt-Effing, 1980; *Thanarla pulchra* (Squinabol, 1904); *Thanarla veneta* (Squinabol, 1903); *Xitus specularius* (Aliev, 1965); *Stichomitra communis* Squinabol, 1903; *Dorypyle anisa* (Foreman, 1978); *Praeconocaryomma universa* Pessagno, 1976; *Dactyliodiscus* cf. *cayeuxi* Squinabol, 1903; *Pseudoaulophacus sculptus* (Squinqbol, 1904); *Rhopalosyringium mosquense* (Smirnova & Aliev, 1969); *Torculum coronatum* (Squinabol, 1904). Diese Radiolarienarten weisen im Prinzip auf ein cenomanisches Alter hin, aber ein oberalbisches Alter ist nicht auszuschließen.

S4 – Hydrologic and climatic signals across the Tibetan Plateau inferred from $\delta^{18}O$ and $\delta^{13}C$ patterns archived in shells of the gastropod *Radix* sp.: a window to the past?

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The Tibetan Plateau has been shown to modify global climate and to influence the Asian monsoon intensities. It hosts numerous lakes as well as the head waters of major southeast Asian rivers on which a billion people depend. The moisture transport onto the plateau is controlled by the Asian monsoons and the Westerlies. Understanding the evolution of the interplay of these circulation systems requires studies on climate archives in different spatial and temporal contexts. Archives which mirror seasonality in particular are still restricted in this region. The aragonite shells of the pulmonate freshwater gastropod Radix, which is widely distributed in the region, represent such suitable archives for inferring hydrologic and climatic signals in sub-seasonal resolution. The shells were sampled for $\delta^{18}O$ and $\delta^{13}C$ isotope ratio analysis along the ontogenetic spiral of growth providing the basis for isotopic records with a sub-monthly resolution. The isotope patterns provide valuable information characterizing lake systems and large-scale as well as regional climate conditions. The $\delta^{18}O$ composition in shells from nine lakes located on a transect from the Pamirs to the eastern margin of the Tibetan Plateau show different patterns depending on lake hydrology (open/closed system, size, water residence time, depth) and locality within the atmospheric circulation (source of precipitation, Westerly or monsoon dominated). The shell patterns exhibit increasing influence of precipitation and decreasing influence of evaporation on the isotope composition from west to east. $\delta^{18}O$ values of shells from lakes on the eastern and central plateau mirror monsoon signals, indicated by more negative values and higher variabilities compared to the more western lakes. The $\delta^{13}C$ compositions are dependent on different carbon sources and biological activity within the particular habitats. General climatic differences of the lake regions due to the different regional settings are clearly mirrored in the isotope compositions

of the shells, without noticeable dependence on the particular lake system. In comparison to other climate archives from the Tibetan Plateau, the isotope patterns in *Radix* shells mirror general climatic differences between the different regions as well as intraannual and even subseasonal changes. The fossil record of *Radix* sp. on the Tibetan Plateau reaches back to the Miocene which opens a long-time window for understanding moisture pathway dynamics of the Asian monsoons and the Westerlies. The application to fossil shells, in order to reconstruct climate variations of the past, will be the next step.

S8 – Evaluating museum collections biases: potential impacts on palaeobiodiversity studies

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Palaeontological collections are both historical heritages and crucial datasets for scientific research. To what extent are those collections representative of the actual palaeodiversity? This question arises from the diversity of institutions (universities, museums, private collections), from the goals of the collections (exhibition, research and / or education), their legal status, and the research and conservation strategies. Moreover, this "museodiversity" can generate some biases, such as an aesthetic-based selection of specimens.

To identify and quantify these biases, we studied different historical and modern collections from the Grignon locality (Eocene, France), considered like a hotspot of malacological biodiversity. The historical collections come from the Muséum National d'Histoire Naturelle (d'Orbigny) and from the University of Burgundy (Changarnier, Valette, "Ferme de l'Orme" and an ancient pedagogical collection). Modern collections were made available by some collectors (Cambien, Dineur, Le Renard and Club Géologique PTT Ile de France) and by recent field-based samplings (Pierrat and Neige). The Pierrat collection was established by a systematic replicated sampling and is considered as the reference for this study because all collected specimens are conserved.

We identify four main biases that are:

– the taxonomic specialization: only some taxa are preferentially collected and conserved. Up to 7 % of the 7700 specimens of Le Renard collection belong to the genus *Chiton*, whereas this taxon represents less than 0,5% in other collections.

– the abundance: the ratio (generic richness/abundance) is heterogeneous across collections (from 1,5% to 19%) and the field-based Pierrat collection does not depart significantly from the other collections.

– the size: large specimens are preferentially collected and stored. Specimens smaller than 3 mm are practically never conserved, except in d'Orbigny's and Pierrat's collections where they represent 25 % and 15 % of the specimens, respectively.

– the completeness: unsurprisingly, complete specimens are more frequently conserved than fragmentary ones. In Cambien collection, 99% of the specimens (n=10846) are complete, but only 66 % in Pierrat's (n=5199).

These biases can have a significant impact on our assessment of paleobiodiversity: although the taxonomic composition can be correctly estimated from the collection, abundance patterns can be strongly affected.

Our study is a call of caution for the use of historical data in palaeodiversity analyses. It justifies the efforts to investigate in detail the constitution of old collections. It also suggests that collections in the making should ideally document and record all the decisions that are taken during their establishment (from the field to the database). Such information will ultimately constitute a corpus of metadata (sampling methods, conservation constraints, criteria of specimen selection,…) to be included into databases. In addition to taphonomical and sampling factors, these "museobiases" should also be made explicit in paleobiodiversity studies involving collections.

S8 – Decoupling between species and genus spatial range-size gradients

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Macroecological and macroevolutionary analyses of spatial gradients in geographic range size or in niche breadth frequently focus on genera rather than on species. However, genus-level gradients are not just a function of per- genus species range size but also of per- genus species richness, thus obscuring species-level patterns, and giving rise to non-linear differences among hierarchical levels. Here, we evaluate the effects of taxonomic level on range-size gradients of marine bivalves at the global scale. We find that bivalve species range sizes are consistently larger at low latitudes (contrary to Rapoport's Rule). However, the data and a simple scaling model show that this species-level gradient is counteracted by higher total species richness of genera occurring at high latitudes: most genera that occur at high latitudes also occur at low latitudes and thus tend to be species-rich, whereas many

genera restricted to low latitudes are species-poor. This range configuration generates an increase in genus range size towards higher latitudes, a pattern that superficially resembles Rapoport's Rule but is in fact caused by geographic ranges of narrow-ranging tropical genera being nested within broad-ranging, almost cosmopolitan genera. The higher per-genus species richness at high latitudes should generate greater range sizes of genera at high latitudes even when latitudinal gradients in sizes of species ranges are the opposite or flat, and latitudinal gradients in genus range size are expected to be strongly decoupled from gradients in niche breadth or dispersal range at species level. Thus, the preferential survival of widespread genera during mass extinctions becomes an interesting puzzle.

S25 – Stratigraphic and paleobiogeographic implications of productid brachiopods from the Carboniferous of Santiago Ixtaltepec, Oaxaca, Mexico

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A sequence of marine rock outcrops in the state of Oaxaca, southern Mexico was divided into two formations, the Santiago formation, which is an informal unit that has been assigned to the Lower Mississippian, and the Ixtaltepec Formation that was originally dated as Middle-Upper Pennsylvanian. This work analyzes the stratigraphic distribution of brachiopods from the order Productida throughout the Carboniferous sequence and allows recognizing the ages of the different stratigraphic levels where they were found. *Tolmatchoffia keokuk* and *Marginatia burlingtonensis corroborate* a Lower Visean age for the lower strata of the Santiago formation; *Antiquatonia costellata*, *Reticulatia americanus*, *Reticulatia huecoensis*, *Buxtonia websteri*, *Echinaria knighti*, *Karavankina fasciatus*, *Linoproductus prattenianus*, *Linoproductus platyumbonus*, *Linoproductus insinuatus*, *Marginovatia aureocolis*, *Marginovatia pumila* and *Cancrinella* sp. were collected in strata of the middle section of the Ixtaltepec Formation and establish a Bashkirian-Moscovian age for the brachiopod-bearing strata. For the lower levels of the Ixtaltepec Formation, the presence of *Semicostella* sp., *Keokukia* sp., *Inflatia inflata*, *Marginovatia minor*, *Ovatia muralis* and *Sinuatella* sp., indicates an Upper Mississipian (Visean-Serpukhovian) age. The presence of Carlinia and *Flexaria*, which were previously known as Mississippian in age, in strata of the middle section of the Ixtaltepec Formation allows to extend their stratigraphic range to the Pennsylvanian. The brachiopods have a strong affinity with faunas described from the Midcontinent, i.e. the east-central United States. This affinity confirms the existence of an epicontinental sea that extended from the current east-central United States to southern Mexico during the Carboniferous.

S22 – MORPHYLL – A data base for the acquisition of ecophysiologically relevant morphometric data of fossil leaves

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Foliage of modern plants provide a wealth of morphometric properties that are influenced by the environment. Thus, this information is relevant for ecological and climatological research. Numerous important and famous fossil floras with high research potential are housed in various museum collections in Europe. Depending on the preservational state in fossil leaves such traits are also preserved but their potential has not yet been fully evaluated. In this project, which is part of „Scientific Library Services and Information Systems (LIS)"-Project of DFG, it is intended to initiate access to morphometric data of fossil leaf collections by digitizing fossil leaves from selected collections and to classify them according to their morphometry. The aim is the creation of a data base that allows for
1) a morphotype-based data base search, and
2) palaeoecological analysis of fossil leaves using morphometric traits.

Qualitative morphological classification of leaf traits will be based on recent standards such as Manual of Leaf Architecture (Ellis et al. 2009) whereas quantitative data are assessed by analysis of various morphometric leaf traits. Both leaf shape as well as venation characters will be included in this investigation. It is planed to provide morphometric data via transnational network databases, such as GeoCASe (Geosciences Collection Access Service). For this purpose morphometric standards, which are suitable for network databases have to be defined and established. In the current starting phase, this project will be focused on floras from Eocene to Oligocene time intervals that encountered substantial changes in climate and atmospheric CO_2. This project shall contribute substantially to an improved research access to museum collections of fossil plants.

S8 – Exceptional geochemical preservation of 47 Myr-old vertebrate remains from the Eocene Messel Pit, Germany?

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The Middle Eocene oil shale deposits of Messel are famous for their exceptionally well-preserved articulated vertebrate fossils that often still display soft tissue preservation. The isotopic compositions of oxygen, carbon and strontium were analyzed on some fossil skeletal remains of Messel's terrestrial and aquatic vertebrates to determine the condition of geochemical preservation. Authigenic phosphate and carbonate minerals, as well as the embedding oil shale were also analyzed to characterize the isotope compositions of diagenetic mineral phases.

The oil shale and siderite have values of $\delta^{18}O_{CO3}$ (0.3 to 1.5 ‰) and $\delta^{13}C_{CO3}$ (14.8 to 17.8 ‰); these are much higher than those of all vertebrate remains. Such positive values are typical for siderite from Messel and other Eocene anoxic lake settings. The strong ^{13}C enrichment is likely due to methanogenesis in the anoxic bottom water of Lake Messel. The enamel of *Propalaeotherium*, a hippomorph perisodactyl, has preserved low $\delta^{13}C$ values around – 8.8 ± 0.7 ‰ typical for C_3 plant feeders. This is in accordance with its presumed leaf-dominated diet in a C_3-plant ecosystem. In contrast, the dentin of the same teeth has about 17 ‰ higher $\delta^{13}C$ values, which indicates a significant diagenetic alteration of the dentin. Bone and dentin of the aquatic vertebrates also have positive $\delta^{13}C$ values from 3.6 up to 10 ‰. These are among the highest $\delta^{13}C$ values reported for skeletal apatite so far, and likely result from diagenetic alteration and/or indicate high $\delta^{13}C$ values of dissolved inorganic carbon in the lake water.

However, the enamel still contains *in vivo* values and seems geochemically well-preserved. This is further supported by a high enamel $^{87}Sr/^{86}Sr$ of 0.711 to 0.712, reflecting the feeding habits of *Propalaeotherium* probably on Permian sedimentary and granitoid bedrocks that surround the Messel Lake. In contrast, dentin has a much lower $^{87}Sr/^{86}Sr$ of 0.706, clearly indicating diagenetic Sr uptake from the volcanically influenced lake/pore water of the Messel maar lake. Similarly low $^{87}Sr/^{86}Sr$ values are found for a bone of the crocodile *Diplocynodon*, a scale of the fish *Cyclurus* as well as the authigenic phosphate mineral montgomeryit.

Enamel $\delta^{18}O_{PO4}$ values of the *Propalaeotherium* teeth are systematically lower than those of the dentin from the same teeth as well as the bones and scales of most aquatic vertebrates. This further corroborates the preservation of biogenic values in enamel.

In conclusion, not only are the vertebrate carcasses of Messel exceptionally well-preserved but also the geochemical composition of their tooth enamel. Enamel of *Propalaeotherium* still contains near-original C, O, and Sr isotope compositions, while bone and dentin samples appear diagenetically altered. Isotope analysis of enamel from Messel vertebrates can thus be used to recontruct their diet, habitat use and mobility yielding new insights into the paleoenvironment and the paleoecology of the Messel ecosystem.

S12 – Biodiversity and evolution of Lochkovian and Pragian (Lower Devonian) Icriodontidae (Conodonta) from northern Spain, a reference for global studies

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Lower Devonian conodonts are classically grouped into endemic and cosmopolitan; despite the great biostratigraphical value of either group, the former are preferably used for palaeogeographical reconstructions and the latter for tie global correlations. Some key regions contain both groups in the same stratigraphical columns, and therefore they bio- and chronostratigraphical value is reinforced. One of these areas is the Spanish Central Pyrenees, which has been proven to be one of the key areas for Devonian global studies.

Most Icriodontidae are considered as an endemic group of taxa, being the species restricted to certain palaeoenvironments and palaeogeographical settings. One of the best areas for studying the early evolution and diversification of this family is the Iberian Cordillera in Northeastern Spain. The record of the main outcrops shows the greatest biodiversity of the genera *Icriodus* and *Pelekysgnathus* in Lochkovian and Pragian strata. A great part of this sequence is also observed in the Armorican Massif (northwestern France) supporting the existence of a Lower Devonian Ibero-Armorican trough, which was already proved by other endemic fossils and sedimentological patterns. Part of this Icriodontidae sequence is also observed in the Pyrenees, where cosmopolitan conodonts prevail. This fact augments the correlation potential of "endemic" Icriodontidae and provides an independent control for their stratigraphical ranges.

Icriodus woschmidti is the oldest recorded icriodid in the Iberian Cordillera (unit d1bβ very close to the Silurian/Devonian boundary). In the Pyrenees its association to *Scyphocrinites* supports this age assignation. Successive records suggest the radiation of, at least, three simultaneous evolutionary branches in the overlain d1cγ unit: 1) *transiens-curvicauda*; 2) *angustoides* sspp. and 3) *rectangularis* group.

Branch 1 starts with *I. transiens* that gave rise to *I. vinearum* in unit d2aα1, a taxon limited to Lochkovian strata. The upper? Pragian *I. curvicauda* comes after a period of no icriodids assigned to this branch, and radiated in the upper Pragian and lower Emsian. All this three taxa are recorded in the Pyrenean sequences, associated to cosmopolitan conodonts.

Branch 2 starts with *I. bidentatus* that is followed by *I. alcoleae* (d2aα2-d2aα3) and *I. angustoides* (d2aα5-d3) in the Lochkovian. The last taxon of this group is *I. castilianus* in the Pragian (d2bβ2-d2cβ4). The Lochkovian components of this clade are also recorded in the Spanish Pyrenees together with cosmopolitan taxa.

Branch 3 is represented by *I. rectangularis* and its descendant *I. lotzei*. This branch has not been recorded in the Pyrenees, but it is also not restricted to the Iberian Cordillera as records are common in France and other Spanish regions (Cantabrian Mountains and Ossa Morena).

The *I. fallax* group that is considered as a vicarious ecological equivalent of the genus *Pedavis* represents a different branch not clearly related to these three.

S11 – The rise of metazoan life

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The Precambrian-Cambrian transition is a key-period in the evolution of Life on Earth during which metazoans come into scene with a variety of entirely new body plans and functional innovations. The wealth of fossil evidence obtained over the recent years from exceptionally preserved biotas has led to accurate reconstructions of the anatomy, lifestyles and even behaviors of early animals and clearly demonstrates the existence of diverse marine communities in the early Cambrian (ca. 540-520 Ma) but still numerous and challenging questions remain. 1- What are the Precambrian earliest ancestors of metazoans and their relationships with other eukaryotic lineages? 2- What may have been the environmental or biological triggers of the first animal radiation? 3- When and how did animals start to build up complex trophic webs and to colonize the marine ecospace? Although it is clear that Early Cambrian animals had already acquired functionalities that made them fitted to exploit a wide range of food resources, there is a lack of direct evidence concerning their diet and exact relationships within the food chain. The functioning of the Cambrian ecosystem has mainly been addressed through a combination of indirect fossil evidence supported by modern analogues and via theoretical models that often lack detailed testing by fossil data. The analysis of gut contents presented here is a novel approach that has the considerable advantage to provide direct evidence for trophic relationships. Our preliminary results obtained from mainly Burgess Shale fossils such as worms and arthropods provide new insights into the feeding behavior, food source, interactions and trophic pathways through which animals transferred mass and energy. Although relatively complex (both primary producers-consumers and detrital pathways), early and middle Cambrian ecosystems differ from present-day ecosystems by their lower taxonomic diversity making them more susceptible to extrinsic environmental effects. Trophic stability seems to have been acquired later in the Ordovician (Great Ordovician Biodiversification Event; GOBE, ca. 480 Ma) with a more than 10-fold exponential increase of species diversity that made animal interrelationships much more complex laying the foundations of modern-style ecosystems.

S25 – Is the ear region of the modern aardvark really primitive? – A comparison of the ear region in fossil and extant Tubulidentata (Mammalia)

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The order Tubulidentata, a member of the still debated mammalian clade Afrotheria, is represented nowadays by a single living species, the aardvark (*Orycteropus afer*). The anatomy and ecology of this highly specialised semifossorial species is still poorly known, but olfaction and hearing seem to be the most developed senses for this animal. Nevertheless, former studies have considered the ear of *O. afer* to be primitive for Eutherians. Unfortunately, there exist as yet no extensive analyses of the ear region of fossil aardvarks, so that most studies dealing with phylogeny and function consider the features displayed by the extant aardvark as representative for the whole order. The aim of the present study is to compare the structure of the middle ear in the last living aardvark with that of fossil Tubulidentata.

The best known fossil aardvarks belong to the genus *Amphiorycteropus* represented by several species both in Africa and in Eurasia. Based on *A. abundulafus*, *A. depereti*, and *A. gaudryi*, our analysis shows that the ear region in *Amphiorycteropus* differs from that in *O. afer* as it presents: a more horizontal ectotympanic (lying on the petrosal), and a stronger post-glenoid process; but has no preotic crest and, most importantly, lacks an ec-

totympanic/alisphenoid contact as well as the notch on the squamosal postglenoid process. Moreover, the ear as a whole is relatively larger in *Amphiorycteropus* than in *O. afer*. This would suggest that the ear region did evolve in Tubulidentata and that *O. afer* displays a derived configuration. However, it is not yet clear if these characters are shared with species of the genera *Leptorycteropus* and *Myorycteropus* (no fossilised ear region known so far), and thus can only be suggested as apomorphic features at the genus level. Interestingly, the Malagasy fossil *Plesiorycteropus* has often been included in Tubulidentata, but was lately included in a separate order Bibymalagasia. Taking into account our new observations in Tubulidentata, the ear region of *Plesiorycteropus* can be distinguished from both *Orycteropus* and *Amphiorycteropus* by: the presence of an external parietal/petrosal contact and a postglenoid foramen; but the absence of a postglenoid process and a piriform fenestra. These differences support the assignment of *Plesiorycteropus* to a separate order.

Our preliminary results raise thus questions about auditory adaptations in fossil aardvarks and could prove useful in deciphering intraordinal phylogeny. Remarkably, within Afrotheria a bony auditory bulla is absent in Tubulidentata but also in Sirenia, a condition which is not widespread in Placentalia and has been suggested to be primitive in Eutheria. Further studies will show if the characters highlighted in our analysis could be used for higher level phylogenies and help to figure out the primitive condition of the ear region in Afrotheria.

S24 – Late Pleistocene and Holocene mammal remains from the archaeological excavation in Lindabrunn (380 m, Lower Austria)

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At the end of the last glacial period in Europe about 10,000 years ago the environments in Europe changed dramatically. The wide open landscapes disappeared and forests began to dominate the main part of Central Europe. Many mammalian species got either extinct or had to find new habitats. The archaeological Pecher cave site in Lindabrunn (Lorenz Smrcka abris) close to the Vienna Basin at the margin of the Alps documents a local faunal transition from 12,000 to 4,000 BC in Lower Austria.

The site yielded bones from about 33 mammalian taxa. Some of the bones testify species which are still extant in the landscapes around the site, but others date from the end of the Pleistocene. Among them are *Lepus timidus*, *Marmota marmota*, *Chionomys nivalis*, and *Rangifer tarandus*. All these species are extinct in the Vienna Basin, but can still be found either in the Alpine region or in northern Europe today.

During the eight years of field work at the Lindabrunn trench several artefacts were found. Beside pottery from the Middle Ages and the Bronze Age also some Neolithic artefacts were brought to the surface. During the faunal analysis one fragment of a human atlas could be identified among the bone fragments. This fragment was dated 4,270 BC to 4,050 BC (VERA-5724).

The actual analysis revealed a peculiar succession of lagomorph species. At the uppermost part of the profile only *Oryctolagus cuniculus* and *Lepus europaeus* were found. About 60 cm below the surface no more evidence of the European rabbit existed. In the deeper part of the trench only *Lepus timidus* could be identified. One of the lower jaws was dated to 12,230 BC to 11,880 BC (VERA-5723) and this indicates the Bølling-Allerød stage of the Late Glacial period.

The main taphonomic agents are different predators like foxes, badger and owls, but human influence concerning a *Lepus* cf. *europaeus* specimen seems very probable.

S9 – Systematic position of *Prionace glauca* (Linnaeus, 1758) inferred from CO1, with comments on the monophyly of carcharhinid sharks (Chondrichthyes, Carcharhiniformes)

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Carcharhinid sharks (Chondrichthyes, Carcharhiniformes) are one of the most divers living shark families with about 53 described species. The fossil record of Carcharhinidae extends back into the Eocene with the oldest records coming from the Southern Hemisphere. In the Miocene, they seemingly diversified rapidly and all living lineages within Carcharhinidae appeared. The genus *Carcharhinus* (Blainville, 1816) is the most specious within the family displaying a wide range of morphotypes and trophic adaptations. The monotypic blue shark, *Prionace glauca* (Linnaeus, 1758), is among the most wide-ranging large-open ocean predators and probably is the most abundant pelagic shark. However, little is known about the differentiation of blue shark populations and whether several species might be present. Despite all progress accomplished in recent years, the relationships of the blue shark within Carcharhinidae but also the intra-relationships of Carcharhinidae are far from being resolved, which is essential to trace their evolutionary history. Based on morphological evidence, the

blue shark is placed in its own genus, which is sister to *Carcharhinus*, whereas molecular evidence occasionally suggested in the past that it might be member of *Carcharhinus*. Here, we used CO1 data from GenBank and different approaches to review the intra-relationships of Carcharhinidae and the systematic position of *Prionace glauca* within this family. The european hare, *Lepus europaeus* Pallas, 1778, and the eagle ray, *Myliobatis aquila* (Linnaeus, 1758), were used as outgroups. The first three methodological approaches yielded very similar arrangements of terminal taxa and support the monophyly of carcharhinid sharks. The Bayesian approach, conversely, provided very different arrangements with [*Carcharhinus acronotus* (Poey, 1860) + *Carcharhinus isodon* (Müller & Henle, 1839)] being the most basal carcharhinids outside the remaining members of *Carcharhinus* and *Galeocerdo cuvier* (Péron & Lesueur, 1822) (tiger shark) forming a sister group with *Lepus europaeus*. This indicates some major problems in using CO1 data for inferring interrelationships with Bayesian approaches. Neighbor joining and Bayesian approaches placed the blue shark, *Prionace glauca*, within the genus *Carcharhinus*. Nevertheless, the position within *Carcharhinus* depends on the method employed with *Prionace glauca* either being sister of *Carcharhinus plumbeus* (Nardo, 1827) (neighbor joining) or *Carcharhinus falciformis* (Müller & Henle, 1839) (Bayesian approached). Consequently, we consider CO1 data not useful for inferring phylogenetic interrelationships within carcharhiniform sharks based on our results. Moreover, it seems mandatory to combine morphological and molecular data for identifying the systematic position of the blue shark, *Prionace glauca*, within Carcharhiniformes and Carcharhinidae, respectively.

S14 – Evolution of locomotion traits in basal cotylosaurs inferred from trackway data

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The trace fossil record of non-amniote reptiliomorphs includes several hundred trackways and individual imprints from the Late Carboniferous and Permian of Europe and North America. In earlier approaches their geometry has been documented in detail by means of angle and length measurements. Here we study a dataset consisting of more than 100 trackways and over 500 step cycles referred to seymouriamorph (*Amphisauropus kablikae*), diadectomorph (*Ichniotherium cottae, I. praesidentis, I. sphaerodactylum, I. willsi*) and early synapsid trackmakers (*Dimetropus leisnerianus*) by means of multivariate statistics (PCA, discriminant analysis) and infer steps of evolutionary change in their locomotion patterns on the basis of trackway-trackmaker correlations and known phylogenetic relationships of the trackmakers.

In addition to descriptive criteria the six ichnotaxa considered here can also be distinguished on the basis of the present numerical dataset (overall error < 5 %). Correlation of pace angulation and the ratio of apparent trunk length to stride length as well as the pattern of hand rotation towards the walking direction indicate a less flexible long axis in the trunks of *Ichniotherium* and *Dimetropus* trackmakers than in those of *Amphisauropus* trackmakers. Among the basal cotylosaur trackways a phylogenetically separate increase in the locomotion capacity from *Ichniotherium praesidentis* via *I. willsi* to *I. cottae* and from *I. praesidentis* to *I. sphaerodactylum* is observed. In some measures, such as pace angulation and body-size-corrected stride length, *I. cottae* is on level with or superior to the contemporaneous *Dimetropus*. To some degree toe proportions are correlated with trackway parameters. In particular the *Ichniotherium* sample displays a correlation between pace angulation and manual digit length which is in agreement with a speed-dependence of hand imprint shape. Our findings confirm that the trend towards a high-velocity raised walk already occurred close to the Carboniferous-Permian boundary in basal cotylosaurs before the later advancements in higher diapsids and synapsids.

S9 – Parallelism in cyprinodontid fishes (Teleostei, Cyprinodontiformes) from northern Mexico indicates rapid morphological evolution without genetic transformations

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The large limestone springs of the Cuatro Cienegas basin in northern Mexico developed recently, probably not more than 10,000 years ago and exhibit the highest degree of organismal endemism found in continental America. The endemic ichthyofauna consists of two species of *Cyprinodon*, *C. atrorus* and *C. bifasciatus*, and fishes from nearctic (Cyprinidae, Ictaluridae, Centrarchidae, Percidae) and neotropical (Characidae, Poecilidae, Cichlidae, Cyprinodontidae) latitudes. Molecular results of our study for two mitochondrial markers (ND2, control region) indicate a common ancestry of *Cyprinodon bifasciatus* with two other pupfish populations of the Conchos pupfish clade, which retained the general pupfish mor-

phology. This indicates that *C. bifasciatus* does not represent a considerably older stock than the two populations of the '*Cyprinodon eximius*' pupfish clade. Conversely, it would be an example of rapid morphological evolution without genetic divergence within a very short time interval. The pupfish *Cyprinodon bifasciatus* differs from other species of the genus insofar as it shares the habitat with as many as 13 other species of fish. The open water, competitive and active life of this species might have resulted in its characteristic fusiform body shape with two dark horizontal lateral stripes. The related pupfish, *Cualac tesselatus*, from La Media Luna (Luis Potosi) is associated with six other teleost species, including two cichlids. This species resembles *C. bifasciatus* in the fusiform body shape, a dark horizontal lateral stripe (a second one is at least insinuated) near the body midline and exhibits little sexual dimorphism. A similar competitive habitat situation could have led to an example of parallelism, which refers to similar features of two species with a common ancestor. The genus *Cyprinodon* has a well established tendency for inter-population variability and measurable plasticity, which were already noted in early systematic studies of the group. Despite present DNA-based phylogenies, early attempts for protein based phylogenies were almost unable to resolve morphologically very different species genetically. In another toothcarp, the guppy, *Poecilia reticulate*, different ecological situations led to morphological changes and in some cases to parallelisms that also are not reflected by alterations in mitochondrial and nuclear DNA markers.

S9 – Molecular systematics of pupfishes (Cyprinodontiformes, Cyprinodon) from northern Mexico

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Speciation processes in desert fishes are intimately tied to the abundance of water. About 4000 years B.P., the previously humid climate of the Chihuahuan region in northern Mexico became increasingly arid resulting in the development of a desert. The current situation was preceded by discontinuous wet periods with large lakes and abundant forests until about 10.000 years B.P. The last recorded pluvial period occurred during the Little Ice Age ca. 200 years ago. The continuous retreat of lakes and rivers led to small, relict water bodies including springs and lakes within small basins. Only few fishes are able to tolerate the often physiologically harsh conditions of these restricted habitats. Habitat separation and subsequent isolation usually results in phenotypic differentiation of fish populations between basins. Rapid morphological evolution includes heterochrony, meristic characters and shapes. Developmental plasticity predominantly drives speciation with subsequent genetic changes. Freshwater pupfishes of the genus *Cyprinodon* (Teleostei, Cyprinodontiformes) from northern Mexico display high endemic patterns, relict populations and rapid allopatric speciation events on small geological time scales. The aim of this study is to conduct molecular analyses of these fishes including several hitherto unknown OTUs (operational taxon units). We employed three mitochondrial markers (ND2, cytb, ctrl region) to reconstruct their interrelationships and evolutionary traits. Taxa included mostly occur in thermal springs in endorheic desert basins. Here, we focus on numerous populations including new but also those species previously not analysed or being now extinct from several basins or lakes, The Guzman Basin, i.e., once was covered by the pluvial Lake Palomas that subsequently fragmented into isolated springs and lakes. One new species from this basin comes from a spring and differs morphologically from the known *C. fontinalis*, which occurs in an assembly of springs in the Guzman Basin. The distance between both occurrences is ca. 100 km and both were separated probably after the Little Ace Age. Genetic analyses of both populations indicate an almost indistinguishable genetic uniformity of both species despite significant morphological disparities. This also is obvious in another system in Cuadro Cienegas, Coahuila. All examined OTUs exhibit various degrees of genetic differentiation from their presumed ancestors. Results indicate a rare case of ecological parallelism in one species, *C. bifasciatus*, and a different genus although both are genetically very different.

S19 – Evidences of aquatic adaptation in Pakicetus (Mammalia, Archaeoceti): a hip cancellous bone perspective

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Summed up by a rich fossil record, the land-to-sea transition experienced by Archaeoceti (Mammalia, Cetartiodactyla) constitutes one of the best examples of secondary adaptation to aquatic environment among Vertebrates. The acquisition of a fully marine life-style occurred in less than 15 million years, during the early-middle Eocene. Throughout this period, the archaeocete cranial and post-cranial musculoskeletal systems underwent dramatic morphological and endostructural changes, re-

flecting biomechanical specializations to aquatic environment. Pakicetids, the earliest known members of Archaeoceti, display an original combination of both specialized anatomical features found in cursorial quadrupeds and characters showing some degree of adaptation to aquatic life. Taken together, these features suggest that pakicetids represent a very early stage of transition to life in water. To which degree they were adapted to this milieu still remains to be specified.

As bone tissue responds and adapts to the external and internal biomechanical loads by alteration of its shape, mass, meso- and microstructures, a fraction of the postural and locomotor behaviour is imprinted in the general architecture and site-specific patterning of the cancellous network. This signal is particularly well-recorded in the pelvis, a key bone involved in the transfer and dissipation of loads during locomotion. Accordingly, in a wide comparative functional perspective, the goal of this study is to explore and characterize the iliac cancellous bone of the pakicetid *Pakicetus*, and to tentatively assess the degree of aquatic dependence in this genus. Through an original radiographic database, the trabecular architecture and its textural properties have been described and quantified in *Pakicetus*, as well as in terrestrial, semi-aquatic and aquatic taxa, including most of the archaeocete fossil families and a large comparative sample of modern mammals. The ilium of *Pakicetus* is characterised by a moderate differentiation of trabecular bundles in the blade and by a high trabecular density at the level of the body. This inner bone structure contrasts with the more heterogeneous and complex architecture observed in terrestrial mammals. By comparison with semi-aquatic modern models, *Pakicetus* likely displayed a substantial aquatic component on its locomotor/postural repertory.

S19 – To validate or not to validate: the re-evaluation of the Halitherium-species complex and its impact on sirenian systematics

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The systematics of the Sirenia (sea cows) is characterised by highly paraphyletic groups, especially the entirely extinct "Halitheriinae" and its type genus "*Halitherium*". Fossil sirenian remains from the German lower Oligocene are usually assigned to the type species *H. schinzii*. Morphological differences, however, raise the hypothesis on the presence of two sympatric species. The revision of the *Halitherium* species complex mainly focuses on the question whether this genus can be proven to be monophyletic. The definition and origin of this taxon, its morphology, phylogenetic position within Sirenia, and the systematics and taxonomy of the *Halitherium* species complex shall be clarified.

For these purposes, a diagnosis limited to characters of the premolar holotype of *H. schinzii* was attempted. Comparative studies, however, showed that this tooth has no diagnostic value and is not certainly assignable to any sirenian species. Therefore, the available material originally assigned to *H. schinzii* was morphologically (re-)investigated.

For a phylogenetic analysis, the species *H. schinzii* was incorporated on the basis of individuals first. The focus was laid on a representative set of specimens that are as completely and well preserved as possible and/or were the basis of species that are synonymies of *H. schinzii* today. Beside *H. christolii* from the late Oligocene of Austria and *H. taulannense* from the late Eocene of France, the *Halitherium* species complex was complemented for the first time with the supposedly Miocene taxon *H. alleni* from North America. Two basal proboscideans (elephants in the broader sense) were combined to a single outgroup complex. A set of 52 sirenian taxa in total was applied to 202 binary morphological characters referring to the cranium, dentition and postcranium. The cladistic analysis resulted in a strict consensus tree that revealed a monophyletic grouping of *H. alleni* and two morphospecies (*H. schinzii* and *H. bronni*) indicating a sister relationship of two sympatric species within the German Oligocene. The species *H. bronni* that was originally assigned to *H.schinzii* significantly differs e.g. in the morphology of the supraoccipital, the upper posterior part of the skull. In addition to this clade, the taxa "*H. taulannense*" (late Eocene of France) and "*H. christolii*" (late Oligocene of Austria) are stem-lineage representatives, whereas "*H. bellunense*" (late Oligocene of Italy) is phylogenetically well nested within the crown group.

As a result of this study, the monophyly of the *Halitherium* species complex that was previously assumed by several authors is not corroborated, whereas support is found for the validaty of a second species in the early Oligocene of Germany.

S7 – Anomalies of the vertebral column in fossil sea cows (Mammalia, Sirenia)

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The vertebral column of sea cows is characterised by a high degree of pachyostosis and osteosclerosis. Especially the bone histology of the vertebral arches and the

spinous and transverse processes is thickened and dense. Normally developed vertebral processes are important as attachment areas for ligaments and muscles of the back. Hence these elements contribute to static and dynamic stability during the extension and flexion of the vertebral column. Abnormalities in the development of vertebrae, therefore, have clinical relevance. There are existing many diseases that affect the attachment modes like enthesitis, an inflammatory disease of the musculoskeletal system. Moreover, there are congenital defects or malformations known that can directly affect either the vertebra as a whole or parts of it. Direct effects include hypoplasia, the underdevelopment of an organ or parts of it caused by either a genetic defect or ontogenetic alteration, and aplasia, which is the total absence of an organ.

This study provides a wide spectrum of vertebral anomalies in fossil sea cows from the lower Oligocene of Germany and Belgium employing morphological data received from CT scans.

Beside left-right asymmetries of the vertebral body, the set of anomalies is supplemented by a number of caudal vertebrae each showing transverse processes with a growth retardation. The affected transverse processes are consequently less developed than their counterparts causing a left-right asymmetry that is interpreted here as hypoplasia. Three of these vertebrae are exceptional in being characterised by the simultaneous presence of three different kinds of anomalies. In addition to left-right asymmetric centra, the transverse processes are hypoplastic to both sides of the centra. Additionally, these vertebrae lack their neural arch, which is explained here by aplasia. As a consequence, these vertebrae have a hexagonal outline with rounded edges indicating the position of the lost or underdeveloped vertebral elements.

The skeletal material presented here is the oldest record of hypoplasia and aplasia in any sirenian. The consequence of a functional deficiency of the vertebral column in the animal's lifetime cannot be excluded. A hypothetical scenario that could be associated with the development of vertebrae deviating from the norm is toxin-producing naturally occurring harmful algal or red tide blooms.

S18 – Psychodiden (Diptera, Nematocera) in burmesischem Bernstein

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Die rezenten Psychodiden (Diptera, Nematocera) werden zurzeit in sechs Unterfamilien aufgegliedert: Bruchomyiinae, Horaiellinae, Phlebotominae, Psychodinae, Sycoracinae und Trichomyiinae. Die einzelnen Gruppen sind unterschiedlich reich in den verschieden alten Bernsteinen vertreten. Am häufigsten werden bisher Vertreter der Trichomyiinae nachgewiesen, deren rezente Arten wahrscheinlich alle mehr oder weniger eng an altes oder zerfallendes Holz gebunden sind. Aus burmesischem Bernstsein waren bisher nur sehr wenige Individuen bekannt: beschrieben sind zwei Arten aus der Unterfamilie Bruchomyiinae, *Dacochile microsoma*, deren Stellung innerhalb der Nematoceren umstritten war, und *‚Nemapalpus' velteni*, deren Stellung innerhalb der Unterfamilie ebenfalls noch nicht endgültig geklärt ist. Weitere Bernsteinstücke aus privaten Sammlungen förderten inzwischen einige neue und äußerst interessante Taxa zu Tage. Zu den aufgefundenen Arten zählt ein Männchen, das problemlos bei den Phlebotominae eingeordnet werden kann. Mehrere Weibchen einer weiteren Art scheinen der Unterfamilie Trichomyiinae anzugehören oder ihr nahe zu stehen. Aber es gibt unter den rezenten Psychodidae mehrere Taxa, mit nur vier Radiusadern im Flügel. Der große, kräftig sklerotisierte Eiablageapparat der Exemplare unterscheidet sich deutlich von dem rezenter Trichomyiinae. Die Zuordnung bleibt daher noch vorläufig. Eine weitere, noch nicht benannte Art wurde in mehr als 10 männlichen Exemplaren gefunden. Diese weisen die meisten Merkmale der rezenten Unterfamilie Psychodinae auf, u.a. Flügel mit Neala und fünf Radiusadern und ein ‚Hypopygium inversum'. Es fehlen daneben aber die nierenförmig geformten Augen und eine dichte Körperbehaarung. Eine vorläufige phylogenetische Analyse stellt diese Tiere tatsächlich in die nähere Verwandtschaft der Psychodinae. Ob es sich dabei um eine ‚Stammart' dieser Unterfamilie handelt, oder um einen eigenen Zweig im phylogenetischen System der Schmetterlingsmücken, muss im Moment offen bleiben. Als Folge dieser Funde erscheint aber burmesischer Bernstein überraschend reich an fossilen Psychodiden aus verschiedenen Unterfamilien.

S8 – Palaeobiology of the rudist assemblages from the 'Red Ereño' limestone (Guernica, Basque Cantabrian Basin, N Spain)

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The Urgonian carbonates (mid-Cretaceous) of the Basque Cantabrian Basin provide an excellent record for palaeoecological studies on rudists dominated ecosystems. The analyzed outcrop is an abandoned quarry near to Ereño locality that was exploited since Roman times and in the last modern phases with the cable method. The resulting polished surfaces provide an excellent bidimensional outlook to analyze the Aptian-Albian rudist-rich lagoon deposits. These particular outcrop conditions have allowed us to carry on a detailed stratigraphic framework and facies mapping, and an exhaustive sampling for sedimentological, palaeoecological and geochemical analysis.

The purposes of this study were: i) to establish the macro- and microbenthonic faunal assemblages and their ecological niches in the different lagoon subenvironments; ii) to analyze the sedimentary evolution of the lagoon system on the basis of the stacking geometry of rudist biostromes and the evolution of their compositional gradients; and iii) to estimate the seawater paleotemperatures of the lagoon based on the elemental composition of the outer *Polyconites* shell and considering the major controlling factors (biogenic controls of shell growth, taphonomic preservation, diagenetic overprint, external controls – temperature and salinity – as well as sampling bias).

It has been recognized two ecological niches (A and B) in two lagoon subenvironments. The niche A is dominated by gregarious associations of elevator rudists (autoparabiostromes constructed by *Polyconites* and *Monopleura*), which formed minimal topographic elevations on the lagoon seafloor. The rudist autoprabiostromes acted as prolific skeletal factory, producing abundant skeletal debris in normal weather conditions and during storms, which have been accumulated in the surrounding forming parabiostromes. The niche B was developed in the depressed areas between the rudists autoparabiostromes, in a muddier lagoon subenvironments. It is dominated by gregarious associations of the oyster-like *Chondrodonta* communities which were strongly influenced by reef-derived storm deposits, highly encrusted by fixosessile lituolids foraminifera and showings high rates of bioturbation.

A *Polyconites* shell sample has been investigated to analyze the microstructure preservation and the diagenetic overprint. An accurate reconstruction of the cement stratigraphy was performed to clearly identify the well preserved early marine stages and the burial cements. The estimated seawater paleotemperature from the $\delta^{18}O$ data of the early marine cement is around 26°C (-2.9 ‰) whereas the recorded paleotemperatures in the shell are higher. Sclerochronological analysis of the rudist shell has revealed a paleotemperatures oscillation about 5°C, reaching the maximum temperature of 31°C (-4.6 ‰). The obtained paleotemperatures from *Polyconites* shell are higher in comparison to previous data but they are consistent with temperatures from comparable latitude during the Aptian-Albian time.

S24 – New insight in the Early Carboniferous cold seeps deposits of Winterberg and Iberg (Harz Mountain): reconstruction of a hydrocarbon dependent environment

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The Early Carboniferous (Visean) seep carbonates deposits of the Winterberg and Iberg in the western Harz Mountain represent one of the few examples of hydrocarbon dependent environments known from this time.

The seeps carbonates occur on the top of the Devonian reef, which drowned shortly before the Frasnian–Famennian mass-extinction event. From the Famennian to the Visean, the drowned reef experienced various phases of colonization by different benthic communities and the formation of several generations of neptunian dikes.

Similarly to other Paleozoic and early Mesozoic localities, the seep-related benthic community is dominated by a low diverse, but high-abundance brachiopod fauna represented, in this case, by the species *Ibergirhynchia contraria*. Nevertheless, a various minor accessory fauna, including archaegastropods (possibly pleurotomariids) and solemyid bivalves have been described in the literature.

Sedimentary fabrics such as clotted micrite, ghost structures of fibrous and botryoidal aragonite, isopachous crusts cements, pyrite and corrosion surfaces and negative $\delta^{13}C$, down to -32 ‰, corroborate the hydrocarbon dependent origin of the carbonates.

These features and components have been used in the literature to differentiate two facies: i) microbialitic boundstone with thrombolytic and laminated fabrics, clotted micrite, isopachous crusts and calcite replacing aragonite cements; ii) brachiopods floatstone with brachiopods enclosed in a microsparitic and micritic matrix and coated by isopachous cement crust.

In this study we analyzed samples collected in recent field campaigns and samples belonging to the collection of the Geoscientific Museum of the Georg August University of Göttingen. Cathodoluminescence and microfacies analyses have revealed the presence of three facies: a) thrombolitic facies, characterized by clotted micrite, fibrous and batryoidal cements, stromatactoids, pyrite, corrosion surfaces and occasionally brachiopods; b) brachiopod-bearing floatstone, with brachiopods embedded in an automicritic matrix and coated by isopachous crusts; c) stromatolitic facies, with layered

micrite and microsparite with large stromatactoids filled with isopachous crusts.

Skeletal remains of unidentified tubeworms and ammonoids have been clearly identified. In addition to this, embedded in clotted micrite, sparitic microspheres surrounded by thin organic coats with a radius ranging between 30 µm and 180 µm have been observed isolated, in dense accumulation and gregarious forms. Remains of two unidentified organisms have been observed inside the brachiopodes floatstone. Both are composed by a cluster of rounded to sub-rounded chambers coated by thin organic layers. They differ in size and shape. One is formed by elongated chambers aligned in rows of chambers and reaching the size of half a millimeter. The other one is smaller in size, about 200 µm, has an oval outline and a grapevine-like structure.

S2 – Biodiversity of benthic foraminifera on the shelf and slope of the Celtic Sea

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The aim of this study was the quantitative analysis of benthic foraminifera from the shelf and continental slope of the Celtic Sea (NE-Atlantic) and a comparison of the results with literature data for this area. *Asterigerinata mamilla*, *Cibicides lobatulus*, *Spiroplectinella sagittula* and *Trifarina angulosa* were the dominant species in samples from a depth range of 115 to 131 m. Only *Spiroplectinella sagittula* and *Cibicides lobatulus* were found as dominant taxa in previous studies. The other species were reported as common or rare. *Textularia pseudogramen* was common in our collections. This taxon, however, was not recorded in previous investigation. Possible reasons could be the determination as another species or low abundances. The percentage distribution of the test structure of all species found was also compared with values from the literature. Species with a hyaline test structure were most abundant, followed by agglutinated species and miliolids. In only a single literature source were miliolids reported as being more frequent than agglutinated species. Regarding the mode of life, there were no similarities between our samples and the literature data. Free-living species were most common, followed by species that live mainly attached. Opportunistic species that can change their mode of life between a free and attached lifestyle, probably depending on the environmental impact, were rare. More samples from the continental slope will reveal how much the faunal composition differs from the earlier data and to which possible causes these differences could be attributed to.

S14 – The quality of the fossil record of anomodonts (Tetrapoda, Synapsida)

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Anomodont synapsids represent the dominant herbivores and most diverse terrestrial tetrapods of the Permian and Triassic. They are one of the few tetrapod clades that survived the end-Permian mass extinction and represent an ideal model group to study biodiversity patterns through time. In this study, we analyse taxonomic and phylogenetic diversity patterns of Anomodontia and evaluate the quality of the fossil record of this group in the South African Karoo Basin and at the global scale. Previous studies suggested that anomodonts experienced three distinct diversification events interrupted by the same number of extinctions, i.e. a mid-Permian, an end-Permian, and a Middle to Late Triassic event. Our results partially confirm these observations, but all three extinctions are only supported by the raw taxonomic diversity analysis in South Africa. The phylogenetic diversity estimates in South Africa and at a global scale reflect only two events, suggesting that the mid-Permian event among anomodonts is likely a relic of a biased fossil record.

However, phylogenetic diversity estimates still need to be interpreted cautiously since the correction depends on fossil sampling as well. Therefore, it is necessarily to evaluate the quality of the fossil record. Based on a recently published comprehensive phylogenetic data matrix of Anomodontia, we estimated a character completeness metric, which calculates the percentage of phylogenetic characters that can be scored for each given species. In addition, we evaluated the impact of the quality of the fossil record on the species diversity of Anomodontia by comparing completeness scores with taxonomic and phylogenetic diversity estimates, bin length, rock outcrop area and number of localities per time bin. At the global scale, the phylogeny of Anomodontia reflects an average quality of the fossil record of 60 % (stage-scale) with an even higher completeness (73.4 %) when the anomodont-devoid Olenekian is excluded. At the regional scale of the South African Karoo Basin, we calculated a quality of the anomodont fossil record of 77.5 %, with the highest values for completeness in the Pristerognathus (91 %) and Tropidostoma (90 %) AZs. For the stages we found a peak of 86 % at the Induan. Furthermore, there is no drop lower than 60 % of the character completeness of the fossil record. Most interestingly, the quality of the fossil record of anomodonts increases from the Late Permian to the Triassic, emphasizing the impact of the end-Permian

extinction event. Only a weak or non-significant correlation was found between the character completeness and raw diversity obtained from SGCS and at the AZ level, and between the CM and estimated phylogenetic diversity. Hence, we conclude that the quality of the anomodont fossil record is persistently high throughout their evolutionary history and does not seem to be influenced by sampling effects or richness.

S22 – Testing for the effects and consequences of mid Paleogene climate change on insect herbivory

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The Eocene appears to have been one of the most biodiverse intervals in Earth's history, and is associated with the most extensive recent migration of the subtropical rainforest biome into the midlatitudinal region. This trend began at the Paleocene-Eocene Thermal Maximum (54.8 Ma), an event defined by a global spike in elevated temperature and a dramatic carbon isotope excursion, as recorded in benthic foraminifera, and an association with increased atmospheric CO_2. Palaeoclimate calculations for the Middle Eocene indicate indicate that the era was also characterized by a subtropical style climate regime. We propose a framework to evaluate how terrestrial food webs evolved approximately 48-44 million years ago, close to the atmospheric CO_2 peak, as well as to the thermal and mammalian species-diversity maxima of the early Middle Eocene. The Messel and Eckfeld Maar localities are well known for their great variety of remains ranging from organic molecules, plants and insects and their associations, to articulated mammals exhibiting soft tissue preservation and stomach contents.

The ecology of plant-insect associations currently is a significant aspect of modern ecological research. Consequently, studies of insect herbivory on fossil leaves provide crucial information on the ecology of feeding associations and the association of plants and their insect herbivores that cannot otherwise be obtained separately from fossil record of plant macrofossils and insect body fossils.

We analyzed insect-feeding damage on 19,868 angiosperm leaves and scored each specimen for the presence or absence of 89 distinctive and diagnosable insect damage types (DT's) found in the total data set, allocated to five main functional feeding groups.

The inventory of insect damage occurring on plant hosts indicates an impressive spectrum of plant-insect associations. Interestingly, the work on the European flora from Messel and Eckfeld shows a much greater diversity of insect feeding than comparable, contemporaneous floras from North America, revealing another important, previously unknown component of the plant-host and insect-herbivore diversification event during the European Eocene.

In summary, the European middle Eocene previously has not been subjected to such a detailed analysis of plant-insect associations and the proposed project would present a significant, new and extended understanding of Eocene regional climate dynamics and how they differ from those of the present day.

S4 – Life stories of sauropods – histological evidence for the ontogenetic stage of different sauropod taxa and its implications for growth, sexual maturity and longevity

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Understanding the life history and growth of sauropods, the largest terrestrial vertebrates ever, represents a challenge. Long bones typically do not provide a good growth record. Therefore we explored the histological growth record in other skeletal elements of simple shape; mainly dorsal ribs, chevrons, and gastralia. Because of their lesser local bone apposition rate in contrast to sauropod long bones, they have the potential to provide a more complete growth record. All sampled sauropod taxa (*Spinophorosaurus*, different Diplodocids, *Camarasaurus* and *Brachiosaurus*, as well as many other indet. Sauropod taxa) from four different localities and found that Lines of Arrested Growth are developed in all studied skeletal elements. However, the best growth record is preserved in the dorsal ribs. In all sampled taxa a minimum of 10 cycles was found at the proximal end of the rib shaft or within the capitulum. 10 LAGs were found in a *Brachiosaurus* rib from the Morrison Formation while other *Brachiosaurus* ribs from Tendaguru show 14 LAGs. In both cases this represents approximately 40 % of the growth record with clear evidence to the adult ontogenetic stage

of both individuals, proved by the External Fundamental System. For an *Apatosaurus* (Morrison Formation) showing 16 cycles, representing 70 % of the growth record, a subadult ontogenetic stage was proved because all samples of the individual are lacking an EFS. With 38 LAGs and a completeness of 87 % the best preserved growth record was found in the dorsal ribs of a small senescent *Camarasaurus* individual (Morrison Formation). In other sauropod samples, like in the ribs of a diplodocid sauropod (Morrison Formation) and in rib fragments, most likely belonging to a *Spinophorosaurus* (Niger), an enormous amount of sharpey's fibers seems to delimit the clear development of LAGs. Nevertheless these samples show about 12 well developed LAGs (~45 % of the growth record) with further cyclicity in the inner cortex. These results suggest that depending on taxon, sauropods grew for about 25-35 years to reach full size. This time span is intermediate between widely diverging earlier estimates.

S12 – Devonian – Mississippian echinoderm community evolution and climate change

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Crinoids and blastoids reached an apex in generic richness and abundance during the Mississippian. Causal hypotheses for this peak in species richness and abundance include the evolutionary transition between the Middle and Late Paleozoic crinoid, macroevolutionary faunas, changes in the structure of carbonate platforms in the Late Devonian, changes in predation pressure, and response to large scale climate change.

Crinoid and blastoid generic richness peaked in the Early Devonian reflecting the success of the camerate-dominated Middle Paleozoic Crinoid Macroevolutionary Fauna during an interval of widespread reefal facies. Throughout most of the Devonian, crinoid and blastoid diversity paralleled the reefal diversity. This pattern changed after Late Devonian extinction events. Famennian and many Mississippian echinoderm communities were dominated by cladid crinoids, and were very successful even after the demise of the Devonian reefal communities.

Although the causes of the Mississippian crinoid and blastoid explosion are probably multifaceted, climatic events in the Devonian played a major role. One of the largest drops in CO_2 occurred during the Devonian and Carboniferous. Crinoid clades show significant, but complex, correlations with CO_2 in this interval. Overall crinoid diversity has a significant negative correlation with CO_2. Individual clades have significant negative correlation (advanced cladids), significant positive correlation (primitive cladids, disparids) or no correlation (camerates, flexibles). None of the clades show correlation with CO_2 under Devonian greenhouse conditions, but camerates, primitive cladids, and disparids all have significant positive correlation with CO_2 under Late Devonian – Carboniferous Icehouse conditions.

Riding (2009) suggested that the peak diversification of crinoids and blastoids during the Mississippian was related to the rise of picophytoplankton in the wake of mass extinction of acritarchs in Late Devonian time coincident with a major drop of atmospheric CO_2. This hypothesis can be tested using information from feeding preferences of living crinoids as well as patterns of crinoid diversity and abundance in relation to productivity. Among Late Devonian-Mississippian (Fammenian-Visean) crinoids, camerates and advanced cladids were the dominant clades, both having pinnule-bearing arms. Non-pinnulate crinoids also contributed, including primitive cladids, disparids, and flexibles, but their generic richness was considerably lower.

Although much work remains to understand the dynamics of echinoderm community evolution in the Devonian and Carboniferous, dramatic climate change had a major impact. Crinoid communities were able to be successful both in the Lower Devonian greenhouse world and in the Mississippian icehouse world because different clades were able to adapt to changing climates and the demise of reef ecosystems and flourish. Whether this success was the result of adaptation to changing sedimentological regime or changing patterns of plankton diversity is unclear at the present time.

S2 – Combining richness, evenness and similarity to track the diversity of fish communities

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The question of how best to measure diversity has spawned considerable discussion, many papers, and several books over the past three decades. Although there is general agreement that diversity has many dimensions (richness, evenness, relatedness, functional similarity), how one might operationally encompass these in comparative studies remains contentious. As a result the diversity literature remains widely dispersed, with no commonly accepted standard for tracking changes in diversity through space and time. One promising approach is to use indices of diversity that produce values in the currency of 'effective numbers of species', such as the well-established Hill numbers. Recent work has modified Hill numbers to incorporate the similarity of species (measured in terms of traits or phylogeny/taxonomy), potentially providing a powerful metric of diversity. Here I will de-

scribe how such metrics can be applied in practice, using contemporary temperate and tropical fish communities as case studies. The results show that incorporating species similarities can have a large impact on inferred diversity changes in space and time, and that including even imperfect information on species similarities is preferable to ignoring these similarities.

S11 – A Meishucun-type early Cambrian (Terreneuvian) ichnofauna from the Malyi Karatau Range (SE Kazakhstan)

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A trace fossil assemblage from the basal Cambrian phosporites of the Koksu and Aktugai sections (Chulaktau Formation) of the Malyi Karatau Range (SE Kazakhstan) is reported for the first time. Based on a rich and significant small shelly fossil (SSF) record, the ichnofauna can be biostratigraphically attributed to the early Cambrian (Terreneuvian Series; Fortunian to Cambrian Stage 2) which embraces the middle part of the Chulaktau Fm., Karatau Mb. in the Malyi Karatau Range (e.g. Missarzhevsky & Mambetov, 1981; Evseev, 2012).

The ichno-assemblage yielded abundant simple epifaunal, rarely bilobed and probably branched non-arthropode traces of various ichnotaxa assoziated with rare (pre-triolobitic) arthropod ichnoassemblage.

The non-arthropod ichofauna consists of partly large bedding-parallel hyporeliefs of simple straight to slightly meandering repichnia of the *Palaeophycus* type as well as bilobate traces of uncertain taxonomic assignment (?*Didymaulichnus isp.* and/or ?*Psammichnites* isp.). This ichnofauna is accompanied by horizons with short vertical U-burrows of the *Planolites*-type. The evidence of *Treptichnus pedum*-like simple branched horizontal traces is supposed but remains problematic. Additionally, a dark-brown Fe- and Mn-rich dolostone with granular phosphorite bands at the base of a manganese-rich stromatolite bed contains vertical, slightly curved burrows with funnel-shaped openings of decimeter size and of uncertain taxonomic belonging.

The rarely preserved arthropod traces can be attributed to *Rusophycus*-type resting traces (probably *R. avalonensis*) as well as to primitive *Cruziana*-type repichnia. The arthropod traces are concentrated in the lower massive phosphorites of the Karatau Member (middle Chulaktau Formation) in the Aktugai locality. Most of them are preserved in the granular phosphorite. Rarely, they occur as positive hyporelief in the overlaying contact to a greenish-grey chert band on the top of the Karatau Member.

The ichnotaxonomic inventary as well as the lithology and depositional facies of the hosting rocks as well as the type of trace preservation in the massive phosphorites resemble the situation in the about contemporaneous Meishucun ichnofauna from eastern Yunnan (South Chinese Platform). This type of ichnofauna appears to be significant for the abundant late Ediacaran to early Cambrian phosporite-dominated shelf deposits worldwide.

S11 – A late Ediacaran "Tube World" from China: exoskeletal macrofossils and trace fossils from the Gaojiashan Section (South Shaanxi), northern Yangtze Platform

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On the late Neoproterozoic Yangtze Platform, the Gaojiashan Member (middle Dengying Formation, Upper Ediacaran: 551-542 My) represents a regional siliciclastic interval within a dolostone-dominated sequence. We here present examples of biomat-related trace fossil horizons as well as examples of unusual preservation of metazoan exoskeletons from this Ediacaran fossil lagerstaette.

The hitherto poorly understood Gaojiashan biota consist of partly large, tube-shaped and three-dimensionally preserved exoskeletons of early metazoans. These tubular fossils (*Gaojiashania* and *Conotubus*) occur in large number mainly in distinct event layers (probably storm layers). Some preservations display taphonomic features of biomat-mediated embedding processes forming "Ediacaran death masks". The trace fossils occurring in the Gaojiashan Member belong throughout to simple bedding-parallel trace types and are exclusively preserved in distinct layers within a dolostone bed above the body-fossil containing siliciclastic sequence. They are always closely related to microbial mat horizons indicating a biomat-related lifestyle (probably undermat-mining lifestyle) of the unknown Ediacaran trace originators.

S18 – Fossil larvae of Berothidae (Neuroptera) from Baltic amber

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The Berothidae (Insecta: Neuroptera), also called beaded or hairy lacewings, is a small neuropteran family with almost 100 species in over 20 genera. It is still under discussion whether Rhachiberothinae should be considered as a family of its own or should be included in Berothidae, but the two taxa most probably are sister-groups. Today, berothids are distributed in a wide range of tropical to warmer temperate regions of the world. The adults are brown in colour and small to medium sized. They have been collected with light traps in diverse habitats, and little is known about their microhabitats. The larvae of only few extant berothid genera are known, and the knowledge of the larval biology is restricted to a few members of the subfamily Berothinae. Like many other neuropteran taxa, they have three larval instars. Information on the larval life style is available for only two genera, *Lomamyia* Banks, which is distributed in North America, and *Podallea* Navás from Africa. In these two berothine genera, the first and third instars live and move actively in the nests of termites and prey on them; the second instar has a very different morphology, it is inactive and does not feed. Fossils of Berothidae have been found since the Middle Jurassic, they comprise mostly adults. The majority of fossils were described from the Cretaceous, only few have been recorded from the Tertiary. Larvae are only known from Eocene Baltic and Rovno amber.

In this study four larval specimens of Berothidae are recorded from Eocene Baltic amber. The inclusions are kept at the Senckenberg amber collection and at the private collections of Thomas Weiterschan (Höchst Odenwald) and Christel and Hans Werner Hoffeins (Hamburg). Two of the larvae probably represent first instars, judged from their sizes around 2 mm. The other two larvae are bigger, and probably represent third larval instars. One of the probable third instar larvae shows remains of possible spider silk in the head region. Additionally, in this specimen deformations of the abdomen are present, which still require some explanation.

S25 – New data on the *Annulata* Events in the Moravian Karst (Famennian, Czech Republic)

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The *Annulata* Events belong to most important global events in the Famennian and correspond to the Upper *Palmatolepis trachytera* zone. They are lithologically characterized by anoxic to dysoxic dark grey to black layers, typically shales or limestones, which are intercalated in sequences of different facies. These event beds yield a rich fauna, especially clymenids, pelecypods, orthocone nautiloids and ostracods. The black limestone lenses from the Moravian Karst, later assigned to the *Annulata* Events, were recorded for the first time by Rzehak (1910), who described their typical fauna from a locality near Brno-Líšeň. Similar facies were later discovered in the Mokrá quarry (Dvořák 1988). Recently, *Annulata* Event beds were found in 4 new localities. The contribution is focused on the preliminary stratigraphical results based on conodont biostratigraphy, gammaspectrometry and carbon isotope geochemistry. Based on conodonts, the black limestone lenses from a locality near Brno-Líšeň can be correlated with lower *Annulata* event.

S3 – Effects of environmental change on the calcification intensity of planktonic Foraminifera: a case study from Sapropel S5

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Planktonic Foraminifera are important marine calcifiers, responsible for almost half of the present-day open-ocean production of biogenic carbonate. Therefore, it is important to understand which environmental parameters influence the calcification of the foraminiferal test. The aim of this study is to test the influence of the exposure to different levels of environmental stress, including terminal stress leading to extinction, on the calcification of planktonic foraminifers. For this purpose we have chosen four species of planktonic Foraminifera from a sediment core section covering the onset of Sapropel S5 in the Eastern Mediterranean (*c.*125 ka), where the ecosystem was exposed to a high stress environment. For all species,

intervals exhibiting local extinctions or strong drops in abundance were selected to investigate responses of the calcification intensity of the tests. This offers the unique chance to assess the reactions of planktonic Foraminifera to severe environmental stress.

Several specimens, taken from a narrow sieve fraction, were individually measured and weighed together using an ultrabalance (d = 0.1 μg); the mean weight of the tests was then normalised for the mean test size in each sample. It could be shown that the shallow dwelling, symbiont-bearing species *Orbulina universa* shows a distinct drop in test weight at the onset of the sapropel, and that the weight is further continuously decreasing thereafter for about 4000 years, until a local extinction of the species. The calcification intensity of that species is also well correlated with stable oxygen isotope values retrieved from tests of *Globigerinoides ruber*, which are probably indicative of the intensity of freshwater influx. In the deep dwelling species *Globorotalia scitula* evidence for a continuous decrease in calcification intensity could be found, that started as early as 3000 years before the onset of the sapropel. *Globorotalia inflata*, a species that mainly lives in intermediate water depths, shows some fluctuations in test weight, but those cannot be attributed to the available information on the timing of environmental change. Interestingly, this species shows much larger intra-sample variations of the test weight than any of the other species investigated. *Globigerinoides ruber* (pink), for which results are still pending, will serve as a second shallow-dwelling species to be investigated. The main influential parameters for the observed fluctuations in calcification intensity are as yet unknown, with changes in freshwater influx from Africa—possibly causing changes in the carbon equilibrium system in the Eastern Mediterranean—or changes in sea water salinity being considered as possible reasons. We show that the calcification intensity of planktonic Foraminifera is subject to fluctuations that can be attributed to environmental changes, and that both long-term (i.e. thousands of years) and short-term (i.e. 100–200 years) reactions can be observed.

S5 – Morphological deviations in planktonic Foraminifera as a reaction to enhanced environmental stress: opportunities and problems

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Foraminifera are amongst the best known groups of fossil protists, featuring a remarkably complete and continuous fossil record. This fossil record holds considerable potential to study how species phenotype (morphology) responds to environmental perturbation. In this respect, it is of particular interest to study such cases where the environmental perturbation on the studied population led to extinction. Such cases are impossible to study at present, because extinctions under natural conditions cannot be predicted. This study investigates the morphological reaction of planktonic Foraminifera when exposed to varying levels of environmental stress, ultimately resulting in extinction. To this end, a sediment section from the Eastern Mediterranean was chosen, that covers the onset of Sapropel S5 (*c.*125 ka). This event was associated with local extinctions of several species of planktonic Foraminifera, and thus offers the chance to investigate the reaction of those species to environmental stress during a natural experiment with known outcome.

In three selected species of planktonic Foraminifera a variety of morphological traits, such as size, roundness, growth pattern, outline, and incidence of abnormal morphotypes, was investigated. In *Orbulina universa*, which shows two local extinctions in the studied time interval, an increase in size and the incidence of abnormal morphotypes could be observed during both intervals immediately preceding the extinction levels. Furthermore, the species shows a significant shift in test roundness with the onset of the sapropel, with roundness values being generally stable in both intervals before and after sapropel onset, respectively. *Globorotalia scitula* shows a local extinction shortly before the onset of the sapropel. Beside a generally variable but otherwise stable morphology a distinct deviation in growth rate and variability of growth rate can be observed immediately before the species becomes locally extinct. In *Globorotalia inflata* no morphological reaction to the observed environmental forcing could be observed; the species became extinct immediately after sapropel onset without an obvious reaction of its shell morphology. These results indicate that morphological reactions on environmental stress in planktonic Foraminifera occur on different time scales and that the type and level of reaction is species-specific. On large time scales long-lasting, stable deviations in morphology can be observed, associated with large environmental shifts. Over short time periods, as a result of fatal stress leading to local extinction, other morphological reactions are obvious. These can most likely be attributed to a relaxation of growth patterns and appear to operate over a time interval of decades or less. We speculate that severe

stress at times preceding extinction either hinders internal control mechanisms that would normally ensure a more regular growth pattern, or it induces the species to relax the morphogenetic constraints and manifest more phenotypic variation, which might increase the chances of survival.

S5 – Travelling through time: the past, present and future biogeographic range of *Amphistegina* spp.

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The larger, symbiont-bearing foraminiferal genus *Amphistegina* is known to occupy warm, oligotrophic waters, preferably within reef areas. Its current biogeographic range lies between 30° N and S, but it has expanded towards higher latitudes during times of extensive global warming (e.g. during the Eocene or the Miocene). During the last century, sea surface temperatures have been rising significantly due to global warming. This trend is expected to continue and climate change scenarios for 2100 suggest a further increase by 3° C in average (IPCC Synthesis Report 2007, among others). There are multiple examples from regions where range shifting of *Amphistegina* spp. can be observed, which most certainly relates to ongoing ocean warming.

In our studies on the biogeography of *Amphistegina* spp., we applied Species Distribution Models (SDMs) in order to evaluate the potential distribution of the taxon under current climate and to predict geographic range changes within the next decades. Our models for the global distribution of *Amphistegina* spp. showed that even under current climate conditions, potentially suitable habitats are not fully utilized and a general range expansion towards higher latitudes can be expected in the future. Furthermore, we generated SDMs for the Mediterranean and the coast of East Africa – two regions where *Amphistegina* spp. has known to expand its biogeographic range for decades. Our results suggest a progress of this trend for the next 50 years. Since *Amphistegina* spp. is one of the most prolific carbonate producers within the world's oceans, the biogeographic changes predicted by our SDMs have to be closely monitored in the future.

S5 – Understanding stable isotope signals from fossil foraminifera – a Turonian Fossillagerstätte from Tanzania

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Upper Cretaceous sediments recovered during the Tanzania Drilling Project from 2007 to 2009 include long intervals with exceptionally well preserved microfossils, providing an excellent sample base for generating stable carbon and oxygen isotopic records as well as other geochemical data. Our study examines inter-species variation in stable isotopic values of benthic and planktic foraminifera and one species of calcareous dinoflagellate cyst species. Our goal is (1) to evaluate the contribution of species-specific vital and microhabitat effects relative to the environmental signals on the isotopic signatures reflected in the foraminiferal tests and (2) to indentify species that are best suited for studies of stable isotopes and temperature reconstructions in the Cretaceous. We present results from a Turonian sequence with relatively stable environmental conditions as inferred from minimal variation in intra-specific $\delta^{13}C$ and $\delta^{18}O$ values across the section. The studied material contains abundant and diverse benthic foraminifer assemblages that indicate an outer shelf to upper slope paleodepth. We performed single species $\delta^{13}C$ and $\delta^{18}O$ measurements for 18 calcareous benthic and 11 planktic species.

Cross plots of $\delta^{13}C$ and $\delta^{18}O$ show distinct offsets between clusters of data points for individual species, reflecting a combination of differences in habitat and disequilibrium fractionation due to kinetic and metabolic effects. Offsets in $\delta^{18}O$ between two groups of trochospiral planktic foraminifera apparently reflect water depth-related differences in temperature during their lifetime. An expected offset is observed between benthic species with aragonitic versus calcitic tests, but systematic offsets among aragonitic species indicate that micro-habitat or vital effects also influence measured values. The lowest $\delta^{13}C$ values among the calcitic benthic foraminifera were observed for species of the genus *Lenticulina*. Because we did not observe differences in their preservation relative to other benthic species, the isotope results suggest a strong influence of combined kinetic and metabolic effects on isotopic fractionation for *Lenticulina* species that are thought to be related to an opportunistic life style and fast growth and calcification rates. Among the studied calcitic benthic species we identify four trochospiral epifaunal to shallow infaunal species that appear to have close-to-equilibrium isotopic values and are preferred for paleoenvironmental reconstructions. Relatively stable within-sample inter-specific offsets in $\delta^{13}C$ and $\delta^{18}O$

across the studied section suggest that correction factors may be applied for species that are out of isotopic equilibrium, except for $\delta^{13}C$ of *Lenticulina* that show very large scatter. However, for most pairs of benthic species our data also indicate covariance between these offsets in $\delta^{13}C$ and $\delta^{18}O$ as a result of different species-specific reactions on environmental changes. This introduces an uncertainty for the application of correction factors in cases of strong fluctuations in temperature or food supply and if species with very different mode of life or physiology are compared.

S5 – Using cathodoluminescence spectroscopy to distinguish biogenic from early-diagenetic calcite in Cretaceous microfossils from the Tanzanian Drilling Project

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Microfossils (dinoflagellates, foraminifera) of rare, spectacular preservation were recovered from Upper Cretaceous sediments (92 Ma) within the scope of the Tanzanian Drilling Project (TDP). Cathodoluminescence (CL)-spectral analysis of this material was motivated by the fact that the pristine dinoflagellate calcite is comparatively Mg-rich; however, it undergoes significant early recrystallization that likely was associated with a decrease in Mg content. We aimed at detecting this process by searching for a shift in wavelength of the ca. 630 nm CL-band which usually is related to changes in Mg content. CL-spectra were acquired using an analytical FEI Nova NanoSEM 600 with a Gatan MonoCL spectrometer operating with a high sensitivity photomultiplier tube (HSPMT) detector and a Xiclone liquid nitrogen-cooled CCD array.

We found that the material shows a different CL spectral property related to "intrinsic" luminescence bands making it impossible to detect a wavelength shift in the ca. 630 nm luminescence band. The unusually strong "intrinsic" Cl-spectral pattern common to the Tanzanian material is characterized by a dominant peak around 395 nm (blue). Studying pure calcite crystals (sinter calcite), this peak has been associated in the literature with luminescence effects different from impurities or defects but rather due to lattice properties causing an electron transition of Ca^{+}- to CO_3^{-}- centers. The best preserved (pristine) specimens of our study reveal delicate surface traits in SEM-imaging and have a glassy light-optical appearance. They represent the calcite that is closest to the original biogenic shell substance. These specimens exclusively show the 395 nm luminescence peak while towards re-crystallization and, finally, cementation the common 625 nm band develops.

Our findings have e.g. taxonomic implications as the surface crystal pattern that we found to represent a re-crystallized shell was formerly thought to be an unaltered biogenic pattern. Apparently, the ratio of blue CL versus Mn-activated CL can be taken as a potential measure of the degree of earliest-diagenetic re-crystallization of biogenically formed calcite. This is important to evaluate the reliability of geochemical proxies for paleo-environmental reconstruction drawn from the study of microfossils. Besides the dinoflagellate-calcite, pristine calcitic and aragonitic foraminifera also show a well-defined ca. 400 nm peak.

S13 – *Saurichthys* from the Upper Buntsandstein (Anisian) of Lower Franconia

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Two to three forms of *Saurichthys* (Pisces: Actinopterygii) are found in grey to yellowish silty claystones of the Röt Formation (Upper Buntsandstein, Anisian, Middle Triassic) of Lower Franconia. Types A and B occur in the "Obere Dendritenschichten" of Hammelburg and are represented by skulls and several complete fishes. Numerous detached opercula from the same level also belong to these types. Type C was collected in a temporary outcrop near Münnerstadt from the somewhat older "Münnerstadt-Bank" and is represented by isolated skulls and skull fragments. All specimens are small, with skulls being generally no longer than about 3 cm and less than 10 cm total length. No larger saurichthyid remains are known from these localities, and the body proportions as well as the ossification of the articulated fishes do not necessarily qualify them as very juvenile individuals.

Types A and B exhibit slight differences in skull roof morphology and ornamentation, which probably are not diagnostic of different species and might be related e.g. to sexual dimorphism. The skull roofing bones of both are ornamented with coarse, roundish tubercles; despite equal size, sutures are distinctly developed in type A but hardly recognizable in type B. Between the orbits, the skull roof is much narrower than in front of them, even at some distance. The body is covered with six longitudinal rows of scales in mid-dorsal, mid-ventral, mid-lateral and ventro-lateral position. Both mid-lateral and ventro-lateral scales

have long and slender dorsal and ventral branches. The mid-lateral scales are anteroventrally inclined, whereas the ventro-lateral scales have a slight posteroventral angle. The fins are small, the pelvics consisting of about ten, and the dorsal and anal fins and each lobe of the caudal fin of about twenty unsegmented fin rays. None of the specimens has pectoral fins preserved.

The skull roof of type C is ornamented with ridges and furrows instead of tubercles and is furthermore distinguished by a longer parietal complex, slightly larger interorbital distance and the straighter course of the supraorbital sensory canal.

Along with the Thuringian locality Jena-Göschwitz and a find from the Röt of Rüdersdorf (Brandenburg), the occurrence in Lower Franconia is the third report of *Saurichthys* from German Buntsandstein. The new finds belong to the smallest known *Saurichthys* specimens, and if they were fully grown, this might document an ecological adaptation different from the saurichthyid-typical piscivorous lifestyle. The remarkably small interorbital distance may have enabled the fish to look upward to the water surface for insects, abundantly found at both Franconian localities.

S14 – Eryopid temnospondyls from different ecosystems of Pennsylvanian up to Upper Permian Laurasia

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Eryopid temnospondyls were widespread in the Late Paleozoic from the Upper Pennsylvanian of New Mexico up to the Upper Permian of the Russian Preural region. The best-known taxa are the genera *Eryops* from the Permocarboniferous of North America and *Onchiodon* from the Early Permian of Middle Europe. Both genera are characterized by one autapomorphy, respectively, the presence of the interfrontal in *Eryops* and an ectopterygoid with very tiny fangs in adult stage of *Onchiodon*.

A well-preserved, partial skull of the temnospondyl amphibian *Eryops* was described from the Pennsylvanian strata of the El Cobre Canyon Formation of Cañon del Cobre, New Mexico. The presence of the interfrontal presents convincing evidence of its assignment to *Eryops*. It is the oldest known record of this genus. The Lower Permian specimens of *Eryops* from New Mexico and Utah are tentatively assigned to *E. grandis*, despite having a more slender skull with a narrow jugal and relatively fine dermal sculpturing. The numerous specimens of *Eryops* from the Permian Red Beds of Texas need a detailed revision.

Onchiodon is presented by the genotype *Onchiodon labyrinthicus* from the Rotliegend (Early Permian, Cisuralian, Asselian) of Niederhäslich in Saxony, and *Onchiodon thuringiensis* from the Rotliegend of Manebach in the Thuringian Forest, both Germany. The latter species lived in open fluviatile environment with anatomizing river channels, flood plains, coal swamps and little lakes. *Onchiodon thuringiensis* was one of the topmost predators together with a sphenacodont and the giant arthropod *Arthropleura*. *Eryops* and *Onchiodon* are characteristic for terrestrial ecosystems.

Other eryopid species known from the Thuringian Forest, Bohemia and French Massif Central have previously been assigned to *Onchiodon*. However, they have retained an elongated interclavicle and a more pointed snout region. They differ in these and other features clearly from *Onchiodon* as well as *Eryops*. So it was necessary to establish the "*Actinodon-complex*" for more aquatic adapted eryopids from the European Early Permian.

Another aquatic adapted eryopid is known from the Pennsylvanian of North America. The temnospondyl *Glaukerpeton avinoffi* from the Upper Pennsylvanian Conemaugh Group of North America is confirmed on the basis of a detailed restudy of two specimens: the holotype from Pittsburgh, Pennsylvania, and a second specimen from an approximately equivalent stratigraphic level in West Virginia. The latter specimen was originally referred to *Eryops cf. avinoffi*, but it is reassessed as *G. avinoffi*. The possession of lateral line sulci and ossified ceratobranchials indicate an aquatic habitus of the adult *Glaukerpeton*.

Both genera of the Russian Upper Permian *Clamorosaurus* and *Syndyodosuchus* are currently being revised and preliminary results are presented.

S16 – Reproductive biology of sauropods and its possible impact on their gigantism: comparative analysis of mammalian, avian, crocodilian and sauropod reproduction

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Body size influences nearly every aspect of the biology of currently existing organisms and many life history variables correlate with body size. Life history variables such as clutch/litter size, number of offspring per year are important for understanding life history strategies and population extinction risk, because such factors are directly related to the fitness of an organism. Body size limits of a taxon reflect not only mechanical or physiological constrains, but also the scaling of its reproductive parameters. According to these observations the reproduction of sauropods could have contributed to their gigantism (in comparison to terrestrial mammals). Large dinosaurs,

like sauropods, might have faced a lower risk of extinction under ecological changes than similar sized mammals as large dinosaurs could have had a higher potential reproductive output than similar sized mammals.

First, we tested the assumption underlying this hypothesis. We therefore analysed the potential reproductive output (reflected in clutch/litter size and annual offspring number) of extant terrestrial mammals, birds and of extinct dinosaurs. Unfortunately, information on life history traits like reproductive output is only scarce or even not preserved in the fossil record, thus terrestrial non-passerine birds were used as ''dinosaur analogs''. Furthermore, we compared crocodile clutch size to body mass relations to those of mammals, birds and sauropods.

We could show that, with the exception of rodents, differences in the reproductive output of similar sized birds and mammals existed even at the level of single orders. Furthermore, fossil sauropod clutches were larger than litters of scaled up mammals and their sizes were comparable to or higher than those of scaled up birds but lower than sizes of scaled up crocodiles. Because the extinction risk of extant species often correlates with a low reproductive output, these differences in reproductive output suggests a lower risk of population extinction in large dinosaurs than in large mammals. Second, we present a very simple, mathematical model that demonstrates the advantage of a high reproductive output. It predicts that a species with a high reproductive output that usually faces very high juvenile mortalities will benefit stronger in terms of population size from reduced juvenile mortalities (e.g. resulting from a stochastic reduction in population size) than a species with a low reproductive output that usually comprises low juvenile mortalities.

Based on our results, we suggest that the reproductive strategy of sauropods could have contributed to the evolution of the exceptional gigantism seen in the sauropods that does not exist in extant terrestrial mammals. Large sauropods, may have easily sustained populations of very large-bodied species over evolutionary time.

S3 – Ancient life and its signatures from early-mid Archaean formations in the Pilbara, Australia and Barberton, South Africa: implications for the Curiosity rover on Mars

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It is now more than 50 years since Barghoorn and Tyler first identified the fossil traces of microorganisms in Precambrian rocks, the 1.9 Ga-old Gunflint Formation on the northern shores of lake Superior. The race was then on to identify the microfossils in the oldest terrestrial rocks. Hans Pflug and his colleagues investigated the 3.6-3.8 Ga-old metasediments on Isua using palynological techniques, finding even yeast cells that were shown to be a younger contaminant. Bill Schopf identified large tubular structures in ~3.5 Ga-old rocks from the Pilbara in Australia that he identified as fossil cyanobacteria. They were later shown to be carbonaceous artefacts – deposited in a hydrothermal chert vein!

Despite the difficulties involved in searching for ancient traces of very primitive forms of life, great strides have been made over the last decades through better understanding of the modes of preservation of prokaryotic organisms and their biosignatures and through the use of newly available technology, such as nanoSIMS and synchrotron radiation for the *in situ* investigation of micrometer-sized fossils. I will present an overview of the latest investigations into early-mid Archaean microfossils that will cover fossil stromatolites, microbial mats, chemotrophs as well as recently identified enigmatic microorganisms that might be planktonic forms.

In view of the imminent landing of the Curiosity rover on Mars whose objective is the search for traces of Martian life, I will briefly address life on Mars from the perspective of the ancient life on Earth.

S3 – Oligotrophic? Eutrophic? Imbalanced nutrients! Black shale formation in a shallow shelf setting during the OAE 2 (Wunstorf, Germany)

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Widespread black shale (BS) occurrences during the Oceanic Anoxic Event 2 (OAE 2, Cenomanian/Turonian boundary) reflect perturbations in major biogeochemical cycles, caused by the onset of the eruption of the Caribbean Large Igneous Province (LIP). Biomarkers, cell biomass remnants of microorganisms, from numerous ODP sites suggest that photic zone anoxia occurred at least periodically in the Protoatlantic during OAE 2. The BS deposition was repeatedly inferred to result from eutrophication of the water body. However, the BS interfinger with white and red calcareous nannofossil oozes on the NW German shelf seas, which are seen as deposited under oligotrophic conditions. Analogous to modern, comparable systems, however, these are better interpreted to represent N-limited pelagic ecosystems.

At Wunstorf (NW Germany; shelf setting, ca. 100 to 150 m water depth), OAE 2 BS alternate with calcareous nanoplankton oozes (eutrophic *versus* oligotrophic in conventional view) at Milankovich-driven 20/100 ky cycles. This introduces the problem that the water body switched between two extremes in a pelagic setting, cut off from significant continentally-derived particulate influx, within very a short time. We analyzed bulk geochemistry and biomarkers from BS and white limestones. Our data show that no photic zone euxinia was developed (lack of biomarkers from green sulfur bacteria), in contrast to sites of the Protoatlantic. However, the occurrence of the biomarker tetrahymanone from bacteriovorous ciliates supports the presence of an at least temporarily stratified water body as does the occurrence of functionalized hopanoids, incl. 2- and 3-methylated structures [(cyano) bacteria, methano- or methylotrophs]. Correlations of total organic carbon (TOC) and $\delta^{15}N$ and high relative abundances of hopanoid biomarkers indicate that BS formation was triggered by a bacterial system, in which (cyano)bacterial N_2-fixation played a crucial role. However, without additional phosphorus, bioproductivity would remain low and imbalanced nutrients in relation to the Redfield Ratio (C = 106, N = 16, P = 1) with high phosphorus ratio are required to foster (cyano)bacterial N-fixation and peak productivity. Increased amounts of dinosterol during BS formation indicate that dinoflagellates bloomed in these settings. Increased continental weathering due to LIP-triggered high pCO_2 introduced the required phosphorus, and due to the widespread N-limited systems, it could bypass the shelf without being consumed. Once BS deposition started, internal P and N-recycling fueled the system further, explaining that peak productivity can remain a local affair in depressions and interfinger laterally with systems without BS deposition. Our data suggest that the application of the termini “oligotrophic” and “eutrophic” are too simplistic to explain the two contrasting biosedimentary systems. Instead, imbalanced nutrients provide a satisfactorily explanation for BS development in this, and most likely also other BS settings in the Phanerozoic.

S2 – Patterns of morphological disparity through geological and research time

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Studies of morphological disparity seek to complement investigations of diversity using various indices of morphological variety. Investigators are typically interested in the manner in which clades have explored ‘design’ space; usually following their trajectories through geological time and often investigating the contributions of constituent subclades to total disparity. Indices of disparity are increasingly being estimated using empirical morphospaces derived from discrete character matrices. In many cases, these matrices are repurposed from cladistic studies, which may sample taxa and characters with subtly different objectives from explicitly phenetic studies.

Here, we argue that whereas phylogenetic analyses all seek to reconstruct the underlying and actual evolutionary tree, empirical morphospaces are abstract constructs with characteristics that reflect the particular purposes for which they were devised. As such, cladistic character-based morphospaces offer one of many possible valid frameworks within which to quantify the distribution of forms in design space. However, such datasets must be treated critically to ensure consistent and adequate taxon and character sampling.

Using the example of priapulid and archaeopriapulid worms, we demonstrate that relative estimates of Cambrian and post-Cambrian disparity from discrete characters have changed very little over the last fifteen years of research time. Many new fossil finds have been incorporated and many new characters coded as a result; however, extant taxa are still more disparate than their Cambrian counterparts and the two groups still occupy adjacent (rather than broadly overlapping) regions of the space. What *has* changed is the significance with which the disparities of the two groups can be distinguished. The relative stability of character morphospaces is contrasted with the extreme sensitivity and lability of parsimony-based cladograms.

More broadly, we survey the manner in which 100 exemplary clades have explored their respective empirical character morphospaces through the Phanerozoic. We test each of these clade disparity profiles for significant bottom or top heaviness (early or late maximal disparity). We find that early maximal disparity is principally a characteristic of Palaeozoic clades, but that this pattern nonetheless predominates over its antithesis once the most obvious effects of mass extinction have been removed.

S25 – Cenomanian (Cretaceous) ammonites from the North Cantabrian Basin, northern Spain

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Fossiliferous Cretaceous rocks are superbly exposed in northern Cantabria, Spain. Cenomanian strata of the North Cantabrian Basin (NCB) yielded a diverse ammo-

nite fauna consisting of nearly 40 taxa: *Phylloceras* (*Hypophylloceras*) *seresitense*? Pervinquiére; *Phylloceras* (*Hypophylloceras*) sp.; *Gaudryceras* (*G.*) *cassisianum*? (d'Orbigny); *Puzosia* (*P.*) *mayoriana* (d'Orbigny); *Pachydesmoceras denisonianum* (Stoliczka); *Metengonoceras* sp.; *Litophragmatoceras incomptum* Kennedy & Cobban; *Forbesiceras largilliertianum* (d'Orbigny); *F. chevillei* (Pictet & Renevier); *F. obtectum* (Sharpe); *M. mantelli* (J. Sowerby); *M. couloni* (d'Orbigny); *M. saxbii* (Sharpe); *M. dixoni* Spath; *Acompsoceras renevieri* (Sharpe); *Acompsoceras* sp.; *Acanthoceras rhotomagense* (Brongniart); *A. jukesbrownei* (Spath); *Cunningtoniceras inerme* (Pervinquière); *C. arizonense* Kirkland & Cobban; *Protacanthoceras arkelli arkelli* Wright & Kennedy; *Thomelites sornayi* (Thomel); *Thomelites* sp.; *Calycoceras* (C.) *naviculare* (Mantell); *C.* (Newboldiceras) *asiaticum spinosum* (Kossmat); *C.* (N.) *asiaticum asiaticum* (Jimbo); *C.* (N.) *hippocastanum* (Sowerby); *Eucalycoceras pentagonum* (Jukes-Browne); *E. gothicum* (Kossmat); *E. rowei* (Spath); *Eucalycoceras* sp.; *Lotzeites aberans* (Kossmat); *Euomphaloceras euomphalum* (Sharpe).; *Metoicoceras geslinianum*? (d'Orbigny); *Metoicoceras* sp.; *Hamites simplex*? d'Orbigny; *Turrilites scheuchzerianus* Bosc; *T. costatus* Lamarck; *Worthoceras vermiculus* (Shumard); *Scaphites equalis* J. Sowerby. Representatives of the subfamily Acanthoceratinae de Grossouvre are most common.

Based on the ammonites collected from the Cenomanian strata of northern Cantabria, the Early Cenomanian *Mantelliceras mantelli* and *M. dixoni* zones, the Middle *Cenomanian Cunningtoniceras inerme*, *Acanthoceras rhotomagense* and *A. jukesbrownei* zones, and the Late Cenomanian *Eucalycoceras pentagonum* and *Metoicoceras geslinianum* zones could be recognized. The latest Cenomanian *Neocardioceras juddii* Zone is represented by a stratigraphic gap. Palaeobiogeographically, the NCB belongs to the "Northern Transitional Subprovince", an intermediate area between the Tethyan and the Boreal realms. The Cenomanian ammonoid assemblage of the NCB is clearly dominated by cosmopolitan and some Tethyan taxa, and true Boreal forms (such as the genus *Schloenbachia*) are absent. The ammonoid fauna is relatively rich and compares well with Cenomanian ammonite assemblages of other European localities mediating between the Boreal and Tethyan realms (e.g., from Cassis, Bouches-du-Rhône, southern France, 42 predominantly cosmopolitan and Tethyan ammonite taxa have been recorded).

S25 – Biofacies, depositional environment and stratigraphy of the Oberhäslich Formation (lower Upper Cenomanian, Saxonian Cretaceous Basin, Germany)

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In Saxony, the global Late Cretaceous transgression is documented by the onlap of shallow-marine sandstones of the lower Upper Cenomanian Oberhäslich Formation onto Palaeozoic rocks of the eastern Erzgebirge, the central part of the Mid-European Island. Based on detailed logging of numerous sections south of Dresden and the study of extensive collection material, the depositional environment and the macrobenthic assemblage of the Oberhäslich Formation have been reconstructed.

South of Dresden, the Oberhäslich Formation attains a maximum thickness of ca. 30 m, but it otherwise may be completely absent due to pre-transgression topography. Nearshore sections are characterized by fossil-poor, high-energy pebbly coarse-grained sandstones with planar cross-stratification deposited above fair-weather wave base. Bioturbated, fine- or rarely medium-grained quartz-rich sandstones accumulated below the fair-weather wave base. From the latter facies, most of the fossils from the Oberhäslich Formation have been collected. The biostratigraphy is based on numerous finds of *Inoceramus* ex gr. *pictus* J. de C. Sowerby. As a rarity, also the zonal index ammonite *Calycoceras naviculare* (Mantell) has been found, confirming an early Late Cenomanian age. The Oberhäslich Formation usually shows a fining-upward trend that may be reversed towards the very top. It has been deposited in a single a 3rd-order sea-level cycle of ca. 1 myr duration and is capped by an unconformity at the base of the overlying Dölzschen Formation (upper Upper Cenomanian).

The macrobenthos of the Oberhäslich Formation is dominated by relatively large bivalves, most notably *Rhynchostreon suborbiculatum* (Lamarck) (29%) and *Inoceramus* ex gr. *pictus* (21%). *Pinna* spp. (4.5%), *Rastellum cariantum* (Lamarck) (3.7%) and *Gervillaria*? *neptuni* (Goldfuss) (2%) are subordinate elements. Moderately common are smaller bivalve taxa such as representatives of the genus *Neithea* (11%), other pectinids (~4%) and limids (7%) while gastropods are nearly absent. Non-molluscan benthic invertebrates are likewise rare and represented by irregular (*Holaster* sp., *Hemiaster* sp., *Catopygus*? sp.) and regular echinoids (spines of cidarids) as well as siliceous sponges (e.g., *Siphonia* sp.). Large *Thalassinoides* and *Ophiomorpha* burrows indicate that crustaceans have been an important part of the infauna, associated by irregular echinoids and polychaetes. Pervasive bioturbation resulted in a post-depositional homogenization of the sediments. Connected with a shallowing at the top of the Oberhäslich Formation, *Skolithos*-like burrows have been observed at one section while at another, the rosetted trace fossil *Dactyloidites ottoi* (Geinitz) occurs in abundance. Bored wood remains are common. All body fossils are preserved as steinkerns.

The benthic assemblage of the Oberhäslich Formation is moderately diverse, consisting of ca. 35 taxa. It is dom-

inated by semi-infaunal (bakevelliids, modiolines, pinnids) and epifaunal (resp. epibyssate) suspension-feeding bivalves (inoceramids, oysters, pectinids, limids). Deep-infaunal bivalves are missing. Deposit-feeding biota are comparably rare, possibly related to the organic-poor character of the substrate (mature quartz sand). The frequent occurrences of articulated bivalves suggest episodic rapid burial, most probably by tempestites. A current-influenced, well-oxygenated and nutrient-rich environment between the fair-weather and storm-wave bases is inferred for the fine-grained sediments of the Oberhäslich Formation.

S15 – The Langenberg-Quarry in Oker – A special window into the terrestrial Late Jurassic of Northern Germany

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The Langenberg Quarry in Oker, Lower Saxony, is a classic and biostratigraphically well dated outcrop of late Oxfordian to late Kimmeridgian marine strata. Paleogeographically, it is located in the Lower Saxony Basin that covered much of northern Germany in Late Jurassic and Early Cretaceous times and that was surrounded by several large paleo-islands.

The Langenberg Quarry is also a very important locality for terrestrial vertebrates, which must have been transported into the basin from a nearby paleo-island. Dwarfing of the largest animal in the fauna, the basal macronarian sauropod dinosaur *Europasaurus holgeri*, has been interpreted as resulting from resource limitations in the island habitat. In particular beds 56, 73, and 83 of the stratigraphy of Fischer yielded terrestrial vertebrates, while most other beds contain a purely marine vertebrate fauna. The composition of carbonates and marls as well as the invertebrate fauna recorded changes in water depth, but there is no sedimentological evidence for subaerial exposure; although one horizon has preserved theropod and possibly also small sauropod tracks.

Beside the abundant and excellently preserved *Europasaurus* material, three bones of a diplodocid sauropod (possibly also dwarfed), and very few theropod bones, the Langenberg Quarry yielded additional exceptional material of terrestrial non-dinosaurian vertebrates. This includes the three-dimensionally preserved articulated skeleton of a small pterosaur, which has been described as the first dsungaripterid from the Kimmeridgian of Germany, and the skeletons of a new taxon of the small non-marine atoposaurid crocodilian *Theriosuchus*.

A new excavation in the most promising layers is scheduled for August and September 2012. It will help to understand the taphonomy and the paleoecology of the terrestrial vertebrates. It is expected that the planned extensive screenwashing will vastly expand the number of known taxa from the quarry.

S17 – The enigmatic bovid Duboisia santeng (Early-Mid. Pleistocene, Java): a multiproxy approach to its palaeoecology

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During the Pleistocene, faunal exchanges between the Sunda Island Java and the East-Asian mainland occur via land bridges, permitting faunal elements of Indo-Chinese origin to enter Java. Hence, most Javanese mammalian taxa are similar if not identical to their mainland relatives. Among the four Javanese bovids, *Duboisia santeng*, however, has been regarded as a typical endemic species due to its small size. So far, except from being obviously smaller than its relatives, nothing is known about *Duboisia's* dietary or habitat adaptations. The vegetation on Java was influenced by climatic oscillations during the mid-Pleistocene and hence provided diverse habitats including open grasslands, seasonal forests, mangroves and swamps, which could put alternating selective pressures on *D. santeng*. We test the hypothesis that *Duboisia santeng*'s small size was an adaptation to occupying a specialized niche in a closed environment.

We apply a multiproxy approach for palaeohabitat reconstruction to better understand the ecology of *Duboisia santeng*: First we reconstruct palaeodiet using 2D-mesowear for a long term and 3D-surface texture analysis for a short term signal. Secondly we perform an ecomorphological reconstruction by morphometric analysis of postcranial elements (six femoral and eight astragali variables) to match diet with habitat preferences and reconstruct mean body mass from 26 allometric equations based on cranial, dental or long bone dimensions.

The mesowear signature of *Dubosia santeng* is characterized by high reliefs with sharp cusps (70%), a few round cusps (15%) and low reliefs with round cusps (15%). This high frequency of sharp cusps in combination with high relief and a lack of blunt cusps are characteristic of an attrition dominated browsing diet in general. Enamel surface textures of *D. santeng* have lower values for density of peaks (*Spd*) and material volume (*Vm*) compared to extant browsers. The values for mean surface roughness

(*Sa*) and core material volume (*Vmc*) lie in between extant browser and grazer. This is indicative of abrasive components in the diet. Considering mesowear as long term and surface textures as a short term dietary signature we conclude that *D. santeng* was neither a grazer nor a fruit browser, but a leaf browser with some endogenous or exogenous abrasive components in its diet. Its estimated mean body mass is 54 kg. The 14 variables taken on femora and astragali placed *Duboisia* among extant forest and light-cover dwellers, which is in accordance with a browsing diet. Thus, we infer that *Duboisia* inhabited forests or semi-closed habitats in the heterogeneous landscape of mid-Pleistocene Java, while the larger bovids like the extinct water buffalo *Bubalus palaeokerabau* are supposed to have lived in open landscapes and swamps.

S17 – A case study of seasonal, sexual and ontogenetic divergence in the feeding behaviour of the moose (*Alces alces* Linné, 1758)

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We examine differential feeding behaviour in a sexual dimorphic ungulate, the moose (*Alces alces* Linné, 1758). Due to different energetic requirements of males and females, as well as between ontogenetic stages (juvenile/subadult vs. adult), we expect individuals to select forage according to their needs: either for quality or quantity. The selectivity should be less pronounced in winter as forage then is less abundant. To determine forage quality in terms of the amount of abrasive components, we apply the mesowear method of dietary evaluation. We find that male and female moose of all age classes have a similar winter diet. In summer, both young and adult females feed on more abrasive food than males. Males of all age classes have to cope with similar levels of abrasives in their diet. This would be explained by differential energetic needs in males and females. While males can afford to feed selectively, females cannot. Females regularly experience periods of high energetic demands during lactation, in which they also need to exploit more abrasive food sources, as compared to males.

S9 – Feeding behaviour of the Triassic plagiosaurid *Gerrothorax* – a case study of aquatic feeding in temnospondyls

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The Middle to Late Triassic plagiosaurid *Gerrothorax* is a highly derived, gill-breathing temnospondyl characterized by its broad, short-snouted skull and a generally flattened morphology. Regarding the aberrant morphology of *Gerrothorax*, the question of how this temnospondyl fed in water has been widely discussed in the past decades, but no integrated picture of mouth opening and hyobranchial movement has been provided so far. In the present study, the cranial and hyobranchial muscles of *Gerrothorax* were reconstructed as far as possible based on direct evidence (spatial limitations, ossified muscle insertion sites on skull, mandible and hyobranchium) and on phylogenetic reasoning (Extant Phylogenetic Bracket, with extant basal actinopterygians, sarcopterygian fishes and salamanders as bracketing taxa). Inferring from skeletal anatomy and the presumed associated muscles, the feeding behaviour of *Gerrothorax* can be reconstructed as follows. The flattened morphology, the short limbs and the heavily built skeleton strongly suggest that *Gerrothorax* was a bottom-dwelling ambush predator. However, if *Gerrothorax* had rested on the bottom and had solely raised its head during prey capture as previously assumed, there would have been by far not enough interspace between skull and pectoral girdle to retract the hyobranchial apparatus and to increase the size of the buccal cavity for suction feeding. Furthermore, the orientation of the muscle scars on the postglenoid area of the mandible indicates that a portion of the depressor mandibulae extended posterodorsally on the trunk behind the skull. This suggests that the depressor was indeed used for lowering the mandible and not to raise the skull as earlier supposed, and implies that the skull including the mandible must have been lifted off the ground during prey capture. It can thus be assumed that *Gerrothorax* raised the head towards the prey with the jaws still closed. Then the mouth started to open rapidly. Analogous to the extant bracketing taxa, this was caused by action of the strong epaxial muscles (further elevation of the head) and the depressor mandibulae and rectus cervicis (lowering of the mandible). During mouth opening, the action of the rectus cervicis muscle also rotated the hyobranchial apparatus ventrally and caudally, thus expanding the buccal cavity and causing the inflow of water with the prey through the mouth opening. The strongly developed depressor mandibulae and rectus cervicis, as well as the well ossified, large quadrate-articular joint suggest that this action occurred rapidly and that powerful suction was generated. Similar to the jaw opening muscles, also the jaw adductors were well developed and enabled a rapid closure of the mouth. In contrast to extant salamander larvae and most extant actinopterygians (tele-

osts), no cranial kinesis was possible in the *Gerrothorax* skull, and therefore suction feeding in *Gerrothorax* was not as elaborate as in these extant forms.

S7 – The use of µ-CT in the investigation of teratologies and bauplan modifications in Larger Benthic Foraminifera

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Teratologies and extremely aberrant forms of Larger Benthic Foraminifera, observed in loose sediments or in thin sections, have been documented ever since the beginning of the studies of Foraminifera. Growth deviations, multispiral growth, conjoined tests, and double (or triple) contemporary equatorial layers are rare evidences but known facts. Although these deviations from the bauplan are known since the 19th century, very few studies have been undertaken to better understand the occurrence of such bizarre geometries. One problem lies in the broad use of thin sections in the investigation of Foraminifera, which can only lead to a partial understanding of the phenomenon because these bauplan modifications are either missed, found by chance or misunderstood due to the fact that only one random - possibly very misleading - cross section of the structure is visible. The second problem with thin sections is the destruction of sometimes rare specimens precluding further investigation.

It is only very recently that new technologies such as the µ-CT and modern 3D-image processing software allow the detailed study of these phenomena. In the search for causes and consequences of these peculiar morphologies, the first important step is to characterize them and to find links connecting the deviations to biological and/or ecological factors. While according to recent research the phenomenon of multispiral growth in nummulitids is assumed to be linked to the incompatibility between the Archimedean geometry of the test and the exponential growth of the protoplasm, very little speculations have arisen so far concerning the underlying causes of conjoined twins in nummulitids.

Conjoined tests have been observed in Recent as well as in fossil Foraminifera, both in smaller benthic genera, such as *Ammonia* and larger benthic forms such as *Nummulites*. These so-called conjoined tests are individuals that seem to have a normal individual development until a rather advanced stage in their ontogeny when they fuse their tests. Several conjoined tests of *Nummulites* have been scanned so far, joined at different ontogenetic stages, (e.g. chamber 33 to chamber 52). After the fusion of their tests, they form new chambers from a common outer lamellae sharing the marginal chord. None of these conjoined individuals seems to be affected in the continuation of their ontogenetic growth.

S5 – Multispiral growth in nummulitids: a three-dimensional approach

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Like most Larger Benthic Foraminifera, nummulitids follow very strict morphogenetic rules. Multispiral growth is a common phenomenon among larger species of *Nummulites*. This work tries to quantify this growing strategy, its occurrence in this group and its consequences in the test architecture and how it influences the palaeobiology of the cell.

The use of micro CT scans permits the measurement of any morphological detail, allows the quantification of the lumina of chambers and chamberlets, and may provide an exact tridimensional model of the specimen including all details often missed by thin sections.

These models might shed light on the cell ontogeny in multispiral coiled nummulitids. Observing chamber volume sequences, it seems that even taking alar prolongations into account, chambers arranged in a single Archimedean spiral cannot provide the cell with the exponential increase in accommodation space which is commonly found in larger forams. In Archimedean spirals the increase of chamber volume is defined by a linear function. The alar prolongations add progressively to the chamber's volume but the increase is also linear. Therefore, the addition of a secondary spiral is the logical consequence of increasing the accommodation space without changing the bauplan morphology.

Cyclic and abrupt variations along the chamber volume sequence have been found in several specimens. Cyclic variation can be linked to the environmental influence affecting the cell during its growth and can help to understand the lifetime of the cell, whereas abrupt changes, such as a sudden increase in chamber dimensions, are probably related to internal factors.

This study, which matches the longevity of such protists with the quantitative approach here proposed, might be the only way to tackle the ontogeny of such giant cells. Furthermore, the investigation of cyclic variations within

such large tests provides a record of Eocene environmental changes over a several years.

S8 – Fluorescent shell colour patterns in bivalves from the Middle Triassic Muschelkalk

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UV-light-induced fluorescence has been widely used to reveal or to enhance residual shell colour patterns of Neogene and Paleogene molluscs. However, very few examples of fluorescent colour patterns are known from Mesozoic marine shells. Here, the widespread occurrence of fluorescence in colour patterns of the pectinid *Pleuronectites laevigatus* and other bivalves from the Middle Triassic Muschelkalk of Germany is reported.

The scallop *P. laevigatus* represents one of the most common fossils of the Upper Muschelkalk. This species is well known for the preservation of colour patterns, which in general consist of radial brownish colour bands and less common zigzag patterns. By using UV-light, obscure or weak colour patterns can be revealed, illustrating that colour patterns are more abundant and much more diverse in *P. laevigatus* than previously known. In addition to patterns composed of radial lines and bands, numerous variations of zigzag and chevron patterns, as well as uniform colouration can be found. The diversity of colour patterns in *P. laevigatus* is similar throughout the Upper Muschelkalk, and shows no biogeographic bias within the Germanic Basin.

A remarkable feature of the colour patterns of *P. laevigatus* is the presence of different fluorescence colours. UV-light-induced colours range from yellow through orange to red with examples of almost all transition colours. Some specimens show no fluorescence at all. Because fluorescence properties, in contrast to colour pattern diversity, correlate with specific geographic areas, and present-day pectinids show no fluorescence of colour patterns, the fluorescence of *P. laevigatus* is interpreted as a diagenetic feature.

Fluorescent colour patterns could also be detected in the epifaunal bivalves *Entolium discites*, *Leptochondria alberti* and *Placunopsis ostracina*.

The results demonstrate that fossil invertebrates contain valuable information beyond morphology. In addition to the investigated specimens from the Muschelkalk, fluorescent colour patterns may be observed in other Mesozoic or even Palaeozoic marine shells and may provide information on the diversity of species and on the diagenetic history of fossils.

S3 – Widespread occurrence of boron-containing organic pigments in the Jurassic red alga *Solenopora*

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Recently, an exceptional group of boron-containing organic pigments has been discovered in pink coloured specimens of the Jurassic calcareous red alga *Solenopora jurassica*. By modern analytical chemistry the fossil pigments, named borolithochromes, have been characterized as boric acid esters with two phenolic moieties. The pigments are highly unusual because of the presence of the element boron, which is rarely found in natural products and has been never found in fossil organic compounds. The borolithochromes represent the first specific pigments from a fossil red alga, however, no analogy with present-day red algal pigments or other known biomolecules of living organisms was found.

Pink colouration of *Solenopora* specimens has been reported from a number of localities in Europe. In order to determine the wider occurrence of the borolithochromes, organic extracts of a set of distinctly pink to reddish coloured specimens representing different localities, stratigraphic horizons and species were analysed by high-performance liquid chromatography–mass spectrometry.

Preliminary results indicate that the borolithochromes are common pigments of *Solenopora* specimens from the Jurassic of Europe. The characteristic pigments were detected in specimens from localities in France, Great Britain, Switzerland, Poland and Spain from Bathonian to Kimmeridgian strata. In addition to *S. jurassica*, the borolithochromes could be determined in *S. helvetica* and *S. condensata*.

S1 – Towards adaptable, interactive and quantitative paleogeographic maps

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A variety of paleogeographic atlases have been constructed, with applications from paleoclimate, ocean circulation and faunal radiation models to resource exploration; yet their uncertainties remain difficult to assess, as they are generally presented as low-resolution static maps. We present a methodology for ground-truthing paleogeographic maps, by linking the *GPlates plate reconstruction tool* to the global Paleobiology Database

and a Phanerozoic plate motion model. We develop a spatio-temporal data mining workflow to compare a Phanerozoic Paleogeographic Atlas of Australia with biogeographic indicators. The agreement between fossil data and paleogeographic maps is quite good, but the methodology also highlights key inconsistencies. The Early Devonian paleogeography of southeastern Australia insufficiently describes the Emsian inundation that is supported by biogeography. Additionally, the Cretaceous inundation of eastern Australia retreats by 110 Ma according to the paleogeography, but the biogeography indicates that inundation prevailed until at least 100 Ma. Paleobiogeography can also be used to refine Gondwana breakup and the extent of pre-breakup Greater India can be inferred from the southward limit of inundation along western Australia. Although paleobiology data provide constraints only for paleoenvironments with high preservation potential of organisms, our approach enables the use of additional proxy data to generate improved paleogeographic reconstructions.

S4 – An attempt of applying a short-lived bivalve, *Paphia textile* to reconstruct the East Asian monsoon during the mid-late Holocene

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Climate of the Beibu Gulf, South China Sea is governed by the East Asian Monsoon (EAM). During summer, the southwest monsoon prevails, whereas during winter the northeast monsoon is dominating. Most existing climate archives such as plankonic foraminifera only provide information on the summer monsoon strength through time, but rarely on the winter and summer monsoons at the same time (palynology) or on a series of subsequent summers and winters (corals). Here, we used oxygen isotope data of shells (*Paphia textile*) obtained from sediment cores from the Beibu shelf that apparently grew during both seasonal extremes. Between 4.2 and 1.7ka, summer $\delta^{18}O$ values exhibited a general trend toward more negative values indicating a strengthening of the summer monsoon (wet and warmer environmental conditions). A similar trend was observed since 0.6ka. During the last 6ka, strongest winter monsoons seem to have existed around 4.2 and 0.6ka. The most negative summer $\delta^{18}O$ values, however, were found in a sub-recent shell from Weizhou island beach, which could be interpreted as an intensified EAM related to anthropogenic forcing. Subsequent studies using a larger sample set are required to confirm the statistical robustness of the findings of this pilot study.

S11 – Terreneuvian small shelly faunas of East Yunnan (South China) and their biostratigraphic implications

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The study aims at describing and discussing the detailed composition of Terreneuvian small shelly fossil (SSF) assemblages of the Meishucun to Huize Region of eastern Yunnan Province (South China). The described sections represent shallow water deposits of the Yangtze Paraplatform that include a number of stratigraphical hiati. The reported SSF assemblages can be assigned to the regional SSF biozones 1-3 (*Anabarites trisulcatus-Protohertzina anabarica*; *Paragloborilus subglobosus-Purella squamulosa*; *Watsonella crosbyi*). The developed correlation scheme for East Yunnan documents the extent and duration of stratigraphical hiati. The distribution of SSFs and the lithological characterization hints toward two major events of exposition of carbonate platform resulting in sedimentary breaks and a possible karstification. This requires new consideration of the previously described stable isotope record of shallow platform strata. Here we also give a critical revision of the SSF distribution for the renowned Meishucun section as shown in some study of recent years.

S5 – Taxonomy and palaeoecologic significance of Turonian calcareous dinoflagellate cysts from the Upper Cretaceous of NW Germany (Salder Formation, Upper Turonian)

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Calcareous dinoflagellate cysts (c-dinocysts) are excellent proxies for, e.g., surface water temperature, salinity, trophic situations and sea level, and size variations among c-dinocysts can be used to track short cold-and warm-water incursions. However, although c-dinocysts occur sometimes in almost rock-forming quantities in

Upper Cretaceous rocks of NW Germany, neither taxonomic investigation were done nor were the potential for palaeoecological and palaeooceanographical analyses exploited. From the type locality of the Salder-Formation (abandoned Salzgitter-Salder limestone quarry, Upper Turonian, Cretaceous), 97 samples from a 60 m thick section (thick bedded limestones with two thins marly intercalations: Marl M_E, *Micraster* Marls) were investigated. Ca. 7000 c-dinocysts were classified based on the calcite crystal arrangement of the walls. Furthermore, ca. 12.000 cysts diameter and wall thickness measurements were done. Morphology, abundance and diversity variations are used for a palaeoecolgic analysis of the Salder Formation. Limestones and marls are dominated by the Subfamily 'Pithonelloideae' Keupp, 1987, which occupy a special position within the Dinoflagellata as they lack a paratabulation. *Pithonella sphaerica*, *Pithonella ovalis* and *Pithonella spiralis* n. sp. ('Pithonelloideae') (in prep.) are most abundant (97-98%), ranging from 68 to 28µm in diameter. Representatives of the Subfamily Obliquipithonelloideae Keupp, 1987 occur exclusively in marls. *Normandia circumperforata*, *Pithonella cardiiformis*, *Pithonella discoidea*, *Pirumella edgarii* and *Obliquipithonella loeblichii* occur accessorily. In total, only 8 species occur, indicating low diversity assemblages. However, there are significant temporal compositional variations with a trend towards *P. spiralis* -dominated assemblages within the limestones and a decrease of *P. ovalis* and *P. sphaerica*. Contrasting, Obliquipithonelloidea with sizes from 62-75µm dominate in marl M_E, while the Pithonelloidea lack. The succeeding *Micraster* Marls are devoid of c-dinocysts. The positive correlation of total cysts amount and increasing $CaCO_3$ content from the marls into the limestones suggest that the marls resulted from the breakdown of the carbonate factory. Wall thickness of c-dinocysts is also prone to vertical variations: from M_E on, wall thickness decreases and the almost identical curve of ovale and sphaerical morphs show that wall thickness is detached from cysts size. This might be the expression of a late Turonian cooling event described elsewhere. Our high abundance/ low diversity assemblage is interpreted to reflect surface water oligotrophy. In accordance is the large quantity of *Pithonella spiralis* and the dominance of sphaerical over ovale morphotypes, indicating pelagic settings. However, the analyses have not yet been completed, and the relation to sea-level triggered environmental perturbations also needs to be elaborated.

S8 – Taxonomic and numerical sufficiency in a Lower and Middle Miocene molluscan metacommunity of the Central Paratethys

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Among the most important questions in quantitative palaeoecology is how taxonomic and numerical resolution affects the analysis of community and metacommunity patterns. A species-abundance data set (10 localities, 213 bulk samples, 478 species, > 49,000 shells) from Burdigalian, Langhian and Serravallian benthic marine molluscan assemblages of the Central Paratethys was studied for this purpose. Assemblages are from nearshore (intertidal and very shallow subtidal) and sublittoral environments represent four biozones and four 3rd order depositional sequences over more than three million years, and are developed along the same depth-related environmental gradient. Diversities of nearshore assemblages have much lower evenness than those from sublittoral environments. At the species level and using abundance data, most localities differ significantly from each other. Decreasing taxonomic resolution from species- to genus- to family level and numerical resolution from abundances to presence / absence data retains a primary spatio-temporal signal of the metacommunity. The negative impact of such a decrease in taxonomic and temporal resolution, however, depends on environments and is much more severe in nearshore assemblages, which are characterized by strong dominance of few widely distributed species than in sublittoral assemblages, which show more even species-abundance patterns.

Conference Field Trips

Field trip 1:

The early Maastrichtian (Late Cretaceous) Chalk of Rügen

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Introduction

We will visit a succession of lower Maastrichtian White Chalk which is exposed at the sea cliffs and various active and abandoned chalk pits in the vicinity of Sassnitz, Jasmund peninsula, Isle of Rügen (Hither Pomerania, NE Germany). The white cliffs of the Jasmund peninsula on the Isle of Rügen which extend from the seaport and fishery town Sassnitz right northwards towards the Königsstuhl (king's chair) then bending west towards the small village of Lohme have been world-renowned by 19th century German Romantic landscape painters, especially Caspar David Friedrich. However, the chalk cliffs of Rügen are also a classical locality of palaeontological research. Commercial chalk exploitation dates back to the middle ages but it was the manufacturer and autodidact Friedrich von Hagenow (1797-1865) who laid the corner stone of palaeontological research on the Rügen Chalk. Hagenow (who owned a quarry at the cliffs near Kieler Bach) was interested in ancient history, ornithology and geology of his native island. Between 1839 and 1842, he published several monographs about invertebrate fossils from the chalk. Today, more than 1400 fossil taxa are known to occur in the lower Maastrichtian chalk. The extensive literature devoted to the palaeontology of the Rügen Chalk (by Deecke, Ehrenberg, Reuss, Voigt, Müller, Nestler, Steinich, Herrig, Kutscher, Frenzel, and Reich, among others) has been compiled by Reich & Frenzel (2002).

Today, the chalk cliffs are still accessible. The Jasmund peninsula, which also harbours one of the most beautiful old-growth beech forests of central Europe has been nominated as a national park in 1990 and now is also an UNESCO world heritage site. Digging for fossils is strictly prohibited at the cliffs. However, the DAMMANN Company runs an active chalk pit (Kreidewerk Klementelvitz) just southwest of Sassnitz, where collecting is allowed against a small fee.

Sedimentary setting and palaeogeography

Upper Cretaceous and early Paleogene Chalk is conspicuous sediment across the European Platform north of the Alpine deformation front and within the Syrian Arc of the Afro-Arabian Platform. Chalk is a unique carbonate rock as it is not restricted to temperature (latitude), water depth (except the Carbonate Compensation Depth (CCD) in the oceans) and is only reliant on pelagic calcareous algal productivity in the surface waters of oceans and seas. Very high sea levels and low continental relief pushed shore-lines and clastic input far into the interior of continents around isolated highlands (Mortimore 2011). The region of Rügen was situated at 40°N far from the coast in the middle seaway between Western European Chalk basins and the Polish subbasin during the Late Cretaceous. The Chalk of Rügen was originally deposited as fairly even fallout from plankton, probably sedimented in form of copepod pellets. The carbonate sediment forming the white chalk consisted of coccolithe/calacareous dinoflagellate skeletons which formed a muddy soft-bottom environment. Non-carbonate content is less than 2 %. Mean rates of sedimentation of the European Chalk (derived from division of thickness by time) are low everywhere across the European platform but vary between tectonically stable regions (e.g., England, Isle of Wight: 2.5 cm ka^{-1}) and areas with rapid subsidence (Danish-Polish trough: 25 cm ka^{-1}). The chalk was deposited distally on an open shelf at water depths well below storm-wave base, equivalent to modern outer shelf to upper slope environments. The quality of sedimentary detail preserved in the chalk of Rügen implies that seafloor redepositional processes must have taken place on a small scale. In contrast, deeper water chalks found in the Central Graben of the North Sea show extensive evidence of bed disruption, slumping and mass flow due to significant topographic changes related to fault movements and salt diapirism. The palaeotopography was controlled by relative subsidence over fault blocks and is reflected by considerable thickness variation of chalks. Accepting that primary production was broadly uniform, lateral thickness variations imply that transportation and re-sedimentation of the plankton rain blanket was a ubiquitous depositional process. Tectonic episodes also produced synsedimentary fracturing of the Chalk and evolution of vein networks and stylolithes.

Lithology

The succession is built up by approximately 90 m of chalk sediment. Burrows of *Thalassinoides* occur abundantly at certain levels alternating with levels dominated by mm-thin grey micro-styolithic seams. The chalk is overlain un-

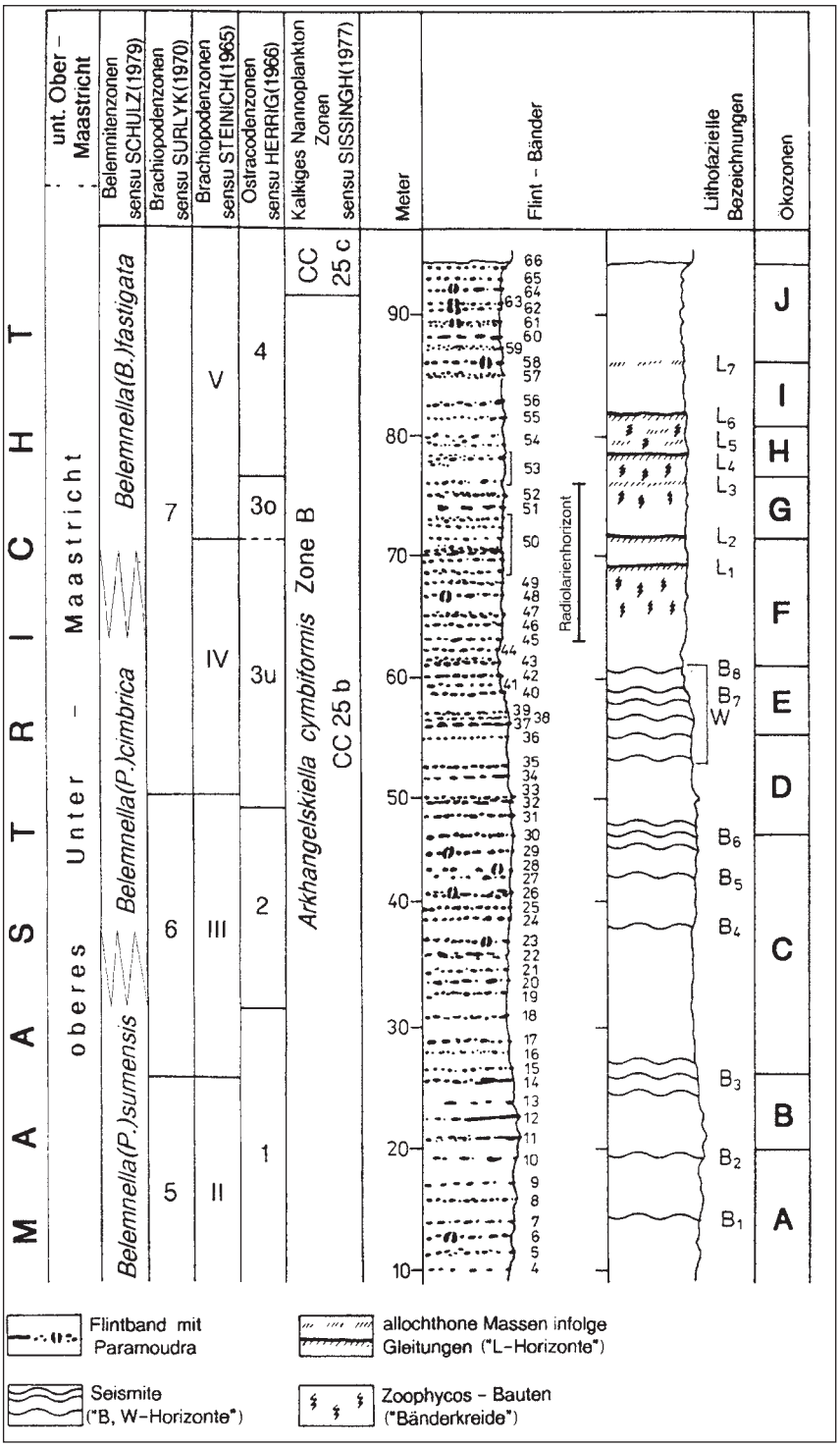

Fig. 1 Lithostratigraphy of the Rügen chalk (reference section: cliff complex VIII) (source: Frenzel 2000)

conformably by Pleistocene tills, glacio-fluvial gravels and sands. Advances of Pleistocene ice eventually resulted in deposition of glacial sediments on top of the Chalk and in thrusting, faulting and folding of the chalk and at least the older parts of the Pleistocene. The Pleistocene sediments comprise tills, clay with scattered boulders, cross-bedded sands, and glacio-fluvial sand and gravel. Due to faulting and folding the chalk cliff is subdivided into 25 sections, traditionally called “Komplexe” portioned by “Streifen” of Pleistocene sediments. The dominant part of the Chalk is a monotonous bioturbated Chalk with bands of black flint nodules at 1-3 m intervals. It is characterized by randomly distributed *Thalassinoides* commonly containing *Chondrites* in the burrow fill. Many burrows are deformed owing to plastic flowage, compaction and later bioturbation.

Flint forms one of the key and most readily noticeable features of the Maastrichtian Chalk of Rügen. The origin and mechanism of formation of flint has been sub-

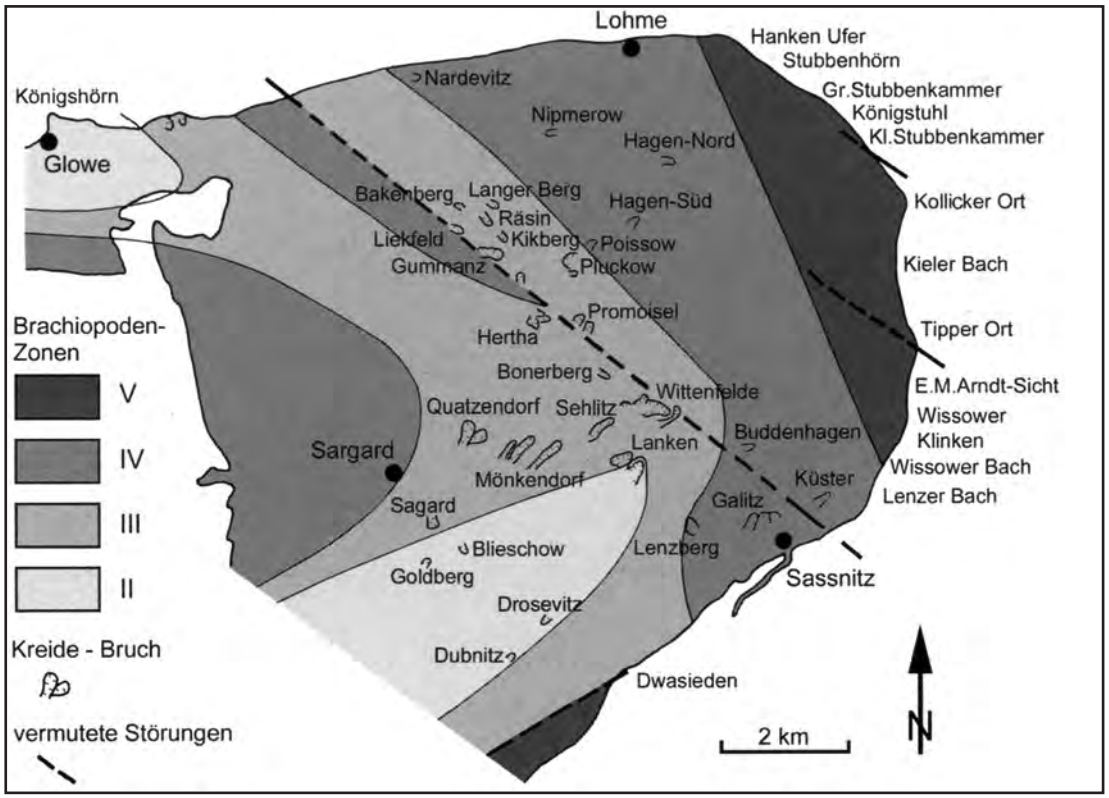

Fig. 2 Map of the Jasmund penisula showing subsurface striking of the Maastrichtian and brachiopod zonation after Steinich, from Reich & Frenzel (2002)

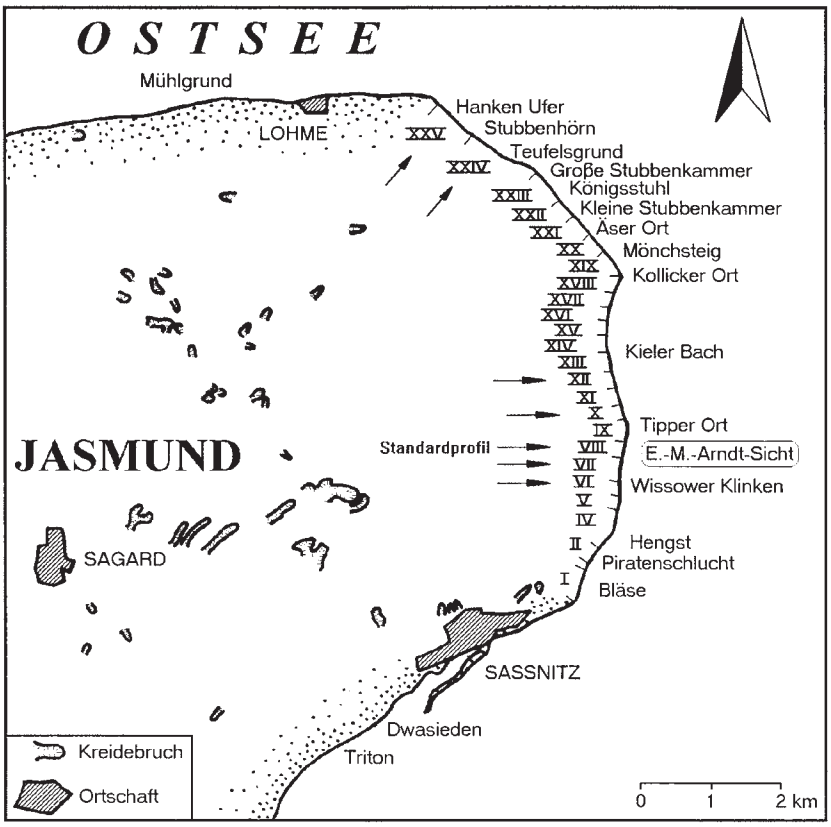

Fig. 3 Map of the Jasmund peninsula showing the position of the chalk sections (“Kreidekomplexe”) after Steinich, from Frenzel (2000)

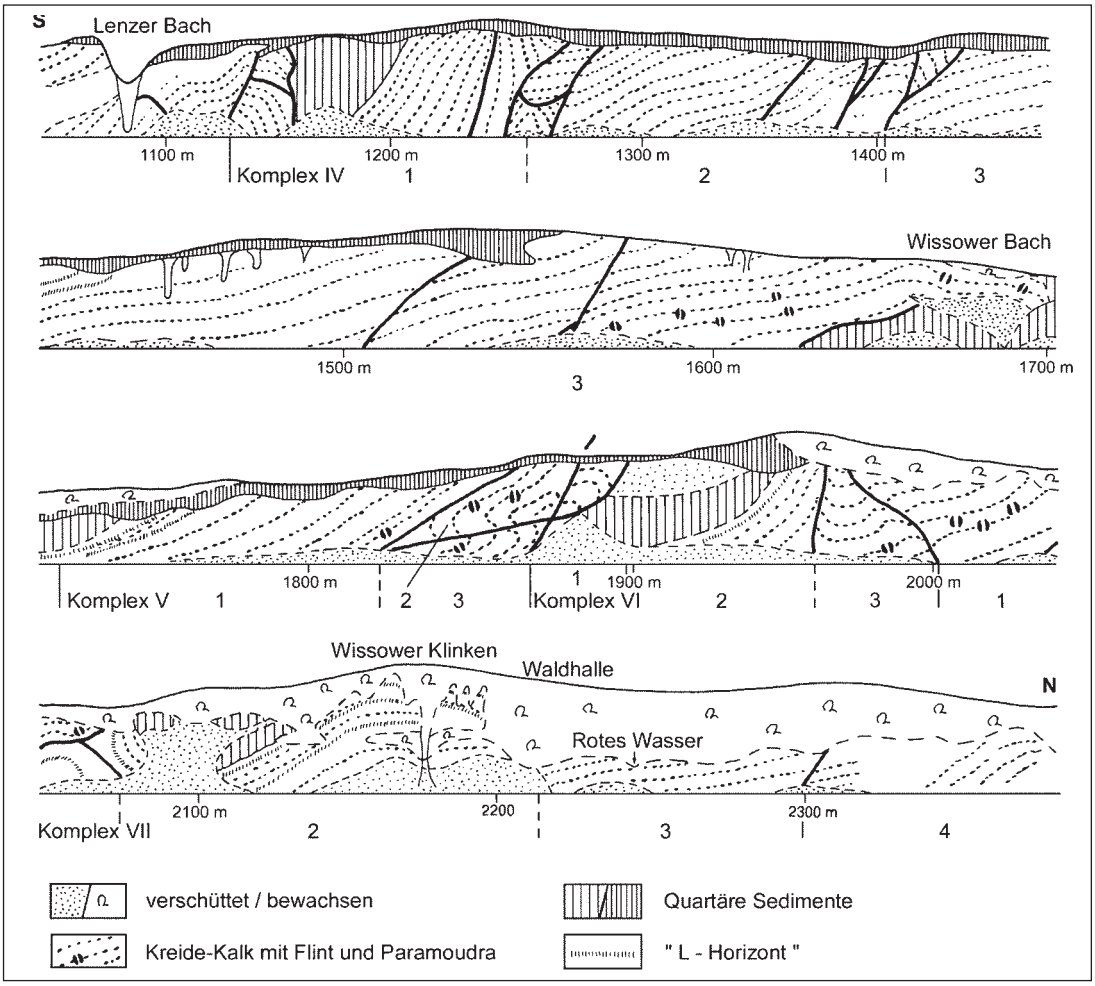

Fig. 4 Scheme of the cliff section between Lenzer Bach (north of Sassnitz) and Rotes Wasser (north of Wissower Klinken). After Steinich, from Reich & Frenzel (2002).

ject of debate for many years (Hancock 1975), but a generally accepted mechanism of flint formation was presented by Clayton (1986). In this model, the silica which ultimately forms the flint is obtained from the shallow (1-5 m) subsurface breakdown of siliceous organisms (such as sponges, radiolarian and diatoms) composed of biogenic opal. This breakdown process results in the supersaturation of pore waters with respect of silica. Such concentrations of silica in pore waters are only metastable and precipitation occurred at the oxic-anoxic boundary located within the sediment at depths of less than 10 m. At this boundary, hydrogen sulphide, rising upwards through the sediment pile from the zone of sulphate reduction, is oxidized to sulphate, liberating hydrogen as a byproduct. The free hydrogen ions would have lowered the local pH significantly resulting in calcite dissolution and the high concentration of carbonate ions liberated by this process acted as a seeding agent for the precipitation of silica.

The close association of many flints with burrow systems (particularly *Thalassinoides*) reflects the higher permeability of burrows in comparison to the surrounding Chalk. These higher permeability zones acted as the principal conduits for upward migration of the hydrogen sulphide and hence were the preferential sites for silica precipitation. The often observed regular repetition of flint bands on a scale of a few decimetres is likely to reflect the cyclical nature of Chalk sedimentation causing a halt to the upward movement of the redox boundary, encouraging flint formation.

Paramudas (“Sassnitzer Blumentöpfe”): these are characteristic, outsized tubular barrel or pear shaped flint concretions which have been interpreted as formed during early to late diagenesis around very long burrows 0.5 cm in diameter and 5-9 m long (Bromley et al. 1975)

Stratigraphy

For stratigraphical assessment, belemnites have been proved to be most useful since planktonic foraminifers and ammonites are scarce or missing. The belemnite zones of *Belemnella sumensis*, *B. cimbrica*, *B. fastigata* and *B. obtusa* sensu Schulz 1979) are all present, indicating an interval of the uppermost lower towards uppermost upper

Early Maastrichtian which equals a time interval of 1.5 ma, about 70 ma B.P. In addition, brachiopods, ostracods and benthic foraminfers as well as lithological marker beds (flint bands, marl seams, bioturbation horizons) have been successfully applied to subdivide the White Chalk of Rügen.

Faunal content

Although faunal assemblages of both benthic and nektonic associations are diverse, macrofossils are not abundant in the white chalk of Rügen. Among the most conspicuous fossils are the calcitic remains of belemnites, echinoderms, oysters (*Pycnodonte*) and inceramids. The benthic ecosystem of the chalk sea was that of a soft-bottom community where mobile deposit-feeders (e.g. irregular echinoids, holothurians), filter-feeders adapted to a life on muddy substrates (e.g inoceramids), and mobile predators/scavengers dominated the biomass. However, biogenic hardparts such as the shells of oysters and inoceramids as well as the discarded tests of large echinoids (e.g. *Echinocorys*) acted as "benthic islands" and gave rise to a diverse epibiont community of sessile filter-feeders, e.g. serpulids, bryozoans, corals, brachiopods, crinoids etc. Larger biogenic skeletons also attracted a diverse community of endolithic bioeroders, e.g., clioniid sponges. The fossil record of molluscs possessing aragonitic shells (gastropods, ammonites) is scarce due to aragonite dissolution. These molluscs are, if ever, preserved as internal molds. Among nektonic organisms, the rostri of belemnites are most conspicuous. Vertebrate animals are represented by occasional findings of shark and teleost teeth and vertebrae, and rare occurrences of reptile teeth (?mosasaurids). Compilations of the fossil organisms of the Rügen chalk have been contributed by Nestler (1975) and Reich & Frenzel (2002).

Collections

A large part of Hagenow's collection, which was housed in Stettin (Szczecin), has been destroyed during WW II. However, parts (especially his archaeological collections) survived in the Kulturhistorisches Museum der Hansestadt Stralsund. The Geological Institute of the Ernst Moritz Arndt Universität Greifswald has a good collection of Maastrichtian fossils from Rügen, including types and originals to the works of Nestler, Herrig, Steinich and others. The Kreidemuseum Gumanz shows a representative sample of Chalk fossils in its exhibition. There are many good private collections; the most important is probably Manfred Kutscher's (Sassnitz) which can be visited upon consultation.

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Field trip 2:

Petrified Forest of Chemnitz – A Snapshot of an Early Permian Ecosystem Preserved by Explosive Volcanism

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The Erzgebirge basin in Saxony

Geological background and stratigraphy

In the 19th century some of the first ideas and principles on Carboniferous and Permian stratigraphy and palaeontology have been developed in this region, mainly carried by the work of August von Gutbier and Hanns-Bruno Geinitz. Nowadays, a renewed interest on Late Palaeozoic tectonic, climatic and biotic processes in the Variscan orogen belt leads to intense research in the Saxothuringian area of this belt, too. New genetic models are discussed for collisional-extensional processes at the Northern border of the Bohemian Massif resulting from recent investigations of the tectonical and geodynamic setting of the Saxothuringian.

The present-day 70 km by 30 km large and NE-SW striking Erzgebirge basin in south Saxony (*Fig. 1*) was discontinuously filled with the molasses of the Variscan orogen. Sedimentation was interrupted by long periods of non-sedimentation and erosion of older basin fill. Subsequent basins were controlled by different geodynamic regimes and, therefore, had a development independent of their precursors. The term Erzgebirge basin includes the entity of these subsequent basins as it describes the present-day distribution of Late Palaeozoic deposits at the northern flank of the Erzgebirge, rather than a specific basin in geotectonic terms.

The Late Viséan is represented by relicts of the **Hainichen** basin. At intersections of deep faults, local basins developed, such as the postorogenic basins of Flöha (Westphalian B/C; Duckmantian/Bolsovian) and the **Oelsnitz** and **Zwickau basins** (Westphalian D – ?Cantabrian). Erosional relicts of additional Westphalian basins exist in the Eastern Erzgebirge, e.g., the B/C **Olbernhau-Brandov** and B-D **Schönfeld-Altenberg** basins. The Rotliegend **Chemnitz basin** arose after the Franconian movements and basin reorganization, and is superimposed on the deep fault system of the detachment between the Erzgebirge Mountains and the the Saxonian Granulite Massif.

Development and basin fill of the Chemnitz Rotliegend basin

Deposits of the Rotliegend cover the whole basin (*Fig. 2*). Basement areas and coal-bearing successions of the Viséan and the Asturian/?Cantabrian were overlain. In the western part of the basin, the oldest Lower Rotliegend sediments (Härtensdorf Formation) rest with an angular unconformity on the deeply eroded upper Zwickau Formation of topmost Westphalian to Cantabrian age. This erosional gap could be related to the Franconian movements at the Stephanian/Rotliegend transition but also to the preceding Asturian movements during or after the Cantabrian as well. Basin development and configuration during the Lower Rotliegend is mainly controlled by volcano-tectonic processes. Frequent ash falls during this time originate from volcanic activity mostly outside the basin, possibly in the NW-Saxony Volcanite Complex, which confines the basin to the North. Starting with the Upper Rotliegend-II, facies patterns follow increasingly NW-SE directions perpendicular to the Variscan strike. The Middle to Upper Permian red beds of the Mülsen Formation formed possibly the transition to the Late Permian Zechstein and Mesozoic platform development. In the NW of the Chemnitz Basin this Upper Rotliegend coarse clastics are covered transgressively by marine Zechstein deposits and their terrestrial equivalents.

The up to 1550 m thick basin fill of the Chemnitz basin consists mainly of alluvial red beds and volcanites and is subdivided in four formations (Fischer 1990; Schneider et al. 2011). The oldest one, the 180 m (max. 280 m) thick **Härtensdorf Formation**, deposited in a WSW-ENE to SW-NE orientated basin, shows basal matrix-supported fan conglomerates. These coarse clastic deposits were formed by debris flows that interfinger towards the basin centre with fine-clastic alluvial and flood plain sediments, mainly siltstones with intercalated channel conglomerates of a braided river system. The often greenish to light grey coloured fills of those channels point on palaeo-groundwater flow. Flood plain deposits contain sporadically centimetre to decimetre thick coal seams of local swamps. Very typical for the flood plain siltstones and silty sandstones are invertebrate burrows of *Scoyenia*-type. Common are calcareous rhizoconcretions in the neighbour-

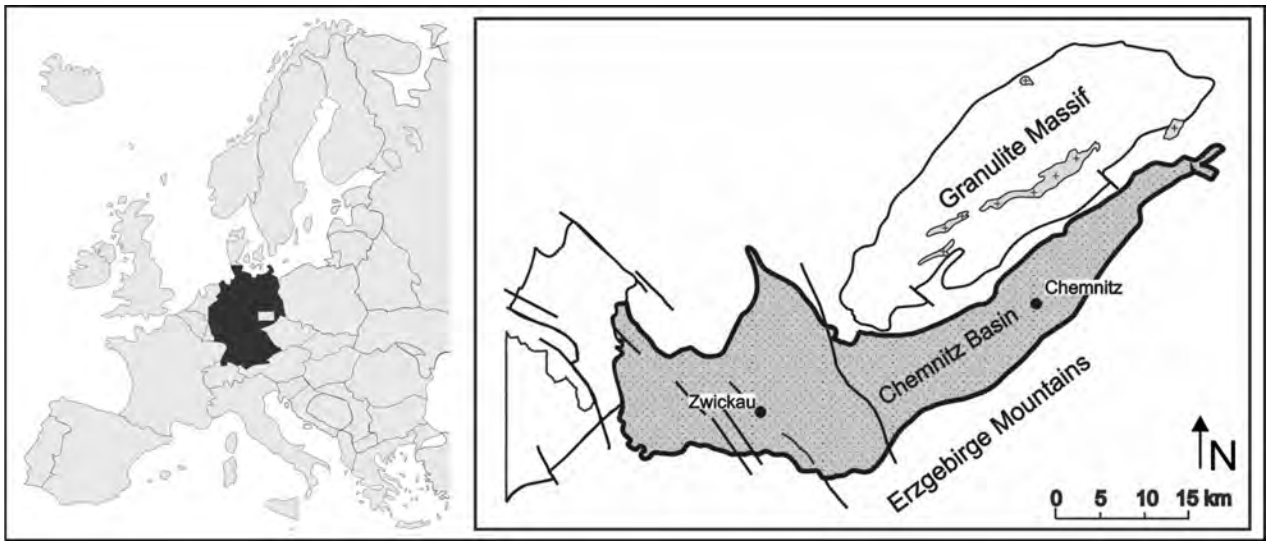

Fig. 1 Location of the study area

hood of the channels and stacked calcisols of different maturity. Decimetre thick micritic limestones with mm-sized gastropods and minute isolated skeletal remains of snake-like aïstopod amphibians indicate the existence of temporary pools and lakes (Schneider & Rößler 1996). The age of the Härtensdorf Formation is determined by macrofloral remains (such as *Alethopteris schneideri*, *Callipteridium gigas*; Barthel 1976) as Lower Rotliegend and by sporomorphs as late Asselian based on the dominance of *Vittatina* spp. (Döring et al. 1999). Volcanism started in the upper Härtensdorf Formation with pyroclastic horizons due to Plinian eruptions and continued into the Planitz Formation which was dominated by extended volcanic deposits.

The base of the up to 170 m thick **Planitz Formation** is marked by the 5 to 25 m thick Grüna tuff. This formation mainly consists of different volcanites, like ash tuffs and ignimbrites and their reworked products as well. Depending on the position to the eruption areas inside and outside the NW-Saxony basin, there are regional changes in thickness and facies pattern, although several tuff horizons form excellent marker horizons throughout the basin. Intercalations of conglomerates, sandstones and siltstones are subordinate. The Grüna pyroclastic rocks are directly overlain by the distinctive Niederplanitz lake horizon, which represents a vertical and lateral sequence of centimetre to decimetre thick lacustrine black, greenish-grey to red claystones and siltstones with intercalated pyroclastics. These deposits formed during a wet climatic phase in an extended lake landscape. The low diversity vertebrate fauna only consists of palaeoniscid fishes and xenacanthid fresh water sharks indicating the linkage of this basin to a larger, interregional drainage system, enabling the immigration of fishes. Flows of trachybasaltic and shoshonitic lavas of up to 70 m thickness originated from different fault controlled eruption centres in the south-western part of the basin. The upper part of the Planitz Formation contains widespread ignimbrites, locally deposited as vitrophyres (pitchstone). The age of the Planitz Formation is determined as late Lower Rotliegend (late Asselian/early Sakmarian) by xenacanthid shark teeth (Schneider 1988); sporomorphs indicate a late Autunian age, comparable to the late Asselian of the Donetsk basin (Döring et al. 1999).

The up to 700 m thick **Leukersdorf Formation** rests erosively on the Planitz Formation. Decametre thick basal conglomerates contain the debris of the eroded Planitz volcanites. Generally, the formation consists of red fan and predominating alluvial to flood plain deposits in three fining-up cycles. Alluvial and flood plain deposits are characterised by the *Scoyenia* facies of wet red beds as well as calcisols of different maturity. Apart from common tiny rootlets this formation basinwide rarely shows any evidence of plant growth. In this respect, the Chemnitz fossil forest is an unusual, very local assemblage with a rich forest flora and fauna.

The top of the first cycle is formed by the maximally 25 m thick fluvial-palustrine Rottluff Horizon, consisting of grey clastics with plant remains and thin coaly layers. The top of the second cycle is marked by several thin limestone beds of the Reinsdorf Lake Horizon. This grey micritic limestone contains gastropods, ostracods, and rarely disarticulated tetrapod remains. Very rarely, laminites delivered poorly preserved branchiosaurid amphibian skeletons. The third cycle is marked by the eruption of the up to 90 m thick Zeisigwald tuff. As rhyolithic volcanism occurred on a widespread scale during the Early Permian, this eruption series particularly influenced the eastern part of the basin. In the area of present-day Chemnitz the eruption of the Zeisigwald volcano additionally resulted in the formation of the Chemnitz Petrified Forest.

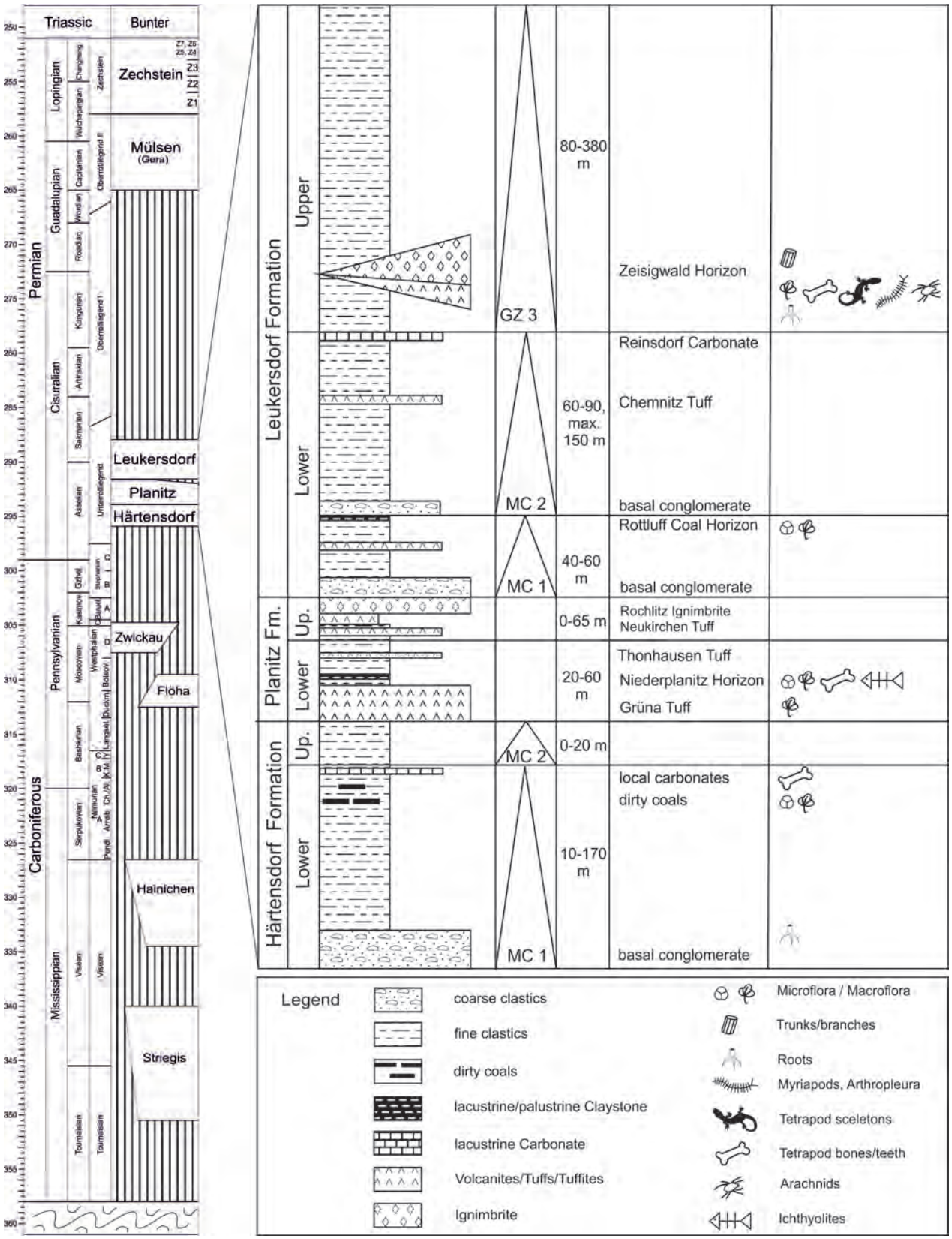

Fig. 2 Stratigraphic frame of the Petrified Forest of Chemnitz, after Berger & Junghanns (2010), modified

The initial blast of a phreatomagmatic eruption cut the majority of the up to 30 m high woody trees. They were later laid down in east-west direction and covered by different pyroclastics (Fischer 1991; Rößler 2001).

The absolute age of this volcanic event of about 290.6 ± 1.8 Ma was recently determined by SHRIMP U-Pb measurements on zircons (K.-P. Stanek, personal communication 2009), which corresponds to the late Asselian–early Sakmarian. This has been supported by a rich palynoflora dominated by the saccate pollen taxa *Potonieisporites* spp., *Florinites ovalis*, and *Vesicaspora* spp., and by *Vittatina* sp. from the palustrine Rottluff Coal in the lower part of the Leukersdorf Formation (Döring et al. 1999). This association shows great similarities of this stratigraphic level and the late Asselian Slavjanskaja Svita of the Donetsk Basin reference section.

Amphibian remains of the *Melanerpeton pusillum* – *Melanerpeton gracile* zone indicate a position in the European highest Lower Rotliegend (Werneburg & Schneider 2006; Schneider & Werneburg 2011).

The following **Mülsen Formation**, is separated from the Leukersdorf Formation by a long lasting hiatus and may reach up to 400 m in thickness. This formation completely consists of red fanglomeratic conglomerates, sandstones, and siltstones deposited in a debris flow/sheet flood dominated fan and alluvial plain environment. Nodular dolocretes are common. Well-rounded coarse sand grains, in places concentrated in the matrix of the fanglomerates, and strips of well-sorted fine to medium sand indicate reworked aeolian deposits. The fossil content is restricted to rare invertebrate burrows and very sparse and tiny root structures. Based on facies patterns, palaeoclimatic considerations, and the relationship to the overlying continental equivalents of near shore marine Zechstein deposits, an Oberrotliegend II (late Guadalupian to earliest Lopingian) age is estimated. Most probably, the Mülsen Formation forms the transition between the post-orogenic Variscan molasses and the platform sedimentation of the Zechstein.

The Petrified Forest of Chemnitz

Historical background of this fossil Lagerstätte

In fossil forests ancient trees from the geological past have been fossilized in growth position. One of these fossil forests is known from Chemnitz, Germany, where an Early Permian landscape was buried instantaneously by volcanic deposits, preserving autochthonous and parautochthonous fossil assemblages (Sterzel 1875; Barthel 1976; Rößler 2001). What makes this fossil Lagerstätte so special in comparison to other fossil forests with tree stumps preserved *in situ* is the historical importance of the Chemnitz fossil forest. Collecting at this site dates back to the early 18th century, and many collections worldwide house exhibition-quality specimens from the Chemnitz fossil forest. The often colorfully petrified tree trunks have attracted the Saxon electors for their splendid collections of jewellery and gem stones. Special officials, the gem stone inspectors, searched throughout the country for such "precious stones". Later, specimens from this site provided the basis for introduction of fossil plant names reaching back to the early days of palaeobotany. Several genera of common late Palaeozoic plants were first described from Chemnitz, type locality of *Psaronius*, *Tubicaulis*, *Calamitea*, and *Medullosa* (Cotta 1832).

The majority of finds was made in the late 19th and early 20th centuries, when residential areas were build. Since the 1990s many new specimens have been recovered during construction works, but all of them were unintentional, because most of the fossil forest has been developed into an urban area. Hence, the possibility of reconstructing both whole plants and the palaeoenvironment in which they grew was limited. Based on accidental finds and on specimens from historical collections, the Chemnitz fossil lagerstätte has been re-investigated in the last decade.

First scientific excavation (2008-2011)

The Museum für Naturkunde Chemnitz carried out a systematic and well-documented scientific excavation of this fossil forest for three and a half years within the city limits of Chemnitz (50°51'58.68"N, 12°57'32.54"E). The excavation site is one of the very few remaining areas that has not been disturbed by building activities and, thus, offered a unique chance to study the fossil forest *in situ*. Specific objectives of the excavation were to find evidence for connections of organs in the Chemnitz plants, and to record coordinates in three-dimensional space for each find, enabling 3D reconstructions of the excavation site (*Fig. 3*), the unearthed plant fossils, and the plant community. In addition, we aimed to investigate the volcanic and sedimentary rocks in the outcrop area to acquire a clearer understanding of the volcanic events and how they affected the ecosystem. Preliminary data consist of a large number of exceptional finds, 3D coordinates, and detailed field observations (Kretzschmar et al. 2008; Rößler et al. 2009, 2010, 2012). Unique features that have been documented here for the first time are: (1) the presence of rooting structures of several taxa that are preserved *in situ* in a single horizon, (2) the occurrence of foliage and reproductive organs associated with petrified stems and branches, and (3) the presence of various animal remains found together with the plants, including reptiles still showing the original body outlines.

The site is located in the middle of a residential area, but fortunately older anthropogenic influences could be excluded in the excavation area, because the excavation site is one of the very few lots on which was never built. The dimensions of the excavated area were 24 m by 18 m, and a depth of at least 5 m, which left ca. 130 m^2 at the bottom of the pit. A huge number of data and specimens was recovered. In all, about 860 collection boxes were filled

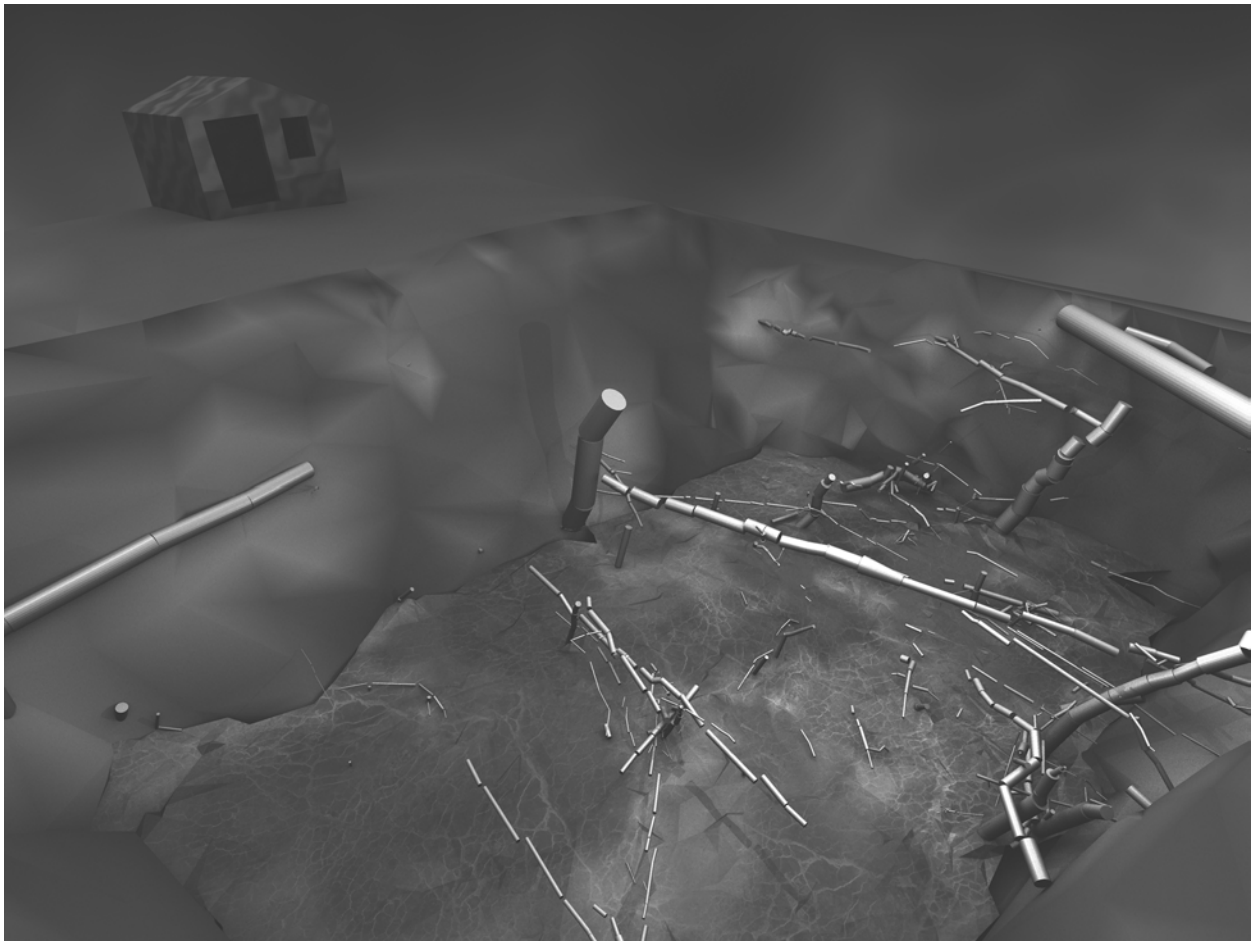

Fig. 3 Three-dimensional model showing excavated stems and branches and the spatial extension of the bleaching haloes surrounding the permineralizations (courtesy of Volker Annacker)

with 630 petrified trunks and isolated branches of various plant groups. In total, 53 trunks still standing upright in growth position were found. In addition, about 1,200 adpressions of associated megafloral and megafaunal fossils and 635 rock samples for future sedimentological, geochemical, and volcanological studies were collected, recorded, and measured in three dimensions.

Section at the excavation Chemnitz-Hilbersdorf. The excavated section comprises of the lower part of the Zeisigwald Tuff Horizon and its sedimentary basement (*Fig. 4*, *Tab. 1*). It has been divided into six units (S1-S6). Unit S5 is further subdivided into four distinct lithofacies (LF5/1-LF5/4). Table 1 lists the main characteristics of these units/lithofacies. The description excludes Units S1 and S2 that represent the recent soil horizon overlying weathered run-off hill scree with scattered log fragments and extending down to approximately 1.3 m depth. The geological section was documented in-depth, and thereby taphonomic phenomena were detected, such as fluid-escape structures, bleaching haloes, catchment areas rich in woody branches, large pyroclasts, and patterns that reveal transport directions.

Unit S6 is interpreted as an alluvial palaeosol, as indicated by a set of diagnostic criteria for soil formation. The most conspicuous feature is the common presence of roots in different forms of preservation, intensive color mottling, and the occurrence of carbonate glaebules of different sizes. The rooting of plants and other processes involved in soil formation (swelling, shrinkage, pedoturbation, various animal activity) have altered or completely destroyed most pre-existing sedimentary structures. A horizon with very large carbonate nodules was recognized 0.8 to 1.0 m below the top surface of Unit S6. This horizon shows a gradational top and base, as well as chert lenses of authigenic silica, and is interpreted as a groundwater calcrete horizon precipitated from the phreatic zone. This palaeosol supported a dense vegetation dominated by hygrophilous elements, but did not develop any peat. As remnants of the primary sediment composition and structures in both the soil horizon and the sediments beneath Unit S6 indicate, soil formation and growth of the forest took place on typical Leukersdorf Formation redbeds. Deposition was dominantly by suspension, in places also with minor bedload of sandy-pebbly braided river channels, and

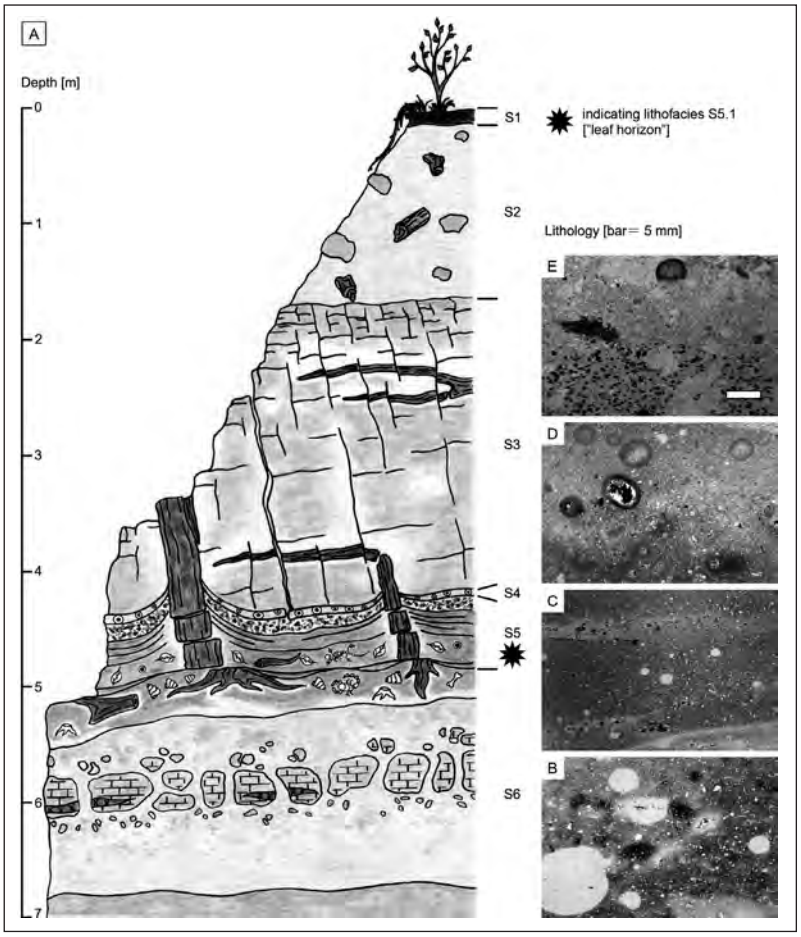

Fig. 4 Geological section at the excavation Chemnitz-Hilbersdorf, illustrating Units S1-S6 and their lithologies. **A**. Interpretative drawing; **B**. Unit S6 palaeosol, the sedimentary base of the former forest showing rhizoliths and intense color mottling; **C**. Unit S5 tuff, the fine-grained material containing the majority of the "adpression" fossil record; **D**. Unit S4 small-sized but strongly lithified, accretionary lapilli containing layer indicating an increasing phreatomagmatic influence; **E**. Unit S3 coarse-grained, lapilli-rich, massive tuff deposited from a high particle concentration pyroclastic flow

caused a multistacked, fine-grained deposit to form in a distal floodplain environment. Complete root systems of the tree fern *Psaronius*, the calamitalean *Arthropitys*, and the gymnosperms *Medullosa* and *Cordaixylon* can be studied and compared for the first time from a single horizon in the Permian. Although these plant groups colonized the same environment and grew closely associated, they show differences in their root types and habitat adaptations. Whereas the sphenophyte *Arthropitys* had a system of woody adventitious (secondary) roots attached at an angle to its thickened stem base and the tree fern *Psaronius* shows a trunk completely enclosed by a downwardly thickening mantle of adventitious roots, the gymnosperms have orthotropic tap roots with plagiotropic lateral roots and associated fine capillary root masses. Detailed analysis of morphogenetic and morphologic aspects of the different root systems will provide a more sophisticated understanding of their habitat preferences and of the physiology and autecology of the parent plants.

Unit S5 represents a half meter succession of ash-tuffs and lapilli stones that may have resulted from low-concentration pyroclastic density currents and accompanying fallout that was caused by an explosive magmatic to phreatomagmatic eruption with pulses of activity and a general increase in intensity.

Facies 5.1 is recognized as an ash-tuff that was deposited during the first volcanic fallout from a Plinian eruption. The occurrence of accretionary lapilli shows the phreatomagmatic character of this eruption that is already apparent in this very initial stage. The uppermost 15 cm of Facies 5.1 probably represent one of the most important horizons of the excavation site. This so called leaf horizon not only contains the majority and smallest plant remains in the entire section, but also many animal remains. Putative pre-eruptive leaf litter is difficult to distinguish from the plant fragments broken by the initial volcanic events. Further analysis of the complete adpression record will be useful for future consideration, especially to look for plant degradation effects or recognize plant remains such as conifer leafy shoots that cannot be referred to this hygrophilous habitat.

Facies 5.2 and 5.3 are comprised of thin-bedded ash-tuffs that may have emplaced as air-fall or ash-cloud surge deposits. During one of these events, a *Medullosa* trunk was broken off and buried in rather coarse-grained ash-tuff. This discovery provides multiple organ connections between the stem, several petioles, and pinnate fronds. However, the preservation shows a gradual transition from the petrified stem, via casts of the petiole bases to foliage adpressions. Unfortunately, the prepara-

Tab. 1 Lower units of the Chemnitz-Hilbersdorf excavation and their geological and palaeontological characteristics

Unit	Lithology	Facies/Structures	Fossil record	Interpretation
S3	light-red to purple-red, in places light-green, lapilli-containing ash tuff >3.35 m	erosively based massive blocks with indications of reworking, poorly sorted, matrix-supported bims clasts (altered into kaolinite), frequently accretionary lapilli, green-colored bleaching zones and hydromuscovite-fluorite nodules enriched in the vicinity of petrifactions, black-colored fluid escape structures in the top of the petrified logs	Petrified trunks and branches of different order, still upright (*in situ*) standing or horizontally to oblique 'floating' in the tuff and indicating transport direction of the flow, rarely adpressions, casts and moulds of plant axes	pyroclastic flow deposit/ignimbrite authigenic hydrothermal alteration related to early fluid mobilization from the incorporated tree trunks or branches
S4	green lithified ash tuff 1.5-8 cm	sharp or gradational based, sharply defined erosive top with different types of polygonal cracks, massive to weakly horizontally stratified, frequently accretionary lapilli	upright (*in situ*) standing petrified trunks , small petrified axes (unidentified), rarely scrappy pteridophyll adpressions	deposit of a low-concentrated pyroclastic density current caused by phreatomagmatic eruption
LF 5/4	light-purple-red (base) to light-grey-green (top) coarse ash tuff 13-19 cm	massive, distinctly reversely graded into bed S4, pumice lapilli, lithoclasts of quartz and micashist, feldspar crystals, nonwelded	rare in fossil remains except upright (*in situ*) standing petrified trunks (*Psaronius, Arthropitys, Medullosa, Cordaixylon*)	
LF 5/3	purple to light-purple-red, medium-grained massive ash tuff, 8-9 cm	horizontal bedded, normal graded, upwards with less pumiceous and lithic fragments, nonwelded	rare in fossil remains except upright (*in situ*) standing petrified trunks	phreatomagmatic eruption with pulsing/increasing intensity
LF 5/2	purple to light-grey-purple matrix-supported fine ash tuff 13-17 cm	thin horizontal bedding, repeated color and grain-size changes, nonwelded, initially normal graded, upwards reverse graded and with laminae of pumiceous and lithic fragments	isolated petrified branches, *Medullosa* terminal trunk portion with attached petioles and fronds (*Alethopteris schneideri*) in upside-down position, upright standing petrified trunks	**LF5/1-5/4** succession of ash tuffs emplaced by low-concentrated pyroclastic density currents and accompanying fallout
LF 5/1	dark purple to red fine ash tuff 15-20 cm	Horizontally bedded to massive, moderately lithified, green mottled, moderately sorted, nonwelded, composed of several normal graded units; at the base and up to three times within S5 horizontal muddy slickensides disrupting fossil trunks	'leaf horizon' with abundant plant remains of different size, upright standing petrified trunks, complete reptile and amphibian skeletons, disarticulated bones, arthropods (diplopods, ?chilopods, arachnids	air-fall tuff deposited during the first volcanic eruption's fallout
S6	red, red-brown, purple, green siltstone, limited mudstone and fine sandstone > 1.85 m	structureless to weakly horizontally bedded, intensive color-mottling, muscovite containing, dark brown to black-colored (Mn-rich) root impressions, uppermost layer densely lithified, around rooting trunk bases carbonate-cemented areas, carbonate nodules of different size, particularly enriched and associated with chert lenses, 0.8 to 1 m below the surface of S6, matrix-supported quartz pebbles	root systems of different arboreal plants, trunk bases rooting *in situ*, preserved as petrifaction or moulds/casts and as green-haloed root traces, petrified deadwood trunks (unidentified), frequently impressions of plant litter, terrestrial gastropods, often associated with plant roots, disarticulated bones, complete scorpions in their habitat	variegated paleosol, maturity increasing with depth calcrete horizon precipitated from the groundwater

tion from the tuff is more difficult than expected and hinders the identification of the pinnae. Nevertheless, the leaf type is comparable to *Alethopteris schneideri*, a frequent seed fern taxon in the Rotliegend of Saxony (Barthel & Rößler 2011), which has been repeatedly noted in close proximity of this *Medullosa* stem. The preserved upper trunk portion reflects a relatively young ontogenetic stage. The question whether this anatomy represents a new species or simply reflects the upper stem portion of a *M. stellata* trunk must remain open at this time. Later, in subrecent times, fine-grained laminae of the tuff succession may have facilitated the formation of horizontal slickensides that resulted in the multiple shears of upright-standing plant axes.

Facies 5.4 is interpreted as a deposit that settled from a dilute pyroclastic suspension current, based on its depositional features. This unit is extremely poor in fossil remains, which makes the interpretation difficult.

The thin but distinctive lithified **Unit S4** clearly indicates increasing phreatomagmatic influence. The deposit contains shards showing shapes typical of both explosive magmatic and phreatomagmatic fragmentation processes. An increase in the occurrence of accretionary lapilli accounts for the presence of suspended ash and moisture in a subaerial environment. Accretionary lapilli are commonly present in ash grain-size fall deposits, and the considerable portion of broken accretionary lapilli could point to a fall deposit like an ash cloud that often accompanies pyroclastic flows. The sum of textural characteristics, such as poor sorting and variation in thickness of the unit, however, also argues for a deposit that resulted from a low-concentration pyroclastic density current. The sum of features recognizable at the top of Unit S4 shows that the ecosystem was nearly destroyed during its deposition. Only a few large trees extended into Unit S3 and, therefore, resisted the depositional processes up to this stage.

Unit S3 is interpreted as a primary pyroclastic flow deposit with a high concentration of particles resulting from a phreatomagmatic eruption. This is evidenced by a variety of criteria that characterize deposits of high-concentration pyroclastic density currents (Druitt 1998; Branney & Kokelaar 2002). Unit S3 shows textural characteristics as poor sorting and reaches from massive to graded and diffusely stratified layers with a sharply defined erosive base. Additionally, the rock exhibits multiple indications of directional flow. In some cases, the buckling of branches is exceptionally well preserved. Tree trunks and branches are frequently broken off, and, if still attached, they are preserved with their apices pointing westward. Whereas the basal part of this unit bears small-sized stems and branches, the axes become larger in diameter toward the upper part of the unit. Primary hot emplacement is indicated by fluid-escape structures frequently observed above tree trunks, indicating heat-mobilized fluids arising from the plant tissues. Fluid mobilization from the trees may also be underlined by the grain-size distribution and geochemical behavior along the upward directed escape structures. Another distinctive pattern that reveals the distribution of the former plant's fluids into the sediment is seen in the frequently occurring bleached zones close to the petrified stems and branches. In 3D space, mushroom-shaped, bleached areas outline the petrified trunks and branches, and commonly widen in the space above them (*Fig. 3*). In addition, preliminary results from the geochemical composition of the tuff matrix indicate some kind of autometasomatic reactions in the upper periphery of the fluid delivering stems or branches and most likely point to an authigenic hydrothermal alteration. Cortex preservation in the woody plants is rather rare, since the periphery of their stems seems to be strongly affected by the hot ignimbrite. In the lowermost centimeters of Unit S3, close to the top of Unit S4, many small, upright plant axes are abruptly truncated, because they were cut by the shearing power of the emplacing Unit S3 density current.

Fossil record. The autochthonous fossil deposit originated from volcanic eruptions and preserved the most complete Permian forest ecosystem known to date (*Figs 5*, *6*). Fifty-three trunk bases, still standing upright in their place of growth and rooting in the underlying palaeosol, characterize this fossil Lagerstätte as a significant T_0 assemblage (DiMichele & Falcon-Lang 2011). This "window" gives insights into a spatially restricted lowland environment that sheltered a dense hygrophilous vegetation of pteridophytes and gymnosperms as well as a diverse fauna of vertebrates, arthropods and gastropods. The majority of the most instructive excavation finds are petrified trunks, axes, and branches of various orders of branching. They are mostly silicified or preserved by purple calcium fluoride, rarely calcified, and give us 3D insight into the cellular detail of arborescent plants and their organs. Among them are psaroniaceous tree ferns that until now are exclusively those of the distichous branching type, calamitaleans of the *Arthropitys* wood type, medullosan seed ferns with a conspicuous anatomical diversity and gymnosperms of cordaitalean affinity. Many of the 53 aforementioned specimens represent basal stem portions of different sizes that are still standing upright in their growth positions and rooted in the underlying palaeosol. The most complete and significant preservation of petrified material was traced in Unit S3. An exceptionally large calamite bears a crown that is repeatedly branched and estimated to have been at least 15 m in height with at least three orders of secondary woody appendages. This is the first time that the branching architecture of an anatomically preserved calamite tree is clearly discernable in three dimensions (Feng et al. 2012). Although petrifactions are more likely to be poorly preserved in both the Units S4 and S5, palaeosol Unit S6 contains many well-preserved, silicified remains, which include both upright *in situ* rooted tree bases and horizontally positioned deadwood logs.

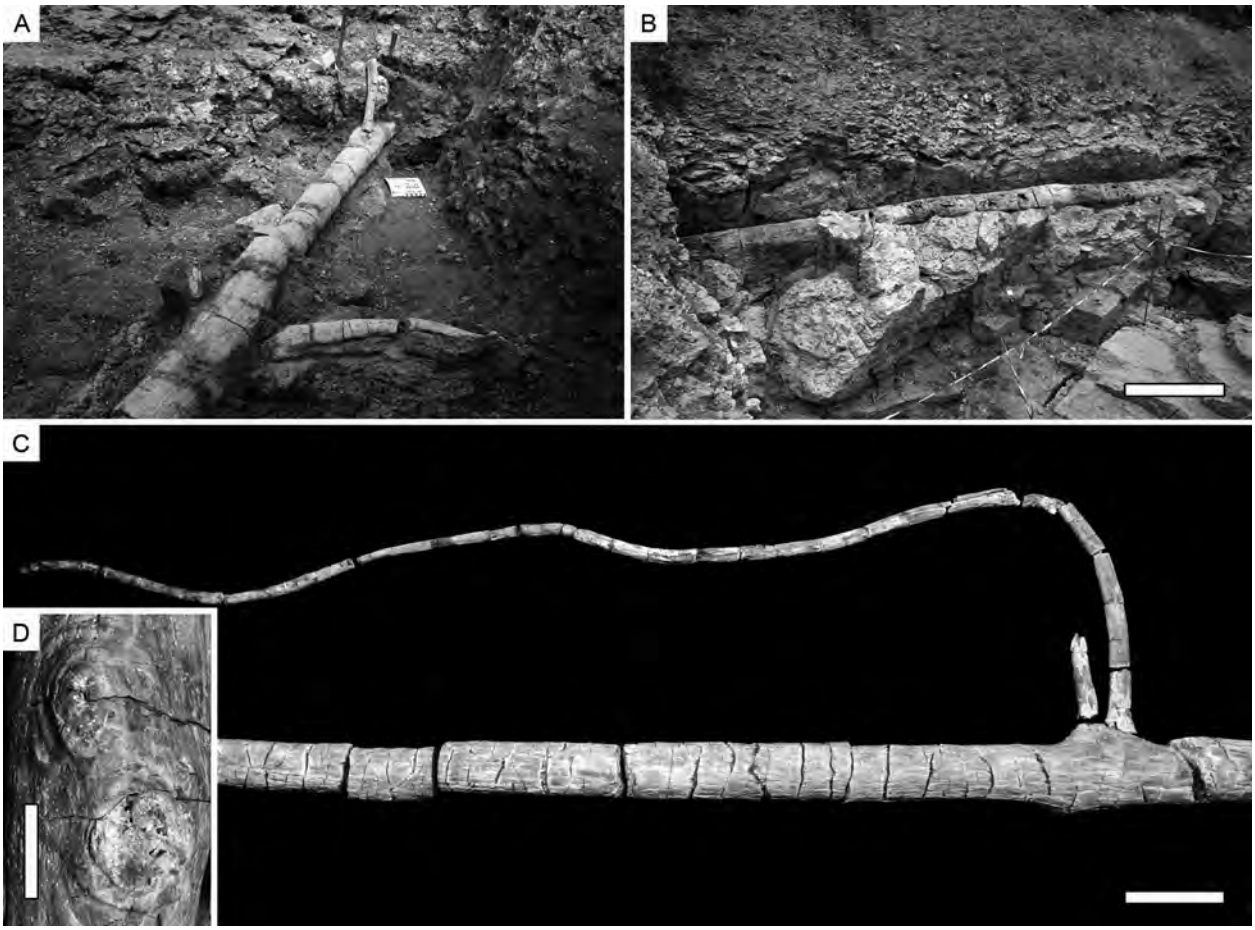

Fig. 5 Preservational diversity of cordaitaleans at the excavation. **A**. *Cordaixylon* trunk with attached branches up to 3 m long embedded in the Unit S3 pyroclastic flow deposit (KH0021); **B**. Gymnosperm trunks in the northernmost part of the excavation area, the one in front is still standing *in situ* (KH0004); the one behind lies horizontally in the Unit S3 ignimbrite (KH0025). Scale bar 1 m; **C**. *Cordaixylon* stem with attached branches. Surface sand-blasted (KH0073). Scale bar 20 cm; **D**. Detail of the specimen shown in Figure 5**C** with branch traces. Scale bar 4 cm

During an early stage of volcanic activity, volcanic ashes were deposited and covered the standing vegetation. As a result, many trees shed their leaves, which are found embedded in a fine-grained ash-tuff layer near the basis of Unit S5, Facies 5.1. Since the plant fossils are exclusively adpressed in the tuff, organic remains are lacking. We, therefore, have neither a classical compression flora nor an impression flora. In contrast to the latter, our fossil material additionally reveals 3D aspects to some degree.

Collecting and detailed analysis of the first fallout and flow deposits represented by the different facies of Unit S5, not only provided a rich plant assemblage. Along with leafy shoots, pinnate fronds, detached whole and fragmentary leaves, the leaf horizon has yielded the first outstanding faunal remains. A diverse fauna of vertebrates, arthropods, and gastropods was discovered for the first time from this site and will enable a more comprehensive view of this fossil lagerstätte. The faunal remains include such vertebrates as several reptile skeletons, aïstopods, and remains of an eryopid amphibian, as well as such invertebrates as diplopods, *Arthropleura* remains, various arachnids like a whip scorpion, and trigonotarbids.

Stop 1: Schönherr Park, outcrop area of the Reinsdorf lake horizon (N 50°50’07.00”; E12°56’12.47”)

In the area of the nowadays Schönherr Park the Reinsdorf lacustrine limestone has been quarried in the 19th century. At the start of the 20th century blocks of the limestone were used to build up an artificial cliff in the park. The Reinsdorf lake horizon could be traced nearly basin-wide (about 500 km^2). It consists generally of two beds averaging 30 cm to 50 cm thickness (R1 and R2) and separated by 2 m to 9 m red clastics. Microfacies points to a typical micritic algal-gastropod-ostracode wackestone of the wet red bed facies with local transitions into laminated (microbial mat) limestone as well as evaporitic sparitic dolomites. Besides a skeleton of the amphibian *Onchiodon* it contains a broad spectrum of isolated microscopic vertebrate re-

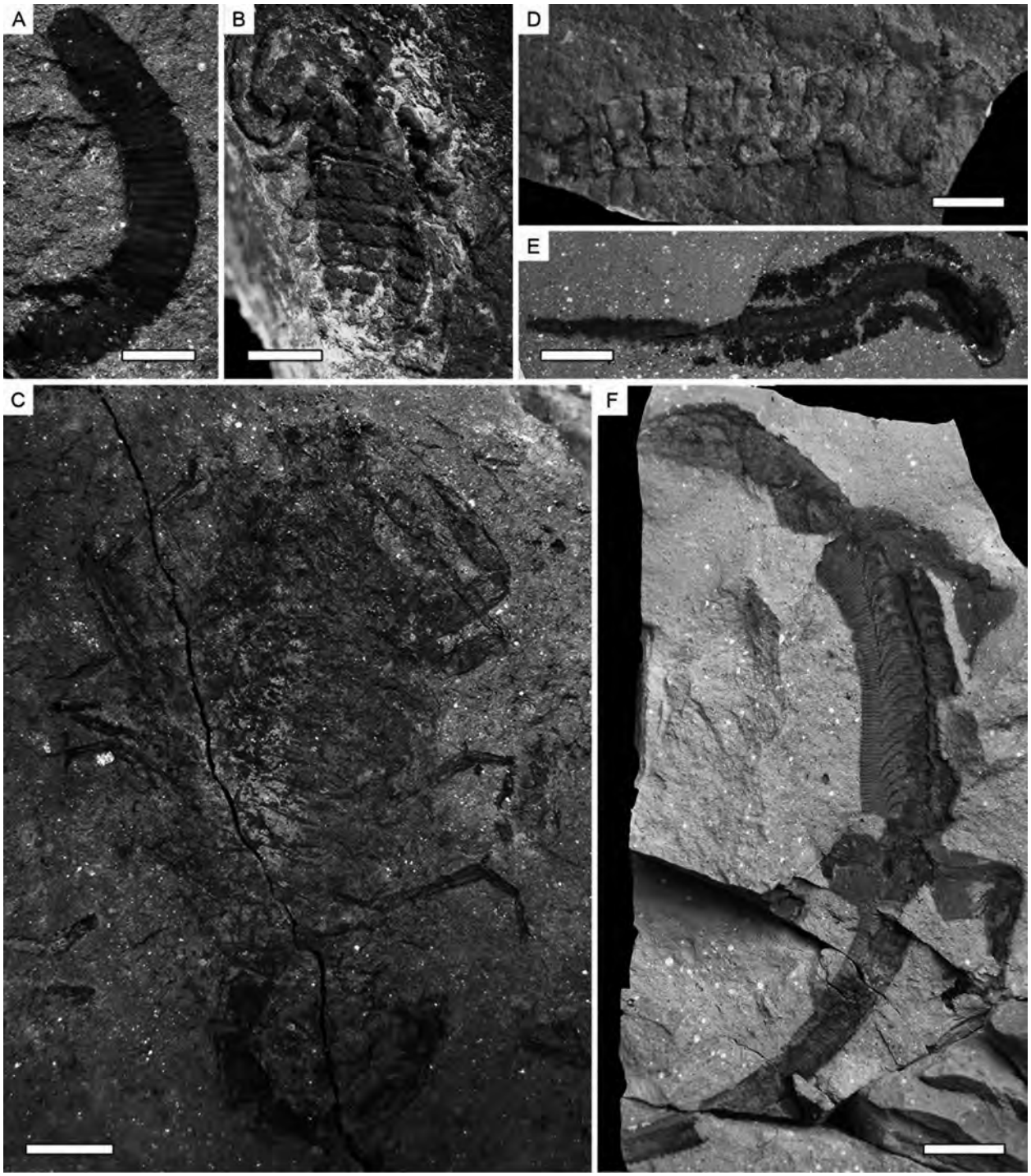

Fig. 6 Diversity of the animal fossil record. **A**. Diplopod impression in the tuff of Facies 5.1 (TA0851). Scale bar 7 mm; **B**. Trigonotarbid arachnid from the tuff of Facies 5.1 (TA0932). Scale bar 3 mm; **C**. Pulmonate scorpion found in the uppermost palaeosol (TA1126). Scale bar 1 cm; **D**. Leg of the giant millipede *Arthropleura* (TA0884). Scale bar 1 cm; **E**. Aïstopod from the tuff of Facies 5.1 (TA0900). Scale bar 1 cm; **F**. Complete reptile skeleton from the tuff of Facies 5.1 (TA1045). Scale bar 2 cm.

mains such as xenacanth teeth, amphibian jaw fragments, ?reptile teeth etc., typical for the practical unknown vertebrate fauna outside of the classical laminated black shale lake horizons of the Euramerican Late Carboniferous and Permian. The Reinsdorf lake horizon coincides with the level of the last perennial lakes in the palaeo-equatorial region of northern Pangaea (wet phase D, Asselian/Sakmarian transition; Roscher & Schneider 2006).

Stop 2: Abandoned Zeisigwald tuff rock quarry Findewirth, Chemnitz (N 50°51'19.0"; E 12°57'56.6")

Many historic quarries for local dimension stone and dumps are located in the forested area NE of Chemnitz. Quarrying aimed to mine the Zeisigwald Tuff of the Leukersdorf Formation, which is the youngest Permian pyroclastic unit of the Chemnitz Basin. The tuff rock has been frequently used in architecture and arts since the middle ages. The phreatomagmatic sequence of the Zeisigwald Tuff is restricted to the eastern part of the Basin. The volcanic vent is assumed to be located in this area (Zeisigwald Caldera). There the deposits reach a thickness of about 90 metres. The pyroclastic succession is subdivided as follows:

- basal crystal-poor tuff of few decimetre thickness (b-horizon),
- several meters tuff of air fall origin (a1-horizon),
- base surge deposits (s-horizon),
- low-grade ignimbrites (ign-horizon) and layers of co-ignimbritic ash falls,
- final tuffs of air fall origin (a2-horizon) and
- reworked pyroclastic deposits.

Accretionary lapilli occur in the s-, ign- and final a-type deposits and reach diameters of almost 3 cm. They occur matrix- to clast-supported and have multiple rims. The nonwelded ignimbrites contain pumice fragments of up to 30 cm length. Lithic fragments of basement rocks (phyllite, gneiss, micashist, quartz) are locally abundant. In the outcrop, beds and lenses of the surge deposits in the lower part of the quarry show parallel to low angle bedding, whereas the ignimbrite deposits appear massive. The Zeisigwald Tuff is geochemically characterized by elevated contents of Be, Sn, F, Li and low contents of Zr. Fluorite petrified parts of the embedded wood fragments as well as selected portions of the tuff itself (e.g. pumice fragments). This eruption destroyed and preserved the unique Chemnitz Petrified Forest. In the city area, the tops of the buried trees point to the W, as is shown by many documented findings. This observation supports the location of the vent in the Zeisigwald area.

Stop 3: "Window to the past" temporary excavation (N 50°50'07.36"; E 12°56'02.57")

Starting in the 2nd half of the 19th century, Chemnitz – as many industrial centres in Germany – experienced a rapid growth. Besides Hilbersdorf in the quarter Sonnenberg plenty of petrified tree trunks were found during the urbanisation and railway construction works, since the Zeisigwald Tuff crops out in this area. Nowadays, only few locations in the city remained undisturbed. One of these is the location of Stop 3.

First exploration activities were performed in 2009. The excavation started in summer 2012 and will be continued during the next years. The aim of the project is to investigate the basal part of the Zeisigwald Tuff, which hosts the Petrified Forest. The base of the pyroclastic succession has been located in about 2 m depth by drilling and geophysical research. Now several trunks have been located, at least some still standing in growth position. With the current excavation project the museum aims to: (1) increase the public awareness of the Petrified Forest of Chemnitz and get in touch with more people interested in the improvement of the city and the region; (2) the excavation site supports the study of late Palaeozoic plants in the fossil-bearing Permian sequence of Chemnitz as the sites of plant growth and burial are largely identical; (3) the fossil record reveals unknown biological features such as organ connections, ontogenetic variability, the branching architecture and root systems of the occurring arboreal plants; (4) since the fossil-bearing horizons can be attributed to short time volcanic processes, the findings enhance our understanding of plant's response to environmental perturbations and enable us to visualize and reconstruct individual volcanic events and their effects on the ecosystem; (5) in comparison with recent volcanic events analogies can be drawn to explain the volcanic processes, and to interpret the taphonomic conditions.

Stop 4: Museum für Naturkunde Chemnitz (N 50°49'51.22"; E 12°29'51.77")

The history of the museum started in the middle of the 19th century with a circle of citizens being interested in natural science in general. In 1859 they founded the 'Naturwissenschaftlicher Leseverein' (renamed into 'Naturwissenschaftliche Gesellschaft' in 1861). Besides common reading of scientific literature, the primary objectives were to create natural history collections and to build up a scientific library. In 1868 these collections were handed over to the City of Chemnitz on condition of soon public access. This was the birth of the oldest museum in Chemnitz. In 1876 the rapidly increasing inventory was made accessible for the public the first time in an exhibition in the Kunsthütte. With the completion of the King-Albert-Museum in 1909, the Municipal Natural History Collections moved into this museum building close at the Theaterplatz. In 1961 the collections were renamed into 'Museum für Naturkunde'. After 95 years in the King-Albert-Museum, where the storage capacity finally exceeded, the Museum established his new base in the former TIETZ department store in 2004. As already embedded in the original conception from 1868,

the museum is also a centre for scientific education. An increased awareness at the beginning of the 21st century awakes the wish to understand the diversity of our natural environment and to conserve it for future generations. With activities accompanying exhibitions, manifold events, talks and excursions, the museum understands itself as a meeting point in the area of tension between the desire for a higher quality of living and the conservation of natural resources. Many committed hobby researchers support the museum in expanding and developing its collections, by providing their knowledge in several environmental education projects as well as in topics like culture, industry and science. The main permanent exhibition – the **Sterzeleanum** – deals with the Chemnitz Petrified Forest. The international reputation of the museum mainly results from its unique collection of petrified wood.

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Field trip 3:

Stop 1: Marine Triassic of Rüdersdorf – The Muschelkalk Quarry

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Introduction

The enormous Muschelkalk Quarry in Rüdersdorf is situated about 25 km east of the centre of Berlin and represents one the most significant geological and palaeontological quarries in the greater Berlin area. Natural exposures of Mesozoic sedimentary rocks are very rare in the states of Berlin and Brandenburg, due to glacial abrasion and subsequent deposition of glacial till during the Pleistocene (Cepek 1995; Wings 2009). The Rüdersdorf quarry is exposed in WSW-ENE direction over a length of 4.2 km (Jubitz 1993) and is divided into two main sections, the western Heinitzbruch and the eastern Alvenslebenbruch. The area around Rüdersdorf represents an anomalous elevation of the pre-Cenozoic basement in northern Germany where loose sediments predominate. Solid rocks usually occur deeper than 1,000 m and are usually known from bore holes. The reason is an accumulation of up to 2,600 m of salt in the underlying Zechstein sediments that caused an uplift of overlying Triassic sediments up to the erosional surface level. The strata around Rüdersdorf are part of such a dome and the sediments in the quarry dip 25-30° to the North (Jubitz 1993). Similar structures in North Germany are, as a result of halokinetic movements, for example, the Buntsandstein rocks of Helgoland and the Zechstein saltdiapir break-through of Sperenberg south of Berlin. The Rüdersdorf Muschelkalk lies at the northern flank of an anticline formed by salt tectonics and is positioned on the eastern border of a northern German-Polish salt diapir basin, which extends from the North Sea to the Polish mountain ranges (Sirocko et al. 2002).

The Triassic structure of Rüdersdorf is located between the Pleistocene plateaus of the younger moraine landscape formed by the Weichselian glacial period in the north (Barnim-Lebus Plateau) and the lowlands with large-scale lakes of the Berlin glacial valley in the south. The exposed profile ranges from the upper Buntsandstein (Upper Röt Formation) to the Upper Muschelkalk (Meißner Formation) down to 60 m below the groundwater table (Streichan 1990; Zwenger 1993). The sediments were deposited in the Germanic Basin when the sea entered the basin through the East-Carpathian Gate and shallow marine carbonates accumulated in the eastern and central parts of the basin in the early Anisian. Rüdersdorf was part of this large depression between the North Sea and the Carpathians (Jubitz 1993). During the uppermost Buntsandstein times, the shallow marine intertidal and sabkha environments expanded west- and southwards reaching a high stand during the Lower Muschelkalk when intertidal zones were greatly reduced

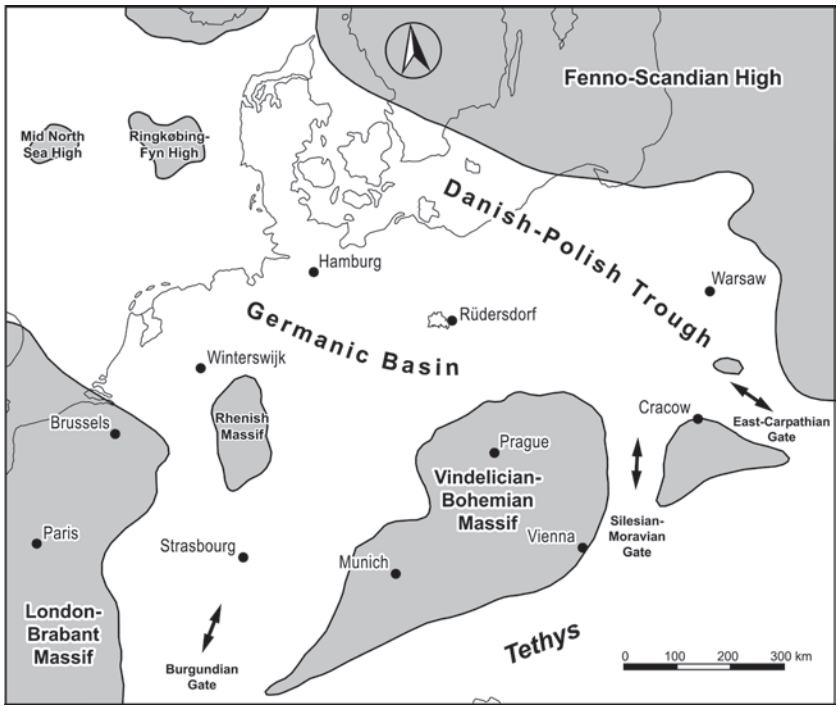

Fig. 1 Palaeogeographic map of the Germanic Basin including the locality of the Rüdersdorf Quarry east of Berlin (after Ziegler 1990; Hagdorn & Seilacher 1993 and Borkhataria et al. 2005)

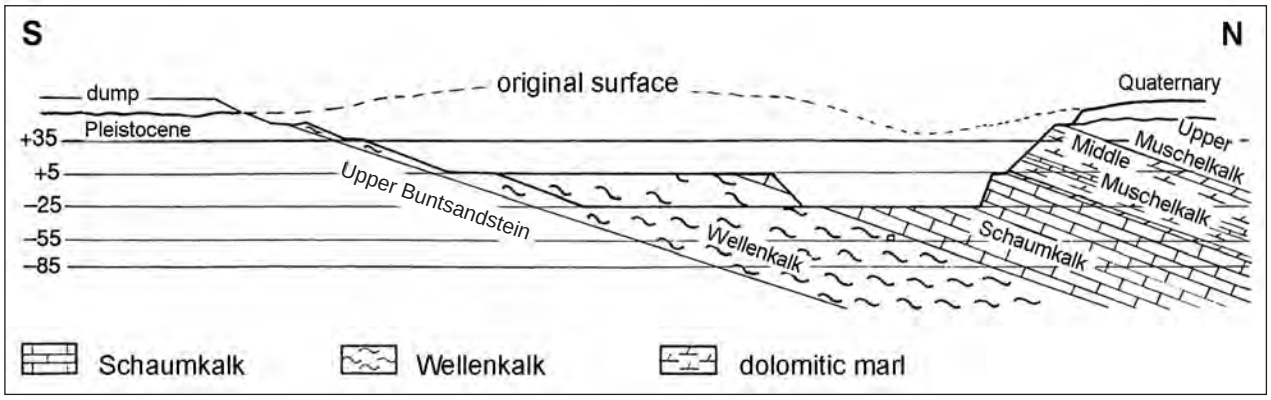

Fig. 2 Simplified cross-section through the Rüdersdorf Quarry (after Streichan 1990, modified)

even in the most marginal coastal areas – especially after the opening of the Silesian-Moravian Gate. With the beginning of the Middle Muschelkalk time, again tidal flats and sabkhas expanded widely around the hypersaline basin centres caused by strong evaporation (Götz 2002; Diedrich 2009). After the opening of a new marine passage, the Burgundian Gate in the southwest, the Germanic Basin was connected with the Mediterranean Tethys in the Upper Muschelkalk and a new euryhaline fauna could migrate northward (Kozur 1974; Zwenger 1988).

The Rüdersdorf locality represents the northernmost deposit of Muschelkalk limestone in eastern Germany. The quarry is of significant economic importance because of its geographic proximity to Berlin where bricks, burnt lime and, later, cement were required. The lime and cement industry had its origin in Rüdersdorf. The historic Brandenburg-Prussia region is extremely poor in natural resources and quarrying of limestone already began in Rüdersdorf around 1220 (Wendland 1993). Today, the Rüdersdorfer Zement GmbH company is one of the largest cement producers in Central Europe.

The Upper Buntsandstein (Röt)

The Röt is characterised by a change from siliciclastic sedimentation of the Lower and Middle Buntsandstein to an increasing deposition of biogenic and chemical sediments such as carbonates, sulfates, and halites (Beutler 1995). The main components of the Röt are colourful, reddish laminated clayey and dolomitic sediments ("Pelitröt"). Its continuous sedimentation under shallow marine-lagoonal conditions was disturbed during the Röt by the opening of the East-Carpathian Gate. Five marine transgressions of different duration and expansion left a carbonate series of variable thicknesses (Zwenger 1993). Significant evidence of transgression period is the Myophorian Member of the uppermost Buntsandstein which leads over to the fully marine development of the overlying Wellenkalk of the Lower Muschelkalk. The faunal content of the Röt is sparse in comparison to the overlying Muschelkalk and contains bivalves, gastropods, brachiopods, and vertebrate remains. The Upper Röt Formation is characterised by a rich mollusc- and microfauna (foraminifers, ostracods) indicating a brackish to marine environment.

The Lower Muschelkalk – Wellenkalk and Schaumkalk

The Lower Muschelkalk begins with the Wellenkalk, a relatively monotonous sedimentary cycle of grey limestone and marls with its characteristic wave-like kind of deposition. The majority of the sediment is extremely fine-grained, originally deposited as calcareous ooze, partly with varying pelitic portion. These carbonate mudstones are very dense and do not show signs of lamination. When exposed, these layers are vulnerable for weathering. They are intercalated with hard layers of calcarenites. The Wellenkalk can be divided into small-scale cycles due to the iterating deposition of both types of rock (Zwenger 1993). The wave-like appearance is not a primary sediment structure originally induced by oscillating water movement or currents but is the result of post-sedimentary subsidence. These deformations occurred when sediments of different density had been deposited.

A third rock type of the Wellenkalk Member is represented by bioclastic limestones containing predominantly fragmented shells of bivalves and gastropods. The thickness of the shell beds varies horizontally and can reach up to half a meter. The bioclastic limestones and the calcarenites often developed as fillings of subaquatically eroded channels. Multiple amalgamated tempestites with coarse-grained elements such as shells at the base occur in the Wellenkalk.

The Wellenkalk was deposited in a shallow epicontinental sea with stillwater areas of reduced circulation leading to higher salinity and limitations for life. The low-energy sedimentation was temporarily interrupted by storm and current events (Zwenger 1988).

The most common fossils of the Wellenkalk are various species of bivalves, especially occurring in the shell beds. Shallow infaunal forms like *Myophoria* and *Pleuromya* are found in mudstones. This environment was also the habitat for scaphopods and many gastropods, such as *Loxonema* and *Omphaloptycha*. Hard substrates are necessary for surface-living, byssate bivalves like *Plagiostoma*. Crinoid remains are relatively rare in the Wellenkalk. Several fish fossils are documented. The Wellenkalk contains teeth of different elasmobranch genera: *Hybodus* (also spines), *Acrodus*, *Polyacrodus*, *Palaeobates*. In addition, hybodont dermal denticles were discovered. Also known are teeth and scales of the palaeoniscoids *Gyrolepis* and *Birgeria*, fragments of the dentary of the perleidiform *Colobodus*, teeth of *Saurichthys*, and scales of the neopterygian macrosemiid *Ophiopsis* (Wischnewsky 2010). Scattered finds of nothosaurian and placodont teeth are reported.

The Wellenkalk Member shows also characteristic assemblages of ichnofossils. The most peculiar finds belong to the branching spreite of *Rhizocorallium* (Helms 1995). Rifts and faults in the Wellenkalk are often infilled with mineralisations, like the strontium sulfate mineral celestine, which represents a typical late to post-diagenetic crystallisation at temperatures below 323 K in marine dolomitic limestone deposits (Bautsch & Damaschun 1995).

The overlying Schaumkalk Member, typical for its porous texture, formed by release of ooids, the main component of this rock type. Generally, the ooids are poorly preserved – many of them vanished after synsedimentary marine diagenesis by dissolution and were replaced by coarse grained calcite or transformed to micrite by microorganisms (see Friedel 1995 for detailed diagenetic processes and the origin of the ooids). The Schaumkalk contains considerably fewer non-carbonatic components in comparison to the

epoch	age	group		succession	standard basin facies	regional stratigraphy	predominant rock type	industrial application
Middle Triassic	Ladinian	Upper Muschelkalk	Hauptmuschelkalk	mo2	Meißner Formation	Ceratite Member	laminated limestone	cut stones (historic)
				mo1β	Trochitenkalk Formation	Glauconitic Limestone		
				mo1α		*Transversa* Member		
	Anisian	Middle Muschelkalk	Anhydrite Succession	mm3β	Heilbronn Formation	Upper Carbonate	dolomitic limest	cement
				mm3α		Upper Wechsellagerung	dolomitic marl	mineral fertilizer
				mm2		Middle Carbonate	marly limestone	cement
				mm1β		Lower Wechsellagerung	dolomitic marl	mineral fertilizer
				mm1α		Lower Carbonate	dolomitic limest	limestone flour
						Orbicularis Member	thin-lam. limest.	cement
				mu1β	Rüdersdorf and Jena Formation	Schaumkalk Stage	porous, thickly layered, partly dense yellowish limestone	burnt lime, hydrated lime (cement)
				mu1α		Wellenkalk Stage	dense, laminated, bluish-grey limestone and marls	Portland cement, slag lime cement, limestone flour
		U. Bsdst.		so3	Upper Röt Formation	Myophorian Member	interbedded thin limestones	

Fig. 3 Stratigraphic units of the Rüdersdorf Quarry (compiled and amended after Zwenger 1993)

Wellenkalk. The yellow colour resulted from weathering of the rock and the release of iron. Ooids indicate a shallow water environment of relatively high energy. The combination of cross-bedding with changing directions and discordant cuts in the Schaumkalk is similar to the development of calcareous sandbars and banks of the Bahama carbonate platform through time (e.g., Schlager & Ginsburg 1981). The Schaumkalk Member also contains Wellenkalk-like rock layers partly with flaser bedding. They occur in the profile at the base of cycles in dekametre dimensions (Zwenger 1993). The lower section of the Schaumkalk reveals fossil hardgrounds developed during longer periods of discontinuous sedimentation. The fossil record in these sections consists of trace fossils like burrows and cemented organic remains such as crinoid elements.

Generally, the Schaumkalk bears a higher number of species than the Wellenkalk suggesting better living conditions. Individual beds yield a rich crinoid fauna, often also containing the ophiurian genera *Aspidura* and *Ophioderma*, with fragments being more frequent than complete specimens (Stoll 1980; Kutscher 1987). Typical ammonoids are *Beneckeia buchi* and *Serpianites antecedens*, an immigrant from the Tethys. Noticeable is the find of a complete three-dimensionally preserved skull of a *Saurichthys* in the Schaumkalk beds (see figures in different views in Streichan 1990 and Schultze & Kriwet 1999). Other vertebrate remains are teeth of *Placodus* (Sauropterygia: Placodontia). Ichnofossils are rare in the Schaumkalk – and not expected either in the energetic ooid sands.

The Schaumkalk is also famous for styloliths, peg-like, cone-shaped or columnar interlocked pressure solution characters that occur commonly at fissures, bedding joints and grain boundaries (Friedel 1993).

The Middle Muschelkalk – spectacular vertebrate fossils

The succession of the Middle Muschelkalk begins with greyish thin-bedded dolomitic limestone and marl. Characteristic is the presence of small druse-like cavities of 0.5-2 mm diameter, originally filled with anhydrite, now, after dissolution replaced by calcite crystals. The basal unit is called the *Orbicularis* Member because of the abundant occurrence of the bivalve *Neoschizodus orbicularis*, an index fossil of circular form – masses of their shells appear in basins of similar facies (Zwenger 1993). The overlying Lower Carbonate consists of nearly the same rock facies.

The overyling Lower Wechsellagerung begins with dolomitic marls followed by strata with an increasing content of gypsum intercalated by fossil-bearing carbonates. These cycles iterate asymmetrically three times within the Lower Wechsellagerung. Noticeable is the Blue Fishmarl ("Blauer Fischmergel") at the base of the Lower Wechsellagerung which has a thickness of 30 to 40 cm. It consists of finely laminated marl with mica-rich layers in between and contains a rich fossil fauna.

The Middle Carbonate consists of thick-bedded alternating dolomitic and marly limestone. The following Upper Wechsellagerung consists mainly of dolomitic marl and evaporites (gypsum, anhydrite). The latter is widely dissolved through subrosion and replaced by relics of ash. The uppermost unit of the Middle Muschelkalk, the Upper Carbonate, contains dolomitic limestone, dolomites and carbonates.

Generally, the water inflow from the Tethyal area was constrained during the Middle Muschelkalk. Water depth was low and temporarily the basin fell dry (Lorenz 1995). The evaporation led to the precipitation of anhydrite, gypsum and halite.

The *Orbicularis* Member is very famous for its sauropterygian finds. Excellently preserved is the skeleton of *Nothosaurus marchicus* Koken (1893), which is housed in the Museum für Naturkunde in Berlin. Many isolated remains of *Nothosaurus* are known from the *Orbicularis* Member, such as teeth, several skulls and jaw fragments, and vertebrae and bones of the appendicular skeleton. Schroeder (1914) erected a number of species which today are all allocated to the species *N. marchicus* (Rieppel 2000). Pachypleurosaurid remains include teeth of *Anarosaurus* cf. *heterodontus*, vertebrae, fragments of ribs and gastralia, girdle elements, epi- and metapodial elements (Klein 2009; Abele 2011).

The Blue Fishmarl contains teeth of *Acrodus* and numerous remains of actinopterygians, such as bone fragments of *Colobodus* and *Semionotus*, also teeth, and scales, and partly articulated specimens of *Gyrolepis*, and remains of *Saurichthys*.

The carbonate beds show faunal elements that are already known from the Lower Muschelkalk: bivalves, gastropods, brachiopods, fish and sauropterygian remains.

After the discovery of Asian affinities of invertebrate fossils, Rieppel & Hagdorn (1997) could draw a similar conclusion for the spread of nothosaurians and pachypleurosaurians from the Far East to the Germanic Basin where species reached at least the western region of Winterswijk, The Netherlands (Albers 2005; Klein & Albers 2009). During the regressional phase of the Middle Muschelkalk and the resulting facies change due to evaporation, the placodonts and nothosaurs disappeared from the Germanic Basin (Rieppel 1999; Diedrich 2010) but were re-established again after sea-level rise.

The Upper Muschelkalk – more water

The Upper Muschelkalk represents a sea level high stand after the opening of the Burgundian Gate and

allowed the immigration of open marine reptiles such as ichthyosaurs (see below).

The lower beds of the Upper Muschelkalk consist of dense greyish limestone, called the *Transversa* Member after the occurrence of the bivalve *Myophoria transversa*. These beds have a high content of CaO (up to 50%) and are more solid than the underlying Muschelkalk beds. Mud cracks indicate dry phases.

The overlying limestone consists of shell beds and sporadic ooid layers and has a greenish colour from the potassium-rich ferric-iron aluminium sheet silicate glauconite (Zwenger 1993). Black chert can often be found in the glauconitic limestone, concretions of silicon oxide which had replaced the original carbonate. Trochites, the stem elements of *Encrinus liliiformis*, that occur in large quantities in the Upper Muschelkalk of central Germany and that gave the name of the formation "Trochitenkalk" (Hagdorn et al. 1998) are rare in the equivalent glauconitic limestone of Rüdersdorf. Vertebrate fossils of the glauconitic limestone frequently occur as isolated, phosphatic remains on bedding surfaces: dermal denticles of hybodonts, teeth of *Hybodus*, *Palaeobates* and *Acrodus* and of the bony fishes *Gyrolepis*, *Birgeria* and *Saurichthys* (Wischnewsky 2010).

The top of the Upper Muschelkalk is composed of the Ceratite Beds. However, its uppermost section is not represented in Rüdersdorf because of glacial erosion. Marly limestone dominates, but isolated layers of siltstone and fine-grained sandstone occur especially in the younger deposits (terrigenous input). During the time of the Meißner Formation the conditions change to a fully marine environment like it was in the Wellenkalk era. Besides bivalves, shells of different species of the cephalopod *Ceratites* are common. An amazing find was described by Edinger (1934). She presented the left cranial half of the ichthyosaur *Mixosaurus atavus* with incomplete rostrum.

Another important fact should not be forgotten: in addition to its significance as a Triassic Muschelkalk exposure, the Rüdersdorf Quarry also has historical importance for glaciology. Torell (1875) discovered scratches on limestone surfaces, which he correctly interpreted as glacial striations. This was the final proof that Scandinavian inland ice once covered parts of central Europe during the Pleistocene.

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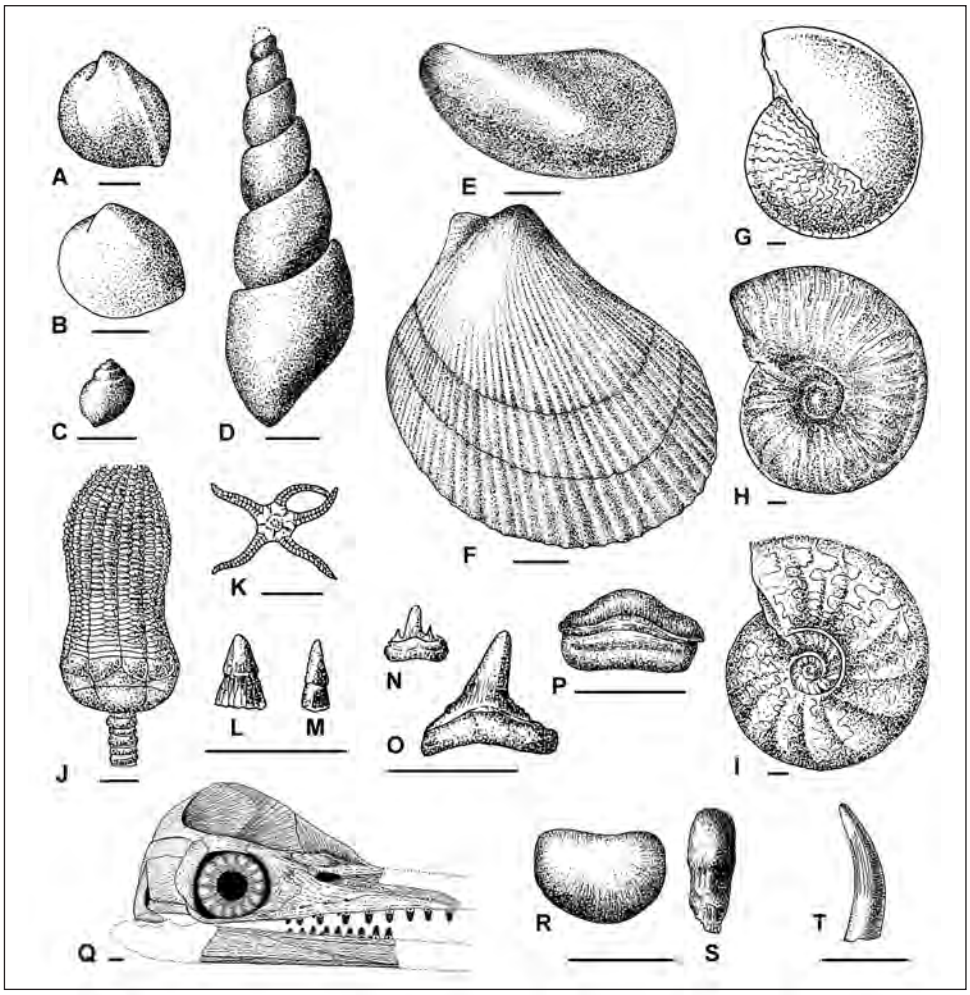

Fig. 4 Typical fossils from the Muschelkalk deposits of Rüdersdorf (compiled and modified after Schroeder 1993 and Maisch & Matzke 2001) and their stratigraphic distribution. **A**. *Myophoria vulgaris*, so_3 to mo_2; **B**. *Neoschizodus orbicularis*, mm_1; **C**. *Omphaloptycha gregaria*, $mu_{1\alpha}$ and $mu_{1\beta}$; **D**. *Loxonema johannisboehmi*, $mu_{1\alpha}$ and $mu_{1\beta}$; **E**. *Hoernesia socialis*, so_2 to $mm_{3\beta}$, mo_2; **F**. *Plagiostoma striatum*, $mu_{1\beta}$ and $mo_{1\beta}$; **G**. *Beneckeia buchi*, $mu_{1\alpha}$ and $mu_{1\beta}$; **H**. *Serpianites antecedens*, $mu_{1\beta}$; **I**. *Ceratites nodosus*, mo_2; **J**. *Encrinus liliiformis*, crown, $mu_{1\alpha}$ and mo_1; **K**. *Aspidura ludeni*, reconstructed ophiurian, $mu_{1\alpha}$; **L**. *Saurichthys mougeoti*, tooth, $mu_{1\beta}$, mm and $mo_{1\beta}$; **M**. *Saurichthys acuminatus*, tooth, $mu_{1\beta}$, mm and $mo_{1\beta}$; **N**. *Hybodus plicatilis*, tooth, $mu_{1\beta}$ and $mo_{1\beta}$; **O**. *Hybodus longiconus*, tooth, $mu_{1\beta}$ and $mo_{1\beta}$; **P**. *Acrodus gaillardoti*, tooth, mm and $mo_{1\beta}$; **Q**. *Mixosaurus atavus*, reconstruction of the cranial skeleton based on all known specimens, mo_2; **R**. *Placodus gigas*, palatine tooth, $mu_{1\alpha}$ and $mu_{1\beta}$; **S**. *Placodus gigas*, premaxillary tooth; **T**. *Nothosaurus* sp., tooth, $mu_{1\alpha}$ to $mm_{1\alpha}$. Scale bars equal 10 mm.

Fig. 5 *Nothosaurus marchicus* Koken 1893, MB.R. 27; specimen initially described by Schroeder (1914) as type of *Nothosaurus raabi*.

Fig. 6 Two scenes showing *Nothosaurus marchicus* in a modern lifestyle reconstruction while hunting for prey. Models of this recently newly reconstructed species were presented for the first time on exhibit ("Zeemonsters in Twente") in the TwentseWelle in Enschede, April 2012. Painting by Remie Bakker, Rotterdam.

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Field trip 3:

Stop 2: Northern Sand Pit at Niederlehme near Königs Wusterhausen: The Rixdorf Horizon (Rixdorfer Horizont) and its Mammal Assemblage

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Introduction

The glacio-fluvial gravels and sands of the Rixdorf Horizon (Rixdorfer Horizont, RH) are a renowned site type of Pleistocene mammals in the Berlin and Brandenburg areas. The term RH was derived from sand pits at Rixdorf (Rollberge), now Berlin-Neukölln (Körnerpark), where mammoth remains were recovered as early as in 1812 (Weiss 1829). Most of the classical sites of the RH have ceased to exist, others are still active, such as the northern sand pit at Niederlehme about 2 km northeast of Königs Wusterhausen, where the excavation of sands for construction purposes can be traced back up to 1880 or even 1870. First mammoth remains were reported there as early as in 1882 (Berendt 1882). Since that time Niederlehme has become one of the most important sites of the RH. In 1999, the gravels and coarse-grained sands exposed in the northern Niederlehme sand pit were designated as lectostratotype of the RH, because the type section (Rixdorf) has been inaccessible for study since the early 20th century (von Koenigswald & Heinrich 1996). Skeletal remains of mammals from the RH have been described in numerous publications. The greatest contribution to the knowledge of the mammal assemblage of the RH was that of Dietrich (1932). A reinvestigation of the finds housed in the Berlin Museum of Natural History, many regional museums and private collections is urgently needed.

Settings

The northern sand pit at Niederlehme is located in the young moraine landscape of central Brandenburg which was essentially formed by the last glaciation (Weichselian). During the Brandenburg Phase, which marks the maximum extent of the Weichselian glaciation, large parts of this region were covered by an inland ice sheet that advanced up to the Baruth ice marginal valley (Baruther Urstromtal) approximately 50 km south of Berlin (*Fig. 1*). Dating of the Brandenburg Phase ranges from 24 000 to 20 000 BP (Litt et al. 2007; Lüthgens & Böse 2011). The inland ice retreat from the Brandenburg ice marginal position left a variety of landforms, among them terminal moraines, till plains, ice marginal valleys (Urstromtäler), melt water channels, kames, outwash plains etc. In the Berlin area and adjacent regions the glacio-fluvial erosion resulted in numerous melt water

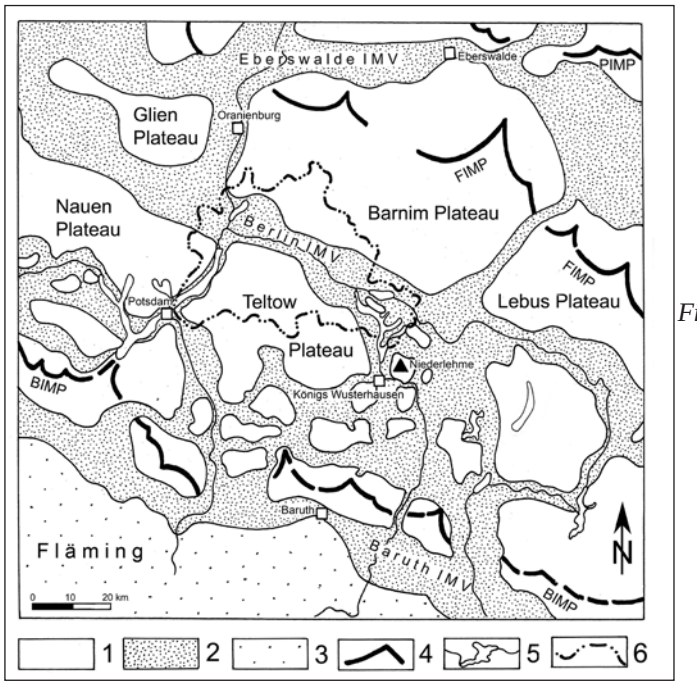

Fig. 1 Young moraine landscape of central Brandenburg, indicating the position of Niederlehme and land forms mentioned in the text (simplified). Modified from Grabenstedt (2006, 2011). **1**: plateaus and plateau-like islands of the young moraine area, **2**: ice marginal valleys (Urstromtäler), melt water channels and low grounds, **3**: old moraine area, **4**: Weichselian ice marginal positions, **5**: water bodies, **6**: city area of Berlin, BIMP: Brandenburg ice marginal position, FIMP: Frankfurt ice marginal position, PIMP: Pomeranian ice marginal position, IMV: ice marginal valley.

channels that dissected the till plains in a series of plateaus (e.g., Teltow) and plateau-like islands. The Niederlehme sand pit is situated at one of these plateau-like islands in the south of the Berlin ice marginal valley (Berliner Urstromtal) (*Fig. 1*). It is mainly built up by tills, gravels and sands. Parts of the Niederlehme plateau island were interpreted as a push moraine (Keilhack 1921) or kame terrace (Dietrich 1932).

Sequence of strata

The Pleistocene deposits exposed in the northern Niederlehme sand pit (*Fig. 2*) reach a thickness up to 25 m and comprise the following main lithostratigraphic units (Cepek 1986; Hermsdorf 2000): The lowermost part of the section is a sandy, grey-brown to olive-brown stained Lower Till (Unterer Geschiebemergel) which was deposited during the Saalian glacial. The reported thickness is about 8 m to 9 m. The top of the lower till shows signs of weathering. Overlaying the Lower till is a boulder pavement (Steinsohle) consisting mainly of nordic crystalline boulders, of which a considerable portion is strongly weathered. The stony gravels and predominantly coarse-grained deposits of the RH that have yielded the mammalian skeletal remains directly overlie the boulder pavement and reach a thickness up to 7 m. Till clasts which were incorporated in frozen condition into the RH are present, as are re-deposited shells of the water snail *Viviparus diluvianus*.

Most notable was the discovery of an approximately 3.0 m wide and 0.5 m deep fluvial channel within the RH, indicating a short interruption of the sedimentation. The channel infill was mainly composed of cross-bedded, coarse-grained sediments containing thin beds of olive-gray silt, that yielded shells of freshwater molluscs (e.g., *Pisidium*, *Valvata*, *Planorbis* and *Viviparus*) carapaces of ostracods (e.g., *Candona candida*, *Limnocythere sanctipatricii*), skeletal remains of fish (*Esox lucius*, *Perca*? sp., Salmonidae indet.), and molars of voles (*Microtus* sp.) and lemmings (*Dicrostonyx gulielmi*, *Lemmus lemmus*) (Heinrich & Hermsdorf 2003). Close to the channel there was an ice-wedge cast, indicating glacial conditions. The channel deposits are overlain by stony coarse-grained sediments, of which the uppermost bed forms a boulder pavement that marks the top of the RH at Niederlehme.

A well-stratified sequence of partly cross-bedded, partly horizontal-bedded fine- to medium-grained glacio-fluvial sands with a thickness of about 15 m directly overlies the deposits of the RH. Gravel beds and silt layers are intercalated at several levels into the layered sands. The upper third of the sandy sequence is ripple-bedded and shows signs of glacio-tectonic deformations. Ice-wedge casts were reported (Böse 1997). The sandy sequence has so far yielded only a few large mammal remains (e.g., *Mammuthus primigenius*). Overlaying the sandy deposits is the remainder of the Upper Till (Oberer Geschiebemergel) of the Brandenburg Phase of the Weichselian that reaches a thickness of about 4.0 m. It is covered in some places by horizontal-bedded sands (2.5 m), which were also deposited under glacial conditions. On top of the sequence there are periglacial cover sediments.

Findings: occurrence, preservation and frequency

The RH at Niederlehme has mainly yielded isolated bones, teeth and antler fragments (*Fig. 3*). Cluster-like accumulations of skeletal remains are very rare. Complete or partial skeletons are lacking. Dentulous jaw fragments are not uncommon. Much of the material is in poor condition, well-preserved findings are the exception. Several postcranial bones are water worn indicating transport and abrasion prior to burial. Some leg bones from the woolly

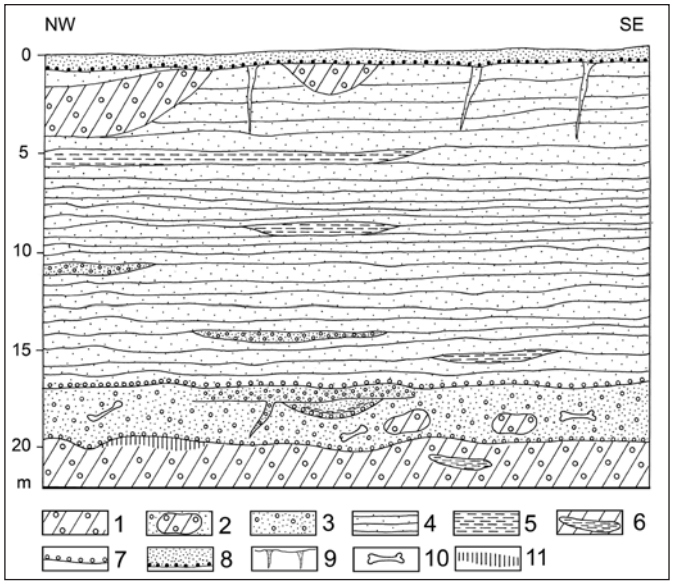

Fig. 2 Schematic geological section of the northern sand pit at Niederlehme near Königs Wusterhausen. Modified from Cepek (1986) and Hermsdorf (2000). **1**: till, **2**: till clast, **3**: stony gravels and coarse-grained sands, **4**: layered fine- to medium-grained sands, **5**: silt, **6**: block of basin silt, **7**: boulder pavement, **8**: periglacial cover sediments, **9:** ice-wedge casts, **10**: skeletal remains of the Rixdorf Horizon, **11**: weathered zone

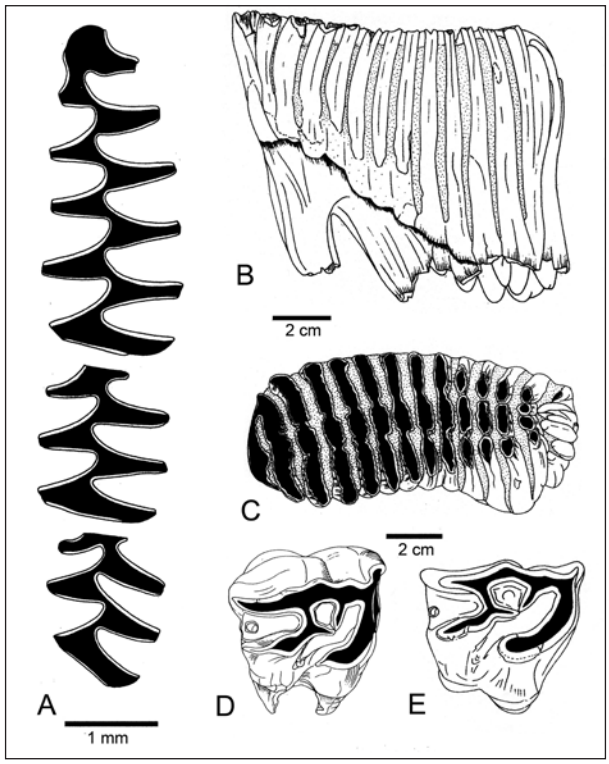

Fig. 3 Mammal molars recovered from the Rixdorf Horizon at Niederlehme (northern sand pit). **A.** *Dicrostonyx gulielmi*, m1-m3 sin, MB.Ma.50382, occlusal view; **B-C.** *Mammuthus primigenius*, m1 sin, MB.Ma.19467 in (B) buccal view and (C) occlusal view; **D-E.** *Coelodonta antiquitatis*, M1/M2 dex., MB.Ma.25894, in occlusal view (D), M2 dex., MB.Ma.25898, in occlusal view (E). Abbreviations: M: upper molar, m: lower molar

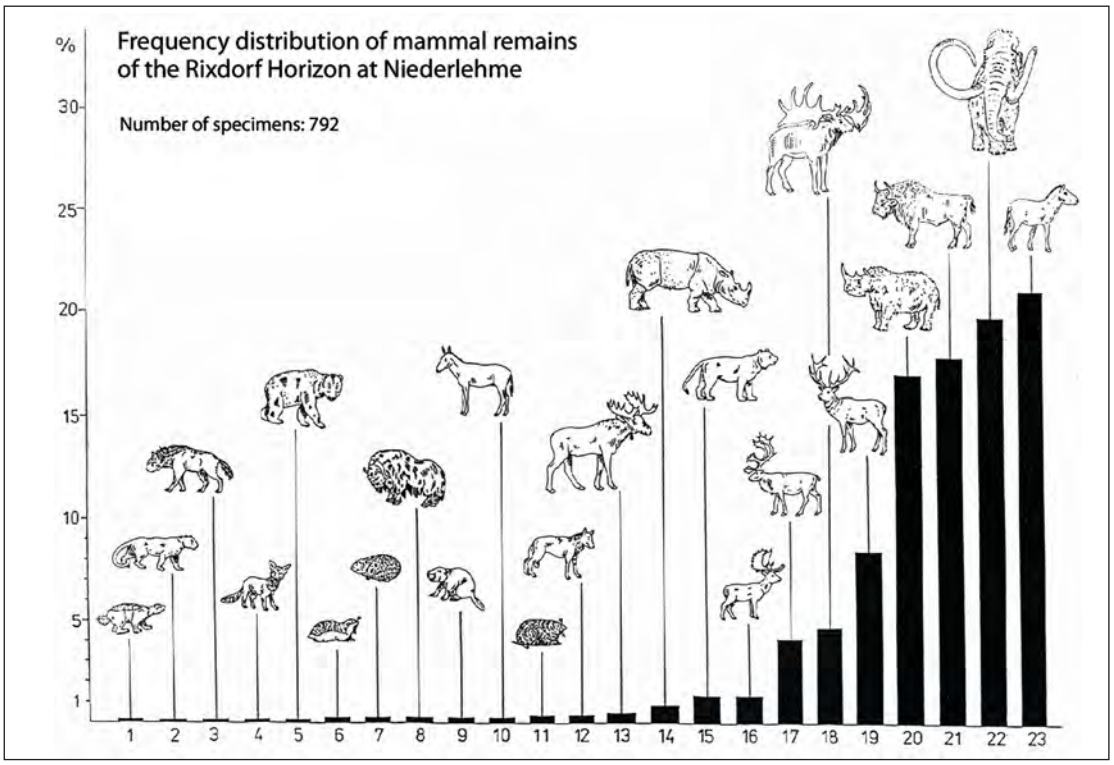

Fig. 4 Frequency distribution of mammal remains recovered from the Rixdorf Horizon at Niederlehme (northern sand pit). Modified from Heinrich (2002). **1**: wolverine (*Gulo gulo*), **2**: leopard (*Panthera pardus*), **3**: cave hyaena (*Crocuta crocuta spelaea*), **4**: Arctic fox (*Alopex lagopus*), **5**: brown bear/cave bear (*Ursus arctos* vel *Ursus spelaeus*), **6**: Norway lemming (*Lemmus lemmus*), **7**: vole (*Microtus* sp.), **8**: musk oxs (*Ovibos moschatus*), **9**: Eurasian beaver (*Castor fiber*), **10**: Asiatic ass (*Equus hemionus*), **11**: Pleistocene collared lemming (*Dicrostonyx gulielmi*), **12**: gray wolf (*Canis lupus*), **13**: moose (*Alces alces*), **14**: Merck's rhino (*Stephanorhinus kirchbergensis*), **15**: cave lion (*Panthera leo spelaea*), **16**: fallow deer (*Dama dama*), **17**: reindeer (*Rangifer tarandus*), **18**: giant deer (*Megaloceros giganteus*), **19:** red deer (*Cervus elaphus*), **20**: woolly rhino (*Coelodonta antiquitatis*), **21**: steppe bison (*Bison priscus*), **22**: woolly mammoth (*Mammuthus primigenius*), **23**: Pleistocene wild horse (*Equus* cf. *germanicus*).

rhino (*Coelodonta antiquitatis*) are thought to show bite marks of cave hyenas (*Crocuta crocuta spelaea*). The bones and antler fragments are usually light brown to medium brown in color, as are the teeth. In addition, a manganese-dendritic mottling and patches of differing brownish colors are present, giving the skeletal remains a specific "outfit", the so-called Rixdorf preservation (Rixdorfer Erhaltung: Dietrich 1932). Unfortunately, nothing can be said about the original position of most skeletal remains kept in the collections due to the lack of written records.

The mammal assemblage of Niederlehme is dominated by large mammals. Small mammals are extremely rare. To date, no hominid remains or artefacts have been recovered. Twenty-three mammalian species have been identified so far. Skeletal remains of *Equus* cf. *germanicus*, *Mammuthus primigenius*, *Bison priscus*, and *Coelodonta antiquitatis*, followed by *Cervus elaphus*, *Megaloceros giganteus* and *Rangifer tarandus* make up the bulk of the mammal findings (*Fig. 4*). Bones and teeth of the remaining mammal species are distinctly less common. The evidence of small mammals is confined to a few finds of rodents (*Castor fiber*, *Dicrostonyx gulielmi*, *Lemmus lemmus*, *Microtus* sp.). The imbalance between large and small mammals is due to collecting bias in the past, when the interest of pit workers and collectors focused primarily on larger attractive specimens such as mammoth molars.

Composition and age of the local mammal assemblage

A striking feature of the Niederlehme mammal assemblage is the co-occurrence of cold-adapted (e.g., *Dicrostonyx gulielmi*, *Lemmus lemmus*, *Alopex lagopus*, *Mammuthus primigenius*, *Coelodonta antiquitatus*, *Ovibos moschatus*, *Rangifer tarandus*) and thermophile species (e.g., *Dama dama*, *Stephanorhinus kirchbergensis*), along with faunal elements that were distributed in central Europe during glacial and interglacial periods such as *Crocuta crocuta spelaea*, *Canis lupus*, *Megaloceros giganteus* and *Cervus elaphus* (*Tab. 1*). This faunal composition, which was also reported from other sites of the RH, has been the subject of much controversial discussions for many years (for details see Schroeder 1930; Dietrich 1932 and Heinrich 1992).

Contrary to several previous authors (e.g., Schroeder 1930), who allocated the mammal fauna of the RH to the Eemian interglacial, Dietrich (1932) interpreted the mammal assemblage as a mixture of contemporary Weichselian and allochthonous Pleistocene species. He argued that the thermophile species such as *Dama dama* and *Stephanorhinus kirchbergensis* are not referable to the RH, because their remains are re-deposited from interglacial sediments. According to Dietrich (1932), the

Tab. 1 Simplified palaeoecological classification of the mammalian species known from the Rixdorf Horizon at Niederlehme (northern sand pit). **1**: cold-adapted species, **2**: thermophilous species, **3**: species, distributed in central Europe during glacials and interglacials, **4**: without allocation.

Taxa	1	2	3	4
Castor fiber			+	
Dicrostonyx gulielmi	+			
Lemmus lemmus	+			
Microtus sp.				+
Alopex lagopus	+			
Canis lupus			+	
Ursus spelaeus vel *Ursus arctos*				+
Gulo gulo	+			
Crocuta crocuta spelaea			+	
Panthera pardus			+	
Panthera leo spelaea			+	
Mammuthus primigenius	+			
Equus cf. *germanicus*			+	
Equus hemionus	+			
Stephanorhinus kirchbergensis		+		
Coelodonta antiquitatis	+			
Megaloceros giganteus			+	
Cervus elaphus			+	
Alces alces			+	
Dama dama		+		
Rangifer tarandus	+			
Bison priscus			+	
Ovibos moschatus	+			

genuine mammal assemblage of the RH consists only of (1) cold-adapted species, which immigrated during the Weichselian into the Brandenburg area (e. g., *Mammuthus primigenius*, *Coelodonta antiquitatus*, *Ovibos moschatus*, *Rangifer tarandus*, *Alopex lagopus*), and (2) native species that could survive from the Eemian interglacial into the Weichselian glacial owing to their ecological adaptabilities (e. g., *Crocuta crocuta spelaea*, *Panthera leo spelaea*, *Canis lupus*, *Megaloceros giganteus*, *Cervus elaphus*). Newcomers and natives are thought to have formed a mammalian fauna that existed in an interstadial episode before the Brandenburg phase of the Weichselian glaciation. The bulk of skeletal remains are assumed to originate from carcasses and skeletons that were flushed out from the land surface, peat bogs, marshes, ponds and lakes before they were incorporated into the gravels and coarse-grained sands of the RH (Dietrich 1932). By contrast, other authors regarded the RH mammal assemblage as mixture of re-deposited Eemian and Weichselian faunal elements that cannot be accurately related to a single interstadial episode of the Weichselian (e.g., Müller-Beck 1966 and Cepek 1986). The precise deciphering of the mammal assemblage of the RH requires further study.

Nevertheless, our understanding of the RH has advanced. Field evidence and the state of preservation indicate that the recently recovered remains of voles and lemmings are contemporary with the RH of Niederlehme (Heinrich & Hermsdorf 2003). In addition, U/Th- and ^{14}C-datings of authochtonous mollusc shells suggest that the vole- and lemming-bearing channel infill mentioned above was deposited between ca. 30 000 and 27 000 BP during the Denekamp Interstadial of the Weichselian (Hermsdorf 2002). Further studies are expected to clarify whether these age determinations are applicable to the entire RH of Niederlehme.

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