Museologia Scientifica e Naturalistica, volume speciale 2011

Museologia Scientifica e Naturalistica

Volume Speciale 2011

TAPHOS 2011

6th International Meeting on Taphonomy and Fossilization

Tübingen, Germany

14th-17th June, 2011

Abstract Volume

Annali dell'Università degli Studi di Ferrara

ISSN 1824-2707

Annali dell'Università degli Studi di Ferrara
Autorizzazione del Tribunale di Ferrara n. 36/21.5.53

Nebelsick J.H., Friedrich J.-P. and Dynowski J.F. (eds.), 2011. 6th International Meeting on Taphonomy and Fossilization. Taphos 2011. Tübingen, 14th-17th June 2011. Annali dell'Università di Ferrara, Sez. Museologia Scientifica e Naturalistica, volume speciale.

6th International Meeting on Taphonomy and Fossilization

TAPHOS 2011

14th - 17th June, Tübingen, Germany

Abstract Volume

James H. Nebelsick, Jan-Peter Friedrich & Janina F. Dynowski

Editors

Scientific Committee

Julio Aguirre
Davide Bassi
Hervé Bocherens
James Nebelsick
Michael Rasser
Günter Schweigert
Adam Tomašových
Thomas Tütken
Martin Zuschin

Local Committee

Samereh Abdolalipour
Fabian Bonitz
Janina Dynowski
Jan-Peter Friedrich
Bettina Geiselhart
Franziska Göhringer
Tobias Grun
Walter Joyce
Willy Kappler
Denise Kaste
Uwe Kurz
Margita Lachenmaier
Tatjana Miranda
James Nebelsick
Christoph-Tobias Oehm
Diedrich Sievers
Eden Volochonsky

Sponsors

EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Tübingen
Universitätsstadt

DFG Deutsche Forschungsgemeinschaft

STAATLICHES
MUSEUM FÜR
NATURKUNDE
STUTTGART
Forschungsmuseum
Am Löwentor und
Schloss Rosenstein

E. Schweizerbart
Science publishers

Universitätsbund Tübingen
Vereinigung der Freunde der Eberhard Karls Universität Tübingen e.V.

Contents

TAPHOS 2011

Institute of Geosciences, University of Tübingen

Programme:

Monday, June 13th: Registration, Institute of Geosciences: 18:00-20:00
Tuesday, June 14th: Field trip to Holzmaden und Nusplingen: Departure: 8:00 in front of the Institute Building; Sigwartstraße 10. Return: ca. 19:00 **19:00 onwards: Icebreaker Party & Registration: Institute of Geosciences**
Wednesday, June 15th: Talks and Posters: Institute of Geosciences, University of Tübingen **(Talks: Lecture Theatre - Room 320, Posters & Coffee: Seminar Room – 245)** **19:00: Evening Reception**
Thursday, June 16th: Talks and Posters: Institute of Geosciences, University of Tübingen **(Talks: Lecture Theatre - Room 320, Posters & Coffee: Seminar Room – 245)** **19:00: Conference Dinner at the "Casino" Restaurant in Tübingen**
Friday, June 17th: Field trip to Solnhofen **Departure: 8:00 in front of the Institute Building; Sigwartstraße 10.** **Return: ca. 20:00**

Time	Wednesday, June 15th
08:00 – 08:45	**Registration**
08:45 – 09:00	**Welcome & Opening remarks**
	Wednesday, June 15th: Morning Sessions
	Taphonomic Processes and Palaeoecological Interpretation
09:00 – 09:30	***Plenary Lecture:*** Yurena **Yanes** Taphonomy and paleoecology of land snail shelly assemblages
09:30 – 09:45	Sue **Beardmore,** Patrick **Orr &** Heinz **Furrer** Morphology and environment: skeletal taphonomy of Triassic marine reptiles from Monte San Giorgio, Switzerland
09:45 – 10:00	Jo **Hellawell & Patrick J. Orr** Deciphering taphonomic processes in the Eocene Green River Formation of Wyoming
10:00 – 10:15	Vlasta **Ćosović,** Drobne **Katica &** Haris **Ibrahmpašić** Role of taphonomic features in paleoecological interpretation of Eocene carbonates from the Paleogene Adriatic carbonate platform (PgAdCP)
10:15 – 10:30	Šárka **Hladilová** Miocene gastropod shells with epibionts – taphonomic and paleoecological interpretations (two case studies)
10:30 – 11:00	**Posters & Coffee**
11:00 – 11:15	José N. **Pérez-Asensio &** Julio **Aguirre** (presenter) Benthic foraminiferal taphonomy of Late Pliocene deposits from the Almería-Níjar Basin (SE Spain)
11:15 – 11:30	Emmanuelle **Stoetzel,** Emilie **Campmas,** Christiane **Denys,** Patrick **Michel,** Bouchra **Bougariane,** Brahim **Ouchaou, Mohammed** Abdeljalil **El Hajraoui &** Roland **Nespoulet** Taphonomic comparison between large and small vertebrates in cave context (El Harhoura 2, Morocco): palaeontological, environmental and archaeological implications
11:30 – 11:45	Brigette **Cohen &** Job M. **Kibii** Actualistic investigation of bone modification by carnivores and birds of prey on small mammals: An insight to the taphonomy of mesomammals from Cooper's Cave, Cradle of Humankind
11:45 – 12:00	Yael **Edelman-Furstenberg** Molluscan shell damage across a nutrient gradient, SW Africa, Benguela upwelling system
12:00 – 12:15	Davide **Bassi,** Marc **Humblet,** Yasufumi **Iryu &** Senji **Matsuda** Macroid growth off Kikai-jima (Ryukyu Islands, southern Japan) and its taphonomic characterization
12:15 – 12:30	Evan N. **Edinger &** Owen A. **Sherwood** Taphonomy of gorgonian and antipatharian cold-water corals in Atlantic Canada: experimental decay rates and field observations
12:30 – 14:00	**Lunch**

	Wednesday, June 15th: Afternoon Sessions
Time	**Exceptional Preservation and Mass Occurrences**
14:00 – 14:30	***Plenary Lecture:*** Derek E. G. **Briggs** Pushing preservation – what is exceptional?
14:30 – 14:45	Ángel **Puga-Bernabéu &** Julio **Aguirre** (presenter) Taphonomy of tempestites versus tsunamites: A case study from late Miocene temperate carbonates (Sorbas Basin, SE Spain)
14:45 – 15:00	Ján **Schlögl,** Régis **Chirat,** Natália **Hudáčková,** Vincent **Balter,** Michael **Joachimski,** Frédéric **Quillévéré,** Andrzej **Pisera** Exceptionally preserved upper bathyal assemblages from the Early Miocene of the Vienna Basin and their significance for the nautiloid habitat and life-style
15:00 – 15:15	Susanne **Lukeneder &** Alexander **Lukeneder** Taphonomy and genesis of a Carnian ammonite mass-occurrence (Triassic, Taurus Mountains, Turkey)
15:15 – 15:30	Walter G. **Joyce and** Oliver **Wings** A terrestrial Konzentratlagerstätte from the Late Jurassic Qigu Formation, Xinjiang Autonomous Region, China
15:30 – 16:00	**Posters & Coffee**
	Biostratinomic Patterns in Marine Environments
16:00 – 16:15	Andrea **Mancosu,** Francesco **Cambuli &** Gian Luigi **Pillola** Biostratinomy and hydrodinamic behaviour of Tariccoia arrusensis: implications for depositional environment of the Riu Is Arrus Member (Upper Ordovician – SW Sardinia, Italy)
16:15 – 16:30	Matias **Reolid &** María Isabel **Benito** Belemnite taphonomy in epicontinental shelf deposits of the Upper Jurassic (Prebetic, Betic Cordillera)
16:30 – 16:45	Emmanuel **Fara,** Benjamin **Pierrat,** Didier **Merle,** Emmanuelle **Vennin &** Pascal **Neige** Back to a famous palaeontological site: facies and biodiversity of the rich mollusc assemblages from Grignon (middle Eocene, France)
16:45 – 19:00	**Poster Session**
19:00	**Evening Reception**

	Thursday, June 16th, Morning Sessions
Time	**Geochemistry and other Methods in Taphonomy**
09:00 – 09:30	***Plenary Lecture:*** Thomas **Tütken** Fossilisation processes and timescales of bones and teeth – implications for geochemical reconstructions of palaeoenvironment and taphonomy
09:30 – 09:45	Krzysztof **Owocki** Microbial activity and uranium anomaly in Late Cretaceous dinosaur bones from Mongolia
09:45 – 10:00	Chris **Ballhaus,** Carole T. **Gee,** Karin **Greef,** Tim **Mansfeldt &** Dieter **Rhede** Fossilization of trees by silicification - an experimental study
10:00 – 10:15	Daria **Kiseleva,** Sergey **Votyakov,** Natalia **Adamovich,** Nikolay **Smirnov &** Nina **Sadykova** Microelement composition and structure of mammal fossil bones and teeth by LA-ICP-MS and Raman spectroscopy
10:15 – 10:30	Achim **Schwermann &** Michael **Wuttke** Computer Tomography controlled decomposition process of a mole as a tool for the forensic taphonomy of fossil vertebrates
10:30 – 11:00	**Posters & Coffee**
	Biostratinomic Patterns in Terrestrial Environments
11:00 – 11:15	Michael **Wuttke &** Achim G**. Reisdorf** Forensic Taphonomy of Carnivorous Dinosaurs from the Late Jurassic Solnhofen Archipelago
11:15 – 11:30	M. Soledad **Domingo,** M. Teresa **Alberdi,** Beatriz **Azanza &** Jorge **Morales:** Mortality patterns in the carnivoran-dominated Miocene assemblage of Batallones-1 (Madrid Basin, Spain)
11:30 – 11:45	Kerstin **Pasda** Trail Creek caves 2 and 9 revisited - Caribou hunting or carnivore use of two Late Pleistocene and Holocene caves in Alaska
11:45 – 12:00	Job M. **Kibii** Taphonomic differences between the South African porcupine (*Hystrix africaeaustralis*) and the North African porcupine (*H. cristata*)
12:00 – 12:15	Ma. Teresa Nohemi **Sala**, Juan Luis **Arsuaga** & Gary **Haynes** Actualistic experiments with wild brown bears (*Ursus arctos*) in the North Spain Mountains
12:15 – 14:00	**Lunch**

	Thursday, June 16th, Afternoon Sessions
	Diversity Controls and Taphonomy
14:00 – 14:30	***Plenary Lecture:*** Loïc **Villier** From field collection to Phanerozoic diversity trends: multi-scale taphonomic biases in the fossil record of the echinoderms
14:30 – 14:45	Adam **Tomašových** & Susan M. **Kidwell:** Fossilization dynamic determined by rapid initial degradation and temporary sequestration: consequences for diversity in the fossil record
14:45 – 15:00	Alistair J. **McGowan** Spatial is special: the potential for spatially-explicit data to separate biodiversity signals from sampling noise
	Rafał **Nawrot** Impact of uneven spatiotemporal sampling on regional-scale paleoecological patterns – examples from the Middle Triassic of the Germanic basin
15:15 – 15:30	Gaëlle **Doitteau,** Philippe **Bouchet,** Pierre **Lozouet,** Anne **Ribaud-Laurenti &** Loic **Villier:** Spatial variations of taphonomic biases and environmental control on the preservation potential of bivalve diversity in Touho Lagoon (Northeast of New Caledonia)
15:30 – 16:00	**Posters & Coffee**
16:00 – 16:15	Stefano **Dominici**, Martin **Zuschin** (presenter) and Didier **Merle**: Shallow marine faunas in the European Cenozoic fossil record
16:15 – 16:30	Tomasz **Borszcz**, Piotr **Kukliński** and Michał **Zatoń** Encrustation patterns on Late Cretaceous (Turonian) echinoids from southern Poland on the background of global data
16:30 – 16:45	Gordon **Turner-Walker** Early bioerosion in skeletal tissues: persistence through deep time
16:45 – 17:00	**Wrap up and future plans**
19:00	**Conference Dinner (Casino, Tübingen)**

Posters – Taphos 2011

(underlined = presenter if different from first author)

Davide **Bassi**, Rachel N. **Leal**, Hideko **Takayanagi**, Yasufumi **Iryu**, Renato **Posenato** & Gilberto M. **Amado-Filho**:
Rhodolith beds from the Abrolhos Bank, Brazilian platform: taphonomy, geochemistry, ecology

Zain **Belaústegui,** Jordi M. **de Gibert** & James H. **Nebelsick**:
A clypeasteroid Konzentrat-Lagerstätte from the Miocene of El Camp de Tarragona Basin (NE Spain)

Emilia R. **Belia** & Raúl **Esperante**:
Unusual Skeletal Arrangement of a Mysticeti Fossil Whale in the Pisco Formation, Peru

Patrick **Chellouche**, Franz Theodor **Fürsich** & Matthias **Mäuser**:
Qualitative and quantitative taphonomy of the Wattendorf Plattenkalk (Upper Kimmeridgian, Southern Germany)

Lucas **Cheme Arriaga**, Claudia I. **Montalvo** & Ramón A. **Sosa**:
Experiments on wind dispersal of rodent bones

Pereira Calça **Cléber** & Thomas Rich **Fairchild**:
Differential preservation of organic-walled microfossils within dolostone, shale, and chert of the Assistência Formation (Irati Subgroup, Permian, Paraná Basin, Brazil)

Cláudia **Costa**, Nelson **Almeida**, Hugo **Gomes**, Sara **Cura** & Pedro **Cura**:
Early diagenesis of ungulate crania in temperate environments: experimentation protocol

Janina F. **Dynowski**:
Distinction of depositional environments based on the taphonomy of microscopic echinoderm remains in tropical shallow water carbonates, San Salvador, Bahamas

Janina F. **Dynowski**, Ben **Thuy** & James H. **Nebelsick**:
Taphonomic study of an echinoid mass occurrence in lower Jurassic black shales

Raúl **Esperante**, Fernando **Muñiz** & Orlando **Poma**:
Taphonomy of a mysticeti whale with a fracture-healed rib, Miocene Pisco Formation, southern Peru

Yolanda **Fernández-Jalvo**, Paloma **Sevilla** & Amalia I. **Cuadros-Casado**:
Digestion vs. soil corrosion in a lower Pleistocene small mammal assemblage

Jan-Peter **Friedrich** & James H. **Nebelsick**:
Encrustation Patterns on an Upper Jurassic, Plate Shaped Sponge from the Plettenberg Quarry, Dotternhausen (SW Germany)

Maria Joana **Gabucio**, Isabel **Cáceres** & Jordi **Rosell**:
Evaluating Postdepositional Processes in the Level O of the Abric Romaní Archaeological Site

Šárka **Hladilová**:
Fossil shark teeth from the Upper Paleolithic/Gravettian Pavlov I site (Moravia, Czech Republic) and their taphonomic evidence

Šárka **Hladilová**:
Taphonomic evaluation of *Spondylus* artifacts from Neolithic (Linear Pottery Culture) graves at Vedrovice (Moravia, Czech Republic)

Nadja **Hoke**, Andrea **Grigat**, Gisela **Grupe** & Michaela **Harbeck**:
Assessing the qualitative preservation of collagen in bones after short interment periods: Comparison of different hydrolysis methods preceding amino acid analysis

Sashima **Läbe**, Chris **Ballhaus**, Carole T. **Gee** & Ronny **Rößler**:
Experimental silicification of the tree fern *Dicksonia antarctica* as a taphonomic analog to volcanic preservation in the Lower Permian forest of Chemnitz

Alexander **Lukeneder** & Susanne **Lukeneder**:
A Triassic ammonite mass-occurrence from the Taurus Mountains in Turkey

Alistair J. **McGowan**:
Using published incidence data to predict marine invertebrate encounter rates in the Midland Valley of Scotland

Bertrand **Martin-Garin**, Evan **Edinger**, Véronique **Chazottes**, Gilles **Conesa**, Marion **Didierlaurent**, Jean-Philippe **Pero** & Anne **Ribaud**:
Taphonomy of massive corals and lateral facies variation in an Oligocene-Miocene coral reef, Carry-le-Rouet, southeastern France

Julien **Michel**, Gaëlle **Doitteau**, Pierre **Lozouet** & Loic **Villier**:
Preservation of biodiversity structure of an exceptionally-preserved Aquitanian bivalve assemblage (Meilhan, SW France)

Claudia I. **Montalvo**, Rodrigo **Tomassini**, Graciela **Visconti** & Sergio I. **Tiranti**:
Taphonomic analysis of the Late Pleistocene micromammals of Quequén Salado, Buenos Aires, Argentina

Fernando **Muñiz**, Raúl **Esperante** & Kevin E. **Nick**:
Evidence of a reef stage associated with a whale skeleton in the Lower Pliocene of Huelva, SW Spain

James H. **Nebelsick** & Michael **Rasser**:
Taphonomy and Palaeoecology of a mass occurrence of Miocene turritelline gastropods

James H. **Nebelsick** & Ulrich **Bieg**:
Microtaphofacies of mixed siliciclastic/bryomol carbonates from the North Alpine Foreland Basin

Krzysztof **Owocki**, Grzegorz **Niedźwiedzki**, Andrey G. **Sennikov**, Valeriy K. **Golubev**, Katarzyna **Janiszewska**, Kornel **Biernacki** & Tomasz **Sulej**:
Horizons with the Late Permian vertebrate coprolites from the Vyazniki and Gorokhovets, Vyatkian Gorizont, Russian Platform – preliminary report

María Dolores **Pesquero**, Yolanda **Fernández**-Jalvo & Luis **Alcalá**:
Diagenetic alterations in Miocene Mammal bones from Cerro de la Garita site (Concud, Teruel, Spain)

María Dolores **Pesquero**, Virginia **Souza**, Luis **Alcalá**, Carmen **Ascaso** & Yolanda **Fernández-Jalvo**:
Calcium phosphate preservation of fecal bacteria pseudomorphs in hyaena coprolites from the Upper Miocene mammal fossil site of La Roma 2 (Teruel, Spain)

Renato **Posenato** & Daniele **Masetti**:
Dynamics of Cochlearites (Early Jurassic aberrant bivalve) reefs

Renato **Posenato**, Marco **Avanzini**, Davide **Bassi** & Nicola **Sprocatti**:
Bivalve pavement successions in oxygen-depleted marginal marine environment (Lower Jurassic, northern Italy)

Matias **Reolid**, Fernando **García-García** & Adam **Tomašových**:
Brachiopod shell-mass accumulations from a prodelta-offshore transition setting (Late Tortonian, Guadix Basin, South Spain)

Matias **Reolid**, Fernando **Pérez-Valera**, Michael J. **Benton** & Ana **Peña**:
A high-energy marine flooding in the red bed Facies (Triassic) of the Tabular Cover (SE Spain) registered by a bone-rich bed with Nothosauria and Placodontia

Ana **Santos**, Eduardo **Mayoral**, Matias **Reolid** & Michael J. **Benton**:
Grazing activity as a taphonomic record of biotic interaction: A case study of a sea-turtle from the Late Jurassic of the Prebetic (South Spain)

Diedrich **Sievers**, Jan-Peter **Friedrich** & James H. **Nebelsick**:
Crows scavenging and preying upon burrowing echinoids on two tidal beaches in Brittany, France

Trine **Sørensen**:
How taphonomy comes to use in conservation and preparation

Barbara **Studencka** & Marek **Jasionowski**:
Peculiar bivalve-serpulid association in the Sarmatian (Middle Miocene) reefs of the Medobory Hills (Ukraine)

Martin **Studeny**, Diethard G. **Sanders** & Martin **Zuschin**:
Paleoecology and microfacies of a Cretaceous transgressive interval (upper Turonian to Coniacian, Northern Calcareous Alps)

Miguel **Téllez**, Marla Itzel **Macías**, Guillermo **Avila**, Oscar **González** & Karl **Flessa**:
δ18O and time averaging on subtidal tanathocoenosis of *Mulinia coloradoensis*, Colorado River Delta, Baja California, Mexico

Nikoleta **Zisi**, Elissavet **Dotsika**, Evangelia **Tsoukala** & Vasilis **Pxycharis**:
Mineralogical and geochemical diagenetic investigation of Ursus ingressus fossil bones

Martin **Zuschin**, Mathias **Harzhauser**, Radovan **Pipik** & Dušan **Starek**:
Continental trace fossils around Lake Pannon (Upper Miocene, Central Paratethys)

Abstracts

Fossilization of trees by silicification - an experimental study

Chris Ballhaus[1], Carole T. Gee[1], Karin Greef[2], Tim Mansfeldt[2] & Dieter Rhede[3]

1) Steinmann Institut, Universität Bonn, 53115 Bonn, Germany
2) Geographisches Institut, Universität zu Köln, 50923 Köln, Germany
3) GeoForschungsZentrum Potsdam, 14473 Potsdam, Germany

Silicification is an important, major taphonomic process in the preservation of plants in the fossil record. Without the ability of plant tissue to attract silica from aqueous solutions and precipitate it in cells as opal, chalcedony, and α-quartz, wood and all other plant tissues would rapidly decompose in an oxygenated environment. Without silicification, we would know very little about the anatomy, life history, and evolution of land plants. When entire forests are preserved intact, which happens when they are buried under volcanic pyroclastic deposits and then permineralized, silicification also allows insights into past ecological and climatic conditions on ancient land surfaces

Silicification involves the filling of pore spaces in the wood structure, known as permineralization. Silicification also comes with the replacement of vascular tissue by SiO2; so thoroughly that many silicified trees consist of close to 100% SiO2, so delicately that the internal organic architecture of the wood tissue is retained, yet so rapidly that even metabolic processes on the subcellular scale can sometimes be frozen in and reconstructed. Any substrate that is able to bring elevated silica in solution is also capable of silicifying plant material; a volcanic ash rich in glassy material, a silica-rich hydrothermal solution from a hot spring, and an immature sediment with abundant detrital feldspar.

In this contribution, the permineralization of trees by pervasive silicification is simulated with closed-system experimentation at 100°C. The silica source in the experiments is a ground rhyolitic obsidian glass with 73 wt.% SiO2 in the glass. The wood samples are coniferous, from the family Pinaceae, and the medium transporting silica from the lithic matrix into the wood tissue is water. A major force driving silica into wood is a pH gradient which is established when trees are buried by volcanic ash, resulting in mildly acidic conditions inside the wood and mildly alkaline conditions in the pore waters of the volcanic ash. Reaction experiments of wood with silica-bearing water (100°C) show that wood has a marked affinity to scavenge silica complexes from an aqueous solution and precipitate them on the cell walls in wood in the form of opal. Most opal precipitates take the form of microspheres with an underlying nanospheric substructure, near-identical in morphology to opal precipitates from natural active hydrothermal wells.

We suggest, as Leo and Barghoorn did in 1976, that silica complexes in aqueous solution, upon entering wood tissue, may share OH groups with organic molecules and may become fixated on cell walls and inside intracellular spaces via hydrogen bonding. Based on the reaction mechanisms identified and the reaction rates quantified by experimentation, a diffusion model is proposed here for the calculation of how long it would take to silicify wood logs as massive as those found in petrified forests worldwide. The times scales calculated range from hundreds to thousands of years, and they accord well with silicification rates derived from natural examples of wood buried by volcanic ash.

References:

Leo, R.F. & Barghoorn, E.S. (1976): Silicification of wood. Botanical Museum Leaflets, 25, 1-47.

Macroid growth off Kikai-jima (Ryukyu Islands, southern Japan) and its taphonomic characterization

Davide Bassi[1], Marc Humblet[2], Yasufumi Iryu[3] & Senji Matsuda[4]

1) Dipartimento di Scienze della Terra, Università di Ferrara, via Saragat 1, 44122 Ferrara, Italy
2) Department of Ocean Floor Geoscience, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba 277-8564, Japan
3) Department of Earth and Planetary Sciences, Graduate School of Environmental Studies, Nagoya University, Nagoya 464-8601, Japan
4) Faculty of Education, University of the Ryukyus, Nishihara, Okinawa 903-0213, Japan

The use of carbonate nodules (macroids, rhodoliths) as palaeoenvironmental indicators is generally based on examples of modern nodule growth. Although nodules are found in both shallow- and deep-water environments, research on their composition, formation, taphonomy and depositional setting has been limited almost exclusively to shallow depths. Recent observations of carbonate macroid growth off Kikai-jima, Ryukyu Islands, reveal the processes by which carbonate nodules may form in a relatively deep (*ca*. 60–100 m), quiet-water setting.

The Ryukyu Island Arc extends from Kyushu to Taiwan, a distance of 1.200 km, along the Ryukyu Trench where the Philippine Sea Plate is subducting beneath the Eurasian Plate. The Okinawa Trough, a back arc basin, formed behind the Ryukyu Island Arc in the Late Pliocene to Early Pleistocene. The formation of the Okinawa Trough is one of the most important factors for initiation and development of coral reefs in the Ryukyus (Iryu et al., 2006). The survey area is an island shelf southwest off Kikai-jima (southern Japan) characterized by continually clear oceanic waters with normal marine salinities. The sea floor is characterized by a flat topography and consists mainly of coarse bioclastic carbonate sediments. The sedimentation rates within the study area are low (Arai et al., 2008). Kikai-jima is a small island that provides minimal sediment to the marine system. Amami-o-shima, located to the northwestward of the studied area is the only large island near Kikai-jima. Sediment derived from this island is likely trapped in submarine channels between the two islands which limits the sediment transportation into the study area (Arai et al., 2008).

The macroids examined in this study were still living when collected because many macroids were covered with living nongeniculate coralline algae and encrusting foraminifera, many of which retained their original colors. Sphericity analysis shows dominance of the sub-spheroidal shape. The sub-spheroidal macroids consist mainly of the encrusting foraminifer *Acervulina inhaerens* in competition with common encrusting and lumpy coralline algae, bryozoans, serpulids and subordinate encrusting smaller foraminifera (*Miniacina*, *Homotrema*). Slabbing the macroids revealed complex internal structures typically consisting of a part of concentrically laminated and superimposed *Acervulina* tests associated with coralline algal thalli.

The outer macroid growth stage shows dominant encrusting foraminifera associated with common to rare warty and rare lumpy coralline thalli. Serpulid worm tubes are well preserved both on the outer macroid surfaces and within the superimposed encrusting sequences made up of the encrusting foraminifera and the bryozoans. The macroids are characterized by extensive boring, sandy-grained infilling, lithification, and local micritization of skeletal framework. Morphological analysis of the bioerosion structures preserved revealed four ichnogenera: *Entobia* Bronn, *Gastrochaenolites* Leymarie, *Trypanites* Mägdefrau and *Maeandropolydora* Voigt. Micro-endolithic traces also occur. All the bioerosion structures correspond to the boring activity of endolithic organisms.

References:

Arai, K., Inoue, T., Matsuda, H., Machiyama, H., Sasaki, K., Iryu, Y., Sugihara, K., Fujita, K. & Nara, M. (2008): Shallow seismic profiling survey on postglacial fore-reef near the present-day northern limit of coral reef formation in the northwestern Pacific. Proc. 11th Int. Coral Reef Symposium, Ft. Lauderdale, Florida, 7–11/07/2008, Session number 2, 49–52.

Iryu, Y., Matsuda, H., Machiyama, H., Piller, W. E., Quinn, T.M. & Mutti, M. (2006): An introductory perspective on the COREF Project. Island Arc, 15, 393–406.

……

Rhodolith beds from the Abrolhos Bank, Brazilian platform: taphonomy, geochemistry, ecology

Davide Bassi[1], Rachel N. Leal[2], Hideko Takayanagi[3], Yasufumi Iryu[3], Renato Posenato[1] & Gilberto M. Amado-Filho[2]

1) Dipartimento di Scienze della Terra, Università di Ferrara, via Saragat 1, 44122 Ferrara, Italy
2) Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rua Pacheco Leão 915, 22460-30 Rio de Janeiro, RJ, Brazil
3) Department of Earth and Planetary Sciences, Graduate School of Environmental Studies, Nagoya University, Nagoya 464-8601, Japan

The Abrolhos Bank, off the southern coast of the Brazil's Bahia state, is considered one of the world's most important reefs because it harbors a high number of marine species found only in Brazil including endemic species of soft corals, mollusks and fishes.

At this place, shallow- and deep-water rhodolith beds represent high biodiversity communities of cemented and boring biota. Here, we report on a case of shallow- and deep-water rhodoliths from rhodolith beds occurring on current-exposed parts of the bank at respectively *ca*. 20 m and *ca*. 60 m water depths. The rhodoliths, mostly spheroidal to rare sub-ellipsoidal in shape, are constituted mainly by encrusting coralline red algae with a massive inner arrangement in competition with *Acervulina inhaerens*, bryozoans, serpulids and subordinate smaller encrusting foraminifera. The outer rhodolith growth stage shows dominant encrusting growth forms. Coralline taxonomic assemblage is characterized by *Hydrolithon rupestris* (Foslie) Penrose, *Lithophyllum stictaeformis* (Areschoug) Hauck, *Lithothamnion superpositum* Foslie and *Mesophyllum engelhartii* (Foslie) Adey.

Taphonomic signatures (such as abrasion, encrustation, bioerosion, fragmentation), geochemical analysis of carbon and oxygen isotope compositions, tomographic analyses and slab surfaces revealed for the first time a suite of characters which provide the genetic history of the studied rhodolith beds. The rhodoliths are inhabited by *Spengleria rostrata* (Spengler) and

Lithophaga nigra (d'Orbigny), two chemical boring bivalves producing the ichnogenus *Gastrochaenolites*. *Entobia*, the work of the sponge *Cliona* (with algal symbionts), the worm boring *Trypanites* and micro-endolithic traces are also present. These boring organisms can remove up to the 10% of the rhodolith volume. All the bioerosion structures correspond to the boring activity of endolithic organisms and, from an ethological point of view, only dwelling structures (domichnia) are present. The ecology of the studied rhodolith beds is discussed.

……

Morphology and environment: skeletal taphonomy of Triassic marine reptiles from Monte San Giorgio, Switzerland

Sue Beardmore[1], Patrick Orr[1] & Heinz Furrer[2]

1) UCD School of Geological Sciences, University College Dublin, Belfield Campus, Dublin 4 (Sue Beardmore e-mail: susan.beardmore@ucdconnect.ie
2) Paläontologisches Institut und Museum der Universität Zürich, Karl Schmid-Strasse 4, CH-8006, Zürich

Taphonomic classifications of fossil vertebrates provide many details of the pathway of a carcass during the death-burial interval, provided observations are made with sufficient detail. Many limitations exist in current classifications, such as the evaluation of the skeleton as a whole, use of a single character, or low number of defined stages relating to the decay process observed. To address the problem, a range of Middle Triassic marine reptiles from the world famous Besano Formation, Monte San Giorgio, Switzerland, were used to develop and test a new method of evaluating taphonomy. The vertebrates are found in marine sediments alternating between black shale and dolomite lithologies, representing normal background sediment and event beds respectively.

The small pachypleurosaurid *Serpianosaurus*, which is most common in the unit, provided the primary dataset. Skeletons were divided into nine anatomical units (the head, neck, dorsal, tail, ribs and four limbs) and scored independently for two characters (articulation and completeness). Values for completeness are consistently greater than articulation for all units, but articulation has a greater range (17-97%) than completeness (25-100%). A bivariate plot for the entire *Serpianosaurus* dataset indicates disarticulation was followed by loss of completeness (Trend 2 of 3) however in the nine units contributing to the overall trend disarticulation and loss of completeness are unbalanced, indicating loss of fidelity is not consistent across a carcass. The plots also indicate loss of fidelity did not take place in the water column: simultaneous disarticulation and loss of completeness is most likely during floating but was not strongly indicated in any unit except for the head. Instead, individuals reached the sediment relatively soon after death, and largely intact, where they decayed during residence phases at the sediment-water interface. Contrasting taphonomies of multiple individuals on the same slab indicate long and varying residence phases. During deposition of the black shales, carcasses progressively decayed becoming more prone to the effects of weak bottom currents; elements were gradually disarticulated and removed. However, the occasional and random deposition of event beds rapidly buried individuals at various stages of decay, preventing further decay and removal of elements. Taphonomic preservation was time dependent, worsening the longer carcasses remained exposed.

A clypeasteroid Konzentrat-Lagerstätte from the Miocene of El Camp de Tarragona Basin (NE Spain)

Zain Belaústegui[1], Jordi M. de Gibert[1] & James H. Nebelsick[2]

1) Departament d'Estratigrafía, Paleontologia i Geociències Marines, Universitat de Barcelona, Martí i Franquès s/n, 08028 Barcelona, Spain
2) Department of Geosciences, University of Tübingen, Sigwartstraße 10, D-72076 Tübingen, Germany

Clypeasteroid beds are a common feature in Cenozoic, particularly Neogene, shallow marine sedimentary rocks, both in tropical and temperate settings, as they are also in analogue Modern environments. Studies concerning the taphonomy of this characteristic group of irregular echinoids have revealed that such an abundance in the fossil record is the consequence of a range of unique features of clypeasteroids that promote their conservation: gregarious mode of life, robustness of their skeleton, high transportability and occupation of the shoreface habitat, which is particularly favorable to their reworking and accumulation (Seilacher, 1979; Nebelsick, 1999; Nebelsick & Kroh, 2002).

This contribution studies one particular clypeasteroid concentration from the middle Miocene of El Camp de Tarragona basin. The sedimentary infill of this extensional basin includes Serravalian shallow-marine facies deposited in a mixed siliciclastic-carbonate platform. The carbonates, typical of deposition in temperate water conditions, are principally constituted by fossils of mollusks, accompanied by common echinoderms, bryozoans and rhodophyte algae. Clypeasteroids from the Miocene of Tarragona have been known since the beginning of the XXth century when several species were described by Lambert (1927). Most of them belong to the genera *Clypeaster* and *Scutella*, although their validity is in need of deep revision.

In any case, clypeasteroids are common as components of coarse-grained skeletal facies and may be locally abundant. Particularly remarkable, it is the *Scutella* concentration level object of this contribution. This sand dollar bed, which is not thicker than 20 cm, bears a maximum lateral observable extension of above 70 m, although it is found in two separate outcrops 650 m apart from each other, what allows us to infer a much larger, hectometric lateral extension. Along with the scutellids, which probably belong to the species *Scutella tarraconensis*, internal and external moulds and shell casts of turritellid gastropods and isolated oyster valves are also common. This *Scutella* bed occurs below a pectinid and barnacle coquina, and overlies a fine-grained, rodophyte biocalcarenite whose top corresponds to a sequence boundary. This surface presents a very irregular topography with grooves and crevices up to 1.5 m deep, which we interpret as related with an episode of subaereal karstification previous to the trangression and the accumulation of the clypeasteroid tests. Scutellid skeletons occur deposited directly upon this irregular surface but also filling the deep and narrow crevices. The concentration bed consists of closely-packed, often stacked, echinoid tests, which are dominantly in vertical and oblique positions, particularly those within depressions. Their number is very high reaching around 150 sp./m^2 in well exposed horizontal surfaces. More than half of them are complete specimens, while the rest are large fragments of several cm. All fossils are denuded, while superficial structures, such as tubercles or ambulacral pores, show in general a good preservation. Nevertheless, almost half of the specimens show different degrees of abrasion, which may expose the system of microcanals of the plate stereom. The degree of encrustation and boring is low with less than fifteen percent of the specimens bearing evidences of skeletozoans. Even those only show a limited presence of small serpulid tubes, a few encrusting laminar bryozoans and isolated worm and bivalve borings.

The low encrustation/bioerosion rate suggests that residence time of these scutellid tests on the seabed was not long, what allows ruling out that this sand dollar accumulation was a long-term, hiatal concentration related with the transgression event. Furthermore, most of them appear complete and relatively well preserved unlike what is to be expected in shoreline accumulations where the individuals would be fragmented by continuous wave activity. Instead, the close-packing, together with the stacked, vertical position of the tests, their variable degree of fragmentation and abrasion, and the lateral persistence suggests that the formation of this *Scutella* bed was probably related with one or several energetic storm episodes in a shallow-water, shoreface environment. This interpretation is consistent with those offered by other authors for similar clypeasteroid beds in different localities (Nebelsick & Kroh, 2002).

Acknowledgments: This abstract is part of the activities of the research project CGL 2010-15047 of the Spanish Science and Innovation Ministry. The authors wish to express their gratitude to Jordi Martinell and Rosa Domènech (University of Barcelona) for showing them the outcrop and for fruitful field discussions.

References:

Lambert, J. (1927): Revision des echinides fósiles de la Catalogne. Memorias del Museo de Ciencias Naturales de Barcelona. Serie Geológica 1(1), 72pp.

Nebelsick, J.H. (1999): Taphonomic comparison between Recent and fossil sand dollars. Palaeogeography, Palaeoclimatology, Palaeoecology, 149, 349–358.

Nebelsick, J.H. & Kroh, A. (2002): The Stormy Path from Life to Death Assemblages: The Formation and Preservation of Mass Accumulations of Fossil Sand Dollars. Palaios, 17, 378-393.

Seilacher, A. (1979): Constructional morphology of sand dollars. Paleobiology, 5, 191-221.

……

Taphonomy of a mysticeti whale with a fracture-healed rib, Miocene Pisco Formation, southern Peru

Emilia R. Belia[1] & Raúl Esperante[2]

1) Facultad de Ciencias Exactas, Naturales y Agrimensura, Universidad Nacional del Nordeste, Corrientes, Argentina
2) Geoscience Research Institute, Loma Linda, California 92350, USA

This study documents and describes a fossil whale (Suborder Mysticeti) specimen with excellent degree of preservation found in the Pisco Formation (Miocene-Pliocene) in southern Peru. The sediment consists of diatomaceous sandstone and siltstone, and lenses of volcanic ash with abundant biotite. The specimen was partially excavated to expose the upper surface of the bones. Part of the tail was not accessible because it extended into the hillside.

The exposed skeleton is a single individual with a skull, two jaws, and two limbs, with only a few limb bones missing, most likely following recent exposure. The skeleton belongs to a single individual. Several elements indicate that the whale is an adult: 1) ribs with flat distal ends; 2) the two elements of the humerus, the articular head and shaft are fused; 3) the vertebral epiphyses are fused to the centra; and 4) the cervical vertebrae are fused.

The post-cervical vertebra are only slightly dislocated from their anatomic position due to rotation and collapse after decay of the soft tissue. Ribs remain close to their life position. Some bones show longitudinal and transversal cracks attributable to the weight of sediment on top. One of the ribs shows a protuberance that corresponds with the callus of the suture of a fracture that occurred at some time during the life of the whale.

Recent studies conducted in carcasses of modern whales indicate that the soft tissue is rapidly removed by macro-scavengers. Subsequently, fat-rich whale bones are colonized by polychaete *Osedax* worms, crabs, microorganisms (bacteria) and other scavengers, causing complete destruction in a very short period of a few weeks to a few years (Smith & Baco, 2003; Esperante, 2005). Heavy bone destruction occurs within a few days after the soft tissue has been removed by scavengers (Esperante, 2005).

In contrast, this Pisco Formation whale fossil shows no evidence of scavenging by macro-invertebrates or vertebrates. Observations of the thin sections of bones (rib and vertebral apophyses) and sediment associated with them also show excellent preservation of bone material. The presence of osteocytes indicates rapid skeletal mineralization and diagenesis. Microborings are observed in some areas of cortical bone indicating colonization by bacteria and/or fungi.

Sedimentologic studies by Esperante (2002) and Carvajal et al. (2000) suggest a shallow marine paleoenvironment in a protected embayment with abundant production and accumulation of diatoms, partially enhanced by diatoms coming from the open sea. Occasional storms occurred within the basin as recorded by hummocky cross-stratified siltstone beds. The presence of volcanic ash throughout and conspicuous tuff layers at various levels in the basin suggest quasi-permanent volcanic activity and periods of greater intensity, respectively.

References:

Carvajal, C., Buchheim, H.P., Poma, O., Chadwick, A. & Brand, L. (2000): Sedimentology and paleoenvironment of whale bearing sediments of the Miocene/Pliocene Pisco Formation, Peru, Annual Meeting. Geological Society of America, Reno, Nevada, A10.

Esperante, R. (2002): Taphonomy of fossil whales in diatomaceous sediments of the Neogene Pisco Formation, Peru. PhD dissertation Thesis, Loma Linda University, United States, 264 pp.

Esperante, R. (2005): How not to become a fossil --Taphonomy of modern whale falls. 2nd International Meeting TAPHOS'05, Barcelona. Universitat de Barcelona, 103-104.

Smith, C.R. & Baco, A.R. (2003): Ecology of whale falls at the deep-sea floor. Oceanography and Marine Biology: An Annual Review, 41: 311-354.

……

Encrustation patterns on Late Cretaceous (Turonian) echinoids from southern Poland on the background of global data

Tomasz Borszcz[1], Piotr Kukliński[1+2] & Michał Zatoń[3]

1) Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, 81-712 Sopot, Poland, e-mail: tomekb@iopan.gda.pl
2) Natural History Museum, Cromwell Road, London SW7 5BD, United Kingdom, e-mail: kuki@iopan.gda.pl
3) University of Silesia, Faculty of Earth Sciences, Będzińska 60, Sosnowiec 41-200, Poland, e-mail: mzaton@wnoz.us.edu.pl

The aim of this study is twofold: 1. provide new data based on a field study and 2. analyze echinoid encrustation patterns through time as based on existing literature. The new field study focuses on sclerobionts from a large collection of echinoids (> 2000 specimens) of the genera *Conulus* and *Camerogalerus*. Samples were collected from five localities in southern Poland (Polish Jura and Miechów Trough), where Turonian carbonates with terrigenous input are exposed. Low intensity (mean ca 5%, maximum ca 10%) and light encrustation exclusively by episkeletozoans are interpreted as the result of interplay between low productivity and brief opening of colonization

windows. Echinoids served as a main substratum and after death they formed a shellground ('echinoid carpet') offering abundant benthic islands for secondary tierers in an otherwise soft bottom environment. The high abundance but low diversity assemblage is represented by three of the six available sessile morphological strategies developed by bivalves, polychaetes, foraminifera, bryozoans, corals and sponges, which suggest environmental homogeneity. Such an assemblage with subtle differences is similar to a nearly contemporaneous assemblage from the Bohemian Basin, which suggests free marine connections. The presence of numerous spirorbids offers insights into their early evolution and may indicate that their first peak in abundance after origination was not prior to the earliest Turonian. This is regarded as one of the important ecological steps towards the rise of the modern sclerobiont communities. Encruster biodiversities are independent of their frequency and, as shown in our new planar projections, lateral parts of tests were preferentially encrusted. This pattern is explained by the combination of largest flat area and stable orientation. Dominating bivalves and serpulids limit the Taylor–Wilson prediction of the composition of the investigated Turonian encrusting communities in the favour of the Lescinsky hypothesis, predicting dominance of such encrusters at that time. Two new descriptive terms, 'micro-alpha' and 'loosening effect' are proposed.

Sampling of the existing literature, including modern and fossil records of echinoid encrustation, shows that echinoid encrustation has increased nearly continuously and dramatically towards the present day, as confirmed by linear regression values of more than 85%. It also demonstrates that recent levels of echinoid fouling have stabilized since the Miocene, while since the Late Cretaceous a more or less continuous record of echinoid encrustation has appeared. Several increases, maximally up to a factor of eight, can be identified since echinoid encrustation first appeared in the Late Carboniferous. This trend is explained as the result of corresponding increases in productivity (richness, biomass, energetic, ecospace utilization) of the marine environment. This conclusion is similar to other documented patterns, such as the number and thickness of shell beds, bioerosion and predation intensity or biodiversity. The projected trajectory is expected to be altered to some degree by various megabiases (e.g. selective reporting, sampling effort, outcrop area, rock volume) in the same way as paleobiodiversity estimations. Two recognized long duration gaps in echinoid encrustation (Late Ordovician – Early Carboniferous, and Permian – Early Cretaceous) are explained partly as bias and partly as biological and taphonomic signals. These gaps are caused mostly by the rapid disarticulation of Palaeozoic-type echinoids, applied methodology, and lack of interest in the encrustation of Jurassic echinoids. Conversely, three short duration gaps in the Cenozoic are interpreted exclusively as a bias. This study adds another component to deciphering the productivity of marine benthic communities through time by investigating large-scale and long-term trends in encrustation, previously poorly studied. It supports quantitatively a step-wise increase of productivity through time.

Acknowledgments: We cordially thank Dr Paul D. Taylor (Natural History Museum, London) for linguistic improvements.

Pushing preservation – what is exceptional?

Derek E. G. Briggs

Dept. of Geology and Geophysics, and Yale Peabody Museum of Natural History, Yale University, New Haven, CT 06511, USA

New research continues to extend the known limits of fossilization and to improve our understanding of preservation processes. Some types of Konservat-Lagerstätten are turning up with remarkable frequency, limited mainly by the distribution of facies and the availability of exposures and exploration time. Various tomographic techniques are yielding unprecedented detail. The extraordinary is preserved in the commonplace – cellular details in fossil leaves and bone. Organic preservation allows structural colours to be restored. And, in spite of diagenesis, traces of decay-prone macromolecules like chitin have now been detected in Palaeozoic fossils. Examples of the new frontiers of preservation will be described and their impact and future potential for palaeontology will be assessed.

Acknowledgements: I thank the Humboldt Foundation (Humboldt-Forschungspreis) for support.

……

Differential preservation of organic-walled microfossils within dolostone, shale, and chert of the Assistência Formation (Irati Subgroup, Permian, Paraná Basin, Brazil)

Cléber Pereira Calça[1] & Thomas Rich Fairchild[2]

1) Curso de Pós-Graduação em Geoquímica e Geotectônica, Instituto de Geociências, Universidade de São Paulo, Rua do Lago 562, São Paulo, SP, Brazil
2) Departamento de Geologia Sedimentar e Ambiental, Instituto de Geociências, Universidade de São Paulo, Rua do Lago 562, São Paulo, SP, Brazil

The Assistência Formation comprises a widespread, well-exposed succession of mostly rhythmic dolostones and shales, with black chert very common throughout the formation. The absence of bioturbation and the abundance of organic matter in these rocks indicate deposition of both the shale and the carbonate under strongly anoxic conditions. Compaction of laminae around chert nodules indicates an early diagenetic origin for much of chert.

Palynological and petrographic investigations have revealed a rich and abundant assemblage of allochthonous, parautochthonous, and autochthonous organic-walled microfossils, including pollen grains, cryptarchs (*i.e.*, unornamented coccoidal unicellular or colonial microfossils), phytoclasts, and delicate cells of cyanobacteria and chlorophycean microalgae. The shale contains a continental palynoflora made up principally of abundant wind-dispersed pollen grains, and not uncommon phytoclasts, together with parautochthonous (phytoplanktonic) cryptarchs. Except for the cryptarchs, these palynomorphs occur as two-dimensional compressions. In the dolostone, the only palynomorphs observed are relatively rare, partly oxidized pollen grains preserved three-dimensionally.

All the types of palynomorphs present in the shale may also be seen in the chert, which also may include very delicate fossil cells representing both planktonic and benthic microorganisms, all of which are preserved three-dimensionally. Benthic microfossils are best seen in the brecciated evaporite bed, in the lower part of the formation, where they comprise massive microbial mats that, in many cases, occupy a significant volume of the sediment. Scarce, dispersed cells in the chert represent planktonic rainout and allochthonous wind-dispersed pollen grains. Of the three lithologies, it is the chert, therefore, that best preserves the original morphology of the microfossils.

Thus, fossilization of the diverse organic components in these three lithologies followed different taphonomic pathways. For example, the anoxic depositional environment of the shale, together with later compaction, favored early bacterial and chemical decomposition and even physical destruction of the less resistant vegetative cells of prokaryotes and unicellular chlorophytes, without, however, obliterating resistant-walled palynomorphs, which nevertheless suffered intense compression. By the same token, in the dolostones, neomorphism, recrystallization, and oxidation destroyed all but the most resistant non-mineralized organic remains (pollen grains). On the other hand, early siliceous permineralization of the sediments not only preserved organic remains at an incipient stage of diagenesis but also impeded significant *further* diagenetic degradation. This was achieved by sorption of negatively charged silica ions to exposed charges on partly degraded organic matter, as hydroxyl or carboxyl bonds, followed by subsequent non-disruptive crystallization of chalcedony (and microquartz) which virtually isolated these organic remains physically and chemically from external agents. Consequently, a wide range of three-dimensional morphological details as well as very delicate fossil cells and benthic micro-assemblages were preserved three-dimensionally with minimal disturbance in the Assistência Formation. This is best seen in the brecciated evaporite bed of this formation in which the hypersaline depositional evidently retarded degradation of the microbial mats (as in modern sabkhas of the Persian Gulf), thereby prolonging the window of opportunity for three-dimensional preservation by siliceous permineralization.

Acknowledgments: Instituto de Geociências, Universidade de São Paulo (IGc-USP), FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo), CAPES (Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior. Jorge Hachiro (IGc-USP) and Paulo Alves de Souza (Universidade Federal de Rio Grande do Sul).

Qualitative and quantitative taphonomy of the Wattendorf Plattenkalk (Upper Kimmeridgian, Southern Germany)

Patrick Chellouche[1], Franz Theodor Fürsich[2] & Matthias Mäuser[3]

1) GeoZentrum Nordbayern, Fachgruppe Paläoumwelt, Erlangen University, Loewenichstrasse 28, D–91054 Erlangen, Germany (patrick.chellouche@gzn.uni-erlangen.de)
2) GeoZentrum Nordbayern, Fachgruppe Paläoumwelt, Erlangen University, Loewenichstrasse 28, D–91054 Erlangen, Germany
3) Naturkundemuseum Bamberg, Fleischstrasse 2, D-96047 Bamberg, Germany

Conservation lagerstätten, such as plattenkalks and laminated limestones, with their characteristically exceptional fossil preservation offer a unique view on ancient communities. Taphonomic studies of these communities are mainly limited to qualitative analyses of fossil assemblages or to particularly famous single specimens such as *Archaeopteryx* or *Juravenator*. This is the more striking, because quantitative taphonomic data can provide us with a new way of understanding the formation of individual conservation lagerstätten and the exceptional preservation of their fauna and flora.

For performing quantitative analyses, hierarchically arranged, comparable taphonomic patterns have to be processed. The Upper Kimmeridgian Wattendorf Plattenkalk, the oldest of the Solnhofen-type plattenkalks of southern Germany, allows such investigations. With an average thickness of 20 cm, every bedding plane along which the laminated rocks split has been equally thoroughly searched for fossils. Moreover, these plattenkalks contain a high number of fossils, many exhibiting the exceptional preservation commonly known from other plattenkalk deposits (Fürsich et al. 2007; Mäuser 2008).

For establishing the basis for a quantitative taphonomic analysis of the Wattendorf lagerstätte, a number of different taphofacies was established by means of euclidean cluster analysis. For this, taphonomic features of the most abundant group of fishes, primarily of the genus *Tharsis*, were recorded, which provide information on the quality of preservation. Percentages of the occurrence of these features per layer were determined and clustered into groups of similar patterns. In the preliminary cluster analysis presented herein, taphonomic features utilized were bending of the spinal column, dissociation of articulated extremities from the trunk, and overall skeletal articulation. Four different taphofacies representing various combinations of these preservational features could be identified.

Taphofacies A consists of only a small number (about 1%) of complete specimens with their heads and caudal fins. Half of the complete specimens are slightly bent. There is a very high amount of separate heads and of all the fish remnants over 90% are articulated.

In taphofacies B, one third of all specimens are complete. Of these, over 90% are slightly bent. The rest of the individuals have a straight spinal column. There is an equal amount (ca. 20%) of separate heads and caudal fins, which corresponds well with specimens lacking their head and/or tail. About 15% of the fishes are disarticulated. In taphofacies C, more than 50% of the fish specimens are complete with heads and caudal fins. Three thirds of these are strongly bent. The amount of separate caudal fins matches well with individuals missing their tails, but there are five times more separate heads than headless fish. Three thirds of the specimens are articulated. Taphofacies D is represented by only a small number of complete specimens. A relatively high amount of individuals has a broken spinal column (more than 50% of measurable specimens). Although the amount of separate caudal fins and tailless fishes correspond well, there are 10 times more separate heads than specimens lacking their head. Nearly 90% of the specimens in this

taphofacies are disarticulated, 54% of these strongly. In future analyses it will have to be investigated, whether these taphofacies can also be reproduced by the taphonomic analysis of other taxonomic groups.

With regard to qualitative taphonomy, the Wattendorf Plattenkalk has yielded two distinct modes of soft tissue preservation as of now. In some fish fossils, phosphatisation of connective tissues can be observed. Besides this phosphatic permineralisation, there is also evidence for primary preservation of soft tissues through pyritisation. These tissues eventually have been hydratised to goethite, similar to the preservation of soft tissues exhibited by some fossils from the early Cretaceous Crato Formation of Brazil (Fielding et al. 2005).

References:

Fielding, S., Martill, D.M. & Naish, D. (2005): Solnhofen-style soft-tissue preservation in a new species of turtle from the Crato Formation (Early Cretaceous, Aptian) of north -east Brazil. Palaeontology, 48 (6), 1301-1310.

Fürsich, F.T., Werner, W., Schneider, S. & Mäuser, M. (2007): Sedimentology, taphonomy and palaeoecology of a laminated plattenkalk from the Kimmeridgian of the northern Franconian Alb (southern Germany). Palaeogeography, Palaeoclimatology, Palaeoecology, 243, 92 -117.

Mäuser, M. (2008): Frankenland am Jurastrand: Versteinerte Schätze aus der Wattendorfer Lagune. Verlag Dr. Friedrich Pfeil, München, 19pp.

……

Experiments on wind dispersal of rodent bones

Lucas Cheme Arriaga, Claudia I. Montalvo & Ramón A. Sosa

Facultad de Ciencias Exactas y Naturales, UNLPam, Uruguay 151, 6300 Santa Rosa, La Pampa, Argentina. lucas_cheme_arriaga@yahoo.com.ar, cmontalvo@exactas.unlpam.edu.ar

Across the plain environment of the Pampean region (central Argentina), several archaeological and paleontological sites are rich in micromammals remains, especially rodents. From a palaeontological and zooarchaeological point of view, it is interesting to understand the processes and agents that may have intervened in the formation of these accumulations. Natural disaggregation of pellets produced by raptor birds and scats of carnivores has been recognized as an important mechanism for the accumulation of small mammal bones in archaeological and palaeontological assemblages. In the plain environment, pellets and scats produced by predators are located in areas associated with nests, dens, latrinas and hollows. Considering that the taphonomic history of pellets and scats consists of multiple phases, each with particular biases and features, it was postulated that several factors may affect bones after their disintegration. In plain environments, the wind can move the bones and create new clustering patterns. In this work, we evaluated the effects of the wind through experiments in a wind tunnel, evaluating the dispersion of bones of small Cricetidae Sigmodontinae rodents, recovered from pellets of barn owl (*Tyto alba*).

Experiments consisted of mobilizing different types of bones on two different substrates, plain and barely rough, with three wind speeds (2.70, 3.70 and 4.70 m/s). In these experiences, both groups of 10 bones of the same type (e.g. femora) and groups formed by different types of bones were mobilized. With the results obtained in these experiments, the different bones were categorized into 4 groups according to their transport susceptibility. These include elements that moved faster than others (group 1: vertebrae, skulls, scapulae) and those who moved more slowly

(group 4: maxillae, incisors, mandibles). Group 2 (metapodials, astragalus, molars, calcaneus) and group 3 (humeri, femora, radii, ulnas, tibias, pelvis) include elements of intermediate mobility, likely linked to the type of substrate. Statistical analysis was performed (test of Kruskal-Wallis nonparametric variance, H value, and comparison in pairs between the mean ranks of the treatments), which helped to confirm the validity of the proposed groups.

The results were compared with experimental data of small mammal bones transported in water flows (Dodson, 1973; Korth, 1979). These comparisons showed that mandibles are the last to be mobilized, both in water and wind, while vertebrae and scapulae are dispersed very fast. The other bones show different susceptibility according to the transport agent. In general, long bones and metapodials tend to behave similarly under both types of transport.

The greatest differences were observed on skulls, mandibles and pelvis. The skulls were quickly moved by wind, but mandibles and pelvis were displaced much more slowly than in water flow experiments. These differences are probably related both to intrinsic properties of each bone, linked to taxonomic issues, and its morphology, favoring or delaying its movement.

Preliminary results suggest that wind is able to scatter small bones, generating a clustered pattern with maxillae, mandibles and incisors, concentrated near the primary area of deposition. In summary, if other factors such as water action are ruled out, the analysis of wind as transport agent of small bones provides additional information that explains the presence or deficit of anatomical elements in archaeological or paleontological sites, located in plain environments.

Acknowledgements: This work was founded by the Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa. We wish to thank Y. Fernandez Jalvo, R. Melchor, M. Zarate and R. Cheme Arriaga for their comments.

References:

Dodson, P. (1973): The significance of small bones in paleoecological interpretation. Contributions to Geology, University of Wyoming, 12, 15-19.

Korth, W.W. (1979): Taphonomy of microvertebrate fossil assemblages. Annals of Carnegie Museum, 48, 235-285.

……

Actualistic investigation of bone modification by carnivores and birds of prey on small mammals: An insight to the taphonomy of mesomammals from Cooper's Cave, Cradle of Humankind

Brigette Cohen & Job M. Kibii

Institute for Human Evolution, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa

The involvement of carnivores and birds of prey in bone accumulation in archaeological and palaeontological fossil assemblages has often been inferred through diagnostic bone modification. The bulk of actualistic and field work investigation, has concentrated on assessing the nature of bone modifications by large carnivores on large bodied mammals, much to the neglect of small mammals. This study seeks to investigate the nature of bone modification of mesomammal carcasses by captive large carnivores and by hitherto undocumented smaller carnivores (caracal, civet and honey badger) and birds of prey (vulture and eagle). Rabbit carcasses will be fed to captive carnivores and birds of prey to identify attributes of bone modification that can be extrapolated as probable expected carcass modification of other mesomammals by similar

predators. Results of the study will comprise a template that can be employed in determining taphonomic agents and processes involved in the accumulation of mesomammals in fossil assemblages, such as the large mesomammal assemblage of Cooper's D in the Cradle of Humankind.

……

Role of taphonomic features in paleoecological interpretation of Eocene carbonates from the Paleogene Adriatic carbonate platform (PgAdCP)

Vlasta Ćosović[1], Katica Drobne[2] & Haris Ibrahmpašić[3]

1) Department of Geology, Faculty of Science, University of Zagreb, Horvatovac 102a, Zagreb, Croatia; e-mail vcosovic@geol.pmf.hr
2) Paleontological institute Ivan Rakovec, ZRC SAZU, Novi trg 2, 1000 Ljubljana, Slovenia; katica@zrc-sazu.si
3) Ina- Naftaplin, Šubičeva 29, 10000 Zagreb, Croatia, e-mail Haris.Ibrahimpasic@ina.hr

The Paleogene (Early Ypresian, SBZ 11 to Bartonian, SBZ 17) carbonates originated on the Adriatic carbonate platform are dominated by various larger foraminiferal facies with subordinate coralline red algae facies. Foraminiferal tests (studied from standard thin-sections) show evidences of mechanical, biological or chemical breakdown with intensity that varies between foraminiferal groups and depositional settings along the shelf gradient (from proximal restricted/lagoonal to outer ramp settings). Effects observed include breakage, cutting of test edges (poles), removal of surface layering, chamber-space infillings, borings, encrustation, corrosion, pitting and their occurrences vary from sporadic to very common across the groups.

Breakages ranging from damage to the terminal chamber/whorl to disintegration into sand- and fine-size fragments are recorded within larger benthic foraminiferal tests in alveolinid-, nummulitid- and orthophragminid-dominated facies. Partially broken tests are most common in alveolinids. The co-occurrence of wide size range of clasts and unequal preservation of alveolinid tests attest to high- to moderate-energy settings, with possible post-mortem reworking (bombardment with sand-sized grains including more persistent nummulitid tests) within a short distance transport. Bioerosion traces in alveolinids are present in forms that were post-mortem transported over a greater distance and settled down in lower energy environments (mid to outer ramp).

The mid-outer ramp environments characterize a predominance of rotaliid foraminifera over miliolids. Nummulites tests show a number of mechanical damages (cutting of tests edges, exfoliation of the youngest whorls, broken tests) as result of post-mortem seaward transportation and/or predation. Coralline red algae are significant biotic constituent in Nummulitic packtones to wackestones, and multi-layer algal encrustation stands out as the most common feature. The post-depositional alternations consist of filling the pore spaces by micrite mud or by sparite, of redistribution of the tests by transport and/or by bioturbation.

The upper-most part of the Eocene shallow-water carbonate succession is represented by Orthophragminae-bearing limestones (ranging in age from the Lutetian to Bartonian). They are mainly composed of orthophragminid and nummulitid tests spread in mud matrix, the former with abundant traces of bioerosion. A statistical analysis of affected specimens reveals that 10% of them are with boring marks. These non–randomly distributed traces point out to the predators or parasites responsible for leaving them, because drilling attacks are size selective and a position of

traces within the test suggesting that they were made to gain access to the inside of the host. The occurrence of traces was controlled by environmental parameters such as low sedimentation rate, mesotrophication, lower photic zones and low energy, parameters that characterize outer ramp settings. As subordinate features, glauconitic infillings are recorded in some chambers spaces, as well as mechanical damages of tests (accompanied with the extensive micritic envelope), altogether suggesting the possible post-mortem transport of from shallower part of ramp towards the upper slope.

……

Early diagenesis of ungulate crania in temperate environments: experimentation protocol

Cláudia Costa[1], Nelson Almeida[2], Hugo Gomes[3], Sara Cura[4] & Pedro Cura[5]

1) Uniarq-University of Algarve (ccordeirocosta@gmail.com)
2) Group Quaternary and Prehistory – Geosciences Centre (uID 73-FCT), Earth and Memory Institute (nelsonjalmeida@gmail.com)
3) Group Quaternary and Prehistory – Geosciences Centre (uID 73-FCT), Earth and Memory Institute (hugo.hugomes@gmail.com)
4) Museum of Prehistoric Rock Art of Mação, Group Quaternary and Prehistory – Geosciences Centre (uID 73-FCT) (saracura@portugalmail.pt)
5) Museum of Prehistoric Rock Art of Mação, Earth and Memory Institute, (pedro-cura@hotmail.com)

In recent years, early diagenesis in animal bones from temperate environments has become an important research focus (Andrews, 1995, Fernández-Jalvo et al, 2010, Magnell, 2010, Nielsen-Marsh et al, 2007, among others). Besides the intrinsic characteristics of the elements buried (e.g. bone mineral density), these studies have demonstrated that other aspects including the environmental conditions, soil chemistry, water content and sediment porosity, microbes and fungi influence the rates of decomposition of organic and mineral components of bone. It is an extraordinary complex phenomenon where many variables converge. As a consequence, it is necessary to reproduce experiments in controlled environments and, most of all, create a *corpus* of information that allows comparisons between these studies.

Following the experimental butchering of ungulate carcasses with experimental quartzite tools, the crania of six animals have been buried with the purpose of monitoring the early diagenetic alterations in the temperate climate of northern Ribatejo, central Portugal.

In this poster, we present the experimental protocol implemented. This protocol stresses the importance of controlling the environmental conditions, the identification of the surrounding vegetation and an accurate description of sediments using grain size and pH analysis, climate conditions (air temperature and relative humidity, precipitation levels) during the time of burial.

We buried six ungulate crania with soft tissue in sandy and calcareous environments, about 20 cm deep. Here we report the results obtained through the macroscopic analysis of the first specimen (CrOvcp1) after 619 days, along with the climate monitoring data, sediment description and vegetation.

References:

Andrews, P. (1995): Experiments in taphonomy. Journal of Archaeological Science, 22, 147–153.

Fernández-Jalvo, Y., Andrews, P., Pesquero, D., Smith, C., Marín-Monfort, D., Sánchez, B., Geigl, E. & Alonso, A. (2010): Early bone diagenesis in temperate environments. Part I: surface features and histology. Palaeogeography, Palaeoclimatology, Palaeoecology, 288, 62-81.

Magnell, O. (2010): Weathering and diagenetic changes of wild boar bones in five different environmental settings. oral presentation presented to New perspectives on taphonomy session, no 11th International Conference of Archaeozoology, ICAZ 2010, Paris 23-28 Agosto.

Nielsen-Marsh, C.M., Smith, C.I., Jans, M.M.E., Nord, A., Kars, H. & Collins, M.J. (2007): Bone diagenesis in the European Holocene II: taphonomic and environmental considerations. Journal of Archaeological Science, 34, pp. 1523-1531.

……

Spatial variations of taphonomic biases and environmental control on the preservation potential of bivalve diversity in Touho Lagoon (Northeast of New Caledonia)

Gaëlle Doitteau[1], Philippe Bouchet[2], Pierre Lozouet[2], Anne Ribaud-Laurenti[1] & Loïc Villier[1]

1) EA 4229, Géologie des Systèmes et des Réservoirs Carbonatés, University of Provence, Marseille, France
2) Muséum National d'Histoire Naturelle, B.I.M.M., Paris, France

There are more and more evidences of an influence of the local environmental conditions and the sedimentary parameters on taphonomic biases, with the consequence of an uneven preservation of diversity properties into the fossil record. The comparison between dead shell assemblages and living communities is a fruitful approach for quantifying the effects of taphonomic perturbations, and we explore the effects of substrate, hydrodynamics, and water depth on the preservation of diversity properties in the dead shell assemblages of bivalves.

The data derive from the collections of the expedition "Montrousier 1993" in the lagoon of Touho (Northeast of New Caledonia). The extensive sampling strategy allowed exploration of a wide range of ecosystems (from mangrove to reef flat, beach, pass, estuary, mudflat, outer shelf) and accumulation of abundant material (more than 83 000 shells of bivalves).

The environmental conditions of every station are described with 13 qualitative variables that consider:

- the nature of the substrate (mud, fine, mixed and coarse sand, hard substrate, coral)
- the hydrodynamics (very high, high, low)
- the water depth and sea floor topography (intertidal, reef flat, slope, and deep outer shelf)
- the input of fresh water at estuaries
- the occurrences of sea grass beds

Each shell is identified at the species level and the material collected dead or alive separated. The diversity of bivalves and its preservation in the dead assemblages are described at local scale by several complimentary indices: species richness, sample-size standardized diversity, rarefaction curve, PIE index of evenness, and the fidelity indices of Kidwell & Bosence (1991).

The preservation of diversity is highly variable among sampling stations. For example, the percentage of living species found dead in the same station (live-dead indices) ranges from 18% to 100% and the percentage of dead species found alive (dead-live indices) from 8% to 70%. The high fluctuation of diversity preservation appears strongly linked to environmental conditions. Live-dead indices in hard substrates are rather low compared to mixed and soft substrates. On average, preservation of living species in dead shell assemblages is higher in deeper environments than

shallow environments while the percentage of dead species found alive in biological communities is higher in shallow environments. The hydrodynamics and salinity are important parameters to explain the variability of preservation in dead shell assemblages. Communities typical of mangrove or other stations with influence of fresh waters are poorly preserved. Environments of mangrove are more unstable chemically, which favour early dissolution, especially of aragonitic shells. In the reef and the lagoon, the sheltered environments where sediment accumulate, are likely to mix material from various micro-environments with a limited fidelity of dead shell assemblages to living communities. Deep environments tend to receive allochthonous elements and the diversity of dead shell assemblages are likely enriched by shell transported from inshore.

References:

Kidwell, S.M. & Bosence, D.W.J. (1991): Taphonomy and time-averaging of marine shelly faunas. In: P.A. Allison & D.E.G. Briggs (eds.): Taphonomy: releasing the data locked in the fossil record, pp.116-209. New York: Plenum Press.

……

Mortality patterns in the carnivoran-dominated Miocene assemblage of Batallones-1 (Madrid Basin, Spain)

M. Soledad Domingo[1+2], M. Teresa Alberdi[2], Beatriz Azanza[3] & Jorge Morales[2]

1) Museum of Paleontology, University of Michigan, Ann Arbor, MI 48109, USA
2) Departamento de Paleobiología, Museo Nacional de Ciencias Naturales-CSIC, 28006, Madrid, Spain
3) Departamento de Ciencias de la Tierra, Facultad Ciencias, Universidad de Zaragoza, 50009, Zaragoza, Spain

Age-frequency distributions, or mortality profiles, of the species recovered in a fossil site have long been recognized as a powerful tool that provides valuable information about the individuals' pre- or postdepositional history (e.g. Kurtén, 1958; Kahlke & Gaudzinski, 2005). This type of analysis is particularly useful when trying to unveil the concentration mode of uncommon assemblages such as the one studied in this work.

Batallones-1 was the first of the localities discovered in the paleontological area of Cerro de los Batallones (Batallones Butte, Madrid Basin, Spain) and is composed of two assemblages (lower level assemblage, LLA, and upper level assemblage, ULA) that were deposited in a cavity of pseudokarstic origin. Fossil remains mainly belong to mammalian taxa and yield a Late Vallesian age (local zone J, MN10, ca. 9 Ma; early Late Miocene). In this study, we will focus on the LLA which shows an overwhelming prevalence of mammalian carnivore remains. The age profiles of the four more common taxa (the two sabertooth cats *Promegantereon ogygia* and *Machairodus aphanistus*, the hyaenid *Protictitherium crassum* and the amphicyonid *Magericyon anceps*) were estimated based on the wear stage of the teeth placed in the mandible and maxilla.

None of the four determined mortality profiles adapt to any of the two classic age distribution models, i.e., attritional and catastrophic. The two sabertooth cats and the hyaenid exhibit an age structure dominated by the prime adults while the amphicyonid shows a mortality profile dominated by the juveniles. The predominance of strong individuals (prime adults) allows discarding a scenario where the most vulnerable animals (young and old) died or were killed. Besides, a mass death and an accidental death (fall into the cave) must also be rejected since, in these contexts, all the age stages should be present.

The weakness or strength of individuals does not only depend on their age but also on their physical condition. Two variables have been quantified as a measure of the physical condition of the individuals from the LLA of Batallones-1: the presence of osteopathologies and the amount of broken canines. The results suggest that there is a prevalence of adults in the assemblage that do not show signals of weakness at least evident in the fossil remains.

The predominance of healthy prime adults leads us to propose a scenario where these individuals incorporated deliberately into a cavity searching for food or water being subsequently unable to make their way out.

Acknowledgments: This study was financially supported by the Spanish Government Ministry of Science and Innovation research projects CGL2008-05813-C02-01/BTE, CGL2007-60790/BTE and CGL2010-19116/BOS and is included in the CAM-UCM 910607 Research Group. MSD benefits from a postdoctoral contract from the Fundación Española para la Ciencia y la Tecnología (FECYT) and the Spanish Ministry of Education.

References:

Kahlke, R.-D. & Gaudzinski, S. (2005): The blessing of a great flood: differentiation of mortality patterns in the large mammal record of the Lower Pleistocene fluvial site of Untermassfeld (Germany) and its relevance for the interpretation of faunal assemblages from archaeological sites. Journal of Archaeological Science, 32, 1202-1222.

Kurtén, B. (1958): Life and death of the Pleistocene cave bear. Acta Zoologica Fennica, 95, 1-59.

……

Shallow marine faunas in the European Cenozoic fossil record

Stefano Dominici[1], Martin Zuschin[2] & Didier Merle[3]

1) Museum of Natural History (Department of Geology and Paleontology), University of Florence, Via La Pira 4, 50121 Firenze, Italy
2) University of Vienna, Department of Palaeontology, Geocenter, Althanstrasse 14., A-1090 Vienna, Austria
3)), UMR 5143, Rue Buffon 8, 75005 Paris, France

We explore abundance data of mollusk families (140 families, 116 samples) along two mid-latitude, intertidal to open shelf marine gradients. The two time intervals are the early-middle Eocene, the warmest interval of the Cenozoic (greenhouse climate), and the Pliocene, approximating the coldest interval, which culminated in the Pleistocene (icehouse climate). Our aim was to explore global marine biotic patterns possibly interconnecting molluscs with other clades.

Despite strong climatic change, the main tracts of trophic distribution on the shelf are rather stable, with intertidal herbivores giving way with depth to shallow subtidal suspension feeders, which in turn decrease to the advantage of deeper subtidal detritus feeders and carnivores, possibly reflecting constancy in the bathymetric distribution of food resources. Littoral environments are characterized by a short trophic web dominated by primary consumers and where carnivores are subordinate. At the other end of the gradient, the open shelf is characterized by a longer web comprising predatory and browsing carnivores, omnivores, deposit- and detritus-feeders. During the time span separating the Eocene from the Pliocene, gastropods experience a stronger change in assemblage composition than bivalves, measured by a deeper change within the herbivore and carnivore guilds (most gastropods) with respect to the suspension and deposit-feeders (most bivalves). Potamidid, ampullinid, batillariid and other littoral and very shallow

subtidal gastropods, ecologically connected to the macrophytes, decrease in abundance and diversity, in favor of smaller hydrobiid, cerithiid and rissoid and other smaller gastropods largely feeding on diatoms. The abundance of these gastropods is consistent with a change in the relative importance of the respective plants, such as mangroves (favoured at greenhouse) and diatoms (favoured at icehouse), measured by both abundance and diversity. The icehouse subitdal biota is characterized by a larger proportion of opportunistic suspension feeders such as turritellids and corbulids, which are better adapted to increased seasonality of food resources.

The long-term change of molluscan assemblages - a proxy for marine benthos in general - on the European shelf is intimately connected to a climate-driven, inversely related shift in diversity of mangroves and diatoms. The regional pattern is consistent with a global, biotically-mediated turnover in benthic composition and diversity in the wake of shrinking tropical belts during the Cenozoic.

……

Distinction of depositional environments based on the taphonomy of microscopic echinoderm remains in tropical shallow water carbonates, San Salvador, Bahamas

Janina F. Dynowski

State Museum of Natural History Stuttgart, Rosenstein 1, D-70191 Stuttgart, Germany
Department of Geosciences, University of Tübingen, Hölderlinstraße 12, D-72074 Tübingen, Germany

The presented study investigates the potential of microscopic remains of all five living echinoderm classes (echinoids, ophiuroids, asteroids, crinoids and holothuroids) in differentiating depositional environments based on the analyses of taphonomic features. At Fernandez Bay, San Salvador Island, Bahamas, five environments were differentiated mainly according to water depth and substrate structure: 1) intertidal beach rock near the shore, 2) subtidal bedrock overgrown by an algal turf, 3) subtidal Sargassum meadow, 4), subtidal mid shelf patch reef, and 5) subtidal clear sand flat without vegetation. From every environment three samples were collected, dry sieved and from the fractions of 125-250µ, 250-500µ and 500-1000µ, at least 50 echinoderm remains were picked and analysed using light microscopy. Each remain was identified to class level and classified into three taphonomic grades for fragmentation, encrustation, bioerosion and abrasion; color preservation was recorded by presence/absence values. The resulting distributional and taphonomic data were analysed using exploratory data analyses.

Echinoid remains comprise the majority of found elements, followed by ophiuroid ossicles. All other echinoderm classes are rare. While the biologically induced taphonomic processes, encrustation and bioerosion, are almost absent in the analysed size fractions of all environments, the physical processes of fragmentation and abrasion have a considerable impact that varies among the environments. Based on the results of statistical analyses a differentiation of three depositional environments is possible: 1) a high energy shore zone with a high percentage of echinoid remains, high fragmentation and high abrasion values, 2) an environment with high fragmentation, but low abrasion values, resulting from algal vegetation, which prevents sediment particle movement, and 3) an environment in comparatively quieter, deeper water settings characterized by a higher percentage of ophiuroid remains and intermediate values for both fragmentation and abrasion. These results show that the taphonomic signature of microscopic echinoderm remains, primarily echinoid and ophiuroid ossicles, provides information about small scale variations in depositional environments and supports the importance of such analyses to gain additional information for the reconstruction of palaeoenvironments.

Taphonomic study of an echinoid mass occurrence in lower Jurassic black shales

Janina F. Dynowski[1+2], Ben Thuy[3] & James H. Nebelsick[2]

1) State Museum of Natural History Stuttgart, Rosenstein 1, D-70191 Stuttgart, Germany
2) Department of Geosciences, University of Tübingen, Sigwartstraße 10, D-72076 Tübingen, Germany
3) Department of Geobiology, University of Göttingen, Goldschmidtstraße 3, D-37077 Göttingen, Germany

Mass accumulations of echinoids are well known from various localities in recent and fossil marine settings. Such occurrences may reflect mass mortalities of dense living populations, or aggregations of living or dead specimens due to strong currents, e.g. caused by storm events. The assessment of sedimentologic and taphonomic features enables the reconstruction of the origin and development of these deposits. The presented study investigates an unusual fossil echinoid mass occurrence at the early to late Sinemurian boundary (lower Jurassic), found in the informally called “alpha black shales”. This unit is renowned for its numerous small regular echinoids and is of special interest because it mainly consists of bituminous black shales indicating poor living conditions (formation under anaerobic conditions).

Field investigations were carried out at a road cut near Dußlingen, South West Germany. Here, a stratigraphic section of about 4 m could be analysed, consisting of an alternation of marly limestones and shale beds. Some of the black shale beds are finely laminated and bituminous, but only one, about 10 cm thick, contains the small echinoids. The excavation of the bed covered an area of about 18 m^2; a representative sediment slab comprising the entire succession of echinoid yielding black shale was removed for detailed study. Based on the small test size rarely exceeding more than 1 cm in diameter, the crenulation and perforation of primary tubercles and the relatively narrow ambulacra these echinoids are tentatively assigned to the genus *Eodiadema*. While the echinoids generally lack apical disc, lantern and spines, the test plates in most cases are preserved articulated. The delicate spines are often found in direct vicinity to the tests, sometimes surrounding them in a radial pattern. In addition, several shale slabs were found with parts of the Aristotle’s lantern (pyramids and/or teeth) inside the tests. Some horizons, however, show only disarticulated plates or mainly spines, which seem to have a preferential orientation potentially reflecting the palaeocurrent direction. The entire echinoid bearing bed shows no evidence of bioturbation, while in the under- and overlying shales trace fossils like *Rhizocorallium* and *Chondrites* are frequently observed.

The fine lamination of the sediment and the preservation state of the echinoids indicate varying, but generally low current energy and sedimentation rate during deposition of the shale beds. Other faunal elements are rare and mainly consist of various bivalves (*Oxytoma* sp., *Entolium* sp., *Gervillella* sp., *Monotis* sp., *Plagiostoma* sp.), ammonites (index ammonite *Microderoceras birchi*, *Arnioceras* sp.), ammonite shells encrusted by serpulids, different ichnofossils, belemnites (*Nannobelus cf. acutus*) and actinopterygian remains (scales and teeth). It is interesting to notice that all faunal components are of small size. Further analyses of taphonomical, palaeoecological as well as geochemical and micropalaeontological aspects of the deposit will help in understanding the formation processes of this deposit.

Molluscan shell damage across a nutrient gradient, SW Africa, Benguela upwelling system

Yael Edelman-Furstenberg

Geological Survey of Israel, 30 Malchei Yisrael St., Jerusalem, 95501, Israel

The Benguela system is one of the world's four major eastern boundary current systems. Off the coast of Namibia (southwest Africa) an intensive wind-induced coastal upwelling persists. The continental shelf is characterized by sediments rich in silica, organic matter and phosphate. The low-oxygen conditions that characterize these systems bring the assumption that they hold very low benthic invertebrate abundances and diversity. Macrofaunal invertebrate assemblages across the full breadth of the upwelling facies were examined for the first time, and were used to infer highly variable seafloor conditions.

Contrary to stereotypes, benthic community structure is highly variable across the upwelling tract and discrete taphofacies could be recognized. Taphofacies 1 (opal-organic rich) has a very low damage profile with high frequency of shell articulation and rare edge modification. Taphofacies 2 (carbonate-rich) is characterized by an intermediate taphonomic profile, while taphofacies 3 (phosphate-rich) has the highest damage profile, having relatively elevated numbers of rounded, fragmented and bored shells and very little associated sedimentary matrix. Thus, with increasing distance from the upwelling cells there is an increase in both predators and micro-boring animal abundance, which fosters post-mortem shell destruction.

The new ecologic and taphonomic evidence supports the existence of a wider range of time averaging in the formation of molluscan sand and gravel samples in the northern Benguela than previously appreciated; these assemblages are not exclusively relictual but reflect a spectrum of types, from within-habitat time-averaging of communities presently occupying the shelf (specifically in areas directly under or marginal to active upwelling cells today – facies 1, 2), to various mixtures of shells from present-day and relictual (locally extinct) benthic communities (in phosphate-rich seafloors, which are offset from active cells – facies 3). Thus by combining the biological evidence with the taphonomic signatures or states of shell damage along with sedimentological evidence for substrate hardening, a proxy for the degree of "relictualness" and an indication for which post-mortem agents controlled the environment is attained.

Both the taphofacies and ecologic data provide ways to distinguish between facies of low and high shell production along an increasing oxygen gradient, and also between assemblages with moderate and higher species richnesses associated with a temporal aspect of increasing time-averaging. Differences in seafloor oxygen concentration along with variable food availability played major roles in structuring the death assemblages under the Benguela system.

Given the scarcity of information on macrobenthic ecology and taphonomy from modern high-productivity settings, these death assemblages can represent a "modern" analog and serve as a proxy for ancient upwelling environments.

Taphonomy of gorgonian and antipatharian cold-water corals in Atlantic Canada: experimental decay rates and field observations

Evan N. Edinger[1+2] & Owen A. Sherwood[3+4]

1) Geography Department and Biology Department, Memorial University, St, John's, Newfoundland, Canada
2) EA 4234 Géologie des Systèmes et Réservoirs Carbonatés, Université de Provence, Marseille, France
3) Biology Department and Earth Sciences Department, Memorial University, St, John's, Newfoundland, Canada
4) Ocean Sciences Department, University of California, Santa Cruz, CA, USA

Taphonomy in bathyal environments is relatively understudied, particularly in the hard-substrate-dominated environments occupied by most types of cold-water corals. Cold-water coral taphonomy is relevant to conservation, because broken or dead corals on the sea floor are often used as evidence of fisheries impacts, but skeletal breakdown might alter or destroy this evidence. We performed aquarium experiments on five species of gorgonian and antipatharian corals with different skeletal compositions and structures, to assess decay rates and estimate the longevity of dead skeletons exposed on the sea floor. Experimental taxa included the gorgonians *Primnoa resedaeformis*, *Keratoisis ornata*, *Paragorgia arborea* and *Paramuricea* spp. and the antipatharian *Stauropathes arctica*, all of which can live for more than 70 years, and most more than 100 (Sherwood & Edinger 2009). All specimens were gathered from fisheries bycatch. *Primnoa* and *Keratoisis* have skeletons composed of both protein and calcite in concentric growth rings, while *Paragorgia* has a spongy skeleton of calcite spicules, and *Paramuricea* has a fibrous organic skeleton. *Stauropathes* has a purely organic skeleton. Pre-weighed frozen pieces of corals were deployed in aquaria in filtered seawater at ambient temperature, either buried 1 cm deep in muddy sand, or elevated above the aquarium floor, with five replicates per treatment. The aquaria were kept in darkness to avoid algal borers, and slowly flushed using chilled filtered surface seawater, with temperatures ranging from +9° to -1°C. A control treatment was cut, weighed, and returned to the freezer. Qualitative experiments on tissue degradation using segments of skeleton with attached tissue included observations both above and below the sediment-water interface.

Dominant taphonomic processes affecting the samples were degradation of the organic components of the skeletons, probably by bacteria, and microscopic dissolution of the carbonate components, including fungal microboring. Skeletons of *Primnoa*, *Keratoisis* and *Stauropathes* experienced no significant weight change during the experiment. The fibrous gorgonin skeleton of *Paramuricea* experienced weight gain due to hydration of the skeleton, as did the antipathin skeletons of *Stauropathes*, to a lesser extent. By contrast, the spongy skeletons of *Paragorgia* experienced 60% weight loss in the first 3 months of the experiment, and were completely degraded by 1 year. Buried *Paragorgia* skeletons experienced faster weight loss than the exposed specimens, while buried *Paramuricea* and *Stauropathes* experienced slower weight gain than exposed specimens.

The rapid disintegration of *Paragorgia* skeletons matched field observations, in which dislodged, partially or completely dead skeletons of *Paragorgia* were extremely friable and usually broke apart during collection attempts. By contrast, dead skeletons of *Primnoa* and *Keratoisis* found in several areas off Nova Scotia and Newfoundland included both recently dead skeletons and specimens radiocarbon dated to > 1000 y BP in age. Dead specimens of *Keratoisis* observed in the field often displayed chalky surface alteration.

Experimentally deployed skeletons of *Primnoa* and *Keratoisis* displayed chalky alteration within 7 months of deployment, with buried specimens exhibiting a greater degree of pitting than

exposed specimens. Organic layers in the buried *Primnoa* samples suffered greater degradation in the buried samples than in the exposed samples. Gorgonin rings of dead *Primnoa* found in the field were frequently degraded, giving the skeletons a cavernous appearance. *Stauropathes* skeletons endured all treatments with very little alteration, preserving spines and other skeletal features well, as observed in bycatch specimens.

Estimated longevity of dead coral skeletons on the seafloor ranges from <1 year for *Paragorgia* to <10 yrs for *Paramuricea*, <20 yrs *Stauropathes*, to > 1000 yrs for *Keratoisis* and *Primnoa*. To detect fisheries impacts on organic-skeletoned deep-sea gorgonians, observations need to be made within months of the damage, while corals are dislodged and dying, but before extensive skeletal decay begins. Alternatively, the high durability of calcitic gorgonian skeletons on the sea floor may lead to time-averaging of the dead assemblage, which complicates the interpretation of dead skeletons for fisheries impacts.

References:

Sherwood, O. & Edinger, E. (2009): Growth rates and lifespans of some deep-sea gorgonian and antipatharian corals of Newfoundland and Labrador. Canadian Journal of Fisheries and Aquatic Sciences, 66, 142-152.

……

Unusual Skeletal Arrangement of a Mysticeti Fossil Whale in the Pisco Formation, Peru

Raúl Esperante[1], Fernando Muñiz[2] & Orlando Poma[3]

1) Geoscience Research Institute, Loma Linda, California 92350, USA
2) Área de Educación y Cultura, Ayuntamiento de Lepe, Huelva, 21440, Spain
3) Universidad Peruana Unión, Ñaña, Lima, Perú

Fossil cetaceans are very common in the Miocene-Pliocene Pisco Formation in southern Peru. Studies by Esperante et al. (2002) show that they are very well preserved, often fully articulated and occasionally with baleen preserved in anatomical position.

The peculiarity of the specimen reported here is the unique arrangement of the fossilized skeleton. The skeleton occurs within a single layer of diatomaceous mudstone and belongs to an adult individual. Most bones are in anatomical position, including dentaries, vertebrae, ribs and the left limb. The right limb is probably buried. Some vertebrae are partially displaced due to collapse after decay of soft tissue. The two dentaries lie dorsal-side up, but the skull is displaced from its anatomical position and lies flat, ventral-side up at a 90^0 angle next to the neurocranium. The two premaxillaries are detached from their anatomical position and lay aside, one sticking out from under the skull at a 45° angle, and the other one tangential to the rib cage and parallel to the vertebral column. Both the displacement of the skull leaving the dentaries intact in their anatomical position, and the detachment of the premaxillaries leaving the rest of the skull intact are unique features so far never reported in the literature.

The awkward position of the skull suggests that it first lay down dorsal-side up (hence the position of the dentaries) and was later lifted, flipped over and lay down in its current position by either water currents or macro-scavengers (sharks). No shark-tooth marks were observed, although they could occur in the buried side of the skull. The two premaxillaries must have been detached from the skull before the latter finally rested ventral-side up.

The overall high degree of articulation and preservation indicates that the skeleton was rapidly buried soon after decay of soft tissue and before any macro-scavengers could destroy the bones. This is supported by the exceptional occurrence of a set of articulated baleen plates under

the left dentary and the neurocranium. Preservation of baleen is highly unlikely because is not made of bony material but keratine, and tends to detach from the maxillary soon after death (Esperante et al., 2008). The skeleton does not show any bioerosion as seen in modern whale skeletons by Esperante (2005) and Smith & Baco (2003), and in fossils by Esperante et al. (2009), Muñiz et al. (2010), and Kiel et al. (2010).

References:

Esperante, R. (2005): How not to become a fossil --Taphonomy of modern whale falls. 2nd International Meeting TAPHOS'05, Barcelona. Universitat de Barcelona, 103-104 pp.

Esperante, R., Muñiz Guinea, F. & Nick, K.E. (2009): Taphonomy of a Mysticeti whale in the Lower Pliocene Huelva Sands Formation (Southern Spain). Geologica Acta, 7, 489-505.

Esperante, R., Brand, L.R., Chadwick, A. & Poma, O. (2002): Taphonomy of fossil whales in the diatomaceous sediments of the Miocene/Pliocene Pisco Formation, Peru. In: M. De Renzi et al. (Editors), Current Topics on Taphonomy. Ayuntamiento de Valencia, Valencia, 337-343.

Esperante, R., Brand, L.R., Nick, K.E., Poma, O. & Urbina, M. (2008): Exceptional occurrence of fossil baleen in shallow marine sediments of the Neogene Pisco Formation, Southern Peru. Palaeogeography, Palaeoclimatology, Palaeoecology, 257, 344-360.

Kiel, S., Goedert, J.L., Kahl, W.-A. & Rouse, G.W. (2010): Fossil traces of the bone-eating worm *Osedax* in early Oligocene whale bones. PNAS Proceedings of the National Academy of Science, 107, 8656-8659.

Smith, C.R. & Baco, A.R. (2003): Ecology of whale falls at the deep-sea floor. Oceanography and Marine Biology: An Annual Review, 41, 311-354.

……

Back to a famous palaeontological site: facies and biodiversity of the rich mollusc assemblages from Grignon (middle Eocene, France)

Emmanuel Fara[1], Benjamin Pierrat[1], Didier Merle[2],
Emmanuelle Vennin[1] & Pascal Neige[1]

1) Biogéosciences, UMR CNRS/uB 5561, Université de Bourgogne, 6 bd Gabriel, F-21000 Dijon, France
2) Département Histoire de la Terre, UMR 5143 & USM 203, Muséum National d'Histoire Naturelle, 8 rue Buffon, F-75005 Paris, France

What are the relations between observed diversity and corresponding facies for highly diversified marine assemblages, especially in storm-generated beds? We explore that issue by investigating a Middle Eocene locality that is both a historical landmark in geology and probably the richest palaeontological spot in the Paris Basin: the Grignon site (middle Lutetien, France). In the main stratigraphic units that have been made accessible recently, we identify six facies that correspond to the following depositional environments (i) mid platform, clastic dominated; (ii) mid to inner platform, proximal storm-dominated deposits; and (iii) inner platform, mud dominated.

Using systematic and replicate sampling, we make a quantitative analysis of Grignon's exceptionally well-preserved benthic molluscan assemblages (nearly 6000 specimens representing 120 genera of bivalves and gastropods). The two main fossiliferous units differ significantly in richness, evenness, and core taxa, but these differences partly vanish in storm beds. Interestingly, samples from storm levels tend to have lower richness and evenness than those from equivalent background beds. This contrasts with several Palaeozoic assemblages that show a reverse situation, and it indicates a strong link between compositional fidelity and faciological features.

Taphonomic evidence and autecological data suggest that spatial averaging is negligible and that single- and amalgamated storm events did not introduce allochtonous taxa. Both the ecology and hydrodynamic properties of autochthonous taxa seem to be the main factor responsible for their local concentration in storm levels. We are currently investigating the impact of storm events

on the representation of the various ecological guilds in the observed assemblages. The role of bioturbation is clear but its extent and consequences are difficult to quantify. As a whole, it seems that the exceptionally rich mollusk assemblages from Grignon are structured by a general shallowing of their environments and, to a lesser extent, by the sporadic interferences generated by storms events and bioturbations.

……

Digestion vs. soil corrosion in a lower Pleistocene small mammal assemblage

Yolanda Fernández-Jalvo[1], Paloma Sevilla[2] & Amalia I. Cuadros-Casado[2]

1) Departamento de Paleobiología. Museo Nacional de Ciencias Naturales (CSIC)
2) Departamento de Paleontología. Facultad de Geología. UCM and CSIC

Identifying digestion effects on fossil bones and teeth of small mammals preserved in karstic infillings may prove to be a difficult task when these elements have also been subject to subsequent soil corrosion. Here we present the example of the taphonomic alterations observed in the small vertebrate fossils from the Early Pleistocene of Quibas (Murcia, Spain), which showed important soil corrosion that hampered identification of processes previous to burial. The assemblage is made up mainly of small mammal teeth and bones (77,6%), which show a high degree of breakage, an important part of which must have taken place during and after burial, as indicated by the type of fractures observed in the fossils. Lack of sorting and abrasion, and, in general, traits observed on this fossil assemblage excludes transport as responsible for breakage. Most bones presented manganese deposits; calcareous coating was also common in the material. Practically all of the material showed as well surface corrosion and root marks. All these features indicated the assemblage, once buried, had undergone important alterations caused by soil interaction. Observations leading to the identification of processes previous to burial were thus hindered, particularly concerning the possibility of identifying corrosion caused by digestion.

Nevertheless, differences in corrosion patterns enabled further characterisation of the assemblage. A superficial type of corrosion extending extensively and homogeneously on the surface of the bones was linked to the action of humic acids, whereas deeper and more located corrosion was referred to digestion. In spite of superimposed postdepositional soil corrosion that masked previous signs of digestion, rodent incisors provided final evidence of predation processes allowing us to identify the predator that produced the original assemblage. Some of these fossils presented a particular pattern of corrosion in which the enamel was intensely corroded on the occlusal surface and only moderately corroded on the rest of the surface. The part of the incisor included within the maxilla or mandible is unaffected by digestion by this predator since it is protected by bone, but the whole of its surface is subject to soil corrosion in the sediment if it loses free form the bone during burial. Hence the differences observed in the degree of corrosion of the enamel of rodent incisors in the assemblage provides traits and criteria to distinguish the effects produced by predators on small mammals bones during ingestion and digestion, from effects of soil corrosion and root marks.

Thus, in spite of the difficulties in the identification of alterations previous to burial in the small mammal assemblage of Quibas, strongly modified by soil interaction, predator involvement in the origin of the assemblage could be recognised thanks to the corrosion pattern observed in rodent incisors.

Acknowledgements: Financial support for this research was obtained from projects: CGL2009-7896/BTE, 11891/PHCS/09, UCM-BSCH GR58/08-910607.

……

Encrustation Patterns on an Upper Jurassic, Plate Shaped Sponge from the Plettenberg Quarry, Dotternhausen (SW Germany)

Jan-Peter Friedrich[1+2] & James H. Nebelsick[1]

1) Department of Geosciences, University of Tübingen, Sigwartstraße 10, D-72076 Tübingen, Germany
2) State Museum of Natural History Stuttgart, Rosenstein 1, D-70191 Stuttgart, Germany

Sponges from the Late Jurassic in southern Germany are well known for their extraordinarily good preservation. The siliceous skeleton of these sponges was mostly dissolved and replaced by calcite whereas the soft parts of the sponge are preserved as grayish or brownish micritic calcite. When embedded in limestone, they are always darker than the surrounding matrix. In sections, internal structures are often apparent, such as ostia, canals, and chambers. Following the Middle Jurassic, sponge bioherms start to construct large reef bodies. The sedimentological conditions and the environmental requirements of the hexactinellid sponges that inhabited these reefs, allow inferring that the water was deeper and less turbulent than that surrounding the co-occurring coral reefs.

The sponges themselves show very specific patterns with regard to various encrusting organisms and calcareous crusts. The calcareous crusts, if present, are mostly restricted to the in vivo upper side of the sponges, while a wide range of solitary and colonial filter feeding encrusters are limited to lower surfaces. The encrusters are dominated by various serpulid polychaets (*Serpula*), brachiopods (*Crania*, Thecidea), and bryozoans (*Berenicea*). Cryptic encrusting communities are well known form the late Jurassic. These encrusters are dependent on the limited available hard grounds that serve as colonizable substrate. In wide areas of Swabia in the Late Jurassic, sponges are the only available substrate.

The main focus of this study deals with the distribution patterns of encrusters on the lower surface of a large (approximately 1m diameter) plate-shaped sponge from the Late Oxfordian of the Plettenberg Quarry, Dotternhausen (SW-Germany). The investigation deals with varying encrustation patterns shown by the encrusters, including: 1) distribution of varying taxa, 2) area of substrate covered, 3) orientation of encrusters and 4) possible species interactions. While brachiopods and bryozoans show similar distribution patterns, with an orientation in a specific direction, the serpulids show a clear zonation from the center of the sponge to the outer margin. The observed encrustation patterns suggest an encrusting sequence initiated during the decay of the sponge, beginning very early with serpulids, followed by bryozoans, and concluding with brachiopods. Additionally, the orientation, size distribution, and the composition of the encrusting community allow conclusions in regards to water current and direction, the original encrustation coverage of the sponge, and the time interval in which the encrustation took place.

Evaluating Postdepositional Processes in the Level O of the Abric Romaní Archaeological Site

Maria Joana Gabucio, Isabel Cáceres & Jordi Rosell

IPHES (Institut Català de Paleoecologia Humana i Evolució Social), Unidad asociada al CSIC, Àrea de Prehistòria, Universitat Rovira i Virgili. Plaça Imperial Tarraco, 1. 43005 Tarragona,

Archaeological sites are the result of multiple taphonomic processes caused by multiple agents. For this, before drawing any behavioral or environmental inferences from archaeological record, researchers must identify the site formation processes (Schiffer, 1983). This requires at a complete taphonomic study. Here, we want to illustrate this concept examining the case of Abric Romaní's level O, dated around 55 ky.

The Abric Romaní site (Capellades, Barcelona, Spain) is a rock shelter located at the northeast side of the "Cinglera del Capelló" cliff, carved out by a tectonic fault and the Anoia River. The stratigraphy is composed of 20 m of well-stratified travertine sediments. The archaeological levels appear as thin layers interbedded between the travertine platforms. This sequence has been dated by U-series at between 40 and 70 ky BP (Bischoff et al., 1988).

Like other levels previously studied (Cáceres, 2002), in level O the origin of the macrofauna accumulations and the main part of taphonomic modifications are due to human activity. Proof of these are, among others, the fracture pattern, the location of cut marks and the large amount of burned bones - related to the high number of combustion structures identified in level O (Vallverdú et al., In press).

However, after human occupations, natural taphonomic processes occur, taking part in the formation of preserved associations. There is few evidence of carnivore, rodent and microorganism activity, but non biological agents are more present. Water abrasion is one of the most outstanding mechanisms of taphonomic alteration, which has modified bones rounding and polishing them. Root etching is also abundant, probably because the mosses have a key role in forming sedimentary platforms at Abric Romaní.

To know the implications of these alterations, we have clarified their degree and location. We then sequenced these modifications taking into account the overlap between them. In addition, field data (three-dimensional location, orientations, etc.) has been used to observe the spatial distribution of fossils with different modifications and to check for preferential orientations. All this has led us to assess the possibility that the fossils had been displaced, for instance by undergoing reorientation or removal. This issue is particularly interesting because water flows can potentially move items accumulated over the substrate (re-sedimentation) or even dig up and move buried items (re-elaboration) (Fernández López, 2000; Fernández-Jalvo & Andrews, 2003). Understanding the role of such processes in the formation of level O represents an important step, especially if we consider that both the macrofauna and the spatial distribution can provide valuable information about Neanderthal behavior inside the rock shelter.

References:

Bischoff, J.L., Julià, R. & Mora, R. (1988): Uranium-series dating of the Musterian Occupation at Abric Romaní, Spain. Nature, 332: 68-70.

Cáceres, I. (2002): Tafonomía de Yacimientos Antrópicos en Karst. Complejo Galería (Atapuerca, Burgos), Vanguard Cave (Gibraltar) y Abric Romaní (Capellades, Barcelona). Universitat Rovira i Virgili. Tarragona. Tesis Doctoral: 661 p.

Fernández López, S. (2000): Temas de Tafonomía. Departamento de Paleontología, Universidad Complutense de Madrid, 167 p. http://www.ucm.es/info/paleo/taphos/index.htm

Fernández-Jalvo, Y. & Andrews, P. (2003): Experimental Effects of Water Abrasion on Bone Fragments. Journal of Taphonomy, 1: 147-163.
Schiffer, M.B. (1983): Toward the identification of formation processes. American Antiquity,. 84(4): 675-706.
Vallverdú, J., Alonso, S., Bargalló, A., Bartrolí, R., Campeny, G., Carrancho, A., Expósito, I., Fontanals, M., Gabucio, M.J., Gómez de Soler, B., Prats, J.M., Sañudo, P., Solé-Raventós, A., Vilalta, J. & Carbonell, E. In Press. Combustion structures of archaeological level O and mousterian activity areas with use of fire at the Abric Romaní rockshelter (NE Iberian Peninsula). Quaternary International.

……

Deciphering taphonomic processes in the Eocene Green River Formation of Wyoming

Jo Hellawell[1+] & Patrick J. Orr[2]

1) Department of Geology, Trinity College, University of Dublin, Dublin 2, Ireland
2) UCD School of Geological Sciences, University College Dublin, Belfield, Dublin 4, Ireland
[†]Present address: Steinmann Institut, Universität Bonn, Poppelsdorfer Schloss, 53115 Bonn, Germany
email: jo.hellawell@uni-bonn.de

The Green River Formation, Wyoming, contains such an abundance of well-preserved flora and fauna that this late Early Eocene lagerstätte is one of the best known from North America. Despite having being studied since the mid-19th century, little is known about the taphonomic processes that resulted in a diverse suite of organisms, especially abundant fossil fish, being preserved in exquisite detail. Frequent well-preserved delicate coprolites serve to further emphasise the unusual nature of the depositional environment. Critically, recent studies indicate that sedimentation rates were low, thus ruling out models that envisage rapid burial as key to excellent preservation. In Fossil Lake the fish are found in mass mortality beds throughout an entire 6m succession of palaeolake sediments, with some horizons reportedly containing as many as 500 fish per square metre. The largely monospecific fossil fish assemblages are preserved in micritic carbonates comprising organic-rich and carbonate-rich fine laminations, interspersed with frequent thin volcanic ash layers; bioturbation or other soft sediment disturbance is absent. The micrites split easily along the sub-millimetre thick laminations, the surfaces of which are, even at low (x5) magnification, not flat lying and parallel, but gently undulating and asymmetrical. In vertical section, the dark organic-rich layers frequently interconnect and anastomose and can be interpreted as having originated as microbial mats on the lake floor, as first postulated by Buchheim & Surdam (1977) for neighbouring Lake Gosiute.

To decipher the processes of fossilisation and, in particular, constrain the timing involved in the preservation of Fossil Lake fish, specimens of extant *Carassius auratus auratus* Linnaeus, 1758 were decayed experimentally. Various scenarios approximating conditions in the Eocene lake were replicated in the laboratory and each then monitored to record the rate of degradation and to assess how the different starting conditions impacted on the taphonomy of the fish. Notably, varying temperature, salinity or oxygen level did not induce any discernable differences in the pattern of decay. Importantly, decay rates were found to vary even in replicate samples. Extant fish had to be weighted at the outset of the experiments to inhibit floating, an observation clearly inconsistent with the dominance of complete and fully articulated skeletons among Green River fish. Although the fish then remained on the sediment surface, in a large number of cases the gas

bladder escaped from the fish in the early stages of the experiment and floated, without causing any obvious disruption to the remainder of the carcass.

During the six-month duration of these experiments, degradation of the carcasses was extensive. The soft tissues decomposed rapidly and extensively and, even in the absence of any disturbance, the resultant skeletal disarticulation far exceeded anything observed in the vast majority of fossil fish from the Green River Formation. The experiments indicate clearly that decay in a quiet-water environment is, on its own, insufficient to explain the consistently high fidelity preservation of Green River fish: some additional factor is therefore implicated. Here we propose that the microbial mats were key, enabling fish carcasses to adhere to the sediment surface. Such mats may have actually enveloped the decaying fish, initiating and sustaining a distinct microenvironment around each. Modern microbial mats can grow over entire corpses within hours or at most days, creating a strongly reducing environment within and inhibiting decay of the fish, thus leading to excellent preservation (Barthel *et al.* 1990). In support of this model we present for the first time evidence of localised pyrite framboids around the fossilised Green River fish, which are not found elsewhere in the sedimentary matrix (i.e. they did not form in the water column). Strongly reducing conditions therefore existed immediately around the carcasses, supporting the idea of an enclosed system and reducing microenvironment having been created by microbial mats.

References:

Barthel, K.W., Swinburne, N.H.M. & Conway Morris, S. (1990): Solnhofen: A study in Mesozoic palaeontology. Cambridge University Press, Cambridge, UK. 236pp.

Buchheim, H.P. & Surdam, R.C. (1977): Fossil catfish and the depositional environment of the Green River Formation, Wyoming. Geology, 5, 196 - 198.

……

Fossil shark teeth from the Upper Paleolithic/Gravettian Pavlov I site (Moravia, Czech Republic) and their taphonomic evidence

Šárka Hladilová[1] & Radek Mikuláš[2]

1) Institute of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno, Czech Republic, sarka@sci.muni.cz
2) Institute of Geology, v.v.i., Academy of Sciences of the Czech Republic, Rozvojová 269, 165 02 Praha 6, Czech Republic, mikulas@gli.cas.cz

Fossil shark teeth are occasionally found at the Gravettian site Pavlov I (South Moravia, Czech Republic). Two specimens remarkable from the taphonomic point of view were studied (Hladilová & Mikuláš 2004, 2005). Both teeth are of Miocene (probably Badenian) ages, and the marine Miocene sediments of the Carpathian Foredeep or Vienna Basin outcropping in a relatively close proximity of Pavlov were interpreted as their potential source areas.

The first specimen is represented by a tooth (height 4.64 cm, maximum width 3.70 cm) of the species *Carcharocles megalodon* (Agassiz, 1843). A considerable part of its root is broken off (sharp fracture edges). The second specimen is represented by an *Isurus desori* (Sismonda, 1849) tooth (height 3.43 cm, maximum width 1.67 cm). Its root is also partly broken off (rounded fracture edges). It is disputable whether the teeth were already incomplete when found by the Pavlovians, or whether the breakages were caused by their own activities.

On the first tooth´s surface, the traces of human treatments are evident, namely the asymmetrical blunting of the serrated cutting-edge, indicating that this fossil has been used by the Gravettians probably as a cutting tool. Though usually more dull and brittle than fresh ones, the fossil shark teeth are naturally highly convenient for such a use (Kozuch 1993). The cutting-edge of the second tooth is generally continuous and shows no evident blunting.

Besides, even intriguing bioerosion or corrasion traces (sensu Briggs & Crowther, 1992 or Brett & Baird, 1986) were found on the enamel surfaces of the teeth. They resulted probably from the action of roots of higher plants on the teeth (analogous traces on fossil shark teeth were found at the locality Starkoč from the Bohemian Cretaceous Basin – Mikuláš & Žítt 1999). These traces were probably formed after the teeth re-burial in sediments directly at the Pavlov I locality, evidently not before the abandonment of this Gravettian site.

Acknowledgements: The study was supported by the Research Project MSM0021622427 and Z 3013 0516.

References:

Brett, C.E. & Baird, G.C. (1986): Comparative taphonomy: a key to paleoenvironmental interpretation based on fossil preservation. Palaios, 1, 207-227.

Briggs, D.E.G. & Crowther, P.R. (1992): Palaeobiology. A Synthesis. Blackwell Scientific Publications, 223-226.

Hladilová, Š., Mikuláš, R. (2004): Fossil shark tooth with the traces of human activity and bioerosion from the locality of Pavlov (Gravettian). In: Hašek V., Nekuda R., Ruttkay M. (eds.). In: Service to Archeology V., 155-158. Brno. (In Czech, English summary.)

Hladilová, Š & Mikuláš, R. (2005): III.9 – Fossil shark tooth. A remarkable working tool from the Pavlov locality. – In: Svoboda J., ed. Pavlov I Southeast. A Window Into the Gravettian Lifestyles. The Dolní Věstonice Studies, 14, 391-395. Brno.

Kozuch, L. (1993): Sharks and Shark Products in Prehistoric South Florida. Institute of Archaeology and Paleoenvironmental Studies. University of Florida, Gainesville, Monograph 2, 52 pp.

Mikuláš, R. & Žítt, J. (1999): The fossil corrosive root traces on rock surfaces and bioclasts (Bohemian Cretaceous Basin, Czech Republic). Bulletin of the Czech Geological Survey, 74, 3, 51-53. Praha.

……

Miocene gastropod shells with epibionts – taphonomic and paleoecological interpretations (two case studies)

Šárka Hladilová

Department of Biology, Faculty of Education, Palacky University, Purkrabská 2, CZ-77140 Olomouc, Czech Republic, sarka.hladilova@upol.cz

At the locality Rudoltice v Čechách (Lower Badenian, Eastern Bohemia, Czech Republic), four specimens of the oyster *Ostrea digitalina* DUBOIS about one year old were found attached to gastropod shells, namely two specimens to the shells of *Pirenella moravica* cf. *variabilis* (FRIEDBERG), one to the shell of *Pirenella moravica variabilis* (FRIEDBERG), and one to the shell of *Pirenella picta* cf. *melanopsiformis* (AUINGER). In 3 cases the oysters´ attachment probably took place either within the lifetime of the gastropods or in the time when their empty shells were approximately in the same position as during the lifetime. In the fourth case the oyster veliger probably settled on the shell after the death of the gastropod, and, in addition, the oyster shell during its growth overlapped shells of sessile worms of the species *Glomerula semisurrecta* (BIVALV), attached earlier to the gastropod shell. The oysters´ attachments and growths were

attended by the development of characteristic sculptures on those parts of their valves that were in immediate contact with the bottom (Hladilová & Pek, 1998).

From the locality of Buituri (Badenian, Transylvanian Basin, Romania), one shell of the gastropod species *Cerithium crenatum* BROCCHI with abundant epifauna was studied (Hladilová et al., 2004). In total, 15 specimens of epibionts of different individual ages (months – years) were ascertained: 9 oysters - 2 *Ostrea digitalina* DUBOIS, 7 *Ostrea* sp., 4 bryozoans - 2 *Schizoporella tetragona* (REUSS), 1 *Schizomavella* cf. *tenella* (REUSS), 1 *Lagenipora*? sp., and 2 sessile worms - 1 *Pomatostegus* cf. *comatus* (ROVERETO), 1 *Pomatoceros* sp. From the total amount of epibionts as well as from the places and types of their attachments it can be concluded that the gastropod shell probably persisted for a long-term (3 years minimally) on the surface of the sea bottom without being buried in its sediments, and that it was utilized as a solid substrate for the settlement of the sessile benthos larvae. The processes of the epifaunal attachments to the gastropod shell - at least partly – did not take place until the gastropod´s death, when its shell was empty, because some specimens of epifauna are attached straight in the mouth of the gastropod shell, namely in the places where the attachment was impossible during the gastropod´s life. The found epibionts represent several settlement phases constituting minimally two colonization sequences immediately connected with the instantaneous gastropod shell positions (the „living" one and the overturned one); the chronological succession of individual attachment phases within the sequences cannot be described and interpreted unambiguously due to the scarcity of evident interactions among the individual epibionts.

Generally, the attachment of epibionts to the gastropod shells confirms the local lack of hard substrate; thus, the sessile benthos was forced to utilize for its attachment any solid objects rising above the bottom.

Acknowledgements: This study was supported by the Grant Project 205/09/0103 (Grant Agency of the Czech Republic).

References:

Hladilová, Š. & Pek, I. (1998): Oysters attached to gastropod shells from Rudoltice, eastern Bohemia (Miocene, Lower Badenian). Bulletin of the Czech Geological Survey, 73, 137-142.

Hladilová, Š., Zágoršek, K., & Ziegler, V. (2004): A Middle Miocene gastropod shell with epifauna from the locality Buituri (Transylvanian Basin, Romania). Fragmenta Palaeontologica Hungarica, 22, 99-105.

……

Taphonomic evaluation of *Spondylus* artifacts from Neolithic (Linear Pottery Culture) graves at Vedrovice (Moravia, Czech Republic)

Šárka Hladilová

Institute of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno, Czech Republic, sarka@sci.muni.cz

Numerous (122 in total) decorative objects made of Recent *Spondylus gaederopus* LINNAEUS shells have been ascertained in the Linear Pottery Culture graves at Vedrovice near Moravský Krumlov (Moravia, Czech Republic – Podborský, 2002; Podborský et al., 2002; Hladilová, 2001; Hladilová in print).

On the majority of *Spondylus* artifacts from Vedrovice, there are often numerous traces of primary natural injuries (especially those caused by the activity of boring organisms, chiefly by boring sponges). They originated in the marine environment before the *Spondylus* shells were

fished out as raw material for decorative objects. The primary injuries generally worsened the mechanical properties of the *Spondylus* shells; nevertheless, the decorative function of the artifacts themselves evidently was not affected adversely.

Occasionally, traces of secondary natural injuries (namely corrosion) are observable. They originated till after the burial of the artifacts due to various chemical processes in the overlying sediments (probably even chemical substances originating during the decay of the buried bodies played some role in these changes).

Practically all the *Spondylus* artifacts from Vedrovice manifest distinct features of human manufacture (removal of the surface layer, cutting, drilling, polishing, etc.), sometimes even with traces of hanging (grooves). During artifact production the original morphology of the *Spondylus* shells was almost fully destroyed, with only some traces occasionally left on the artifact surfaces (contour lines, relics of resilium or tooth sockets, muscle scars, some relics of original colour, etc.). The chance for preservation of natural morphological elements is generally proportional to the original (un)completeness of the given valve used for artifact manufacture. A relatively high portion of the original morphology can remain preserved on the "medallions" manufactured of almost complete *Spondylus* valves. By contrast, among pendants, bracelets etc. made of segments only of *Spondylus* valves, it is preserved less frequently, and among beads, the original morphological elements were usually completely destroyed; occasionally, only the typical inner valve structures or traces of primary or secondary injuries are observable.

The taphonomic analysis of *Spondylus* artifacts from Vedrovice represented a helpful tool both for the comparison of *Spondylus* artifacts ages with the age of the archaeological site itself, and for the differentiation among the original morphological elements of *Spondylus* valves, their natural (= primary, secondary) injuries, and the traces of human activities (artifact manufacture and usage).

Acknowledgements: This study was supported by the project MSM0021622427 (Czech Republic).

References:

Hladilová, Š. (2001): Results of Palaeontological Study of Neolithic Decorations from Vedrovice (Culture with Linear Pottery. In: Hašek V., Nekuda R., Unger J. (eds.): Ve službách archeologie III., 89-91. MVS Brno, AÚ AV SR Nitra. Brno. (In Czech, English summary.)

Hladilová, Š. (in print): Paleobiological Study of *Spondylus* Jewelry found in Neolithic (LPC) Graves at the Locality Vedrovice (Moravia, Czech Republic). In: Ifantidis F., Nikolaidou M. (eds.), *Spondylus* in Prehistory. New Data and Approaches. Contributions to the Archaeology of Shell Technologies. BAR International Series (in print) 183-192. Oxford.

Podborský, V. (2002): *Spondylus* decoration from Linear Pottery culture graves in Vedrovice. Archeol. Rozhledy, LIV, 223-240. Praha. (In Czech, English summary.)

Podborský, V. et al. (2002): Zwei Gräberfelder des neolithischen Volkes mit Linearbandkeramik in Vedrovice in Mähren. Ústav archeologie a muzeologie Filozofické fakulty Masarykovy univerzity, 344 pp. Brno. (In Czech, German summary.)

Assessing the qualitative preservation of collagen in bones after short interment periods: Comparison of different hydrolysis methods preceding amino acid analysis

Nadja Hoke[1], Andrea Grigat[1], Gisela Grupe[1+2] & Michaela Harbeck[2]

1) Department Biology I, Anthropology and Biodiversity, Ludwig-Maximilians-University Munich, Großhaderner Straße 2, 82152 Martinsried, Germany
2) State Collection for Anthropology and Palaeoanatomy, Karolinenplatz 2a, 80333 Munich, Germany

Shortly after death, all body tissues, including bone and its components, inevitably undergo taphonomic changes that consequently lead to total dissolution of the dead body sooner or later. Depending on multiple factors, such as burial context, temperature, soil pH, water balance etc., decomposition is either favoured, causing faster alteration and loss of tissue, or delayed, resulting in a better preservation. Despite the fact that many authors emphasize the crucial role of the first years *postmortem* in setting the course for long-term preservation or decay, little systematic research has been conducted in this field, and many questions still remain unanswered.

The aim of this study was to trace the initial bone collagen breakdown from the first years of interment up to later burial periods in order to investigate the mechanism of mineralized peptide degradation under varying soil conditions and the influence of inhumation time. Assessing the integrity of bone collagen is essential for various archaeometric analyses, focusing on radiocarbon dating and stable isotope analysis to reconstruct dietary patterns of past populations.

HPLC amino acid analysis is a useful tool for tracing compositional alterations of bone collagen on the amino acid level. However, hydrolytic sample preparation is a sensitive issue, especially for archaeological protein extract which might most likely show alteration in its structure and amino acid composition compared to fresh collagen. Hydrolysis temperature, duration and the agent used severely influence the results of amino acid analysis.

We analyzed a set of long bones from two different cemeteries with burial times ranging from 8 to 60 and 90 to 150 years and hydrolyzed the extracted collagen under oxidative and anoxic conditions with 6 N HCl as well as with 4 M methanesulfonic acid.

Comparative amino acid analysis (HPLC) revealed that hydrolysis with methanesulfonic acid is more useful for monitoring the selective loss of certain amino acids, which is important to trace the onset of potential diagenetic effects. HCl hydrolysis affects too many residues during hydrolysis and thus creates methodological artifacts that mask natural degradation processes.

A terrestrial *Konzentratlagerstätte* from the Late Jurassic Qigu Formation, Xinjiang Autonomous Region, China

Walter G. Joyce[1] & Oliver Wings[2]

1) Department of Geosciences, Universität Tübingen, Hölderlinstraße 12, 72074 Tübingen, Germany, e-mail: walter.joyce@uni-tuebingen.de; and Yale Peabody Museum of Natural History, 170 Whitney Avenue, New Haven, CT 06511, USA
2) Museum für Naturkunde Berlin, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin, Invalidenstraße 43, 10115 Berlin, Germany, e-mail: oliver.wings@web.de; and Department of Geosciences, Universität Tübingen, Hölderlinstraße 12, 72074 Tübingen, Germany

We introduce a spectacular new terrestrial *Konzentratlagerstätte* from the Late Jurassic Qigu Formation of the Turpan Basin of Xinjiang Autonomous Province, China. The new locality represents a mass accumulation of basal eucryptodiran turtles preliminarily identified as the freshwater aquatic xinjiangchelyid taxon *Annemys* sp. The fossiliferous horizon of the *Konzentratlagerstätte* can be conceptualized as consisting of two internested zones. The inner zone is approximately 10 m in diameter and is surrounded by a more expansive, oval shaped outer zone of at least 10 m by 30 m. In the inner zone, the fossiliferous layer is thickened, shows evidence of mixing with sediments from below, and fully articulated turtle skeletons are packed at a density of up to 36 turtles per square meter. In the outer zone, the fossiliferous layer is even and yields approximately 5 fully disarticulated turtles per square meter. Based on these numbers, we estimate that 4000 turtles must have been buried at this locality. Based on the available sedimentological evidence, we conclude that the turtles accumulated in a contracting lake during a drought and perished when the lake dried up completely. This taphonomic conclusion is consistent with previous environmental reconstructions of the Turpan Basin during the Late Jurassic in predicting a monsoonal, subtropical climate interspersed with severe, episodic droughts.

……

Taphonomic differences between the South African porcupine (*Hystrix africaeaustralis*) and the North African porcupine (*H. cristata*)

Job M. Kibii

Institute for Human Evolution, University of the Witwatersrand, Private Bag 3, Wits 2050, South Africa

Whereas the characteristic feature of a porcupine lair is the presence of numerous gnawed objects, the nature, volume, and the rate at which the objects are accumulated is dependent on the availability of the objects on the ground but not on the amount already present in the lair. In the open grasslands of South Africa, dry and slightly weathered bones comprise the majority of items that the South African porcupine (*Hystrix africaeaustralis*) transports and accumulates. In the bone deficient highland tea-growing regions of Kenya, the North African porcupine (*H. cristata*) has resulted to moving and accumulating discarded plastics in dens. The assemblages accumulated by the two porcupine species retain the typical porcupine gnaw marks. It seems that irrespective of geographical region, porcupines will collect any hard objects that they can gnaw to hone their continuously growing incisors.

Acknowledgements: The author would like to thank the Institute for Human Evolution and the University of the Witwatersrand for support and facilities.

Microelement composition and structure of mammal fossil bones and teeth by LA-ICP-MS and Raman spectroscopy

Daria Kiseleva[1], Sergey Votyakov[1], Natalia Adamovich[1],
Nikolay Smirnov[2] & Nina Sadykova[2]

1) Institute of Geology and Geochemistry, Urals Branch of RAS, Pochtovy per., 7, 620151, Ekaterinburg, Russia
2) Institute of Animal and Plant Ecology, Urals Branch of RAS, 8-e Marta str., 202, 620144, Ekaterinburg, Russia

Present work continues a multidisciplinary study of modern and fossil small mammals bone and teeth remains emphasizing on their trace element composition (LA-ICP-MS) and structure (Raman spectroscopy) as a tool to reconstruct bone fossilization conditions and reveal chronological and space heterogeneity.

Investigated Late-Quaternary material from different locations of Urals region represents various rodents bone remains (jaws and teeth) from different depth and age sites (from modern to ancient with tens of thousands years old) from zoogenic deposits in karstic cavities.

Solid bone and teeth fragments microelement analysis was performed by LSX-500 (Cetac) laser (Nd:YAG 266 nm) coupled to ELAN 9000 ICP-MS (PerkinElmer). Raman spectra were obtained by LabRam HR (HORIBA Sceintific) with laser 514 nm.

More than 40 elements were analyzed; the greatest difference between samples of different age was observed for REE and some other high charged elements (Sc, Y, Zr, Hf, Ta, Th, U). Attempts were made to evaluate the microelement accumulation mechanisms in bone and tooth tissue. Some geochemical indicies were calculated such as Σ(REE)n, (LREE/HREE)n, (La/Sm)n, (La/Yb)n, and (Eu/Eu*) and (Ce/Ce*) anomalies. REE in investigated samples were found to be significantly fractionated; most of them are enriched in heavy REE ((LREE/HREE)n<1).

To obtain information regarding changes in the amounts of the mineral and organic matrix among different-aged samples a curve-fitting procedure for each Raman spectrum was performed by PeakFit V.4.11. For each spectrum, the original dataset was divided into several spectral regions representing the mineral and organic matrix: phosphate band (930–980 cm^{-1}), B-type carbonate band (1065-1070 cm^{-1}), organic matrix amide I band (1400–1800 cm^{-1}), organic matrix collagen C-H and C-N vibrations band (2750-3350 cm^{-1}).

Degree of apatite crystallinity was estimated as a fraction of 964 cm^{-1} peak from deconvoluted by 3 peaks area 930-980 cm^{-1}. The carbonate/phosphate ratios were calculated as the carbonate/phosphate band area ratios. Degree of mineralization was calculated as phosphate/amide I band area ratios.

Obtained data had pointed out to perspectives of using solid state spectroscopy methods (LA-ICP-MS and Raman spectroscopy) for investigation of bone and teeth tissues conversion during fossilization.

Acknowledgments: Authors thank A. Galkin («Nytek Instruments», Moscow) and M. Krylova (Institute of Mineralogy, UB RAS, Miass) for assistance in Raman spectroscopy experiments.

Experimental silicification of the tree fern *Dicksonia antarctica* as a taphonomic analog to volcanic preservation in the Lower Permian forest of Chemnitz

Sashima Läbe[1*], Chris Ballhaus[1], Carole T. Gee[1] & Ronny Rößler[2]

1) Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn
2) Museum für Naturkunde Chemnitz
* E-mail: sashimalaebe@uni-bonn.de

The preservation of in situ plants in volcanic settings, such as found in the Lower Permian forest of Chemnitz, involves either permineralization by percolating silica-rich water or vapor. Study of thin sections of the silicified adventitious roots of *Psaronius* sp. from Chemnitz shows that the primary SiO_2-precipitates consist of α-quartz and chalcedony (originally opal). The α-quartz was idiomorphically formed in cavities and lacks any water-rich fluid inclusions, although SiO_2 was transported and infiltrated in a water phase into the plant material. Rare, gas-rich inclusions indicate that the silicification of the Chemnitz forest occurred under pressure and temperature conditions where water was in the vapor stability field (> 100°C). The porous plant tissue likely acted as a conduit for gases or fluids originating from hydrothermal activity after the forest was initially covered by hot pyroclastics. The low confining pressure in the volcanic ash, as well as the impregnation with fluorspar which is common in the Chemnitz plants, point to mineralization in the vapor phase, and not in the liquid phase as has been previously assumed, as fluorides have a strong tendency to fractionate in the gas phase during hydrothermal processes

This hypothesized taphonomic scenario was duplicated experimentally in the laboratory using tissue samples from the trunk of the tree fern *Dicksonia antarctica*, whereby small blocks of stem tissue were subjected to SiO_2-saturated vapor in an autoclave. The autoclave consists of a reservoir connected to a copper tube containing the tree fern sample. The copper tube is joined to the autoclave via a ball valve. A mixture of water and an SiO_2-source (pulverized obsidian with 73 wt% SiO_2) was equilibrated at 150°C in the autoclave for several days to dissolve as much SiO_2 in the water as possible at the pressure and temperature conditions inside the autoclave. The valve was then carefully opened and the vapor phase released in a controlled manner through the tree fern sample in the copper pipe. SiO^2 in the form of opal was deposited in and on the plant tissue directly from the vapor.

Ultrastructural studies of the experimentally silicified tree fern samples using SEM show that layers of opal spherules of several microns in thickness were precipitated on cell walls. The silicification was not only superficial, covering the outer surfaces of the sample block, but also penetrated far into the plant tissue, into the interior of the cells, and even into the intercellular spaces. Treatment with the SiO_2-rich vapor for only 90 minutes was sufficient to silicify the sample block of tissue partially. The experimental samples are currently being analyzed by electron microprobe for the two-dimensional distribution of silicon, carbon, calcium, and alkali metals. Further investigations will include transmission electron microscopy of the silicified cell walls to document possible affinities between functional groups of organic substances and the SiO_2-complexes in the vapor phase and to clarify reaction mechanisms that lead to the replacement of organic matter by SiO_2 during the process of plant silicification.

Taphonomy and genesis of a Carnian ammonite mass-occurrence (Triassic, Taurus Mountains, Turkey)

Susanne Lukeneder & Alexander Lukeneder

Geological and Palaeontological Department, Natural History Museum, Burgring 7, A-1010 Vienna, Austria
susanne.mayrhofer@nhm-wien.ac.at; alexander.lukeneder@nhm-wien.ac.at

While the Carnian Crisis, also known as the Carnian Pluvial Event, took place within the western Tethys, an ammonite mass occurrence was deposited within an intrashelf area on the western end of the Cimmerian System with intermediate connection to both, the Neo-Tethys and the Palaeo-Thetys Oceans. This ammonite mass occurrence (*Orthoceltites* sp.), now located at the boundary from Kartoz and Kasimlar Formation (Anatolia, Turkey), can act as proxy for the environmental activities and biotic crisis in the Carnian time (Upper Triassic).

A case study in 3D modelling on the ammonite genus *Orthoceltites* is presented. The latter studies are essential for palaeooceanographic and palaeobiological conclusions. Statistical analysis of the orientation and relative position (e.g. imbrication) of the ammonite shells can hint to current or transport directions. 3D modelling of ammonites will lead to a geometrical reconstruction and shed light on the biostratinomic and additional diagentic processes.

The proposed research integrates well established 3D visualisation and geometrical modelling techniques in an exciting palaeontological task of reconstructing the distribution and alignment of ammonite in a Triassic mass-occurrence from Turkey. The 3D reconstruction of ammonite, calcite cement and calcite veins from digitized polished sections will be performed, using the commercial software package GOCAD. Individual objects can be created from imported 2D sections by combining matching line features to a surface object. Statistical analysis of the orientation and relative position (e.g. imbrication) of the fossils, but also calcite cement distribution (representing geopedal structures) and post-diagenetic calcite veins displacing several ammonite will complete the geometrical reconstruction. Moreover, 3D surface laser scan data will be visualized in GOCAD, and by further processing size, orientation and distribution can be extracted. Expected 3D modelling results will be essential to reach geodynamic, palaeooceanographic and palaeobiological conclusions. Investigations, undertaken at sections (e.g. Asagiyaylabel) possessing this time interval, can work as proxy for the major Upper Triassic Tethyan crisis. Environmental changes as displayed by the sea level and climate can become clearer and the 'motor' behind the demise better understood.

A Triassic ammonite mass-occurrence from the Taurus Mountains in Turkey

Alexander Lukeneder & Susanne Lukeneder

Geological and Palaeontological Department, Natural History Museum, Burgring 7, A-1010 Vienna, Austria
Emails: alexander.lukeneder@nhm-wien.ac.at, susanne.mayrhofer@nhm-wien.ac.at

The Upper Triassic in general, and the Carnian stage in detail was devastated by one of the most severe ecological crisis of the Mesozoic Era, the Carnian Crisis (= Carnian Pluvial Event), when the carbonate platforms demised and with them most of the reef-builders disappeared. The *Orthoceltites* assemblage (ammonoids, cephalopods) was formed in the Carnian Crisis, now located at the boundary from Kartoz and Kasimlar Formation (Anatolia, Turkey), can act as proxy for the environmental activities and biotic crisis in the Carnian time. It has to be noted that the ultimate cause of this drastic Mesozoic crisis is still under comprehensive discussion.

The main investigation topics of the submitted project are the palaeoecologic, palaeobiogeographic, litho-, cyclo- and magnetostratigraphic development of the Upper Triassic (Carnian) ammonoid mass-occurrence at the Asagiyaylabel section in Anatolia (Turkey), formed during the Carnian Crisis. This area is a key section within the Taurids and has a connecting and intermediate position. Situated on the western end of the Cimmerian System at that time it shows connection to both, the Neo-Tethys and the Palaeo-Tethys Oceans. New insights into the taxonomy and the palaeoecology of the investigated ammonoids and associated macro- and microfossils are expected. The abundant ammonoid *Orthoceltites*, at least 200.000.000 specimens, is assumed to be a new species. Further topics of investigation are the original position and environmental conditions of the sedimentation area at the Asagiyaylabel section, located in the Taurids. The formation of the ammonoid beds is either autochthonous or allochthonous (transported). Expected 3D modelling results will be essential to reach geodynamic, palaeooceanographic and palaeobiological conclusions. This further leads to the question of the original water depths during the formation of ammonoid mass occurrences.

As a multitasking project, one aim is to underline a crucial fact in working within different sciences as the Structural Processes Group at the Departments of Geodynamic and Sedimentology (University of Vienna) and the Geometric Modelling and Industrial Geometry group (3D technology at the Vienna University of Technology). Interdisciplinary collaboration with other scientists is essential in modern times. Statistical analysis of the orientation and relative position (e.g. imbrication) of the ammonoid shells can hint to current or transport directions. 3D modelling of calcite-cement distribution (representing geopedal structures) and post-diagenetic calcite-veins displacing several ammonoids will complete the geometrical reconstruction and shed light on the biostratinomic and additional diagentic processes. The combination in analysing different fossil groups with additional analysis of istotopic, magnetostratigraphic, cyclostratigraphic and geochemical features will help to extract details of the Upper Triassic history around one of the most severe crisis in the Mesozoic time, the Carnian Crisis. Investigations, undertaken at sections (e.g. Asagiyaylabel) possessing this time interval, can work as proxy for the major Upper Triassic Tethyan crisis. Environmental changes as displayed by the sea level and climate can become more obvious and the 'motor' behind the demise better understood.

Biostratinomy and hydrodinamic behaviour of *Taricciola arrusensis*: implications for depositional environment of the Riu Is Arrus Member (Upper Ordovician – SW Sardinia, Italy)

Andrea Mancosu[1], Francesco Cambuli[2] & Gian Luigi Pillola[1]

1) Dipartimento di Scienze della Terra, Cagliari University, via Trentino 51, 09127 Cagliari, Italy. andrea.mancosu@gmail.com; pillolag@unica.it
2) Dipartimento di Ingegneria Meccanica, Cagliari University, Piazza D'Armi, 09123 Cagliari, Italy. cambuli.f@unica.it

The Riu Is Arrus Mbr. (M.te Argentu Fm.- SW Sardinia) contains a rich assemblage of *Taricciola arrusensis* (Hammann et al., 1990), an Upper Ordovician, nonmineralized, blind, effaced trilobite-like arthropod, endemic to Sardinia. Along Riu Is Arrus valley, southeast of Fluminimaggiore, two complete stratigraphyc sections of Riu Is Arrus Mbr. were measured and biostratinomically evaluated. The *Taricciola* remains occur in massive gray siltstones which usually show the absence of sedimentary structures and a complete lithological homogeneity, except for some laminated levels. Stratigraphical and sedimentological analyses reveal that the most fossiliferous siltstones overlie the microconglomerates of the lower-middle part of the Riu Is Arrus Mbr. The *Taricciola* assemblage is characterized on articulated exoskeletons, all appendageless, and isolated cephala and pygidia; only few organic remains, probably belonging to plants and rare trace fossils occur in these oligotypic taphocenosis.

The arthropod exoskeletons, which are preserved as a thin carbonaceous film and exhibit a three-dimensional preservation, are not evidence of abrasion, fragmentation and preferred - orientation in plan. Observation on fine-grained beds reveals two taphofacies, characterized respectively by high proportion of articulated exoskeletons and by the accumulation of disarticulated sclerites. The first taphofacies shows that more than 95% of the articulated remains of *Taricciola arrusensis*, which constitute 45% of the total remains, are oriented ventral side-up. The preferred convex down position is supposedly related to the peculiar morphology and the post-mortem rheotaxis. Isolated cephala and pygidia are not evidence for a strong preferred dorsoventral orientation. In this work, some hypotheses on a simplified shape of Taricciola are drawn, in order to study the hydrodynamic behaviour of the exoscheleton by means of Computational Fluid Dynamics.

After modeling the *Taricciola* body and finding center of gravity and moments of inertia, a commercial CFD code has been used, based on the Finite Volume methodology that solves for the governing equations. The code simulates the interaction between the fluid and the exoskeleton during the post-mortem settling path. This is done by means of a simplified Fluid-Structure Interaction methodology based on a six degree freedom model. The results explain this preferred dorsoventral orientation and provide information on both lifestyles of *Taricciola* and physical features of the depositional environment. Integration of biostratinomic, hydrodynamic, stratigraphical and sedimentological data permits detailed inference of the depositional model of Riu Is Arrus Mbr. and strongly suggests a very quiet marginal/lagoonal shallow water environment.

References:

Hamann, W., Laske, R. & Pillola, G.L. (1990): *Taricciola arrusensis* n.g. n. sp., an unusal Trilobite-like arthropod. Rediscovery of the "phyllocarid" beds of Taricco (1922) in the Ordovician "Puddinga" sequence of Sardinia. Boll. Soc. Pal. Ital., 29, 163-178. Modena.

Pillola, G.L. & Mancosu, A. (2010): The intriguing Ordovician "trilobite" *Taricciola arrusensis* (Arthropoda, Naktaspida, Naraoiidae) from Sardinia: new data and perspective. Third international Paleontological Congress, London 2010, June 28-July 3, Abstract, p. 314.

Taphonomy of massive corals and lateral facies variation in an Oligocene-Miocene coral reef, Carry-le-Rouet, southeastern France

Bertrand Martin-Garin[1], Evan Edinger[1+2], Véronique Chazottes[1], Gilles Conesa[1], Marion Didierlaurent[1], Jean-Philippe Pero[1] & Anne Ribaud[1]

1) EA 4234, Géologie des Systèmes et des Réservoirs Carbonatés, Université de Provence, Marseille, France
2) Geography Department and Biology Department, Memorial University, St. John's, Newfoundland, Canada

Taphonomy of massive corals was investigated to help understand lateral facies variation in an Oligocene-Miocene reef in southeastern France. The coast of Carry-le-Rouet – west of Marseille – displays a succession of continental and marine sediments of Late Oligocene to Early Miocene age. The Parareefal Cap de Nautes Unit and the Bioclastic Carry Unit contain patch reefs and biostromes exposed in a mixed carbonate-siliciclastic sequence that accumulated in a pull-apart basin (Demory et al. 2001). The most extensive reef episode in the sequence, named R3, reaches approximately 5 m in thickness, and extends laterally over more than 1 km. Bedding-plane exposures of this reef are found in intertidal outcrops in several locations along the coast, with vertical profiles of the reef in fewer localities. The reef apparently suffered subaerial exposure) Santerre 2010), followed by burial under mixed carbonate-siliciclastic sediments. The four most common corals in all exposures of the reef were massive to submassive Porites and Tarbellastraea, phaceloid Caulastrea, and Mussismilia. Lateral variations of coral-colony morphologies and coral generic composition, suggest a gradient in sedimentation and wave exposure along R3, with an eastward reduction in foliose Turbinaria and increasing cover of Acropora and branching Porites. Coral composition – e.g. Monticulastraea, Pavona, etc. – suggests highest wave exposure at the central two sites.

To assess taphonomic alteration, especially fragmentation, encrustation, and macrobioerosion, of massive corals in reef R3, five to ten colonies of massive to submassive Porites and Tarbellastraea were collected from each of four intertidal bedding-plane exposures. Two-to-three-centimeter thick slabs of each coral were cut and polished to reveal encrustors and macroborings, which were identified by their morphology and scored using presence-absence in each slab. Total bioerosion relative to cross-sectional area was measured in a subsample of three non-adjacent slabs within each of 3 – 4 corals per species per site using image analysis software. Fragmentation appeared to be more common at the westernmost site, particularly for smaller corals. Encrustor diversity was highest in the westernmost site, while the easternmost site had only calcareous algae. Common encrustors included calcareous red algae, laminar and robust bryozoans, vermetid gastropopds and oysters. Encrustation on the bottom sides of corals was observed only at the westernmost site. The most common macroborings in the westernmost site were Entobia spp. sponge borings, including both large-chambered borings resembling E. devonica and E. convoluta, and small-chambered forms corresponding to E. ovula, E. dendritica, and E. retiformis. Gastrochaenolites spp. – mostly G. torpedo – were also quite abundant in all sites, and were the most common borings in all sites. Gastrochaenolites often contained round shell remains attributed to Lithophaga, but borings with shells of Gastrochaena were not observed. Two possible specimens of Gastrochaenolites vivus, with false floors indicating growth in a live coral host, were observed at one of the central sites. Trypanites, attributable to worms, were less frequent in Tarbellastraea than in Porites, where they were generally almost as common as sponge or bivalve borings, but contributed far less to total bioerosion. Total macro-bioerosion levels were < 1 – 10% of cross-sectional area, with very high variability among coral colonies. Initial results suggest higher fragmentation and more diverse encrustation and macroborings in the west, and slightly

lower total bioerosion in the east, impling longer post-mortem exposure time in the western site, and higher burial rates to the east (Estrada Alvarez et al 2004).

References:

Demory, F., Conesa, G., Oudet, J., Mansouri, H., Münch, P., Borgomano, J., Thouveny, N., Lamarche, J., Gisquet, F. & Marié, L. (2011): Magnetobiostratigraphy and paleoenvironments in shallow-water carbonates: the Oligocene-Miocene sediments of the northern margin of the Liguro-Provençal basin (West Marseille, southeastern France). Bulletin de la Société Géologique de France, 182: 37-55.

Estrada Alvarez, L.M., et al.,(2004). Taphonomy of modern corals from Madang Lagoon, Papua New Guinea. In: Best, M.M.R. & Caron, J.-B., 2004. (eds.) Canadian Paleontology Conference Proceedings No. 2, GAC publications, 23-28.

Santerre, Y. (2010): Influence de la diagenèse précoce et de la dynamique sédimentaire sur la distribution des propriétés pétrophysiques dans les réservoirs carbonates. PhD Thesis, Université de Provence Aix-Marseille I, Marseille, France, 279 p.

……

Spatial is special: the potential for spatially-explicit data to separate biodiversity signals from sampling noise

Alistair J. McGowan

School of Geographical and Earth Sciences, University of Glasgow, Glasgow, G12 8QQ

Much effort in palaeobiology has been expended on estimating taxonomic richness at various levels over the course of the Phanerozoic. While this has been a very fruitful approach, in terms of stimulating research it does have one major drawback in terms of our perception of biodiversity change: it leads us to treat the whole world as a single data point and focus on temporal variation. Yet the training of geologists, biogeographers and ecologists tends to lead towards a focus on spatial variation. What benefits for paleobiodiversity analyses might arise from returning to the notion that spatial is special?

The current re-investigation of Phanerozoic richness curves, highlighted in the 2010 Lyell meeting and a forthcoming volume, has begun to show some of the benefits of being able to think about data at multiple spatial scales. The concern with a range of geological and sampling biases has driven work to compile large datasets of fossil collection data with good geographical and stratigraphic data. A related aspect of this work has been the much more widespread collection and use of abundance data to understand the structure of the fossil record. While 'alpha-level' collecting on the outcrop has always been a major part of palaeontology, these new methods have lent new urgency to the need to collect such data. I will present the case that such spatially-explicit data may have a key role to play in the current debate on the relative proportions of signal to noise in Phanerozoic biodiversity trends.

My current project is focused on adapting and extending the methods of Cam et al., who used spatially-explicit data from the North American Breeding Bird Survey (BBS) to examine the possibility that observed species/area relationships (SARs) could be the result of sampling bias alone. Cam et al. hybridized a number of techniques, but their work contains one important insight and a methodological approach that could be very powerful in disentangling genuine biodiversity signals from the noise of geological and sampling biases.

Cam et al. (2002) used spatially-explicit analysis of the BBS routes along roads, which in a palaeontological context could be transects or movement up or down a section, to demonstrate that by comparing estimated SARs with the observed SARs that the steeper initial part of the curve on observed SARs was the result of the failure to detect taxa in small areas, which was a function of the detection or

encounter probability. In palaeobiology, this could also encompass preservation failure as an additional or separate parameter.

The second part of the Cam et al. (2002) study has great methodological potential. Using the estimated SARs as input data, they tested the oft-invoked hypothesis that the shape of SARs is driven by an increase in the number of habitats sampled as the area sampled increases. Statistical comparison of the slopes of the SARs and the habitat-area relationships (HARs), which were calculated using two different metrics found no significant relationship and cast doubt on increasing habitat diversity as a causal driver of biodiversity increase.

By extension palaeobiologists could go beyond HARs to also examine curves based on the number of geological units encountered and the different taphonomic environments to move this technique into a multivariate context appropriate for understanding signal to noise ratios in the fossil record.

Acknowledgments: This work was funded by a Royal Society of Edinburgh/Scottish Government Postdoctoral Fellowship co-funded by Marie Curie Actions.

References:

Cam, E., Nichols, J.D., Hines, J.E., Sauer, J.R., Alpizar-Jara, R. & Flather, C.H. (2002): Disentangling sampling and ecological explanations underlying species-area relationships. Ecology, 83, 1118-1130.

……

Using published incidence data to predict marine invertebrate encounter rates in the Midland Valley of Scotland

Alistair J. McGowan

School of Geographical and Earth Sciences, University of Glasgow, Glasgow, G12 8QQ

As resources and time to spend on field collection become scarcer and expert local knowledge becomes lost we need to explore new ways to use previously collected data from museum collections and published papers to estimate biodiversity in the fossil record. While new discoveries in exotic locales are often the source of new taxa (Benton, 2008), leading to increases in taxonomic richness, this is only one facet of biodiversity, although it is often the measure that is stressed. An aspect of biodiversity sampling of extant taxa that it would be valuable to bring in to palaeobiological studies is the routine resurvey of local areas to record abundance data and understand how common or rare individual taxa are within an area.

My current focus is upon the Carboniferous of NW Europe, but my 'local patch' is the Midland Valley of Scotland. A considerable amount of baseline data is available from UK museums and the work of the British Geological Survey (BGS). While these data are useful, they do tend to focus on richness (Guralnick & Van Cleve, 2005).

Wilson (1967, 1989) are somewhat unusual: Wilson recorded the proportion of sites from particular stratigraphic horizons based on occurrences in the BGS collections. Beyond the information on fluctuations on occurrences through time, these data have other potential uses. They serve as both a means of parameterizing species estimation curves (Cam et al., 2002). An important element of this technique is estimating the detection probability of a taxon in a given sample in a spatially-explicit sampling scheme. Cam et al. developed these techniques for extant taxa, but they can be adapted for use in the fossil record, where we must also deal with the

preservation probability as a parameter in determining encounter rates.

Another use of these tables is as a set of predictors for the likelihood of finding particular taxa. If a taxon is found in 90-100% of samples then we can test whether this is the case in new samples. My own fieldwork, and that of BGS field geologists, will be used to place confidence intervals on these estimates. Such a framework also offers a significant opportunity for 'citizen science' activities, where fossil surveys could be arrange along similar lines to those for biodiversity surveys of extant taxa. Volunteers could go out and survey sites and compare the taxa they find to the checklists of Wilson.

An important element of this work is to prove the worth of having continual sampling programmes in regions that are well-sampled and accessible to parameterize our models of biodiversity accumulation in a way that we cannot in more inaccessible areas. Such work also offers significant opportunities to do science *with* the public, while deepening the appreciation of the fossil biodiversity on their doorstep.

Acknowledgments: Thanks go to M. T. Dean, M. Akhurst, M. A. Browne, R. Smith, P.J. Brand, all of BGS for help with resources relating to Wilson's papers and collections. This work was funded by a Royal Society of Edinburgh/Scottish Government Postdoctoral Fellowship co-funded by Marie Curie Actions.

References:

Benton, M.J. (2008): How to find a dinosaur, and the role of synonymy in biodiversity studies. Paleobiology, 34, 516-533.

Cam, E., Nichols, J.D., Hines, J.E., Sauer, J.R., Alpizar-Jara, R. & Flather, C.H. (2002): Disentangling sampling and ecological explanations underlying species-area relationships. Ecology, 83, 1118-1130.

Guralnick, R. & Van Cleve, J. (2005): Strengths and weaknesses of museum and national survey data sets for predicting regional species richness: comparative and combined approachesDiversity and Distributions, 11, 349-359.

Wilson, R.B. (1967): A study of some Namurian marine faunas of Central Scotland. Transactions of the Royal Society of Edinburgh, 66, 445-490.

Wilson, R.B. (1989): A study of the Dinantian marine macrofossils of central Scotland. Transactions of the Royal Society of Edinburgh, 80, 91-126.

……

Preservation of biodiversity structure of an exceptionally-preserved Aquitanian bivalve assemblage (Meilhan, SW France)

Julien Michel[1], Gaëlle Doitteau[1], Pierre Lozouet[2] & Loïc Villier[1]

1) EA 4234, Géologie des Systèmes et des Réservoirs Carbonatés, Université de Provence Aix-Marseille I, Marseille, France
2) Muséum National d'Histoire Naturelle, B.I.M.M., Paris, France

Are exceptionally-preserved fossil assemblages showing similar diversity structure to dead shell assemblages of modern sedimentary system? Independently of taxonomic composition, are there metrics of the diversity structure that allow for characterizing depositional environment and/or pristine ecosystem?

We adress these issues by studying an extremely rich and well preserved bivalve assemblage collected in Miocene deposits of the Vives quarry (Meilhan, SW France). Sediment is a bluish, unlithified carbonate sand (mostly fine- and medium-grained sand) including sandstone pebbles and abundant macrofossils. Original mineralogy, either calcitic or aragonitic, is well preserved, as

demonstrated by a remnant of color patterns on gastropod shells. Most abundant biotic remains are molluscs, foraminifers, and coral fragments (mostly *Porites*). Close to 25.000 bivalve shells of 85 genera were counted from a single sand sample. Both paleontological and sedimentological data indicate a peri-reefal environment. Rarefaction curve of Meilhan assemblage displays a steep slope up to ~600 shells and approaches the honrizontal asymptote, indicating that bivalve diversity is well sampled. The high value of PIE index (0,938) suggests a fairly homogeneous shell distribution within the assemblage.

The fossil data are compared to dead and living fauna of a modern reefal setting (Touho area, New Caledonia), which is assumed to sample a modern analogue of Meilhan paleoenvironment. The species richness of the Meilhan sample is relatively lower than modern dead assemblages. The shape of the rarefaction curve and PIE index, however, compare well to modern data, especially those of deep (50 m water depth), sandy depositional environments found downward the reef slope. Taxonomic associations analysed by cluster analyses (i.e. Ward's method and Euclidian distances) of genera occurrences confirm the affinity of Miocene Meilhan assemblages with New Caledonian dead shell assemblages of deep, sandy depositional environments.

The fossil assemblage of the Vives quarry is likely to preserve the diversity structure of the original dead shell assemblage. This diversity structure compares well to a modern analogue, despite of 17.000 km distance, 20 Ma-age difference, and 65% of common genera. Thus, diversity structure could be considered in the deep time for characterizing paleoenvironments.

……

Taphonomic analysis of the Late Pleistocene micromammals of Quequén Salado, Buenos Aires, Argentina

Claudia I. Montalvo[1], Rodrigo Tomassini[1], Graciela Visconti[1] & Sergio I. Tiranti[2]

1) Facultad de Ciencias Exactas y Naturales, UNLPam, Uruguay 151 6300 Santa Rosa, La Pampa, Argentina cmontalvo@exactas.unlpam.edu.ar
2) AUSMA, Universidad Nacional del Comahue, San Martín de los Andes, Neuquén, Argentina

Although it has been mentioned that the birds of prey (mainly Strigiformes) may have produced accumulations of small vertebrates in Quaternary levels from the Pampean region (Argentina), taphonomic analysis to support this affirmation are still scarce.

The main goal of this study is to present results of taphonomic analysis of the micromammals remains recovered from pellets from a section exposed at the banks of Quequén Salado river (38°26'14.14" S, 60°40'13.29" W, Buenos Aires). The stratigraphic succession is interpreted as a fluvial system consisting of a lower sector made up of fine laminated siltstones with pedogenic features (rhizoconcretions and weak peds) interpreted as a floodplain environment. The upper section (channel deposits) is composed of cross-bedding sandstones overlain by massive siltstones. The succession is assigned to the Late Pleistocene based on the presence of megamammals *Macrauchenia patachonica* and *Glyptodon reticulates*.

The studies assemblage consisting of remains coming from whole and disaggregated pellets recovered from the floodplain deposits. A total of 3,119 remains were recovered. Two specimens were assigned to reptiles Iguanidae, while the rest were mammals: marsupials Didelphidae (*Lestodelphys halli*) and rodents Octodontidae (*Ctenomys* sp.) and Cricetidae (*Reithrodon auritus* and Eligmodontia sp.), with estimated body masses ranging between 17 and 200 grams.

This analysis was undertaken following the taphonomic methodology of Andrews (1990). The minimal number of elements (MNE) evaluated was 1,797 and the minimal number of individuals (MNI) was 34, estimated on the basis of mandibles. The average of relative abundance was 58.71%. The best represented skeletal elements were mandibles, humeri and femora. Molars, vertebrae, and scapulas were the skeletal elements with minor representation. Three indexes were calculated to assess the relationship among skeletal elements. The first two indexes, that give an idea about the preservation state of the cranial elements, show a deficiency of these elements. The third index shows an important loss of distal elements in relation the proximal ones. The isolated molars and empty alveoli ratio indicates loss of mandibles and maxillary. The degree of digestion was calculated for molars, incisors, proximal femora, and distal humeri, although it should be noted that more than 90% of skeletal elements show evidence of light modification.

Among the postcranial elements evaluated from breakage, proximal portions predominated (37.15%), but complete elements (23.72%) were frequent. Complete skulls were scarce. More than 25% of the mandibles only lacked the articular portion and retained all their teeth. Other cranial elements had different degrees of completeness. The percentage of remains modified both by digestion and breakage is low. These features and the anatomical representation results, indicate that the studied assemblage was produced by a nocturnal bird of prey, most likely *Tyto alba*. This species was reported in Pleistocene deposits of Buenos Aires province.

A suite of two thin sections of pellets was examined with a petrographic microscope. In both samples, the original bone microstructure was preserved intact, there were only small fractures caused by compression. Fossil bone cavities and fractures were filled by sparite, sometimes as druses, and Fe/Mn oxides. There was no evidence of bioerosion. The pellet matrix was argillaceous, including different minerals (e.g. quartz, calcite, plagioclase, Fe/Mn oxides). On the basis of EDX (Energy Dispersive X-ray) analysis performed on a fossil bone, the presence of original calcium phosphate is inferred, while the pellet matrix shows the same chemical components of bearing levels. No pellets or fossil bones show evidence of reworking. Their degree of preservation suggests a low energy environment consistent with the floodplain conditions inferred for the bearing deposits.

Acknowledgements: This work was founded by the Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa. We wish to thank M. Zarate for their comments.

References:

Andrews, P. (1990): Owls, caves and fossils. Predation, preservation, and accumulation of small mammal bones in caves, with the analysis of the Pleistocene cave faunas from Westbury-sub-Mendip, Somerset, UK. Natural History Museum Publications, London.

Evidence of a reef stage associated with a whale skeleton in the Lower Pliocene of Huelva, SW Spain

Fernando Muñiz[1], Raúl Esperante[2] & Kevin E. Nick[3]

1) Área de Educación y Cultura, Ayuntamiento de Lepe, Lepe, Huelva, 21440, Spain and Grupo de Investigación RNM 316 "Tectónica y Paleontología", Universidad de Huelva, 21071 Huelva, Spain
2) Geoscience Research Institute, Loma Linda, California 92350, USA
3) Earth & Biological Sciences Department, Loma Linda University, Loma Linda, California 92350

Whale falls cause a large impact on seafloor ecology due to the pulse of organic matter supplied to the water and sediment. Smith & Baco (2003) identified four stages in the development of the ecological communities associated with these whale falls: (1) a mobile-scavenging stage, consisting of macro-vertebrates and invertebrates; (2) an opportunistic stage, consisting of polychaetes and crustaceans; (3) a sulphophilic stage (bacteria), and (4) a reef stage, represented by suspension feeders that settle on the bones and associated sediment after depletion of organic material. In general, whale falls are colonized by both organisms that settle and live on the bones, and organisms that perforate the bones (bioerosion) and live inside them.

The reef stage is not known in modern whale carcasses. However, it is inferred by the presence of suspension feeders such as sabelid, chaetopterid, and serpulid worms, and bentonic crinoids, ophiuroids, cnidarians, and ctenophorans. This stage is very rare in fossil whale skeletons. Dominici et al. (2009) report a community of balanids, and various types of bivalves associated with the skeleton of a whale in the Pliocene of Italy. Esperante et al. (2009) report the occurrence of the epibionte *Neopycnodonte* (Ostreoida) biva9lves associated with a partial whale skeleton (Balaenoptera) from the Lower Pliocene Huelva Sands Formation in Huelva (SW Spain). The present work describes this association as a clear example of a reef stage (*s.s.*) associated with a marine vertebrate skeleton.

Dispersion of ostreids happens during the planctonic larvarian phase, followed by the bentonic phase, when they show specific preference for hard substrates (rocks, corals, shells, and bones), although they also settle in firm and stable substrates of the sea bottom and, exceptionally, in xylic substrates. In this sense, the skeleton of a whale represents an excellent hard substrate ("bony reef") for the settlement and development of ostreids.

In the case studied, *Neopycnodonte* shells occur both individually and in clusters closely associated with the bones and surrounding sediment. Clusterts occupy the space around missing vertebral apophyses and always on the same side of the skeleton, which suggests that these spaces were optimal for the settlement of larvae and that the ostreids developed an orientation strategy to take advantage of maximum suspension food in an enviroment of low energy.

On the other hand, the *Neopycnodonte* shells are mainly articulated, arranged in life position, with little evidence of bioerosion structures (*Entobia* and *Gastrochaenolites*), and in various sizes representing different ontogenetic stages.

The occurrence of the *Neopycnodonte* colony, as well as the taphonomic characteristics of the whale skeleton (Esperante et al. 2009, Table 2) suggest that biostratinomic processes were relatively prolonged before burial, in a sublittoral-circalittoral zone, at water depth of approximately 30-50 m, under low to moderate hydrodynamic energy and sedimentation rates.

References:

Dominici, S., Cioppi, E., Danise, S., Betocchi, U., Gallai, G., Tangocci, F., Varelli, G. & Monechi, S. (2009): Mediterranean fossil whale falls and the adaptation of mollusc extreme habitats. Geology, 37, 815–818.

Esperante, R., Muñiz Guinea, F. & Nick, K.E. (2009): Taphonomy of a Mysticeti whale in the Lower Pliocene Huelva Sands Formation (Southern Spain). Geologica Acta, 7, 489–505.

Smith, C.R. & Baco, A.R. (2003): Ecology of whale falls at the deep-sea floor. Oceanography and Marine Biology Annual Review, 41, 311–354.

Impact of uneven spatiotemporal sampling on regional-scale paleoecological patterns – examples from the Middle Triassic of the Germanic basin

Rafał Nawrot

Institute of Geology and College of Inter-Faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, Al. Żwirki i Wigury 93, 02-089 Warsaw, Poland

Accounting for variability in biodiversity and faunal composition in spatial and temporal scales smaller than the scale which particular research questions concern is a crucial prerequisite for correct interpretation of recorded paleoecological patterns. There is a growing awareness among paleontologist of this potential problem, and sampling designs and analytical techniques explicitly addressing this issue are getting more and more popular in quantitative paleoecological studies. However, the effects of uneven sampling have been usually discussed in context of either small-scale (outcrop-scale) analyses or global-scale, mainly occurrence-based studies.

Continuous development of Paleobiology Database (PBDB) have recently facilitated quantitative, abundance-based analyses of interregional, geographic variation in paleoecological patterns. An example of such attempts is Bonuso & Bottjer (2008) study on Middle and Late Triassic patterns in taxonomic and ecological structure of brachiopod mollusk assemblages in different biogeographic realms, including Germanic basin. However, at this finer scale of resolution the potential threat of pitfalls and misinterpretations resulting from uneven sampling and monographic effects can be more severe than on global scales. In spite of more than 200 years of geological and paleontological investigations in Middle Triassic Muschelkalk strata of the Germanic basin, quantitative assemblage-level data are still surprisingly scarce. Analysis of Muschelkalk collections available in PBDB reveals that only 5 out of 83 invertebrate collections include quantitative, field-based paleoecological data and all of them come from only one locality representing narrow stratigraphic interval. All other PBDB collections representing Muschelkalk strata are either based on analysis of museum specimens, include only semi-quantitative assessment of relative abundance of taxa or presence-absence data, or are based on taxonomic studies limited to particular taxonomic groups. Compilation of data from primarily literature and from independent field study shows that PBDB collections used by Bonuso & Bottjer (2008) to characterize Muschelkalk benthic assemblages capture only very limited portion of spatiotemporal variability in faunal composition present within the Germanic basin and cannot be regarded as representative for the whole basin. Environmental variation related to interplay of sequence stratigraphic framework and changing basin paleogeography controls ecological structure and composition of Muschelkalk faunas. Importantly, if data on other Muschelkalk assemblages had been used instead of the PBDB collections in the comparative analysis of Triassic biogeographic realms, significantly different results would have been obtained, throwing doubts on robustness of the authors' conclusions.

This case study by focusing on classic and seemingly well studied Middle Triassic successions of the Germanic basin, clearly illustrates potential biases involved in interregional quantitative paleoecological analyses based solely on published literature data.

References:

Bonuso, N. & Bottjer, D.J. (2008): A test of biogeographical, environmental, and ecological effect on Middle and Late Triassic brachiopods and bivalves abundance patterns. Palaios, 23, 43 -54.

Taphonomy and Palaeoecology of a mass occurrence of Lower Miocene Turritelline Gastropods from the North Alpine Foreland Basin

James H. Nebelsick[1] & Michael W. Rasser[2]

1) Department of Geosciences, University of Tübingen, Sigwartstraße 10, D-72076 Tübingen, Germany
2) State Museum of Natural History Stuttgart, Rosenstein 1, D-70191 Stuttgart, Germany

Turritelline Gastropods have a unique life style as semi-infaunal filter feeders and are known to occur in very high densities in nutrient rich shelf setting. Although well known in the literature, there have been few specific taphonomic studies of these mass occurrences. We have studied a well known mass deposit of these gastropods in the Upper Marine Molasse of the North Alpine Foreland Basin. This locality, the "Erminger Turritellenplatte", was used historically as a building stone and a fossil collecting site. An excavation revealed a ca. 3.5 meter, highly variable section dominated by coarse sands and sandy limestones. Turritelline gastropods can be very common along with subordinated oysters, aragonitic shelled gastropods and bivalves and shark teeth.

The turritelline gastropods show varying densities and orientations ranging from densely packed occurrences showing weakly bivariate orientations, to very highly univariate orientations of loosely distributed examples. These differences are correlated with increasing water depth and changing hydrodynamic conditions. Shell concentrations resulting from both transport mechanisms as well as winnowing effects are reconstructed within the section. The orientation of the gastropods can be used to determine local current patterns.

Thin section analysis shows that the aragonite skeletons of the gastropods have been completely replaced by calcite. At a microscopic level, this results in an increase of shell diameter and a masking of fine sculpturing of the outer shell surface. Furthermore, the apex and aperture of the skeletons are often damaged if not removed. Such taphonomic affects are important considering the difficulties of taxonomic identification of turritelline gastropods which use these features as diagnostic characters.

……

Microtaphofacies of mixed siliciclastic-bryomol carbonates from the Lower Miocene North Alpine Foreland Basin

James H. Nebelsick[1] & Ulrich Bieg[2]

1) Department of Geosciences, University of Tübingen, Sigwartstraße 12, D-72076 Tübingen, Germany
2) RAG Rohöl-AufsuchungsAG, Schwarzenbergplatz16, A-1015 Vienna, Austria

Carbonate rocks, in contrary to isolated macroscopic objects, have rarely been specifically addressed in terms of taphonomic features. Microfacies analysis, however, is highly conducive for analyzing taphonomic features. In fact, many aspects of carbonate analysis in the field and at thin section level inherently take taphonomic features into account. In some cases, taphonomic processes which are directly related to component preservation can be disseminated and quantified using thin section analysis than is possible in field studies. Taphonomic protocols based on isolated macroscopic fossils may be of little use in analyzing taphonomic features in highly indurated carbonate sequences.

In this study the microtaphofacies of Lower Miocene, shallow water, mixed carbonate -

siliciclastic environment from the North Alpine Foreland Basin (Molasse Sea) of southern Germany are analyzed. The studied sediments range from bryomol carbonates to siliciclastics allowing environmental interpretation to be made with respect to both biogenic composition (dominated by bivalves, gastropods, bryozoans and barnacles), as well as siliciclastic grain characteristics and sedimentary features. Facies interpretation shows a varied near shore facies distribution dominated by carbonates which grade into higher energy, siliciclastic offshore sediments. Taphonomic features are assessed along this gradient with respect to total component composition as well as by following the trajectories of individual components types. The results are interpreted with respect to general sedimentary environment and details concerning biogenic production, component robustness, hydrodynamics and biological disturbance.

……

Microbial activity and uranium anomaly in Late Cretaceous dinosaur bones from Mongolia

Krzysztof Owocki

Institute of Paleobiology, Polish Academy of Sciences, Twarda 51/55, 00-818 Warszawa, Poland

Microbial destruction of bone has been well researched, but potential preservational influences of microbes on bone are relatively unstudied. This study examined evidence for microbially induced mineralization in fossil bones buried in a terrestrial setting. Mineralized fungal hyphae and lithified bacterial extracellular polymeric substances were found. From a dozen dinosaur specimens excavated by Polish-Mongolian expeditions (1963-1971) from Tsagan Khushu locality, Nemegt Valley, Mongolia over half were affected by intense internal and external diagenetic mineralization by non-stoichiometric Mn-Ba and Fe-rich oxide-carbonate preserving excellently histological bone structure. Black to dark grey oxide-carbonates occur as a colloform layers up to 4 mm thick encrusting the bone and separating it from the arkosic bedrock. SEM images revealed that the authigenic coating consists of poorly rounded and poorly sorted detrital grains (predominantly quartz and feldspars) trapped in the fine-grained (~10 µm) oxide-carbonate matrix with spherical to botryoidal structure. Periosteal parts of the examined bones show extensive microbial tunneling, most often of budded type and in one case wedl type with inner parts of bones left intact.

Microbial tunnels are filled in by oxide-carbonates similar in composition to the bone encrustations. Investigations with the BSE show that the Haversian and Volksman`s canals are occupied by spherical oxide-carbonate agglomerates, up to 10 µm in diameter with distinct cellular inner structures. The individual cells have an oval to rhombic shape and vary from 0.5 to 1.5 µm in size. Larger canals, medullar cavities, the cancellous bone *trabeculae* and the resorption canals have spheres grown on the walls, with the remaining space filled up by calcite. Accumulations of spheres form extend oxide-carbonate rims around larger bone cavities. In one case tiny mineralized branching filaments crossing boundaries between bone and precipitated mineral in the medullar cavity were found. These are interpreted as fungal hyphae. ICP-MS investigations of the fossil bone phosphate showed that bones with abundant oxide-carbonates have one order higher uranium concentrations than bones unaffected by microbial activity from

the same locality, but have similar concentration of REE. The $(Sm/Pr)_N$ vs. $(Sm/Yb)_N$ pattern is characteristic for terrestrial fluvial environments (Trueman, 1999) whereas REE enrichment pattern and Gd/Yb values are typical for shallow groundwater, with circum-neutral pH values (Martin et al., 2005).

The considerable uranium concentrations found in the fossilized bones and significant negative cerium anomalies suggest burial in the well drained and oxidized soils. EMP analyses of periosteal parts of specimens with precipitated autigenic phases indicate UO_2 concentrations up to 0.49 wt% while in the inner parts where microbial activity was minor to none, UO_2 content is below EMP detection limit. Bioaccumulations of uranium occur in a wide range of micro-organisms, like iron-reducing bacteria (Ganesh et al., 1997; Francis et al., 2000). Subsurface micro-organisms are known to reduce U (VI) organic complexes (such as citrates and lactates) to U (IV) and to oxidize it again to soluble uranium-carbonate complexes under reducing conditions sustained by a continuous supply of organic carbon and CO_2 production from metabolism (Francis et al., 2000; Tokunaga et al., 2008). The carbonate ion is one of the most environmentally important inorganic complexing agents of uranium and monomeric and dimeric uranyl carbonate species predominate at pH values over 5 (Francis et al., 2000). Theoretical studies (e.g. Krestou et al., 2004) of the hydroxyapatite-U (VI) system show that, depending on the pH, uranium (VI) can precipitate either in the form of $Ca(UO_2)(PO_4)_2$ or as $CaUO_2(CO_3)_2$. These precipitates are extremely stable in acid and neutral solutions. Microbial mediation in the introduction of uranium-containing inorganic complexes that lead to the recrystallization of bone apatite can therefore not be excluded in the studied material, but this requires further investigation.

References:

Francis, A.J., Dodge, C.J., Gillow, J.B. & Papenguth, H.W. (2000): Biotransformation of uranium compounds in high ionic strength brine by a halophilic bacterium under denitrifying conditions. Environmental Science and Technology, 34, 2311-2317.

Ganesh, R., Robinson, K.G., Reed, G.D. & Sayler, G.S. (1997): Reduction of hexavalent uranium from organic complexes by sulfate- and iron-reducing bacteria. Applied and Environmental Microbiology, 63, 4385–4391.

Krestou, A., Xenidis, A. & Panias, D. (2004): Mechanism of aqueous uranium (VI) uptake by hydroxyapatite. Minerals Engineering, 17, 373-381.

Martin, J.E., Patrick D., Kihm, A., Foit, F.F. & Grandstaff, D.E. (2005): Lithostratigraphy, tephrochronology, and rare earth element geochemistry of fossils at the classical Pleistocene Fossil Lake area, South Central Oregon. Geology, 113, 139–155.

Tokunaga, T.K., Wan, J., Kim, Y., Daly R.A., Brodie, E.L., Hazen, T.C., Herman, D. & Firestone, M.K. (2008): Influences of organic carbon supply rate on uranium bioreduction in initially oxidizing, contaminated sediment. Environmental Science and Technology, 42, 8901-8907.

Trueman, C.N. (1999): Rare earth element geochemistry and taphonomy of terrestrial vertebrate assemblages. Palaios, 14, 555-568.

Horizons with the Late Permian vertebrate coprolites from the Vyazniki and Gorokhovets, Vyatkian Gorizont, Russian Platform – preliminary report

Krzysztof Owocki[1], Grzegorz Niedźwiedzki[1+2], Andrey G. Sennikov[3], Valeriy K. Golubev[3], Katarzyna Janiszewska[1], Kornel Biernacki[4] & Tomasz Sulej[1]

1) Institute of Paleobiology, Polish Academy of Sciences, Warsaw
2) Department of Biology, University of Warsaw
3) Institute of Paleontology, Russian Academy of Sciences, Moscow
4) Department of Geology, University of Warsaw

Numerous and well preserved coprolites of vertebrates (probably all reptiles in origin) have been found in the Vyazniki and Gorokhovets localities of European Russia. Three identified coprolite-bearing horizons are in the Upper Permian (Changhsingian) deposits of the upper part of Vyatkian Gorizont (uppermost Tatarian). Nearly 100 coprolites were collected and are referred to the three distinct ichnomorphotypes. The coprolites were gathered from a brown-greenish mudstone with coprolite 'breccia-like' layer and also from intra-sandstone conglomerates that were deposited in a floodplain environment probably during a sheet-flood event. The coprolites were produced by small and medium-sized carnivorous vertebrates and contain fish (scales) and small tetrapod remains. In one, large-sized coprolite a small fragment of amphibian bone was also found. It is suggests that was possibly produce by large therapsid or by early archosauromorph predator. SEM images (both in scattered and backscattered electrons) show that coprolite matrix has its bulk mass made of abundant spheres and thin walled vesicles with diameters 0.5-4 µm. Electron Micro Probe analyses of polished thin sections of coprolites show that the matrix is composed of microcrystalline carbonate-fluoride-bearing calcium phosphate with small amounts of calcium replaced in the crystal lattice by Na, Sr. The optical microscopy and EMP investigations show that iron and manganium oxides are responsible for elevated iron (0,52-7,26 wt% Fe) and manganium (up to 1319 ppm) concentrations in the bulk mass of coprolite. Other metals (e.g.V, Ni) can be associated with oxides forming spheroids with diameters 3-10 µm. This is first detailed description of vertebrate coprolites from the Vyatkian Gorizont of Russia.

Trail Creek caves 2 and 9 revisited - Caribou hunting or carnivore use of two Late Pleistocene and Holocene caves in Alaska

Kerstin Pasda

Institut of palaeoanatomy and history of domestication, Ludwig-Maximilians University of Munich, Kaulbachstr. 37, 80539 Munich

The Trail Creek caves 2 and 9 situated on the Seward Peninsula in Alaska were excavated by Helge Larsenbetween 1949 and 1950. Both caves contained artefacts and bones in excellent state of preservation and greatnumber. Some supposed dog teeth in the upper layers together with the early dating of a supposed smashed bison calcaneus (13,080 bp) by man led Larsen (1968) to the conclusion of the early occupation of North America by man. The teeth that were originally determined as dog turned out to be deciduous canini of brown bear by later investigations (Dixon & Smith 1986), the osteological material was anew documented in the spring of 2004 (Pasda in prep.).

The lack of cut marks initially gave rise to doubts on the interpretation of Larsen that the caribou bones were introduced by hunters for the purpose of marrow extraction. Analyses of the skeletal part frequencies show no similarities with archaeological sites but also not with carnivore dens. The skeletal part frequencies indicates that complete animals were introduced into the caves which is neither necessarily an indication for typical human nor for typical animal activity.

The artefacts of both caves are mainly unambiguous hunting weapons as projectile points, arrowheads or lance heads. A manufacturing of flint artefacts did apparently not occur in the caves. The hunting weapons got probably along with the hunted animals into the caves. In both caves similar situation existed in the spatial distribution and frequency of artefacts and of caribou bones.

The fracture pattern of the bones indicates the storage of skeletal parts for a time in frozen condition (Outram 2002). The low percentages of tooth marks on the whole and on midshafts sections of caribou bones, the absence of cylindrical diaphyses and the uniformity of fragmentation pattern indicate that not animals but humans were responsible for the bone collection of most of the caribou remains. The uniformity of the fragmentation over a time period of several thousand years shows that the caves were specifically visited for the same purpose and with the same tradition over a long period of time.

References

Larsen, H. (1968): Trail Creek. Final report on the excavation of two caves on Seward Peninsula, Alaska. Acra Arctica Fasc. XV. (København 1968).

Dixon, E.J. & Smith, G.S. (1986): Broken canines from Alaskan Cave deposits: Re-evaluating evidence for domesticated dog and early humans in Alaska. American Antiquity 51, 341-351.

Pasda (in prep.): Trail Creek Caves 2 and 9 revisited - The animal bones. (in prep.) BAR British Archaeological Reports (10323), (Oxford). Manuscript, 226 S. (in prep.)

Outram, A.K. (2002): Bone fracture and within-bone nutrients: an experimentally based method for investigating levels of marrow extraction. P. Miracle & N. Milner (eds.): Consuming passions and patterns of consumption. McDonald Institute Monographs (Cambridge 2002), 51-63.

Benthic foraminiferal taphonomy of Late Pliocene deposits from the Almería-Níjar Basin (SE Spain)

José N. Pérez-Asensio & Julio Aguirre

Departamento de Estratigrafía y Paleontología, Facultad de Ciencias, Campus de Fuentenueva s.n., Universidad de Granada, 18002 Granada, Spain (jnoel@ugr.es & jaguirre@ugr.es)

Taphonomic features of benthic foraminifera from the Rambla Quebrada section (Late Pliocene, Almería-Níjar Basin, SE Spain) have been analysed. The studied deposits consist of an alternation of siliciclastic sediments (conglomerate, sand, and silt) and *Cladocora caespitosa* coral banks. We collected 11 samples (labelled RQ-1 to RQ-11) representing different sediments and facies. We have quantified several taphonomic attributes using different alteration categories (0 meaning absence of the specific taphonomic attribute): fragmentation (0 to 4), abrasion (0 to 3), dissolution (0 to 3), borings (0 to 3), presence of recrystallization (coatings on the foraminifer tests), fillings (empty shells and shells filled by calcite), and preservation of the original test or preservation as moulds. The quantitative taphonomic study is based on the first 300 benthic foraminifer tests picked up from the 125 µm residues. A Q-mode cluster analysis based on the taphonomic measurements allows us to propose a taphofacies model.

Taphonomic results indicate deposition in a low-energy environment, a shallow sheltered bay, characterized by low fragmentation (<25%) and very low abrasion. This is consistent with the palaeoenvironmental conditions inferred based on sedimentological and facies analysis, as well as on the taphonomy of macroinvertebrates.

Q-mode cluster analysis shows an initial division of samples into two groups depending on recrystallization. One cluster groups samples characterized by low recrystallization (<50%), and the other one pools samples with high recrystallilzation. In the highly recrystallized benthic foraminifer group, the remaining taphonomic attributes cannot be assessed. Therefore, borings and abrasion cannot be observed. In addition, recrystallization makes foraminifer tests more resistant to physical and chemical processes. As a consequence, very low fragmentation is common in recrystallized tests. Recrystallization usually occurs after burial, and it is difficult to discern whether it is an early or a late diagenetic alteration.

Samples with low recrystallization are separated into three subgroups. A) One subgroup includes only one sample (RQ-1), which shows high fragmentation and abrasion compared with the rest of the samples. This suggests long-term exposure of the tests in a relatively high-energy environment. B) A second subgroup (including samples RQ-4, RQ-5, RQ-10, and RQ-11) is characterized by moderate abrasion. This group can be split into two subgroups. Subgroup 1a (samples RQ-4 and RQ-5) has considerable boring, indicating long exposure in the taphonomic active zone (TAZ). In contrast, subgroup 1b (RQ-10 and 11) shows the least boring, suggesting less exposure time. Subgroup 1b includes samples in highly bioturbated sediments. Bioturbation reworks the sediment, burying and exhuming shells. Therefore, biological reworking could account for the moderate abrasion observed in subgroup 1b. C) Finally, the third group clusters samples (RQ-6, RQ-7, and RQ-8) showing considerable boring and very few unbroken tests. High exposure and moderate hydraulic energy could account for this group.

The vertical evolution of taphonomic attributes indicates less exposure time in the TAZ (less boring) and low hydrodynamic energy (less fragmentation) towards the top of the studied section. This is consistent with the palaeoenviromental evolution inferred: a sheltered bay that is gradually restricted and filled up by the progradation of fan-delta systems. Fan-delta sedimentation could also contribute to rapidly burying foraminifer tests, thus diminishing the exposure time.

Diagenetic alterations in Miocene Mammal bones from Cerro de la Garita site (Concud, Teruel, Spain)

María Dolores Pesquero[1+2], Yolanda Fernández-Jalvo[2] & Luis Alcalá[1]

1) Fundación Conjunto Paleontológico de Teruel-Dinópolis, Avda. Sagunto s/n, 44002 Teruel, Spain
2) Museo Nacional de Ciencias Naturales (CSIC), C/ José Gutiérrez Abascal 2, 28006 Madrid, Spain

Cerro de la Garita site is located on the western edge of the Neogene Basin of Teruel (Spain). This basin is located in the north-eastern part of the Iberian Peninsula within the Iberian Range. The site yielded a large taxonomic mammal list that characterises the middle Turolian (Upper Miocene) (MN zone 12 *sensu* Mein, 1990 or local zone L *sensu* Dam et al., 2001) with an age around 7 million years. The sedimentary environment is characterized by a shallow, highly alkaline lakeshore.

The study presented here focuses on a characteristic type of diagenetic alteration consisting of a dusty surface that may affect partially (periosteal or endosteal surfaces) or entirely the cortical bone of fossils. We carried out an exhaustive study based on mineralogical and chemical composition using different spectrometries and observation using different microscopic techniques, to discover the aetiology and relevance to the formation (taphonomy) of the site. Fossils, sediments and altered surfaces were analysed through X-Ray diffractometer, X-Ray fluorescence, Raman spectrometry, energy dispersive spectrometer (EDS), wavelength dispersive spectrometer (WDS) and cathodoluminiscence, as well as scanning electron microscopy, confocal and optical microscopes.

The results obtained indicate that the dusty texture is exclusively calcite crystals. These crystals appear closely related to a characteristic bioerosion observed in this palaeo-lakeshore site. This bioerosion has recently been described (Pesquero et al., 2010) and it is characterized by microtunnelling and cavities peripherally penetrating the fossil bone. Results obtained from these specimens show that where bioerosion is present, "bone has entirely become calcite". This is a rather spectacular alteration and we propose the following hypothesis. This biogenic agent, apart from eroding the bone surface, produced a specific micro-environment in which the hydroxyapatite chemical components became instable and the lake water became highly saturated in CO_2. As result of this situation, a chemical and physical change took place on the bone, with a rapid combination of exogenous diagenetic carbonate and the bone calcium forming calcite micro-crystals, and phosphate disappeared dissolved in water. The low consistency of these neoformed calcite micro-crystals collapses when touched giving a dusty appearance to these fossils. This may, probably, be a pattern rather than an exceptional case, as this phenomenon (dusty surface) is relatively frequent in fossils related to aquatic or damp environments.

Acknowledgements: Excavations in Concud, preparation of fossils and palaeontological research have been possible thanks to the support of the *Dirección General de Patrimonio Cultural, Gobierno de Aragón* (projects 028/96, 022/97, 133/98, 142/99 and 107/03). This study is one of the palaeontological research projects subsidized by the *Departamento de Educación, Cultura y Deporte* and the *Dirección General de Investigación, Innovación y Desarrollo, Gobierno de Aragón* (Research Group E-62, FOCONTUR) and Spanish Ministry of Science and Innovation (Projects CGL2009-13903, CGL2007-66231, CGL2010-19825).

References:

Mein, P. (1990): Updating of MN zones. In: Lindsay E., Fahlbusch V. & Mein P. (eds): European Neogene Mammal Chronology. Plenum Press, New York: 73–90.

van Dam, J.A., Alcalá, L., Alonso Zarza, A.M., Calvo, J.P., Garcés, M. & Krijgsman, W. (2001): The Upper Miocene mammal record from the Teruel–Alfambra region (Spain). The MN System and continental stage/age concepts discussed. Journal of Vertebrate Paleontology 21 (2), 367–385.

Pesquero, M.D., Ascaso, C., Alcalá, L. & Fernández-Jalvo, Y. (2010): A new taphonomic bioerosion in a Miocene lakeshore environment. Palaeogeography, Palaeoclimatology, Palaeoecology, 295 (1-2), 192-198.

Calcium phosphate preservation of fecal bacteria pseudomorphs in hyaena coprolites from the Upper Miocene mammal fossil site of La Roma 2 (Teruel, Spain)

María Dolores Pesquero[1+2], Virginia Souza[3], Luis Alcalá[1], Carmen Ascaso[2] & Yolanda Fernández-Jalvo[2]

1) Fundación Conjunto Paleontológico de Teruel-Dinópolis, Avda. Sagunto s/n, 44002 Teruel, Spain
2) Museo Nacional de Ciencias Naturales (CSIC), C/ José Gutiérrez Abascal 2, 28006 Madrid, Spain
3) Instituto Ciencias Agrarias (CSIC), C/ Serrano 115dpdo, 28006 Madrid, Spain

The La Roma 2 site (Upper Miocene, Late Vallesian, MN10) is located in the northern part of the Teruel Basin (Spain). Its fossil-bearing level of grey clay marls is interpreted within the context of a marginal lacustrine environment that experienced episodic flooding events and which received external lutitic supplies. The site is characterized by a concentration of hundreds of mammalian coprolites that represent the defecated remains of digested bones. They are attributed to the Upper Miocene hyaenid *Lycyaena chaeretis.*

In this study we were interested in the description of the matrix surrounding the bone inclusion to look for evidences of preservation of other components of the scat such as organic inclusions or fecal bacteria. The material studied in the present work included several coprolites recovered from La Roma 2 site during excavation seasons, mainly in 1992, and 2006-2009. The coprolites were analyzed using optical microscopy, transmission electron microscopy (TEM) and scanning electron microscopy at high and low vacuum modes (SEM).

The analysis of the coprolites mineralogy has provided information on the diagenetic history of the fossil site. Transverse thin sections show that the coprolite is composed by a microcrystalline phosphatic matrix. However, three different zones may be identified within the coprolite: two are produced by primary deposition, with one showing a homogenous texture, and the other one having a heterogeneous matrix; the third zone was produced by secondary origin, and shows a highly homogeneous texture.

SEM images of the the primary homogenous zone showed the matrix composed of spherulites with diameters of 1-3µm. In polished sections by backscattered detection mode these vesicles showed a thin-walled structure made of needle shaped crystals, often presented as doubled walled vesicles. In most part of the matrix these vesicles became embedded in a fine grained calcium phosphate precipitate. Apart of these vesicles there were micron-scale, spherical and elongated holes in the fine mineral precipitated around the spherulites. These small holes can be interpreted as the mineral pseudomorphs that resemble in size and shape of rod and coccoid bacteria present in the moment of the scat deposition. In this area without recrystallization processes the structure of the microspherulites indicated a clear inorganic origin and the rapid precipitation allowed the preservation of remains of bacteria as molds in the coprolite matrix. However in a second phase the hyaenid coprolites suffer other mineralogical processes due to the infiltration of fluids though the porous matrix after buried. These fluids enriched in carbonates and salts indicated the presence of a swamp area like the one around the lake in La Roma 2.

Acknowledgements: Excavations in La Roma 2, preparation of fossils and palaeontological research have been possible thanks to the support of the *Dirección General de Patrimonio Cultural, Gobierno de Aragón* (projects 02/92, 332/2006, 184/2007, 230/2008, 230/08/2009 and 230/08/09/2010). This study is one of the palaeontological research projects subsidized by the *Departamento de Educación, Cultura y Deporte* and the *Dirección General de Investigación, Innovación y Desarrollo, Gobierno de Aragón* (Research Group E-62, FOCONTUR) and Spanish Ministry of Science and Innovation (Project CGL2009-13903, Project CGL-19825 and Project CGL2010-160004).

Dynamics of *Cochlearites* (Early Jurassic aberrant bivalve) reefs

Renato Posenato & Daniele Masetti

Dipartimento di Scienze della Terra, Università di Ferrara, Via Saragat 1, 44100 Ferrara.

Bivalves experienced two main evolutionary adaptive phases of gregarious aberrant eteroconch shells with high biosedimentary value, represented by the Cretaceous rudists and the Early Jurassic *Lithiotis* fauna. Although mostly restricted to the Pliensbachian, the latter bivalves have a wide geographical distribution occurring both in Tethyan and Panthalassian carbonate platforms, where they originated relevant biogenic accumulations, both as bivalve reefs and bivalve reef mounds.

The most important and common bivalves of *Lithiotis* fauna are *Lithiotis*, *Lithioperna* and *Cochlearites*. In the Southern Alps (Italy), these genera occur in the Rotzo Formation (Calcari Grigi Group) of Trento Platform, which represents their historical and key study area. *Cochlearites* is here the widespread and most relevant frame-builder form. It has a spoon- to ribbon-shape, inequivalve, fully aragonitic shell, reaching up to 70 cm in height. This suspension feeder had a bottom stabilization variable through ontogeny: cemented at early stage, semi-infaunal and mud-stickers at adult stage.

Several well preserved *Cochlearites* build-ups, some very expanded laterally, have been carefully analysed in order to define their taxonomic composition, biofabric and geometry. They have a thickness ranging from few decimetres to few metres (3-4 m), and a lateral extension from few to several hundreds meters (500-700 m). The most part of these biogenic concentrations are monospecific, although an early *Lithioperna* stage and *Lithiotis*-*Cochlearites* assemblage have been sometime observed. At the outcrop scale, the build-ups exhibit a tabular geometry deriving from a prevailing lateral growth, testified by clinoform surfaces, starting from a dome-shape core raised above the sea-floor. The lateral extremities of these tabular bodies pinched-out towards the interbuildup areas. These trenches are infilled by algal and foraminifer mudstone-wackestone, with floating shells or/and sedimentological accumulations of fragmented shells, prograding on the flanks.

A *Cochlearites* build-up shows the following evolution: stabilization, colonization, accretion and prograding phases. The stabilization phase is represented by a bivalve rudstone, interpretable as a storm layer, generally containing megalodontid fragments which constituted the hard substrate for the attachment of pioneering individuals. The colonization phase is generally represented by concordant shells, sometimes substituted by *Lithioperna*. The accretion phase, controlled by the accomodation space, sedimentologic and biologic factor interaction, determined the reef core building and mound elevation. The reef core has a framework represented by banana bunch-like aggregates (bivalve reef stage), which acted as sediment trappers (bafflestone). The aggregates show an apparent chaotic arrangement in bi-dimensional sections and consist of strongly re-crystallised or dissolved shells, a diagenetic imprint probably connected with the emersion.

The prograding phase (bivalve reef mound stage) is originated by the lateral addition to the buildup flanks of clinostratified sedimentary bodies, characterized by oblique and imbricated autochthonous individuals with concavo-convex and very large shells living on the build-up slopes. These shells mark the reef slopes which grew centrifugally from the reef core. The flanks represent the most conspicuous part of reef, sometime extending over hundreds of meters, and the most favourable niche for *Cochlearites* growth.

Bivalve pavement successions in oxygen-depleted marginal marine environment (Lower Jurassic, northern Italy)

Renato Posenato[1], Marco Avanzini[2], Davide Bassi[1] & Nicola Sprocatti[1]

1) Dipartimento di Scienze della Terra, Università di Ferrara, Via Saragat 1, 44100 Ferrara
2) Museo Tridentino di Scienze Naturali, Via Calepina, 14 - 38122 Trento

The Lower Jurassic of Trento Platform (Southern Alps, Italy) is represented by the Calcari Grigi Group (Grauen Kalke), a thick shallow water carbonate succession whose most fossiliferous unit is represented by the Rotzo Formation (?Sinemurian – Pliensbachian), renowned for the aberrant bivalves of *Lithiotis* fauna, aragonite Skeletal Lagerstätten, and terrestrial flora. The Rotzo Formation is characterised by marl / limestone alternations deposited in shallow marine-lagoon environment.

In the central-western Trento Platform, the basal Rotzo Formation is characterised by metre-thick cycles of subtidal ooid/oncoid wackestone overlain by dark grey bioturbated mudstone, laminated mudstone and fissile dark grey and black organic-rich marlstone and claystone. The laminated mudstone and marlstone yield frequent bivalve pavements of oligospecific assemblages dominated by *Eomiodon*, an opportunistic brackish shallow infaunal veneroid. These bivalves are associated with oligohaline ostracods and freshwater thecamoebians (Boomer et al., 2001; Bassi et al., 2008). Litho- and biofacies indicate environmental conditions ranging from nearshore euhaline waters to oxygen-depleted brackish marshes/ponds, with a high input of terrestrial organic matter, culminating with terrestrial conditions. The *Eomiodon* horizon from the basal Rotzo Formation, recording probably a humid climatic phase, predates the appearance and development of the large bivalves of *Lithiotis* fauna.

The *Eomiodon* pavements are “shell plasters” (*sensu* Cherns et al., 2011) originated by low energy storm waves after mass mortality events caused by bottom anoxia, within a restricted, brackish and shallow environment. Shells are preserved either with the original aragonite and decalcified. The pavements have been analysed considering both taphonomic signature (e.g., size, sorting, disarticulation, fragmentation and bioturbation degree) and alpha diversity.

The studied *Eomiodon* pavement succession consists of early and late accumulations. The early accumulations, occurring above a decimetre-thick laminated dark grey limestone and almost barren in fossils, yield monospecific *Eomiodon* assemblages consisting of small- sized specimens. Occurrence of “butterfly” specimens and no hydraulic sorting suggest parautochthonous accumulations. Although physiological constrains caused by low oxygenation cannot be excluded, the small *Eomiodon* size is likely to be the result of very short (seasonal) oxygen availability which allowed the growth of a single generation on soft substrate. Absence of bioturbation and winnowing determined a rapid burial of the small-sized shell pavements impeding the settlement of sessile benthic larvae.

Size increasing, fragmentation, bioturbation and unsorted shells characterise the upper accumulations. These taphonomic signatures suggest a higher bottom oxygenation, longer time of residence and shallowing trend. Occasionally, vertebrate remains (crocodiles and fishes), vertical roots and evidences of emersion, such as dinosaur footprints, are also preserved. Winnowing and tidal currents kept brushed the shell pavements allowing the sessile benthos colonization. In fact, these upper pavements contain *Lithioperna*, an epibyssate genus of the *Lithiotis* fauna, which makes here its first appearance with very small individuals.

References:

Bassi, D., Fugagnoli, A., Posenato, R., & Scott, D.B. (2008): Testate amoebae from the Early Jurassic of the western Tethys, northeast Italy. Palaeontology 51, 1335-1339.

Boomer I., Whatley R.C., Bassi D., Fugagnoli, A. & Broglio Loriga, C. (2001): An Early Jurassic oligohaline ostracod assemblage within the marine carbonate platform sequence of the Venetian Prealps, NE Italy. Palaeogeography, Palaeoclimatology, Palaeoecology 166, 331-344.

Cherns, L., Wheeley, J.R., & Wright, V.P. (2011): Taphonomic bias in shelly faunas through time: Early aragonite dissolution and its implications for the fossil record. In: Allison, P.A. & Bottjer, D.J. (eds.): Taphonomy, Second Edition: Process and Bias Through Time. Topics in Geobiology 32. Springer, pp. 79-105.

……

Taphonomy of tempestites *versus* tsunamites: A case study from late Miocene temperate carbonates (Sorbas Basin, SE Spain)

Ángel Puga-Bernabéu & Julio Aguirre

Departamento de Estratigrafía y Paleontología, Facultad de Ciencias, Campus de Fuentenueva s.n., Universidad de Granada, 18002 Granada, Spain (angelpb@ugr.es & jaguirre@ugr.es)

Beds of shell concentrations are recorded in the late Miocene temperate carbonate shelf deposits of the Sorbas Basin (SE Spain). These beds show sedimentological and facies features allowing them to be interpreted either as tempestite-related or as tsunami-linked event deposits. Both tempestites and tsunamites are event deposits related to high energy processes. Incoming waves erode the seafloor and backflow surges transport the sediment basinwards, forming discrete shell-beds. However, the distinct intensity of the hydrodynamic events produces significant differences in scales. Sedimentary characterization of storm-beds and tsunamites are relatively well known both in the Recent and in the geological record. However, little attention has been paid to the taphonomic behaviour of the shelly material and to its preservation traits. Here, we present a taphonomic characterisation of the storm-related and tsunami-linked shell-bed deposits in the Sorbas Basin.

Several taphonomic attributes have been quantified in five 20-cm side squares distributed in different shell beds: a) fragmentation; b) articulation; c) edge roundness-sharpness; d) encrusting; e) borings; f) original shell mineralogy; g) orientation with respect to the stratification surface (horizontally, obliquely, and vertically oriented shells); h) concavity orientation. All these taphonomic attributes were measured in six well-characterized shell beds, three of them representing tempestites and the other three beds interpreted as tsunami deposits. A Q-mode cluster analysis was carried out to group sampled beds based on their taphonomic attributes.

Taphonomic results indicate that: a) tempestites show higher degree of fragmentation than tsunamites; b) articulation, although very low in both types of shell concentrations, is higher in tempestites than in tsunamites; c) bioclasts in the tempestites show rounded edges while in tsunamites they are preferentially sharp; d) shells in the tempestites present higher percentages of borings and encrustations than those preserved in the tsunamites; e) shells are mostly concave-up oriented in the tempestites while concave-down settled in the tsunamites; f) shells are predominantly horizontally oriented in the tempestites but perpendicular in the tsunamites. Obliquely oriented shells are more abundant in tsunamites than in tempestites.

The depositional mechanisms involved in the formation of tempestites and tsunamites account for the different preservation of shells. During the storms, shells are subjected to traction currents transporting the bioclastic material over the seafloor. This sedimentary mechanism would produce high fragmentation and abrasion. Under this hydraulic regime, shells are preferentially

horizontally oriented. Stacked, concave-up oriented shells are typical of storm deposits. Finally, shell concentrations can then be exposed on the taphonomic active zone for long periods of time, favouring colonization by encrusters and borers.

On the contrary, tsunamis are extremely powerful events that erode and rework bioclastic particles that are transported within a very dense matrix-rich flow, thus shells are transported in a roughly coherent mass of sediment, favouring lower percentages of fragmentation and abrasion. In addition, this sedimentary mechanism would produce a more chaotic shell orientation, thus outnumbering vertically oriented bioclasts. Finally, travelling within a very dense matrix-rich flow preclude biological colonization after deposition.

The Q-mode cluster analysis separates two well-differentiated groups of samples; one of them includes the three samples located in the tempestite deposits, and the other clumps the rest of the samples, located in the tsunami deposits.

……

Belemnite taphonomy in epicontinental shelf deposits of the Upper Jurassic (Prebetic, Betic Cordillera)

Matias Reolid[1] & María Isabel Benito[2]

1) Dept. Geología, Universidad de Jaén, Campus Las Lagunillas sn 23071 Jaén, Spain
2) Dept. Estratigrafía, Univ. Complutense Madrid, IGEO–CSIC, 28040 Madrid, Spain

Recent interpretations of palaeoclimatic conditions during the Late Jurassic in the Tethys Realm have been made based on the analysis of stable isotopes of C and O from belemnites. However, the analysis of the preservation of these belemnites is not common and only the use of the cathodoluminiscence is frequently used for determining diagenetic effects which can change the original chemistry and the isotopic signal of the biogenic carbonate. The aim of this work is the analysis of the taphonomic features of belemnites from epicontinental shelf deposits of the Middle Oxfordian-Lowermost Kimmeridgian of the South Iberian Palaeomargin. Both section has been selected in the Prebetic (Betic Cordillera): 1) Pozo Cañada in the External Prebetic representing mid-shelf environment, and 2) Río Segura in the Internal Prebetic representing outer-shelf environment.

A detailed taphonomic analysis was performed on 188 belemnites and 56 thin sections from Pozo Cañada section (External Prebetic) and 101 belemnites and 31 thin sections from Río Segura section (Internal Prebetic). They correspond to *Hibolithes* while *Belemnopsis* are less common. Biostratinomic and fossildiagenetic features, including size, fragmentation, corrasion, microboring, encrustation and burial-related diagenetic processes, were analyzed in each specimen, using petrographic and geochemical techniques.

Fragmentation affects the phragmocone and the rostrum cavum and is usually transversal and rarely longitudinal through the apical line. Isolated fragments of epirostrum are commom. The corrasion affects the exposed surfaces producing irregular surfaces. Microborings are very common represented by: a) Fungal hyphae; b) *Fasciculus dactilus*-like and *Scolecia filosa*-like borings (cyanobacteria); c) *Entobia* (sponge). e) Large microborings with Y-shaped branching (diameter 100-500 µm) subparallel to rostrum surface; f) Large cylindrical to ellipsoidal borings related to cirripeds; and g) *Palaeconchocelis starmachii* (rhodophyte). Microbes and sessile foraminifera (*Vinelloidea*, *Bullopora*, *Tolypammina*, *Thurammina*, *Placopsilina* and *Subdelloidina*)

are the main encrusters. Microbial films are composed of dense micrite or clotted-peloidal microfabric.

The most common fossildiagenetic processes are small-scale dissolution and recrystallization of the apical zone and outer growth rings of many belemnites. These processes can be enhanced by fracturing and stylolite formation. These processes typically make specimens non-suitable for geochemical analysis. However microsampling of well-preserved and altered areas from the same specimens, performed directly from thin sections after petrographic study, have allowed obtaining excellent geochemical results.

The taphonomic features analysed in the belemnite rostra are clearly influenced by the lithofacies and the shelf setting. The intensity of corrasion, microborings and encrustation indicate time-exposure and allow us establishing in which lithofacies the sedimentation rate was higher. The belemnites from lithofacies of the Internal Prebetic, that is, the outer shelf deposits (lumpy limestone and lumpy-oncolitic limestone), present high values of corrasion, microboring and encrustation indicating long-time exposure. Low values of corrasion, microboring and encrustation is shown by belemnites from the lithofacies of the External Prebetic representing deposition in mid shelf environments (spongiolithic limestone, spongiolithic marl-peloidal limestone, and marl-limestone rhythmite) with high clay content.

……

Brachiopod shell-mass accumulations from a prodelta-offshore transition setting (Late Tortonian, Guadix Basin, South Spain)

Matias Reolid[1], Fernando García-García[1] & Adam Tomašových[2]

1) Dept. Geología, Universidad de Jaén, Campus Las Lagunillas sn 23071 Jaén, Spain
2) Dept. of Geophysical Sciences, University of Chicago, 5734 S, Ellis Ave. Chicago, 60637 USA

The taphonomy and paleoecology of the Upper Miocene brachiopod accumulations from a prodelta to offshore transition setting of northern margin of the Guadix Basin can improve our knowledge of these organisms during the Cenozoic and in modern habitats due the characteristics of the outcrops studied: (1) brachiopods form thick shell-beds and (2) brachiopods were numerically dominant in benthic communities.

The studied deposits represent a shallow, coarse-grained Gilbert-type delta distally evolving to a high-energy currents-dominated offshore. A depth of 20–30 m for the brachiopod-rich beds is deduced from the deltaic clinoform geometry. Brachiopod shells form 200 m-long and <3.5 m thick concentrations at the bottomset. They are oriented transversely with respect to the direction of delta progradation.

Shell-beds correspond to a 3.5 m-thick, coarsening-upward unit composed of gravel intervals and cross-stratified sandy intervals, in accordance with the prograding stacking pattern of the delta system. They are overlain by gravel lens-shaped bodies, interpreted as debris flows at the bottomset. In proximal settings, two main shell-beds have been distinguished, separated by a bed with poor shell abundance. The thickness of the rich shell-beds decreases to distal parts of the basin. The shell-rich bed A (<1.5 m-thick) consists of coarse-grained sands with pebbles and bioclasts. The middle shell-poor bed B (20-400 cm-thick) is characterised by cross-bedding. The shell-rich bed C (2 m-thick) consists of coarse-grained sandy matrix with bioclasts. The macrofossil assemblages are dominated by *Terebratula terebratula* (65–76%). Bivalves (16–28%) of the

families Pectinidae, Cardiidae and Ostreidae are also common. Encrusting and ramose bryozoans (1–8%) are rare and echinoids and ahermatypic corals are scarce.

Mean size of bioclasts is 3.2 cm and size of *Terebratula* ranges from 1.2-6 cm, but the specimens smaller than 20 mm are almost absent (5.2%). The fragmentation index is variable (24–53%), with the highest values in the shell-bed B and at the top of the shell-bed C. Delicate ramose bryozoans and ahermatypic corals occur in the shell-bed A. The fragmentation in brachiopods is higher in brachial valve (43%) than in pedicle valve (32%). Disarticulation is extensive and affects 100% of bivalves and 89% of brachiopods. The pedicle valves predominate (76%). The disarticulated valves are mainly oriented convex-up in the shell-beds A and B (54%), and concave-up in the shell-bed C (67%). The encrustation index is higher in the shell-bed A (17%) than in the shell-bed B and C (9%) with high diversity of encrusters and borers in the shell-bed A (encrusting bryozoans, serpulids, sessile foraminifera, and Entobia). The encrustation index is higher in brachial valves (25%) than in pedicle valves (16%) and encrusters are located both on external and internal side of the valves.

The diversity is decreasing upwards and might indicate (1) conditions of increased stress or disturbance, (2) environmental changes that affected the composition of regional species pool, or (3) changes that favoured species adapted to low resource availability or firm and temporally-stable substrate.

The predominance of pedicle valves is related to higher vulnerability of brachial valves to mechanic breakage or higher susceptibility to out-of-habitat winnowing, because the pedicle valve is thicker and larger than the brachial valve. High proportions of disarticulated specimens as well as the presence of encrusters on internal sides of valves indicate enough time exposure on sediment-water interface. However, the lowest fragmentation of the shell-bed A indicates that the exposure did not last for a long time after death The decreasing values of encrustation in the shell-bed B and at the top of the shell-bed C may indicate a more rapid burial, a less stable substrate, or increasing turbidity related to higher sedimentation rate and water energy. The same taphonomic trend is observed toward distal parts of the delta.

Distal settings of delta system are dominated by planar cross-stratified sandstones interpreted as currents-dominated megarripples and sandwaves. There the brachiopods are located at the bottoms of sandwaves and megaripples. The assemblage consists almost exclusively of small brachiopod fragments (2.7 cm mean size), with high fragmentation index (45%) and disarticulation (100%), convex-up valves (69%) and absence of encrustation and borings. The source area of these shell concentrations were probably the beds A, B and C from proximal settings of the delta.

Reductions and expansions in the onshore-offshore distribution of brachiopods over short intervals of time were probably related to variations in sedimentation rate, substrate stability and water turbidity that were driven by delta progradation and offshore hydrodynamic. *T. terebratula* flourished in times of reduced sedimentation rate. High shell bed thickness implies that this brachiopod species attained high population density over relatively long durations of time in very shallow, siliciclastic environments (and not in hard-bottom environments), in contrast to assumptions about their low production rate during the Cenozoic. At times of highest rate of delta progradation, high sedimentation rate, unstable substrate, and high turbidity probably exceeded the tolerance threshold of *T. terebratula*, and they disappeared with the onset of debris flow.

A high-energy marine flooding in the red bed Facies (Triassic) of the Tabular Cover (SE Spain) registered by a bone-rich bed with Nothosauria and Placodontia

Matias Reolid[1], Fernando Pérez-Valera[1], Michael J. Benton[2] & Ana Peña[1]

1) Dept. Geología, Universidad de Jaén, Campus Las Lagunillas sn 23071 Jaén, Spain
2) Dept. of Earth Sciences, University of Bristol, Wills Memorial Bld, Queen's Road, Bristol BS8 1RJ, UK

The Tabular Cover of the Iberian Massif in the Southeastern Palaeomargin is characterized by continental Triassic deposits in typical red bed facies over the Palaeozoic basement. The facies are mainly constituted by continental red sandstones and siltstones with gypsum-rich levels in the transition to Jurassic limestones. Carbonate horizons are scarce. The Triassic deposits (Chiclana de Segura Formation) were developed in a fluvial-coastal system during the Middle to Upper Triassic. This formation is 300 meters thick in the Puente Génave-Villarrodrigo area (east of the Jaén province, Spain), and constituted a monotone succession. This study is focused in a limestone bank located in the lower part of this formation, which is recognized along more than 30 kms. This bank presents a variable thickness (5-30 cm) and is recognized among red and green sandstones and siltstones. The base is usually constituted by a grey sandstone bed is composed by quartz, micas and scarce bioclasts in a micritic and shows sequences made of parallel lamination, high-angle cross lamination, hummocky cross lamination and wave-ripple lamination at the top. Some isolated marine vertebrate remains are registered. This energetic bed is very variable in thickness (0-50 cm) and in some outcrops it pinches-out rapidly in few meters.

The upper part of the carbonate bank is a limestone bed with a bioturbated base and abundant marine vertebrate fossil remains more abundant to the top. The microfacies is a packstone with abundant bioclasts (gastropods and bivalves) showing high fragmentation degree and imbrications. Quartz is an important component in the microfacies with increasing values to the top in a sequence of coarsening upwards. The fragments of the bones are mainly located in the top of the bed being isolated and fragmented pieces of Nothosauridae, Pachypleurosauridae, Placochelydae and Placodontidae. The more abundant remains are vertebrae, ribs, scapulae, tooth and osteoderms. These fossil bones are preserved as apatite with local malachitization and pyritization. The bones usually present broken surfaces, and in some cases rounded broken surfaces. The largest remains are less than 12 cm. In the Villarrodrigo sector this bed presents a dense accumulation of well-preserved small gastropods in the top surface. Above this limestone the sedimentation continues with red siltstones and sandstones.

The carbonate bank is interpreted as a marine deposit representing a high-energy event and records an exceptional marine flooding in a distal fluvial environment. In fact, this bed constitutes the only open marine deposits recognized in all the Villarrodrigo section. The sedimentary structures registered in the lower part of the bank are typical of storm deposits and indicate the deposition in a single episode, probably related with an exceptional storm (hurricane) or a tsunami. The fragmentation, uncoupling and dispersion of the vertebrate bones and the imbrications in the bioclasts are consistent with the high energy event which favoured the accumulation of bones according to their size and density. Storm deposits are typical in marine, epicontinental carbonates of Muschelkalk facies in the Betic Cordillera (Siles and Cehegín formations), but they had not been described in the Tabular Cover. The features of these deposits made them clearly distinctive in the continental and monotonous Triassic deposits of the Tabular Cover and therefore, these are a valuable tool for regional correlation. The importance of this bed is higher taking into account the abundance of the marine reptile remains since they are the only vertebrate remains registered in Triassic rocks from the Tabular Cover and Betic Cordillera (South Spain).

Actualistic experiments with wild brown bears (*Ursus arctos*) in the North Spain Mountains

M[a] Teresa Nohemi Sala[1], Juan Luis Arsuaga[1] & Gary Haynes[2]

1) Departamento de Paleontología. Universidad Complutense de Madrid and Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos. C/ Monforte de Lemos, 5. -28029-Madrid (Spain). Email: nsala@isciii.es
2) Department of Anthropology, University of Nevada, Reno, NV 89557, USA

Actualism is a very useful tool for taphonomic studies, as it allows understanding the behavior of the fauna in the past. In this work we present data obtained from experiments with wild brown bears from the Cantabrian Mountains in northern Spain.

There are some previous studies dealing with bears as taphonomical agents (Haynes, 1982, 1983; Saladiè et al., In press). Nevertheless, these usually refer to bears held in captivity. The aim of this study is to add new data on the wild bear behavior regarding its ability for transportation, dispersal and bone modification.

Working with wild bears is not an easy task in Spain. The scarce number of individuals and the frailty of their survival require a very careful treatment when experimenting with their behavior. For these experiments we have collaborated with FAPAS, a foundation for the protection of wild life. FAPAS has been doing for years a phototrap follow-up of the wild brown bear diet, and the problems that the current legislation regarding the spongiform encephalopathy disease has posed to the availability of domestic carcass as food for them.

Using phototrapping data from FAPAS, we present in this study a 3-year follow-up of the activity of the brown bear with 9 equid carcasses. This follow-up has allowed us to know for each of the carcasses what different carnivores have accessed it, in which cases it was bears that accessed it, and how many times they have done so. This has also allowed us to detail the wild bear general behavior regarding the peripheral transportation and consumption sequence.

In a second stage of the experiments, we went to the spots where the remains were left. Once there we measured their dispersal, and took the bones for the subsequent study of the tooth marks and fracture patterns on them.

The results show that the wild brown bears do not take the carcasses to their dens, but are able to perform their peripheral displacement of tens of meters before eating them, and then there is a dispersal of the remains some meters around the spot. On the other hand, the long bones of big-sized carcasses show no fractures, but they show tooth marks (scores, pitting, punctures and furrowing) on the cancellous bone of the epiphyses. Ribs and vertebrae show fractures and furrowing. Innominate bone shows also furrowing on the ilium and ischium cancellous bone.

The results of this study are in agreement with previous works and also shed some light on the behavior of this carnivore in the wild. The data gathered are of great importance when interpreting paleontological and archaeological sites where the bear is a likely taphonomical agent.

Acknowledgements: We would like to thank Ministerio de Educación (FPU grant AP2006-04737 to Nohemi Sala). This research was supported by the Ministerio de Ciencia e Innovación (CGL2009-12703-C03-03 project). To Francisco Gracia for his advice. We are grateful to FAPAS, especially to Roberto Hartasánchez, Monchu Magarán and Joaquín Morante.

References:

Haynes, G. (1982): Utilization and Skeletal disturbances of North American prey carcasses. Artic, 35, 266-281.

Haynes, G. (1983): A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones. Paleobiology, 9, 164-172.

Saladié, P., Huguet, R., Díez, C., Rodríguez-Hidalgo, A. & Carbonell, E. (Published online in Wiley Online Library). Taphonomic modifications produced by modern brown bears (*Ursus arctos*). International Journal of Osteoarchaeology.

……

Grazing activity as a taphonomic record of biotic interaction: A case study of a sea-turtle from the Late Jurassic of the Prebetic (South Spain)

Ana Santos[1], Eduardo Mayoral[1], Matias Reolid[2] & Michael J. Benton[3]

1) Dept. Geodinámica y Paleontología, Facultad de Ciencias Experimentales, Campus de El Carmen, Universidad de Huelva, Avda. 3 de Marzo, sn, 21071 Huelva, Spain.
2) Dept. Geología, Universidad de Jaén, Campus Las Lagunillas sn 23071 Jaén, Spain
3) School of Earth Sciences, University of Bristol, Wills Memorial Bld, Queen's Road, Bristol BS8 1RJ, UK

The study of bioerosion trace fossils has brought up, among other things, interesting insights into the ecological interactions between species. This research is focused on bioerosion traces on an Oxfordian turtle carapace from the Upper Jurassic of the Prebetic (Betic Cordillera, South Spain). The specimen was found in a limestone bed of a marl-limestone rhythmite in the Bimammatum Zone.

The carapace is 43 cm long and 34 cm wide. The remains are preserved as phosphate (francolite). The specimen is largely intact, with most of the elements of the carapace remaining fused in their original positions. The degree of fragmentation is low and appears largely to affect the distal parts of bones, which are fractured and not rounded. The plastron has collapsed into the cavity of the carapace.

On the external surface of the carapace are groups of pentaradiate grooves which cover it extensively, and which frequently overlap each other. The trace is composed of five grooves arranged in a star-shaped pattern. Each groove is rectilinear with a length between 3 mm and 10 mm and a width between 0.6 and 1.1 mm. The angle between radial scratches has an average value of 72º. The diameter of modular units varies between 6.5 and 10 mm. The plastron and other bones do not have trace marks on their surface.

The low degree of fragmentation and the low dispersion of skeletal components suggest a low-energy environment. This is congruent with the absence of any sedimentary structures indicating turbulence and is also supported by the microfacies comprising a fine-grained wackestone with peloids. Previous paleoecological and taphonomic studies on macroinvertebrate assemblages (primarily ammonoids) have indicated a low energy and low degree of fragmentation within a softground at a mid-shelf environment with an estimated palaeobathymetry of ~60-80 m (Olóriz et al., 2006). The unusual burial orientation of the specimen is possibly due to the post-mortem activity of scavengers. The fragmentation of some bones could also be related to scavenging activity by larger organisms, since the water energy was likely too low to attribute the breakage of bones (supported by the very low fragmentation present in ammonoids of the horizon). The plastron having was collapsed via sedimentary load. The distribution of bioerosion indicates preferential colonization of the carapace. The features of bioerosion are consistent with *Gnatichnus pentax* Bromley, 1975, produced by the grazing activity of regular echinoids. From an ethologic point of view, these structures belong to pascichnia (grazing structures). The external surface of the carapace was oriented downwards in the

bed, and so pascichnia activity probably occurred prior to the carapace being overturned. These grooves are interpreted by Bromley (1975) as browsing and foraging traces produced by dental erosion by regular echinoids. The major representatives of regular echinoids at today are *Sphaerechinus granularis, Paracentrotus lividus* and *Arbacia lixula*, and all of them live from the littoral zone to 30 m depth maximum. Nevertheless, the existence of an extensively browsed carapace of a turtle could indicate the presence of algal films in shallow-water environments.

References:

Bromley, R.G. (1975): Comparative analysis of fossil and recent echinoid bioerosion. Palaeontology, 18, 725-739.

Olóriz, F., Reolid, M. & Rodríguez-Tovar, F.J. (2006): Approaching trophic structure in Late Jurassic neritic shelves: a western Tethys example from southern Iberia. Earth-Science Reviews, 79, 101-139.

……

Exceptionally preserved upper bathyal assemblages from the Early Miocene of the Vienna Basin and their significance for the nautiloid habitat and life-style

Ján Schlögl[1], Régis Chirat[2], Natália Hudáčková[1], Vincent Balter[3], Michael Joachimski[4], Frédéric Quillévéré[2] & Andrzej Pisera[5]

1) Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University in Bratislava, Mlynská dolina, 842 15 Bratislava, Slovakia
2) Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, UMR CNRS 5276, Université Lyon 1, 27-43 Boulevard du 11 Novembre 1918, 69622 Villeurbanne Cedex, France
3) Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, UMR CNRS 5276, Ecole Normale Supérieure de Lyon, 46 Allée d'Italie, 69364 Lyon Cedex 07, France
4) North Bavarian Center of Earth Sciences, University of Erlangen-Nuremberg, Schlossgarten 5, 91054 Erlangen, Germany
5) Institute of Paleobiology, Polish Academy of Sciences, ul. Twarda 51/55, 00-818 Warszawa, Poland

Exceptionally preserved upper bathyal assemblages (< 200 m) collected at Cerová-Lieskové locality in the Western Slovakia (eastern margin of the central Vienna Basin) represent one of the most exceptional nautilid deposits reported so far. The deposits are massive, locally laminated calcareous clay and clayey silt with thin tempestites (up to 5 mm thick) and several thin sandstone layers. The age of the deposits is late Karpatian according to the regional stratigraphic scheme (latest Burdigalian). Microfossil assemblages consist of planktonic and benthic foraminifers, radiolarians, sponge spicules, ostracods, coleoid statoliths, fish otoliths, bathyal shark teeth and diatoms. Macrofossils are represented by fishes and multiple invertebrate groups, including small siliceous sponges, bivalves, gastropods, scaphopods, nautilids, coleoids, regular and irregular echinoids, star fishes, brittle stars, and crustaceans (decapods, isopods and barnacles). Plant debris, wood fragments, well preserved leafs and even ears are locally present. At least 2 demosponge species (most probably belonging to Polymastidae, Hadromedrida) and agglutinated foraminifers of the giant species of Bathysiphon genus are preserved intact but flattened. Other exceptionally preserved fossils are nautilid jaws with chitinous lamellae still present, similarly preserved coleoid jaws, organic black bands around the nautilid shell edge, articulated skeletons of several *Callianopsis* species, and articulated isopod moults with both parts of the exoskeleton preserved in situ. Scanning electron microscopy (SEM) reveals that individual shells are exceptionally well-preserved. Raman spectroscopy (Jobin Yvon, HR800) shows that maxima at 702

cm-1 and 706 cm-1 characteristic of aragonite occur in all bivalve, gastropod, scaphopod and Aturia specimens. Planktonic foraminifers exhibit a maximum at 713 cm-1 characteristic of calcite.

Palaeoenvironmental analyses are based on benthic foraminiferal associations and stable isotopes from gastropods, bivalves, scaphopods, nautilids and planktonic foraminifers. Two step equations estimating paleodepth on the basis of present-day distribution of foraminifers (Hohenegger 2005) indicate bathymetric range between 240 – 330 m, with extreme values ranging from 149 m to 498 m. Benthic Foraminiferal Oxygen Index shows that the sediments were deposited under dysoxic to low oxic conditions.

In addition to general rarity of the fossiliferous Miocene bathyal deposits and numerous new species described from the locality, this site is unique because it yielded abundant (about 500 specimens) and very well-preserved newly hatched as well as adult shells of the Tertiary nautilid genus *Aturia*, associated with upper and lower jaws. These assemblages represent the first unequivocal case of autochthonous nautilid deposits reported so far. Oxygen isotope ratios show that *Aturia* was nektobenthic during the whole ontogeny, similarly as Nautilus. However, in contrast to Nautilus, both newly hatched and adult *Aturia* lived at the same water depth and temperature (about 240-330m and 14.5-16°C) in which the eggs were laid. The dysoxic paleoenvironmental setting in which *Aturia* occurs in abundance may be interpreted in light of both the capacity of Nautilus to exploit/tolerate oxygen-depleted waters, and the molecular phylogenetic tree of cephalopodszuschi, suggesting plesiomorphic physiological traits associated with hypoxia tolerance. Since the last common ancestor of *Aturia* and *Nautilus* may be traced back at least into the Jurassic, this sheds new light onto the relative scarcity of Mesozoic and Cenozoic nautilids in well-oxygenated, epicontinental shelf deposits.

References:

Hohenegger, J., 2005. Estimation of environmental paleogradient values based on presence/absence data: a case study using benthic foraminifera for paleodepth estimation. Palaeogeography, Palaeoclimatology, Palaeoecology 217, 115-130.

……

Computer Tomography controlled decomposition process of a mole as a tool for the forensic taphonomy of fossil vertebrates

Achim Schwermann[1] & Michael Wuttke[2]

1) Steinmann-Institut, University of Bonn, Nussallee 8, D-53115 Bonn; Germany
2) Generaldirektion Kulturelles Erbe, Große Langgasse 29, D-55116 Mainz, Germany

In the record of aquatic fossil lagerstätten, one normally has to deal with a completely disarticulated (in a forensic sense) skeleton, which does not seem to give information on the decompositional process of the former soft and connective tissues of the skeleton.

To understand the maintenance of the post-dispositional movement of bones in the fossil record, it is necessary to understand the former different and deferred processes of soft tissue decomposition by autolysis and putrefaction; and the order of disarticulation or disintegration of connective tissue between bones.

Contemporary research on decomposition processes of vertebrates in an aquatic environment, made by forensics and palaeontologists, mainly describe observations which where

visible by the naked eye from the outside of the corpse. Internal decomposition processes which control the disarticulation of joints within the corpse are rarely documented in 2-D by X-rays by Richter (1994) and Wuttke (1983).

To reconstruct the forensic taphonomy of fossil vertebrates, information is needed in 3-D about the potential amplitude and deferred movement of skeletal elements within a corpse when the integument is intact, depending on gravity and putrefaction gases and possible hydrodynamics in the environment. The micro-CT analysis is an important tool for the study, because it is a non-destructive possibility, to documentthe inner-disarticulation.

Acknowledgements: We thank Thomas Martin and Julia Schultz for their supportive advice.

References:

Richter, A. (1994): Lacertilier aus der Unteren Kreide von Uña und Galve (Spanien) und Anoual (Marokko). Berliner geowiss. Abh., E14, 1-147; Berlin.

Wuttke, M. (1983): Aktuopaläontologische Studien über den Zerfall von Wirbeltieren. Teil I: Anura. - Senckenbergiana lethaea, 64 (5/6): 529-560; Frankfurt a.M.

……

Crows scavenging and preying upon burrowing echinoids on two tidal beaches in Brittany, France

Diedrich Sievers[1], Jan-Peter Friedrich[1+2] & James H. Nebelsick[1]

1) Department of Geosciences, University of Tübingen, Sigwartstraße 10, D-72076 Tübingen, Germany
2) State Museum of Natural History Stuttgart, Rosenstein 1, D-70191 Stuttgart, Germany

Burrowing irregular sea urchins from the species *Echinocardium cordatum* are widely distributed on the fine sandy beaches of Brittany in northwestern France. There have been a number of studies concerning predation on regular echinoids by various bird species, but observations on birds feeding on irregular sea urchins are rare. This is probably due to the fact that most of the irregular sea urchins are more or less deeply buried in the sediments of the deep eulittoral and upper sublittoral zone and so are out of the reach of birds living on the shore.

In this study, we investigated on two different beaches in Brittany, St. Efflam in northern Brittany and Morgat on the Crozon peninsula in eastern Brittany in February 2011. Both beaches host a comparable total species composition, with *E. cordatum* being sometimes quite abundant (St. Efflam: 1-4 specimens per 0,25m^2, Morgat: 3-26 sp. per 0,25m^2) in the lower shore parts with a high fraction of fine, oxygenated sands. Although there are some species of larger birds living on those beaches (var. sea gulls and crows) only crows seem to feed upon washed-out sea urchins. We observed the behavior of the crows while searching for prey, individuals feeding and we analyzed the remaining patterns on the feeding sites. The observed feeding patterns beak traces and characteristic broken and emptied tests of *E. cordatum*. Footprints of crows are also present. Those patterns can clearly be distinguished from those of sea gull which feed exclusively on mussels.

There are major differences in the taphonomy of the sea urchin remains between the two sites. The small *Echinocardium* of Morgat are preyed while still alive as the broken tests while the larger Individuals of St. Efflam beach are transported up the shore by the surf after death, are abraded on the oral side, are missing spines. Breakage of these tests is mostly restricted to the top

side of the individual, probably due to hydrodynamics transport properties of the test. Burrowing sea urchins of the species *Echinocardium cordatum* seem to be an important food source for crows living near the shore. Observed traces on feeding sites indicate that only crows feed exclusively on these sea urchins. Although the test breakage is more restricted in individuals from St. Efflam, the remaining thin shell fragments, complete tests or even bird footprints have almost no chance of preservation.

Acknowledgments: Museum of South Jutland, Department of Natural History and Paleontology and Department of Conservation. The Royal Danish Academy of fine Arts, School of Conservation. University of Copenhagen, Institute of Geography and Geology.

……

How taphonomy comes to use in conservation and preparation

Trine Sørensen

Department of Conservation, Museum of Southern Jutland, Fabriksvej 17-21, DK-6510 Gram, Denmark., trsr@museum-sonderjylland.dk

The palaeontological conservator can benefit greatly from many different academic fields, not least, taphonomy. Knowledge of how a fossil is preserved aid planning and execution of excavation, preparation, conservation and storage of the fossil.

Here examples are given from a case study of the preparation of a shark, *Cetorhinus sp.*, from the Late Miocene Gram Formation. The fossil consists of 11 vertebrae, a few complete and several fragments of gill rakers. Variations in mineral contents within the tissues of a single vertebra, some gill raker fragments and in the surrounding clay sediment were examined. Samples were taken for microscopy and XRD mineralogical analyses and for SEM/EDX and EMPA geochemical analyses.

On the excavation site taphonomic features, such as the succession of disarticulation as a result of decay, transportation, etc. provides better conditions for finding more material despite scattering of elements. The shark vertebrae were disarticulated, tipped over on the articular surfaces and spread over an area of several m^2. Local carbonate cementation, a greenish colour of authigenic glauconite and a rise in concentration of fragments of invertebrates, microfossils and faecal pellets indicated the presence of preserved shark material in the Gram Clay.

Diagenetic processes such as compaction, cementation and replacements decides the form of preservation and thus dictate the choice of preparation methods in the conservation lab. When working on fragile shark vertebrae, acid preparation can often help gently freeing the delicate structures. However, in the present study case, the presence of humidity sensitive pyrite aggregates of the framboidal crystal type within the fossil cause the method to be rejected in favour of mechanical preparation methods. Fragmentation of gill rakers occurs readily before sedimentation. Fragmentation and transportation processes make fragments difficult to find during excavation and even during preparation, and sieving of the sediment is necessary. Teeth and denticles of *Cetorhinus* are small and also hard to find without sieving.

The preserved parts of the Miocene vertebrae correspond to the secondary calcification of the vertebrae of the recent basking shark (*Cetorhinus maximus*). X-rays show the morphological types resemble each other. In thin sections the inner structures of the fossil vertebrae appear as weakly defined and porous as in the recent vertebrae. In this structure only partial

permineralization has occurred, causing the vertebrae to be fragile, fragments difficult to glue due to poor and diffuse fracture surfaces and not suitable for making casts. In contrast, the exoskeletal gill rakers still have the smooth, dense surface of the more resistant enameloid. Chemically, the vertebrae and gill rakers consist of apatite that contains fluorine as do recent shark apatites. No major replacements but various substitutions may have occurred. In addition, phosphates from either decomposed organic matter or dissolved apatite from the vertebra in the case study have precipitated as apatite along with the carbonates around the vertebra.

Because of the structure of the vertebrae and the lack of support from complete permineralization the shark fossil is susceptible to mechanical damage, and must be handled with the greatest care. Also unstable climate and high humidity degrade both fossils and sediment. Especially pyrite oxidation should be prevented. Shark vertebrae enclosed in carbonate concretions are better preserved and protected during storage than the ones without cementation. Consequently, fossil material embedded in Gram Clay without cementation should be prepared and conserved first.

Acknowledgments: Museum of South Jutland, Department of Natural History and Paleontology and Department of Conservation. The Royal Danish Academy of fine Arts, School of Conservation. University of Copenhagen, Institute of Geography and Geology.

……

Taphonomic comparison between large and small vertebrates in cave context (El Harhoura 2, Morocco): palaeontological, environmental and archaeological implications

Emmanuelle Stoetzel[1], Emilie Campmas[2], Christiane Denys[3], Patrick Michel[2], Bouchra Bougariane[4], Brahim Ouchaou[4], Mohammed Abdeljalil El Hajraoui[5] & Roland Nespoulet[1]

1) Muséum National d'Histoire Naturelle, Département de Préhistoire, UMR 7194, 01 rue René Panhard, 75013 Paris, France
2) PACEA-IPGQ, UMR 5199, Université Bordeaux 1, B18, avenue des facultés, 33405 Talence CEDEX, France
3) Muséum National d'Histoire Naturelle, Département Systématique et Evolution, UMR 7205, 55 rue Buffon, 75005 Paris, France
4) Université Moulay Ismail, Faculté des Sciences, Département de Géologie, BP 11201 Zitoune, Meknès, Morocco
5) Institut National des Sciences de l'Archéologie et du Patrimoine, angle rues 5 et 7 Rabat instituts, Madinat Al Irfane, Rabat Hay Riyad, Morocco

Recent studies on macro-, meso- and microfaunas in Morocco contribute to obtain new information on the palaeoenvironmental changes during Late Pleistocene and Holocene in this region. Taphonomic analysis of the faunal assemblages allows determining the origin of the accumulations and detecting biases of faunal preservation. However, large and small vertebrates of same levels are rarely studied simultaneously despite the complementary taphonomic and palaeontologic information that they can provide. Because taphonomic agents may act differently on both small and large vertebrate bones, and the latter can be buried in the same times, we employed a comparative approach. We present here the results of the taphonomic studies made on macro-, meso- and microfaunas of the levels 1 to 8 of the El Harhroura 2 cave (Rabat-Témara, Morocco; Late Pleistocene-Holocene). We first attempt to recover the taphonomic histories of pre- and post depositional processes of all vertebrates in order to compare and discuss the

different types of accumulations, as well as post-depositional processes having affected bones. At El Harhoura 2, in spite of anthropic marks on bones indicating sporadic human occupations, large carnivores (which have to be determined) seem to be the major accumulators of large mammals in almost all levels (except maybe Level 8). Remains belonging to mesofauna don't present anthropic marks, but several traces attributed to non human predators. Concerning small vertebrates, they were mainly accumulated by owls (*Bubo ascalaphus*, Levels 1, 7, 8) and diurnal raptors and/or small mammalian carnivores (Levels 3, 6). In Levels 2, 4 and 5, an unknown predator or several predators could have simultaneously or successively accumulated small vertebrates. Thereby, a large range of predators seems to have occured all along the stratigraphy. Bones of large, medium and small vertebrates display light weathering traces (cracks, splitting, desquamation) and rare trampling striations, indicating a relatively quick burying (< 5 years). On the contrary, neither rounding nor polishing by water was observed. Root marks are very numerous in all the material, but large mammal bones present a higher bias due to coating by sediments than for small vertebrate ones. Because of a lack of taphonomic referentials on north-african predators and post-depositional processes (weathering, burying) it is at present time difficult to characterise precisely the taphonomic biases and their impact on fossil communities. However, these biases are probably low and seem not to affect significantly the reliability of palaeoenvironmental reconstructions. Indeed, palaeoecological signals delivered by large and small mammals are very corroborating, indicating an alternation of arid (Levels 2, 5, 7) and relatively humid periods (Levels 1, 3, 4, 6, 8) at the end of the Quaternary in north-atlantic Morocco. We discuss these results at the light of a broader environmental and archaeological context in order to contribute to a better characterisation of the human occupations of this region.

……

Peculiar bivalve-serpulid association in the Sarmatian (Middle Miocene) reefs of the Medobory Hills (Ukraine)

Barbara Studencka[1] & Marek Jasionowski[2]

1) Polish Academy of Sciences Museum of the Earth in Warsaw, Al. Na Skarpie 20/26, 00-488 Warsaw, Poland
2) Polish Geological Institute – National Research Institute, ul. Rakowiecka 4, 00-975 Warsaw, Poland

Excellent bivalve record from the Early Sarmatian (Middle Miocene) reefs of the Medobory Hills provides new information about the environmental tolerance of the genus *Obsoletiforma* Paramonova. These reefs are composed of an unusual assemblage of skeletal organisms (serpulids and bryozoans) and calcite precipitates. The most noticeable is the absence of marine stenohaline taxa in these serpulid-microbialite reefs and the abundance and ubiquity of representatives of the genus *Obsoletiforma* (Studencka & Jasionowski, 2011). This Paratethyan endemic bivalve genus is inferred to spring from the genus *Cerastoderma* Poli (Nevesskaja et al., 2001).

Out of 12 bivalve species belonging to 4 families that inhabited the Sarmatian reefs, five species represent the genus *Obsoletiforma viz*., *O. lithopodolica* (du Bois), *O*. *gatuevi* (Kolesnikov), *O. sarmatica* (Kolesnikov), *O. volhynica* (Grischkevitsch) and *O. vindobonensis* (Laskarew). The species *O*. *gatuevi*, *O. lithopodolica* and *O. sarmatica* commonly occur in serpulid (or bryozoan) microbialite boundstone, the dominant facies of reefs. Locally these cockles are ubiquitous and formed oligotypic accumulations, whereas the occurrence of *O. volhynica* is largely restricted to the serpulid-microbialite frame consisting of superimposed bunches of semi-parallel serpulid tubes covered with microbialitic crusts. The species *O. volhynica* has not been reported from the Early Sarmatian calcareous buildups;

its thin, delicate, subquadrate in outline shells were earlier reported from the sandy facies. In contrast, the forms intimately associated with serpulid colonies are much longer (up to 30 mm in length), their shape having changed during the lifespan of the animal: in shells up to 12–14 mm in length the outline is subquadrate, while it is distinctly rhomboidal in larger individuals. It is highly likely that serpulid colonies provided very favourable environment for the settlement and growth of *O. volhynica*. Although volumetrically subordinate in the Sarmatian reefs, the serpulids played a key role in the reef frame construction. Serpulids are enormously opportunistic organisms, able to survive in environmental conditions characterized by a wide range of physicochemical parameters. They thrive on shallow sea bottoms, in waters with high, low or fluctuating salinities, and variable temperatures. Massive accumulations of serpulid tubes are typical of environments of high ecological stress that are inhospitable to other biota. Hence, the abundance and ubiquity of *O. volhynica* together with densely clotted serpulid colonies clearly illustrate that species was fully adapted to life in extremely stressed environments. It could show similar behavior to *Musculus sarmaticus* (Gatuev) observed together with it wherever the environmental conditions were sufficient to allow the growth of densely clotted serpulid colonies providing shelter for byssally attached bivalves.

The bivalve-serpulid association observed in the Sarmatian Medobory reefs proves that *Obsoletiforma* was apparently characterized by very high fertility typical of opportunists that rapidly colonize new habitats. It was able to thrive not only in near shore muddy gravel, muddy sand and sand substrates like modern representatives of *Cerastoderma* but also in reefal habitat.

Acknowledgement: This research has got partial financially support from the Polish Ministry of Science and High Education (project No 307 113 635).

References:

Nevesskaja, L.A., Paramonova, N.P. & Popov, S.V. (2001): History of Lymnocardiinae (Bivalvia, Cardiidae). Paleontological Journal, 35, supplement 3, S147–S217.

Studencka, B. & Jasionowski, M. (2011): Bivalves from the Middle Miocene reefs of Poland and Ukraine: A new approach to Badenian/Sarmatian boundary in the Paratethys. Acta Geologica Polonica, 61, 1-35.

……

Paleoecology and microfacies of a Cretaceous transgressive interval (upper Turonian to Coniacian, Northern Calcareous Alps)

Martin Studeny[1], Diethard G. Sanders[2] & Martin Zuschin[1]

1) University of Vienna, Department of Palaeontology, Althanstraße 14, A-1090, Vienna, Austria
2) University of Innsbruck, Institute of Geology and Paleontology, Innrain 52, A-6020 Innsbruck, Austria

In the Gosau Group of Brandenberg (Northern Calcareous Alps, NCA), an interval recording the turnover from a marine transgression characterized by carbonate-lithic shore zone deposits to establishment of an overall more quiet, shallow subtidal environment colonized by corals, rudists and skeletal sponges is studied.

In its lower part, the transgressive succession consists of carbonate-lithic shore zone deposits rich in well-rounded gravels to boulders derived from the local Triassic rock substrate; this interval is very poor in fossils. The transgressive package shows net fining-upward into parallel-laminated and cross-laminated carbonate-lithic arenites, respectively, that locally are fossiliferous (e.g., corals, skeletal sponges). This package is overlain by the interval studied in more detail herein.

The interval is characterized by floatstones to rudstones rich in large angular fragments and entire fossils of colonial corals, radiolitids, *Plagioptychus*, and hippuritids; in addition, alcyonarian sclerites, fragments of echinoderms (Echinoidea, Holothurioidea, Crinoidea), and clasts of corallinacean, solenoporacean and dasycladacean algae are common. This fossil assemblage records a shallow subtidal, ecologically favourable setting colonized by level-bottoms of corals, sponges and rudists and, perhaps, incipient patch reefs thereof. Development of frame reefs, however, was quenched by episodic high-energy events that lead to toppling and fragmentation of biocalcifyers. Relative to fossil assemblages from similar depositional settings of the Gosau Group, the studied interval shows an unusually high diversity of metazoan biocalcifyers.

……

$\delta^{18}O$ and time averaging on subtidal tanathocoenosis of *Mulinia coloradoensis*, Colorado River Delta, Baja California, Mexico

Miguel Téllez[1], Marla Itzel Macías[1], Guillermo Avila[1], Oscar González[1] & Karl Flessa[2]

1) Facultad de Ciencias Marinas, Universidad Autónoma de Baja California, km 103 carretera Tijuana-Ensenada, Ensenada, Baja California, México
2) Department of Geosciences, University of Arizona, Tucson, AZ 85721, USA

The ecology of the Colorado River delta has been severely disrupted by the diversion of water flow for use in human activities. One of the most noticeable evidence of this are impressive death assemblages of the once abundant endemic estuarine bivalve *Mulinia coloradoensis*, which are widely distributed along the delta's intertidal mudflats and coastal cheniers (Thompson, 1968, Kowalewski et al., 2000; Téllez et al., 2000). Several studies on these shell deposits have shown that taphonomic characteristics and Oxygen isotope have high potential for interpreting paleoenvironmental conditions before the damming of the river and the consequent impact on the delta ecology. However, little is known about the subtidal assemblages. This study is focused on subtidal tanathocoenosis of *M. Coloradoensis*, which were collected along 4 transects and 16 stations by dredging from a boat. Shells of juvenile organism were sieved and separated, picking two shells of each station by taphonomic aspect: one of evident "old" appearance, and the other one looking recent. Each shell was cutted, polished and mounted on a slide to see the growing lines. From the umbo and shell edge a sample was obtained by microdrilling for $\delta^{18}O$ analises. The objetive was to investigate if there are differences in the isotopic composition during the spawn and death of the organism related with time averaging and the former estuarine conditions. Results shown that isotopic composition varies from -4.44‰ to 3.96‰ in the umbo and -3.87‰ and 0.23‰ in the edge of recent shells; on the "old" ones the range was between -2.79‰ and -0. 95‰ in the umbo and -3.90‰ and -1.57‰ in the edge. Because more negative Isotopic values were expected for the old shells and close to the river mouth, many shells are not agree with this statment which is more evident in the intertidal environment. This suggest a more active time averaging in the subtidal dominate due to mixing and transport paralel to the coast by the strong tidal currents of the area.

Acknowledgments: We thank to Universidad Autónoma de Baja California project 360, and Conacyt project CB-2007-01-84710 for financial support.

References:

Téllez, M.A., Avila, G.Y. & Flessa, K.W. (2000): Significado paleoecológico de tanatocenosis de Mulinia coloradoensis en el delta del Colorado. XII Congreso Nacional de Oceanografía, Huatulco, Oax., Libro de resumenes, p. 137.

Thompson, R.W. (1968): Tidal flat sedimentation on the Colorado River Delta, northwestern Gulf of California. Geol. Soc. Amer. Mem., 107, 133 pp.

Kowalewski, M., Avila Serrano, G., Flessa, K.W. & Goodfriend, G.A. (2000): Dead delta's former productivity: two trillion shells at the mouth of the Colorado River. Geology, 28: 1059-1062.

……

Fossilization dynamic determined by rapid initial degradation and temporary sequestration: consequences for diversity in the fossil record

Adam Tomašových & Susan M. Kidwell

University of Chicago, Department of Geophysical Sciences, Chicago, IL 60637, USA

Dynamics of fossilization determined by magnitude and temporal constancy of degradation, reworking, and burial rates fundamentally affect the quality of the fossil record at local and regional scales, i.e., its temporal resolution, completeness, and stratigraphic disorder. Our quantitative understanding of these rates is limited by a relatively short temporal duration of experiments or natural observations of fossilization processes and by the fact that a temporal range of postmortem age of skeletal remains observed in sea-floor sediments significantly exceeds a temporal range expected if they undergo a simple exponential degradation. However, *distributions of postmortem ages of skeletal remains* exposed on the sea-floor that represent precursors of fossils allow us to quantify the preservation dynamic that determines the fossilization of skeletal remains *over several centuries and millennia*. Accounting for the fact that the time of final degradation of sampled skeletal remains is not available, we find that distributions of postmortem skeletal ages of two molluscan species each from four subfossil assemblages in the Southern California Bight can be explained by two-phase exponential degradation dynamic characterized by an initially very high degradation rate that is replaced by an order-of-magnitude slower degradation rate after several decades. Such time-heterogeneity in degradation rates is consistent with degradation processes that act at two temporal scales: shells rapidly degrade on the sediment-water interface and degrade relatively slowly when temporarily sequestered within deeper sediment layers. Time-varying degradation models have consequences for paleoecology and conservation biology because they predict that time averaging of fossil assemblages can be an order of magnitude larger than median survival time of individual shells. This decoupling between the expected survival time and the expected temporal range can simultaneously allow (1) high time averaging and (2) preservation of fragile species even when background degradation rates on sea-floor surface are high. Using the example from the Southern California Bight, we show that regional diversity is thus acquired more quickly by sampling death assemblages than by sampling living assemblages.

Early bioerosion in skeletal tissues: persistence through deep time

Gordon Turner-Walker

The Natural History Collections, Bergen Museum, University of Bergen, Postboks 7800, 5020 Bergen, Norway and Graduate School of Cultural Heritage Conservation, National Yunlin University of Science and Technology, 123 University Road Sec 3, Douliou, Taiwan

Microbial bioerosion is an important factor in the degradation of bones and teeth. Second to scavenging by vertebrates it probably represents one of the major determinants of the long-term preservation of skeletal material into deep time. Microbially mediated bioerosion is known to take place in a wide range of depositional environments: aerated soils, oxygenated fresh- and marine waters. In anoxic environments microbes will also colonise the porosity of bony tissues but they do not appear to directly degrade mineralized collagen. Although a number of known microorganisms have been identified that bore into mollusc shells and calcareous rocks, identification of which species are involved in the destruction of skeletal materials has not yet been established. Many possible culprits have been suggested, including algae, cyanobacteria, fungi and bacteria.

Microscopical alteration of ancient bone by boring microorganisms has been known since 1864 when the great Viennese pathologist and histologist Carl Wedl described the meandering labyrinth of tunnels that now bear his name. Similar features in fossil bones were observed by Roux in 1887 who called them "Bohrkanäle" and coined the name *Mycelites ossifragus* for the responsible microorganism. Later research has shown that tunnelling in bones and teeth can be categorised by their morphology as either: Wedl (attributed to fungi), linear longitudinal, budded and lamellate tunnelling, although any single bone section may exhibit several of these types. All of these tunnels have diameters around 5-10 µm. With the more widespread use of electron microscopy many of these features have been found to have a fine structure comprising numerous sub-micron tunnels with diameters between 400 nm and 800 nm. These small tunnels are confined to discrete zones, each 10–40 µm across, imparting a spongiform appearance to the affected bone and often are surrounded by a hypermineralised border. This latter tunnelling is most commonly identified in archaeological bones excavated from aerated soils. It is absent from bones excavated from below the water table and in bones from very cold climates. Conversely, bones from tropical soils are typically almost entirely consumed and fragmentary.

Several researchers have attempted to replicate the tunnelling seen in ancient bones by inoculating fresh bones with garden soil and incubating them for several weeks. Despite luxuriant fungal growth on and within the bone porosity the majority of these experiments have been inconclusive and none has successfully replicated the spongiform porosity that is the dominant feature of soil-buried bone. The warm, moist soils of the tropics constitute an ideal environment for actualistic taphonomic and diagenetic studies. Specimens of fresh bovine bone buried at a depth of one metre in both aerated and waterlogged soils for one year do show the very early stages of characteristic diagenetic features seen in ancient bones. More interestingly, the bone recovered from the aerated soil in this study suggests that a single causal organism can produce features matching several of the named tunnelling morphologies. These ongoing experiments, together with knowledge amassed by studying archaeological bones excavated from known burial environments, permit the reconstruction of the depositional histories of fossil bones through identifying successive waves of bone-colonising organisms.

Bioerosion of skeletal elements in marine environments is of extreme antiquity, with characteristic tunnelling having been identified in Cambrian conodonts. However, the antiquity of the soil bacteria responsible for the spongiform tunnelling seen in archaeological and sub-fossil bone is at present unknown. That these characteristic structures do survive through deep time is testified by their recognisable morphology in Miocene fossil bones. Future research hopes to trace the development of these organisms further into the geological past.

Fossilisation processes and timescales of bones and teeth – implications for geochemicial reconstructions of palaeoenvironment and taphonomy

Thomas Tütken

Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Poppelsdorfer Schloss, 53115 Bonn, tuetken@uni-bonn.de

Bones and teeth are often the only direct fossil remains of animals and humans and hence represent valuable archives for palaeobiology, palaeoecology and palaeoenvironment of fossil vertebrates. The bone and tooth microstructure is often well-preserved down to the µm-scale in fossil specimens recording growth marks and other histological features that are often used for life history reconstructions of extinct animals or humans. In contrast, the chemical composition of bones and teeth is often altered during the fossilisation process and biomolecules such as proteins or DNA are usually only preserved in Holocene or Late Pleistocene skeletal remains. The chemical, mineralogical and histological changes in fossil skeletal remains during diagenesis themselves are a valuable source of information in their own right. They enable us to characterise and quantify the post-mortem history, diagenetic milieu, taphonomic processes and the timing of fossilisation and hence to what extent the original chemical information stored in the bioapatite and the biomolecules has been altered or retained.

Diagenesis is a complex process that is very site specific, not linearly related with burial time but rather controlled by different external factors such as microbial attack, temperature, humidity, hydrology, pH, redox conditions of the burial environment but also the skeletal tissue itself. Because of chemical and structural differences bone, dentine and enamel and their respective organic and inorganic components are differently affected by fossilisation processes. Compared to bone, enamel has an order of magnitude larger bioapatite crystals, a low organic content and negligible porosity making it much less prone to diagenetic alteration. Thus enamel can preserve original isotopic compositions even over geological time periods. In contrast, bone is liable for diagenetic alteration. The degradation of the collagen by microbial attack and/or hydrolysis is one of the most fundamental and earliest alteration steps during bone diagenesis. The collagen loss changes the bone's porosity and leads to an exposure of the thermodynamically instable, nm-sized bioapatite crystals with a large and reactive surface area, leading to their dissolution and/or recrystallisation and hence an increasing apatite crystal size. This results in an intense chemical and isotopic exchange of the bone with the environment either by adsorption of ions, diffusion, ion exchange in the apatite lattice or by the precipitation of secondary minerals in bone pore spaces. The latter allow inferring of the physicochemical milieu prevailing within the bone and in its burial environment during their formation. Furthermore, microbial attack by bacteria or fungi occuring rapidly post-mortem is commonly observed in archaeological bone, resulting in characteristic tunnelling and destruction of the bone microstructure causing both collagen loss and a spatial redistribution of bone material. In contrast, most palaeontological bones do not show microbial alteration and often a have perfectly preserved bone microstructure making them valuable archives for palaeohistology. Hence bones, especially those weakened by microbial attack, have been dissolved and do not survive into the fossil record.

Those fossil bones surviving in the burial environment need appropriate physicochemical conditions (e.g., soil pH, hydrology) to achieve stability and were in the long term lithified by the diagenetic processes. Generally, during early bone diagenesis and bioapatite recrystallisation, the most intense chemical and isotopic exchange with the ambient diagenetic fluid takes place. This may lead to partial or even complete resetting of isotopic signatures and significant trace element and REE uptake, with the latter often considered to be restricted to only a few ten thousand of years. Recent radiometric Lu-Hf dating studies of fossil bones yielding younger Lu-Hf than their known stratigraphic ages, however,

clearly demonstrated open system behaviour and prolonged diagenetic REE/trace element uptake in fossil bones over millions of years. This implies that bone fossilisation processes last over geological not just millennial time scales as is commonly assumed.

……

.

From field collection to Phanerozoic diversity trends: multi-scale taphonomic biases in the fossil record of the echinoderms

Loïc Villier

Laboratoire de Géologie des Systèmes et des Réservoirs Carbonatés, Case 67, Bâtiment de Sciences Naturelles, 3 place Victor Hugo, 13331 Marseille, France

With approximately 17 000 occurrences of genera, the Paleobiology Database offers a reliable sample to explore the properties of the echinoderm fossil record. Individual collection records are described with information on lithology (carbonate, siliciclastic, mixed), sedimentary environment (coastal, shallow or deep subtidal), taphonomy (time averaged or snapshot deposits), and the type of fossil occurrences (complete skeletons, fragmentary material), that allow assessments of taphonomic biases.

The diversity of the echinoderm is counted as number of genera sampled per geological period or epoch draws. The diversity curve draws two cycles of increasing and decreasing richness, with peaks in the Silurian and the Upper Cretaceous, and shows low values during the Permian-Triassic transition and the Neogene. The taxonomic richness is correlated to sampling effort (number of collections) and the classical parameters recognized as taphonomic mega-biases (1st order sea-level changes, sediment availability), but most striking is the parallelism with the carbonate accumulation curve. Compared to other marine invertebrate groups, the echinoderms are significantly more common in collections with carbonates. The affinity to carbonates does not mean that echinoderms are more diversified or easily preserved in carbonates, but it rather reflects sampling and/or ecological biases.

The overall diversity pattern of the echinoderms is determined by crinoids in the Paleozoic and echinoids in the post-Paleozoic. Crinoids often occur as isolated skeletal elements but an accurate identification requires the preservation of complete bodies generally in snapshot deposits or restricted environments. The decreasing frequency of snapshot deposits in the Post-Paleozoic and a change in ecological affinities from shallow to deep waters during the Cenozoic should have alter the relevance of the fossil record. Echinoid can be preserved as complete bodies but occur more often as isolated skeletal elements and naked tests. The test plates are not fused altogether in the Paleozoic forms that remain difficult to identify when collected as isolated elements. In contrast, the tests are solid skeletal boxes, easy to identify in most post-Paleozoic Echinoidea. This implies a trend of increasing preservation potential that is reinforced by the radiation of infaunal forms since the Jurassic.

The asteroids and ophiuroids display parallel diversity curves that suggest a major control of taphonomy. The preservation of complete body fossils generally relies on burial through snapshot deposits and is restricted to occasional storm deposits from the intertidal to the upper offshore. Conversely, isolated skeletal elements are very common, easily extracted from poorly lithified sediments, but more difficult to identify at genus or species-level. The collections derived from time-averaged suites of skeletal elements sample more diversity. Whereas snapshot occurrences

are the rule throughout Paleozoic, the frequency of time-averaged collections increases during the Mesozoic, which overestimates the relative diversity.

The fossil record of holothurians is generally restricted to dermal sclerites found scattered into the sediments. The diversity of sclerite forms is assumed proportionate to the organismal diversity. Extraction of sclerites proceeds generally through the disintegration with acetic acids of carbonate rocks with limited diagenetic alteration. Such an uneven sampling strategy strengthens the links between the sampled diversity and the sedimentary record.

Large scale affinities of echinoderms to carbonates may derive from a preference to shallow tropical environments. The methods of sampling standardization widely used for correction of diversity data should reduce the biases implied by the uneven carbonate preservation. However, the taxonomic richness varies among groups, and within a group, according to their sensitivity to taphonomic biases. Combining the data of various taxa should add noise and complicate the extraction of an evolutionary signal.

……

Forensic Taphonomy of Carnivorous Dinosaurs from the Late Jurassic Solnhofen Archipelago

Michael Wuttke[1] & Achim G. Reisdorf[2]

1) Generaldirektion Kulturelles Erbe, Große Langgasse 29, D-55116 Mainz, Germany
2) Geologisch-Paläontologisches Institut Basel, Bernoullistrasse 32, CH-4056 Basel, Switzerland

Up to now, we only know about two dinosaurs (i.e. *Compsognathus longipes*, *Juravenator starki*) found in the lithographic limestone of the Late Jurassic Solnhofen Archipelago. Little attention has been given to the taphonomy of these small Solnhofen dinosaurs in a forensic taphonomic context.

To reconstruct the dynamics of decomposition and a possible disturbance of the primary anatomical context, one has to analyse all postdispositional agents, which could have influenced the postmortem fate of the dinosaurs.

In the fossil record, one normally has to deal with a completely disarticulated (in a forensic sense) skeleton, which does not seem to give information on the decompositional process of the soft tissues and the skeleton.

To understand the maintenance of the anatomical context or the post-dispositional movement of bones in the mentioned context, it is necessary to understand the following: 1) the different processes of soft tissue decomposition by autolysis and putrefaction; 2) the order of disarticulation or disintegration of connective tissue between bones; and 3) the potential amplitude of movement of skeletal elements in an aquatic environment, depending on gravity, putrefaction gases, hydrostatic pressure and hydrodynamics.

Using the techniques of forensic taphonomy, it is widely possible to reconstruct the taphonomic fate of *Compsognathus* and *Juravenator* and, furthermore, the palaeoenvironment where they came to rest.

Acknowledgements: We thank Ursula Göhlich und Helmut Tischlinger for their supportive advice.

References:

Chiappe, L.M. & Göhlich, U.B. (2011): Anatomy of *Juravenator starki* (Theropoda: Coelurosauria) from the Late Jurassic of Germany. N.Jb. Geol. Paläont., Abh., 258, 257-296.
Göhlich, U.B. & Chiappe, L.M. (2006): A new carnivorous dinosaur from the Late Jurassic Solnhofen archipelago. Nature, 440, 329-332.
Ostrom, J.H. (1978): The osteology of *Compsognathus longipes*. Zitteliana, 4, 73-118.

……

Taphonomy and paleoecology of land snail shelly assemblages

Yurena Yanes

Instituto Andaluz de Ciencias de la Tierra (CSIC-Universidad de Granada). Camino del Jueves s/n, 18100 Armilla, Granada, Spain. Email: yurenayanes@ugr.es

Land snails are ecologically relevant due to their crucial role as secondary producers within terrestrial ecosystems. Also they are socio-economically important for their potential use in gastronomy, pharmacy and agriculture. Indeed, multiple archeological evidences reveal that humans have exploited land snails in current and past civilizations. However, mollusks generally receive much less publicity and minor research efforts than other organisms, for instance vertebrates. Sadly, an alarming global decline of non-marine mollusks has been repeatedly documented, which indicates the necessity of further education, research and conservation management of this invertebrate group. The fossil record offers a unique opportunity to evaluate the effects of climate change and human impact upon terrestrial malacofaunas, both in space and time. Land snails are possibly the most abundant terrestrial invertebrates which are preserved in paleontological and archeological sites worldwide. Their fossil record appears to span back to the Carboniferous, although they are most abundant during the Quaternary. Many Quaternary land snail taxa are extant and therefore, modern analogous are often available. Since land snails interact with the environment and other organisms, variations in their taxonomic composition may be used as a paleoenvironmental and paleoecological proxy. However, this implies that fossil assemblages have reliably preserved the original biological signature, even with a number of physical-chemical and biological processes operating at different spatio-temporal scales. Quantitative taphonomic and paleoecological studies upon live, dead and fossil land snail assemblages are critical to evaluate the quality and fidelity of ancient shell accumulations. However, these kinds of studies are quite scarce and much research is needed toward understanding land snail shell burial processes and their potential use as proxies to reconstruct past ecosystems. This talk summarizes some recent findings about taphonomy, fidelity, time-averaging and the application of stable isotopes on terrestrial shelly assemblages and it outlines future directions in fossil land snail research investigations.

Mineralogical and geochemical diagenetic investigation of *Ursus ingressus* fossil bones

Nikoleta Zisi[1+2], Elissavet Dotsika[2], Evangelia Tsoukala[1] & Vasilis Pxycharis[1]

1) NCSR Demokritos, Institute of Materials Science, Aghia Paraskevi, 153 10 Attiki, Greece. nzissi@ims.demokritos.gr, edotsika@ims.demokritos.gr
2) Aristotle University, School of Geology, 54 124 Thessaloniki, Greece. lilits@geo.auth.gr, melfosv@geo.auth.gr

An extensive excavation in Loutra Almopias Cave brought to light a plethoric collection of fossil bones and teeth. The majority of the findings belong to the extinct species *Ursus ingressus* (Rabeder et al., 2004). Pleistocene cave bears are of great interest of both paleontological and geochemical point of view. The isotopic investigation of such findings is used for palaeoclimatic reconstruction and palaeodietary habits. The relative strong presence of cave bears in Europe renders them important for an extended palaeoclimatic study for the European continent. Nevertheless, a diagenetic investigation of the fossil samples is crucial in order to verify the reliability of the isotopic analysis.

The complex phenomenon of diagenesis over geological time involves physical, chemical, histological and mechanical alterations that occur at the post-mortem period to present and depend on the local taphonomic conditions.

During a concurrent isotopic study of the paleontological material a diagenetic investigation took place. The techniques used for the present study are well established, while a comparison of both modern (*Ursus arctos*) and fossil (*Ursus ingressus*) bears realized in order to arrange boundaries among the isotopically altered and non-altered fossil samples. 43 specimens of fossil and 6 specimens of modern bones were analyzed mineralogically using X-ray diffraction, while Fourier Transform InfraRed spectroscopy (FTIR) was used to clarify whether or not the carbon isotopic signal of bioapatite was exclusively biogenic. This was accomplished by examining the composition of the mineral fraction of fossil bones prepared for isotopic analyses (CO_3/PO_4) and comparing them with modern samples. The isotopic data used is presented thoroughly in Dotsika et al. (2011). The procedure for the preparation of the samples and the selection of the absorbance peaks was in accordance to Wright & Schwarcz (1996). The results of the study revealed that the alteration of the bones did not deteriorate the isotopic signature, which allows the use of the findings for palaeo-climatic and palaeodietary study.

Acknowledgments: The authors would like to thank Lecturer A. Godelitsas and Dr. Tzitzios Vasilios, for their crucial help and advices during the sample analyses, Mr. A. Giannakopoulos for modern samples proving.

References:

Dotsika, E., Zisi, N., Tsoukala, E., Poutoukis, D., Lykoudis, S. & Giannakopoulos, A. (2011): Palaeoclimatic information from isotopic signatures of Late Pleistocene *Ursus ingressus* bone and teeth apatite (Loutra Arideas Cave, Macedonia, Greece). Quaternary International, in Press.

Rabeder, G., Hofreiter, M., Nagel, D. & Withalm, G. (2004): New taxa of alpine cave bears (Ursidae, Carnivora). Cahiers scientif. / Dép. Rhône -Mus. Lyon, Hors série 2, 49–67.

Wright, L. & Schwarcz, P. (1996): Infrared and isotopic evidence for diagenesis of bone apatite at Dos Pilas, Guatemala: Palaeodietary implications. Journal of Archaeological Science, 23, 933-944.

Continental trace fossils around Lake Pannon (Upper Miocene, Central Paratethys)

Martin Zuschin[1], Mathias Harzhauser[2], Radovan Pipik[3] & Dušan Starek[4]

1) University of Vienna, Department of Palaeontology, Althanstrasse 14, A-1090 Vienna, Austria
2) Natural History Museum Vienna, Burgring 7, A-1010 Vienna, Austria
3) Geological Institute, Slovak Academy of Sciences, Dumbierska 1, 974 01 Banská Bystrica, Slovakia
4) Geological Institute, Slovak Academy of Sciences, Dúbravská cesta 1, SK-840 05 Bratislava, Slovakia

Trace fossils are well known from marine deposits but comparatively few studies exist from terrestrial, fluvial or limnic environments. The Central Paratethys is a case in point, because many ichnological studies were performed in its Middle Miocene marine fossil record, but virtually nothing is known from the Upper Miocene continental environments in and around Lake Pannon. We studied five conspicuous trace fossil associations in the Vienna basin in Austria, Slovakia, Czech Republic and Hungary each restricted to a specific time horizon and palaeoenvironment. The oldest trace fossil associations (11.2 My) were studied at Atzelsdorf (Lower Austria). The small-scale structures (mm-cm sized) are only known from sandy Delta plain deposits of the Palaeo Danube River north of Vienna and are tentatively related to the activity of insects. Similarly small trace fossils from tempestitic sandy layers of the Hypolimnion of Lake Pannon were investigated at Hennersdorf (Lower Austria). They were produced by burrowing infauna of unknown affinity, which incompletely mixed the sediments. Millimetre-sized potential fodinichnia (feeding structures) with some resemblance to *Chondrites* were observed in the hypo- and epilimnion of Lake Pannon at the locality Sopron (Hungary). Exceptionally large traces (cm-dm size), associated with small-scale irregularly corrugated burrows with chamber-like structures, forming a branching network are known from somewhat younger deposits at the locality Gbely in Slovakia and Hodonín in Czech Republic. They represent relatively nearshore and delta-influenced deposits of the Epilimnion of Lake Pannon. The traces are tentatively allocated to the *Thalassinoides* type and were probably either produced by crustaceans or vertebrates, but no body fossils were yet found. The stratigraphic sequence of these trace fossils potentially mirrors a continuous environmental change and is therefore of ecostratigraphic importance.

Author Index