8th International Meeting on Taphonomy and Fossilization

14-17 September 2017

Vienna, Austria

Programme and Abstracts

Editors: Martin Zuschin, Mathias Harzhauser & Susanne Mayrhofer

Organizing Committee

Martin Zuschin (University of Vienna)

Mathias Harzhauser (Natural History Museum Vienna, Austria)

Scientific Committee

Paolo Albano (University of Vienna, Austria)

Julio Aguirre (University of Granada, Spain)

Davide Bassi (University of Ferrara, Italy)

Björn Berning (Oberösterreichisches Landesmuseum Linz, Austria)

Juan Carlos Braga (University of Granada, Spain)

Stefano Dominici (University of Florence, Italy)

Andreas Kroh (Natural History Museum Vienna, Austria)

James Nebelsick (University of Tübingen, Germany)

Adam Tomasovych (Slovak Academy of Sciences, Bratislava, Slovakia)

Jörn Peckmann (University of Hamburg, Germany)

Field trip organizers

Mathias Harzhauser (Natural History Museum Vienna, Austria)

Oleg Mandic (Natural History Museum Vienna, Austria)

Martin Zuschin (University of Vienna)

Contents

Taphos 2017
Programme (Overview)

Thursday, 14 September

Pre-meeting excursion, Neogene of northern Vienna basin and Eggenburg. Departure 8 am; meeting point is the side entrance of the Natural History Museum (NHM) Vienna, Burgring 7 (see maps 1 and 2); return to the NHM at 6 pm.

Icebreaker at Natural History Museum (use main entrance to the museum, see maps 1 and 2); starts at 6 pm (registration is possible during Icebreaker).

Friday, 15 September

All events of this day take place at the Geocenter of the Univ. of Vienna, Althanstrasse 14, 1090 Vienna (see maps 1 and 3)

Registration (starting at 8 am)

Opening of the meeting at 8.45 am at Lecture Hall 2 (HS2) of the Geocenter

Scientific sessions (talks and posters), starting at 9 am, Lecture Hall 2 (HS2), Geocenter

Evening barbecue at the Geocenter, starting at 6 pm

Saturday, 16 September

Scientific sessions (talks and posters), starting at 9 am, Lecture Hall 2 (HS2), Geocenter, Althanstrasse 14, 1090 Vienna (see maps 1 and 3).

Closing of the meeting and future plans, starting at approximately 3.45 pm

Dinner at a Viennese Heurigen (traditional wine tavern), starting at 8 pm (see maps 1 and 4)

Sunday, 17 September

Post-meeting excursion, Neogene of southern Vienna basin. Departure 8 am; meeting point is the side entrance of the Natural History Museum (NHM) Vienna, Burgring 7 (see maps 1 and 2); return to the NHM at 6 pm.

Taphos 2017

Scientific programme

(**Bold names** indicate presenters)

Friday, 15 September 2017

8.00	Registration
8.45-9.00	Welcome and opening

9.00-9.30 Keynote lecture
Magnus Ivarsson
The fossil record of igneous rock

Friday first morning session
Chair: Juan C. Braga

9.30-9.45	**Miguel Iniesto**, Christophe Thomazo, Emmanuel Fara, Emmanuelle Vennin, Nicolas Olivier, Gilles Escarguel and Arnaud Brayard *Exceptional preservation of the Paris Biota (Spathian, USA), the oldest Early Triassic marine Konservat-Lagerstätte*
9.45-10.00	**Clément Jauvion**, Sylvain Bernard, Pierre Gueriau and Sylvain Charbonnier *Unravelling fossilisation processes in the La Voulte-sur-Rhône Lagerstätte from the study of exceptionally preserved crustaceans*
10.00-10.15	**Patrick Meister** *Primary dolomite formation on a Triassic coastal alluvial plain*

10.15-11.00 coffee break and posters

Friday second morning session
Chairs: Davide Bassi & Emilia Jarochowska

11.00-11.15	**Julio Aguirre**, Oscar Ocaña, Rosa Domènech, Jordi Martinell, Eduardo Mayoral, José Noel Pérez-Asensio and Ana Santos *Concentrations of cnidarians in early Pliocene deposits of the Manilva Basin (Málaga, SW Spain)*
11.15-11.30	**Mathias Harzhauser**, Ana Djuricic, Oleg Mandic, Martin Zuschin and Norbert Pfeifer *Taphonomy and population structure of an early Miocene Crassostrea shell bed based on the analysis of 3D point cloud data*
11.30-11.45	**James H. Nebelsick** and Jeffrey T. Thompson *Taphonomy and sedimentation of mass accumulations in siliciclastic dominated environments: A case study from the Miocene echinoid dominated Button Beds in Central California*
11.45-12.00	**Susanne Mayrhofer**, Alexander Lukeneder and Leopold Krystyn *Depositional conditions of Carnian ammonoid shell-concentrations decoded by applying 3D-visualization-techniques combined with classical taphonomic analyses*
12.00-12.15	**Juan C. Braga** and Fernando Sola *An exceptional concentration of empty aragonite-shell molds (Quaternary, Almería-Níjar Basin, SE Spain)*

12.15-12.30 **Theresa Nohl**, Axel Munnecke and Emilia Jarochowska
Taphonomic bias in limestones and marls – a quantitative palaeontological approach to the genesis of limestone-marl alternations

12.30-14.00 lunch break

14.00-14.30 Keynote lecture
Silvia Danise
Taphonomy of large marine vertebrates: from modern whale falls to the fossil record

Friday first afternoon session
Chair: Björn Berning

14.30-14.45 **Raúl Esperante** and Orlando Poma
Marine mammal preservation in a siliciclastic transgressive succession, Middle Miocene Pisco Formation, Perú

14.45-15.00 **Caitlin E. Syme**, Stephen F. Poropat, Jay P. Nair and Travis Tischler
Taphonomy of the sauropod dinosaur Austrosaurus mckillopi type individual: a short-lived saurian deadfall in the Early Cretaceous Eromanga Sea

15.00-15.15 **Karina Grömer**
Organic remains from archaeological contexts. Forensic taphonomy applied to prehistoric graves

15.15-16.00 coffee break and posters

Friday second afternoon session
Chairs: Adam Tomašových & Paolo G. Albano

16.00-16.15 **Diego A. García-Ramos** and Martin Zuschin
Cycles of brachiopod pavements in a Pliocene mixed carbonate - siliciclastic Prograding Wedge (SE Spain): implications for sequence stratigraphy

16.15-16.30 **Emilia Jarochowska**, David C. Ray, Philipp Röstel, Graham Worton and Axel Munnecke
Harnessing the stratigraphic bias at the section scale: conodont diversity in the Homerian (Silurian) of the Midland Platform, England

16.30-16-45 **Rafał Nawrot**, Daniele Scarponi, Michele Azzarone, Alessandro Amorosi, Jacalyn M. Wittmer, Troy A. Dexter, Kristopher Kusnerik, Roger W. Portell and Michał Kowalewski
Apparent mass extinctions produced by stratigraphic architecture

16.45-17.00 **Vanessa Julie Roden** and Wolfgang Kiessling
Abundant taxa determine beta diversity

17.00-18.00 poster session

18.00-22.00 barbecue

Saturday, 16 September 2017

9.00-9.30 Keynote lecture
Michael Stachowitsch
Death, Destruction & Mayhem – Anoxia revisited

Saturday first morning session
Chairs: James H. Nebelsick & Oleg Mandic

9.30-9.45	**Paolo G. Albano**, Ivo Gallmetzer, Alexandra Haselmair, Adam Tomašových, Michael Stachowitsch and Martin Zuschin *Historical ecology of the introduction of the alien bivalve Anadara transversa in the Adriatic Sea*
9.45-10.00	**Adam Tomašových**, Ivo Gallmetzer, Alexandra Haselmair and Martin Zuschin *Evaluating mixing, burial and production of mollusks during the Holocene on the NE Adriatic shelf (southern Gulf of Trieste)*
10.00-10.15	Madhura Bhattacherjee, **Devapriya Chattopadhyay**, Bidisha Som and Ammu Sankar *Reliability of death assemblages in predicting depositional processes: Insights from a modern tropical siliciclastic marine setting*
10.15-10.30	**Johann Hohenegger** *New methods for comparing living associations and death assemblages*

10.30-11.15 coffee break and posters

Saturday second morning session
Chairs: Julio Aguirre & Devapriya Chattopadhyay

11.15-11.30	**Tobias B. Grun** and James H. Nebelsick *Taphonomy as a proxy for stable shell constructions*
11.30-11.45	**Oksana Malchyk** *Nautilid taphomorphs as a source of palaeobiological information: an example from the Upper Cretaceous of Poland*
11.45-12.00	**Wolfgang Eder**, Johann Hohenegger and Antonino Briguglio *Limitation of biometric studies on Heterostegina due to mixing of different megalospheric morphotypes*
12.00-12.15	**Julian Huemer**, Steffen Kiel, Jörn Peckmann and Martin Zuschin *Brachiopod Communities within Tectonic Crevices in the Upper Triassic Dachstein Formation*
12.15-12.30	**Michał Krobicki** *Taphonomic record of Mesozoic crustacean remains – Late Jurassic (Oxfordian) and Early Cretaceous (Valanginian) case studies*

12.30-14.00 lunch break

14.00-14.30 Keynote lecture
Alfred Galik
Animal remains and their potential in prehistorical and historical contexts

Saturday afternoon session
Chair: Silvia Danise

14.30-14.45	**Patrick J. Orr**, Laetitia B. Adler, Susan R. Beardmore, Heinz Furrer, Maria E. McNamara, Enrique Peñalver and Ragna Redelstorff *"Stick 'n' peel": how unusual patterns of disarticulation and loss of completeness in fossil vertebrates originate as a result of carcasses adhering to the substrate during decay*
14.45-15.00	**Oleg Mandic**, Daria Carobene, Mathias Harzhauser, Ursula B. Göhlich, Reinhard Roetzel, Christoph Spötl and Michael Meyer *Taphonomy of the Bullendorf mammoth site in Lower Austria*
15.00-15.15	M. Dolores Pesquero, Dores Marin-Monfort and **Yolanda Fernández-Jalvo** *Substrates, microbes and preservation*
15.15-15.45	coffee break and posters
15.45-17.00	closing of the meeting and future plans
20.00	Dinner at a Viennese Heurigen

Posters

(**Bold names** indicate presenters)

Gáspár Albert**, Gábor Botfalvai** and Attila Ősi: *Making high resolution 3D model of a bonebed from GPS data to assist taphonomical analyses - case study of the Santonian vertebrate site of Iharkút (Hungary)*

Alejandra M. Andrada, **Dario G. Lazo** and Graciela S. Bressan: *Taphonomy of axiid decapods within early diagenetic carbonate concretions from the Agrio Formation (Lower Cretaceous), Neuquén Basin, west-central Argentina*

Davide Bassi, Juan C. Braga, Julio Aguirre, Masato Owada, Jere H. Lipps, Hideko Takayanagi and Yasufumi Iryu: *Relations between landlords and tenants: modern macroid/rhodolith growth rate and boring bivalve activity*

Davide Bassi, Renato Posenato, James H. Nebelsick, Masato Owada, Enrica Domenicali and Yasufumi Iryu: *Rare example of boreholes in Lower Jurassic marine shallow-water lithiotid bivalves*

Mélani Berrocal-Casero, Fernando Barroso-Barcenilla and Fernando García Joral: *Diagenetic compression as a key to interpret life position in brachiopods*

Mélani Berrocal-Casero, Julia Audije-Gil, Juan Alberto Pérez-Valera, Vanda F. dos Santos and Manuel Segura: *First data on micropreservation of the Middle Triassic Vertebrate remains of Riba de Santiuste area (Guadalajara, Spain)*

Giulia Bosio, Elisa Malinverno, Anna Gioncada, Karen Gariboldi, Daniela Basso, Thomas DeVries, Claudio Di Celma, Sergio Andò, Fabrizio Berra, Mario Urbina and Giovanni Bianucci: *Taphonomic and diagenetic history of the Miocene mollusks in the Pisco Formation Fossil-Lagerstätte (Ica Valley, Peru)*

Gábor Botfalvai and Attila Ősi: *Ankylosaur mass death assemblage from the Late Cretaceous of Iharkút (Hungary) and its effect on an ancient river ecosystem*

Valentina Brandolese, Davide Bassi and Renato Posenato: *Taphonomic analysis of Lower Jurassic larger-bivalve accumulations in the Trento Platform*

Claudia Buhlemann, Davide Bassi and **James H. Nebelsick:** *Microtaphofacies of Upper Oligocene ramp depositional systems from Northern Italy*

Francisco José Poyato-Ariza, Hugo Martín-Abad, Anabel López-Archilla, Michael Pittman, Miguel Iniesto, Thomas G. Kaye and **Ángela D. Buscalioni:** *Combining experimental taphonomy, laser-stimulated fluorescence imaging, and exceptional fossils: fish eyes from Las Hoyas (Early Cretaceous, Spain)*

Gabriela Calábková, Martin Ivanov and Jiří Chlachula: *Microbial alterations of Late Pleistocene fossil mammal bones from permafrost environments of northern Yakutia (NE Siberia)*

Patricia Canales Brellenthin, Yolanda Fernández Jalvo and **Paloma Sevilla:** *How does digestion affect bat bones? An experimental approach*

Tarcila Franco, **Davide Bassi**, Alex Cardoso Bastos and Gilberto M. Amado-Filho : *Taphonomic process interaction in mesophotic rhodoliths from the Vitoria Trindade Seamount Chain, South Atlantic*

Sara García-Morato and **Yolanda Fernández-Jalvo:** *Small mammal taphonomy from PRERESA Late Pleistocene riverside site (Madrid, Spain)*

Tobias B. Grun: *Learning from the present, understanding the past: drill hole recognition for the fossil record*

Darío G. Lazo, Mariano Remírez, Ernesto Schwarz and Ben Thuy: *Taphonomy of brittle stars associated with a tempestite bed from the Lower Cretaceous Agrio Formation of the Neuquén Basin, west-central Argentina*

Oscar Emilio Rodrigo Lehmann, Osvaldo Velan and **Darío G. Lazo:** *CT scanning as a tool for taphonomic analysis of shell beds: a case study on small irregular echinoid concretionary accumulations from the upper Hauterivian of the Neuquén Basin, west-central Argentina*

Oksana Malchyk, Magdalena Łukowiak and Marcin Machalski: *Sponge borings on the Late Cretaceous nautilids from Poland and western Ukraine: taphonomic implications*

Dores Marin-Monfort, Ana Fagoaga, Cristo M. Hernández, Bertila Galván and **Yolanda Fernández-Jalvo**: *Small mammal taphonomy of Unit Xb from El Salt Middle Palaeolithic site of Eastern Iberia*

Rafał Nawrot and Barbara Studencka: *Museum collections versus standardized bulk samples: a case study of the Middle Miocene bivalves from Vanzhuliv and the Zhabiak ravine (western Ukraine, Central Paratethys)*

Jan-Filip Päßler, Kristina Weber, Anna Sabbatini, Alessandra Negri, Jan Steger, Martin Zuschin, Bella S. Galil and Paolo G. Albano: *Biotic and abiotic changes of the Mediterranean shelf of southern Israel*

Alexander H. Parkinson, **Yolanda Fernández-Jalvo** and Peter Andrews: *Global weathering: the experiment and the protocols*

Katarzyna Płonka, Alfred Uchman and Michael A. Kaminski: *Taphonomy of the large foraminifer Arthrodendron Ulrich, 1904 based on physical experiments*

Poma Porras Orlando Alan and Kevin E. Nick: *Taphonomy and paleoenvironmental conditions of whales skeletons in cross section from Cerro Tinajones and Cerro el Buque near of the base in the Pisco Formation (The miocene/pliocene), Ocucaje, Ica Perú*

Renato Posenato, Michele Morsilli, Davide Bassi and Stefania Guerzoni: *Taphonomy of lower Aptian (Cretaceous) Chondrodonta (Bivalvia) carpets in the Apulia Carbonate Platform (Gargano Promontory, southern Italy)*

Alejandra Rojas, Mariana Demicheli and Sergio Martínez: *Taphonomy of the Late Pleistocene marine molluscan assemblages from Uruguay*

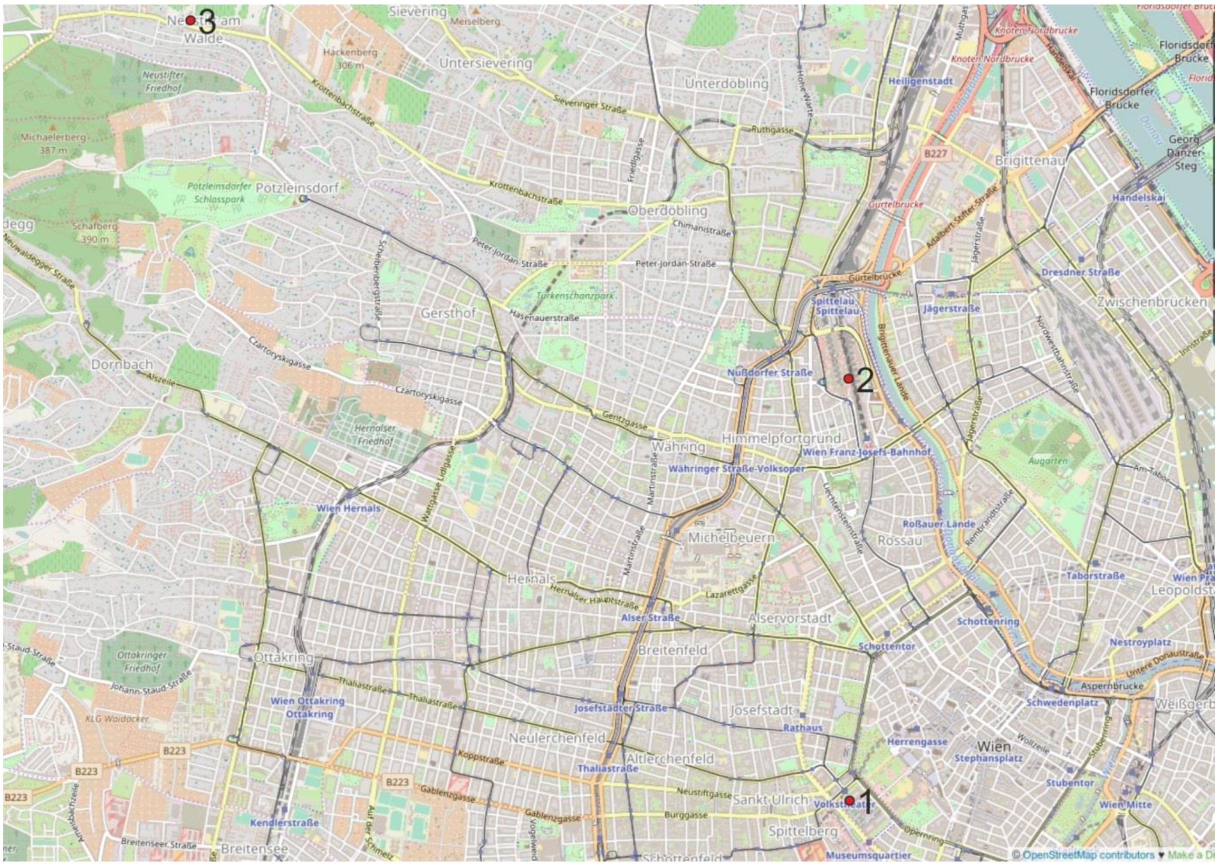
Lucía Rueda Domínguez, Dolores Pesquero, Dores Marin-Monfort and **Yolanda Fernández-Jalvo:** *Comprehension of small compression!*

Frederico Tapajós de Souza Tâmega, Paula Spotorno-Oliveira, Ricardo Coutinho, Paula Dentzien-Dias, Leandro Manzoni Vieira and **Davide Bassi:** *First occurrence of shallow-water macroids on the southern coast of Brazil*

Martin Ubilla, Andrés Rinderknecht and Mariano Verde: *Taphonomy and Late Pleistocene-Early Holocene mammal extinction (southern Uruguay, South America)*

Sven Zille, Tobias B. Grun and **James H. Nebelsick:** *Post-mortem encrustation patterns of Clypeaster rosaceous tests from San Salvador, The Bahamas and their effects on preservation potentials*

Map 1
(City map with sites of the meeting)



1 Natural History Museum Vienna, Burgring 7, 1010 Vienna
- Starting point for pre- and post excursion (Thursday and Sunday)
- Site of the Icebreaker (Thursday evening)

2 Geocenter, UZAII, University of Vienna, Althanstrasse 14, 1090 Vienna
- Scientific sessions (Friday and Saturday)
- Barbecue (Friday evening)

3 Heurigen Fuhrgassl-Huber, Neustift am Walde 68, 1190 Vienna
- Conference dinner (Saturday evening)

Map 2
(Natural History Museum Vienna)

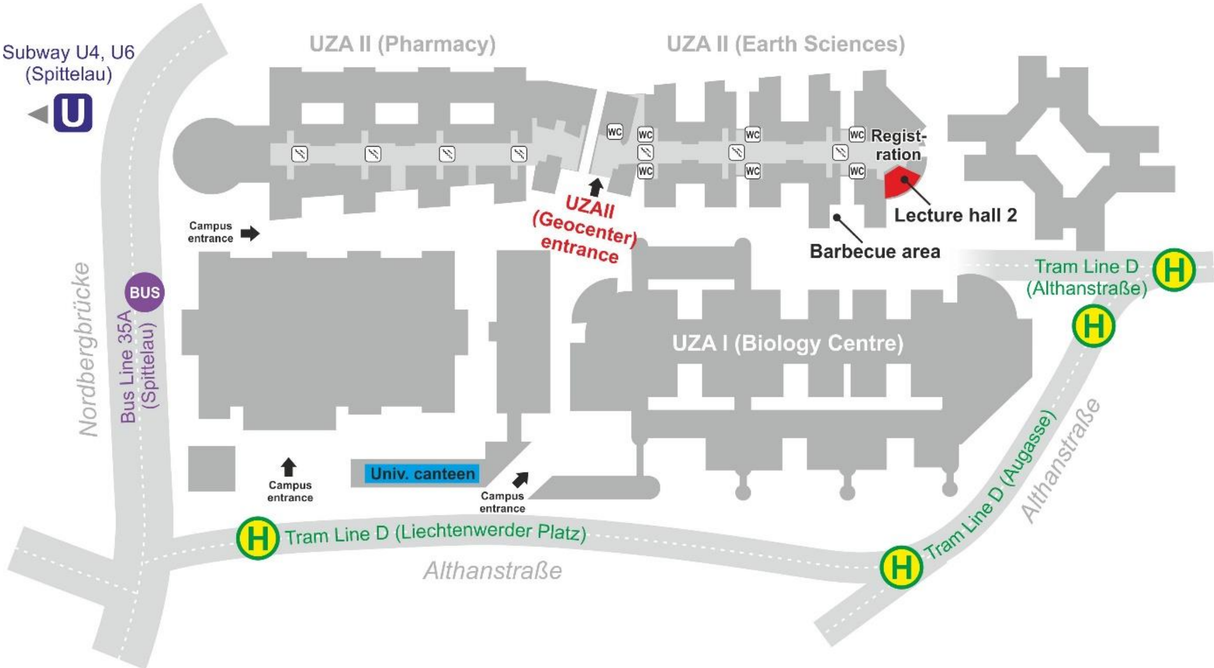
Natural History Museum Vienna, Burgring 7, 1010 Vienna

Starting point for pre- and post-excursion (side entrance)

Site of the Icebreaker (main entrance)

To reach the museum use subway line U2 or U3 and exit at station Volkstheater.

Map 3
(Geocenter, University of Vienna)



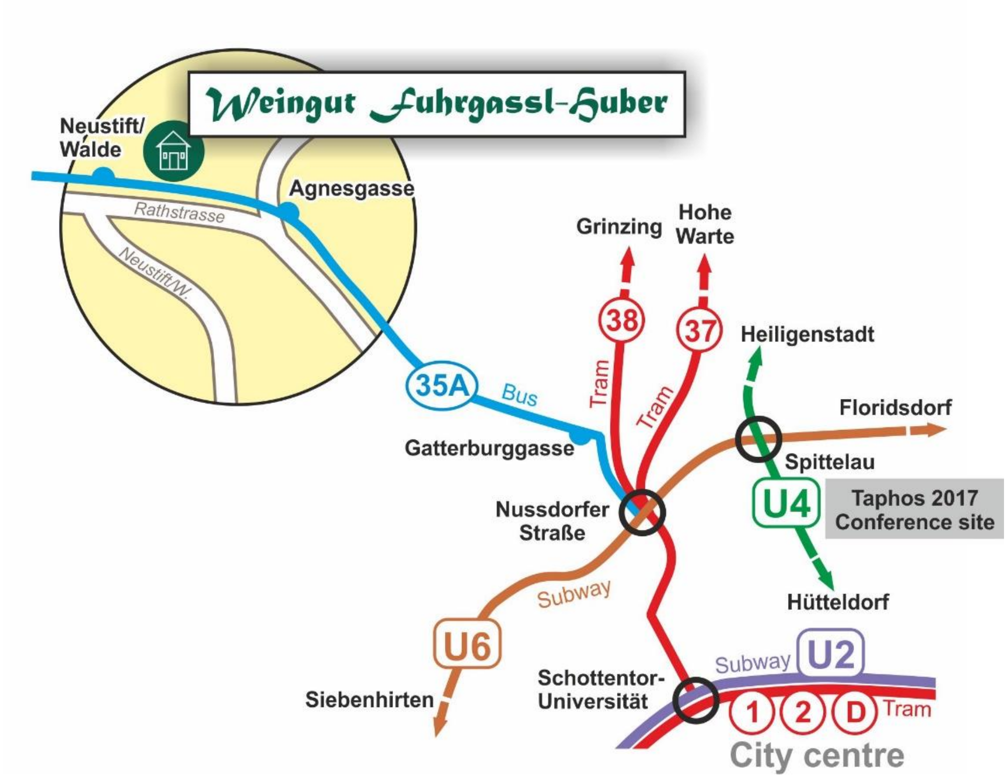
Geocenter, UZAII, University of Vienna, Althanstrasse 14, 1090 Vienna

Scientific sessions

Barbecue

To reach the Geocenter use subway line U4 or U6 and exit at station Spittelau. Alternatively, you may want to use tramway D and exit at station Liechtenwerder Platz.

Map 4
(Heurigen Fuhrgassl-Huber)



Heurigen Fuhrgassl-Huber, Neustift am Walde 68, 1190 Vienna
Conference dinner (Saturday evening)

The conference dinner takes place at the "Weingut Fuhrgassl-Huber", a traditional Viennese wine tavern. To reach the Heurigen use the bus 35A (enter either at station Spittelau or at station Nußdorfer Straße) and exit at station Neustift am Walde (after a ride of about 30 minutes). From there it is a one-minute walk (ca. 50 meters).

For the return trip we also recommend using bus line 35A (last trips: 23:40, 23:55) and the subway or a taxi service (e.g. 0043-1- 31300, -40100, -60160).

Abstracts

Concentrations of cnidarians in early Pliocene deposits of the Manilva Basin (Málaga, SW Spain)

Julio Aguirre[1], Oscar Ocaña[2], Rosa Domènech[3], Jordi Martinell[3], Eduardo Mayoral[4], José Noel Pérez-Asensio[5] and Ana Santos[1]

[1] Dpto. Estratigrafía y Paleontología, Facultad de Ciencias, Campus de Fuentenueva s.n. Universidad de Granada, 18002 Granada
[2] Dpto. de Biología Marina, Fundación Museo del Mar, Muelle España s/n, 51001, Ceuta
[3] IRBio (Biodiversity Research Institute). Dpt. de Dinàmica de la Terra i de l'Oceà, Facultat de Ciències de la Terra, Universitat de Barcelona (UB), Martí Franquès s/n, E-08028 Barcelona
[4] Dpto. Ciencias de la Tierra, Facultad de Ciencias Experimentales, Universidad de Huelva, Campus de El Carmen, Avd. 3 de Marzo, s/n, 21071 Huelva
[5] GRC Geociències Marines, Dpt. de Dinàmica de la Terra i de l'Oceà, Facultat de Ciències de la Terra, Universitat de Barcelona (UB), Martí i Franquès s/n, 08028 Barcelona

Early Pliocene deposits cropping out close to the present-day Málaga coast (S Spain) contain a rich and abundant fossil record. Molluscs are, by far, the most abundant group followed by cnidarians, barnacles, brachiopods, echinoids, and vertebrates. These highly diversified assemblages were favoured by the presence of upwelling currents linked to superficial Atlantic waters flowing eastwardly into the Mediterranean Sea through the Strait of Gibraltar. In the Manilva Basin (W Málaga), early Pliocene deposits are notably dominated by cnidarians belonging to the orders Scleractinia and Alcyonacea. This study focuses on the taxonomic composition of the cnidarian assemblages and their preservation features in order to provide clues on the palaeoecological settings in which these fossil assemblages formed.

During the early Pliocene, the Manilva Basin was a small embayment in the north-west margin of the Alborán Sea (Western Mediterranean). An intensively karstified relief, called the Sierra de la Utrera, formed by Mesozoic carbonates and Oligocene-Miocene turbiditic sandstones and marls that emerged in the centre of the basin. Early Pliocene deposits surround the relief and in its middle part, where they fill up karstified cracks with vertical walls linked to joints and faults. Two sections where cnidarians are particularly abundant were logged: 1) Canuto de la Utrera section, located in the centre of the Sierra de la Utrera, and 2) Los Álamos section, in the eastern part of the sierra. Cnidarian taxa identified in both sections include the scleractinians *Flabellum* cf. *macandrewi*, *Madrepora oculata*, *Dendrophyllia ramea*, *Asterosmilia marchadi*, *Asterosmilia* sp., and *Coenosmilia fecunda*, as well as scarce internodes of bamboo corals, gorgonians of the family Isididae (most likely *Lepidisis* cf. *longiflora*), and rare fragments of holdfasts attributed to gorgonians of the family Primnoidae.

In the Canuto de la Utrera section, the early Pliocene deposits consist of homogeneous yellowish clays with a *Neopycnodonte* shell bed 2 m thick intercalated in the middle part of the section. Barnacles, as well as corals, are associated with the bivalves. Cnidarians are widespread in the clays. The most abundant taxa are the semiinfaunal corals *Flabellum* cf. *macandrewi* and *Asterosmilia* cf. *marchadi*. These occur as casts and moulds but showing very delicate features. *Neopycnodonte* bivalves in the shell bed are articulated and some barnacles show traces of their original colour patterns. The dominant corals indicate deposition in a deep-water setting with fine-grained substrate and the taphonomic features of the whole fossil assemblage suggest low-energy conditions. They were most likely formed in a sheltered deep-water karstification crack that opened in the Mesozoic substrate. The low diversity of the coral assemblage in this site is consistent with restricted (sciafilous) palaeoenvironmental conditions.

Los Álamos section shows blue clays at the base that change upwards to silts and, finally, to coarse-grained sands. Large blocks and boulders, up to 2 m in diameter, derived from the Sierra de la Utrera are embedded in the silts and sands. Channelled microconglomerates, conglomerates, and breccias also intercalate in the silts and sands. The metamorphic composition of the clasts indicates that they came from the emerged substrate to the north of the basin. In Los Álamos section, cnidarians are especially abundant in the lower half of the section with pectinids, barnacles, and bryozoans as associated faunas. The cnidarian assemblage is more diversified than in the Canuto de la Utrera section and is characterized by *Madrepora oculata*, *Dendrophyllia ramea*, *Asterosmilia marchadi*, *Asterosmilia* sp., *Coenosmilia fecunda*, and gorgonians of the families Isididae and Primnoidae. These are concentrated in thin beds, up to 15 cm thick, and, more rarely scattered in the silts. They preserve fine ornamental features and their original aragonitic skeletons but show signs of dissolution, i.e. chalkiness indicated by powder easily leaving residues on the fingers. In addition, arborescent forms, such as *Madrepora* and *Dendrophyllia*, often show partially preserved branching. Concentration in thin beds suggests that cnidarians were accumulated after lateral transport. The occurrence of cnidarians coming from different habitats is consistent with this reworking. However, the preservation of delicate features and branching patterns indicate that accumulation was close to their life positions. Therefore, this assemblage allows the inference of the submarine landscape lying close to the original habitats of cnidarians. Three different tiers can be recognized: 1) the semiinfaunal species of *Asterosmilia* inhabiting in a siliciclastic and bioclastic bottom formed the lowest tier of the cnidarian community; 2) the branching *C. fecunda* belonged to the next tier, with colonies attached to rocks and skeletal substrates on the sea floor; and 3) arborescent forms of *M. oculata* and gorgonians constituted the highest tier of the community, colonizing hard bottoms on the sea floor as well as submarine cliffs. *D. ramea* occupied this highest tier but in shallower positions, above the colonization of white corals and bamboo corals.

Historical ecology of the introduction of the alien bivalve *Anadara transversa* in the Adriatic Sea

Paolo G. Albano[1], Ivo Gallmetzer[1], Alexandra Haselmair[1], Adam Tomašových[2], Michael Stachowitsch[3] and Martin Zuschin[1]

[1] Department of Palaeontology, University of Vienna, Althanstrasse 14, A-1090, Vienna, Austria
[2] Geological Institute, Slovak Academy of Sciences, Dúbravska cesta 9, 84005, Bratislava, Slovak Republic
[3] Department of Limnology and Bio-Oceanography, Center of Ecology, University of Vienna, Althanstrasse 14, A-1090, Vienna, Austria

Human disturbance modifies selection regimes, potentially depressing native species fitness and enabling the establishment of alien species with suitable traits (the "selection regime modification" mechanism). A major impediment to testing the effect of disturbance on invasion success is the lack of long-term data on the history of invasions. We reconstruct the introduction history of the invasive bivalve *Anadara transversa* in the northern Adriatic Sea and test the hypothesis that the late 20th century occurrence of hypoxic events promoted by human-induced eutrophication shifted the selection regime in favor of hypoxia-tolerant species such as *A. transversa*, facilitating its establishment.
A transversa's native range is eastern and southern North America. It was detected in the Mediterranean Sea first in Izmir (Turkey) in 1977, then in Thessaloniki (Greece) in 1993 and in the northern Adriatic Sea from Venice to Ancona in 2000. To reconstruct its introduction history, we collected 1.5-metre sediment cores at 21 m depth off the Po river delta in the Adriatic, extracted, counted and measured shells of the target species as well as the accompanying *Nucula nucleus*, *Abra alba*, *A. nitida* and *Corbula gibba*. The age of sediment layers was quantified using two independent methods: ^{210}Pb radiometric sediment dating and radiocarbon calibrated amino acid racemization dating (AAR) of bivalve shells. The entirely distinct assumptions and potential biases of these two approaches make them well suited for cross-validation. Sediment grain size and the content of major (Fe, Al), minor (Mn, P) and trace elements (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) and persistent organic pollutants (polycyclic aromatic hydrocarbons – PAH, polychlorinated biphenyls – PCB) was determined.
Our results suggest that *A. transversa* was introduced in the northern Adriatic Sea already in the 1970s, i.e., ca. 25 years earlier than its first record, tripling the known history of the species in the basin. In the same period, the onset of major eutrophication shifted communities towards hypoxia-tolerant species such as *Corbula gibba*. Although *A. transversa* is tolerant to hypoxia (Anadarinae possess hemoglobin and erythrocytes in the blood) and although there is evidence of continuous propagule input, it failed to reach reproductive size and to establish until the late 1990s. This introduction stage was also marked by the rarity of juveniles of locally abundant species such as *Nucula nucleus* and *Abra* spp. in death assemblages, suggesting that bivalve reproduction and recruitment were negatively affected by environmental factors, in particular a peak of sediment metal contamination. The reduction of these stressors finally enabled *A. transversa* to reach reproductive size and establish self-sustaining populations. The contemporaneous increase in body and population size triggered the first detection.
Subfossil assemblages in sediment cores allowed us to (1) disentangle the distinct stages of invasion, (2) quantify establishment and detection time-lags and (3) finely reconstruct the interaction between environmental factors and the invasion process. We demonstrate that

while disturbance does promote invasions, a synergism of multiple disturbances can shift selection regimes beyond tolerance limits and induce significant time lags in establishment.

Making high resolution 3D model of a bonebed from GPS data to assist taphonomical analyses - case study of the Santonian vertebrate site of Iharkút (Hungary)

Gáspár Albert[1], Gábor Botfalvai[2,3] and Attila Ősi [2,3]

[1] Eötvös Loránd University, Department of Cartography and Geoinformatics, Pázmány Péter sétány 1/A, Budapest, 1117, Hungary; albert@ludens.elte.hu
[2] Hungarian Natural History Museum, Baross u. 13., Budapest, 1088, Hungary
[3] Eötvös University, Department of Paleontology, Pázmány Péter sétány 1/c, Budapest, 1117, Hungary

The geographic information system (GIS) is a useful tool for analysing the spatial distribution of the collected specimen. However, the methodology and usability of the bone mapping has changed only in small increments during the last decades because the meter-grid system and the measure tape are still the most commonly used techniques for mapping specimens in paleontological sites, and computer assisted spatial analysis is not well-known in taphonomical studies yet.
The aim of the presented study is to give an insight into the usability of the 3D modelling methods in fossil mapping from the measuring processes to the spatial analysis creating 2D or 3D model. The usability of the presented methods is demonstrated by the 3D mapping of a bone-yielding bed of the Late Cretaceous vertebrate locality in Iharkút, Hungary in order to show the optimal database structure, the spatial querying, which is managed from simple data table formats, and the 3D modelling. Such aim can be achieved using high precision (error < 2 cm) GPS on the field, or detailed mapping with measure tape. When collecting the findings, each of them are classified on the field and an alphanumerical identification code is given to them. In order to facilitate the later analysis and data processing this code should contain information about the size, the anatomical type, and the taxonomical group of the findings. The relational database will also contain four data tables (coordinates, taxonomical groups, anatomical types, size).
Our approach was to use Excel as the database management program because it is well known amongst palaeontologists. For the primary spatial analysis, we developed a Visual Basic macro for Excel with a user interface. Based on the 3D geometry (point positions), queries can be executed to reveal hidden relations between groups of findings using the macro. The results are exported as text data (csv files). The secondary spatial analysis requires knowledge about the geometry of the bonebed itself. During the excavation base and top surface of the bonebed were measured from time to time, and using interpolation the layer models were created in a 3D geological modelling software (Jewel Suite). These bounding surfaces made it possible to calculate the relative position of all findings within the bonebed.
In the present study we demonstrate that using the geometry, the relative position, and the paleontological attributes, several aspects of spatial analysis can be done using standard GIS programs. Related to the dinosaur bonebed of Iharkút locality three preliminary case studies were done. The first one is a complex spatial analysis and the visualization of the bonebed with Jewel Suite, demonstrating the density distribution of findings (Fig A and B). Secondly the vertical distribution of differently sized bone material was analysed using the relative position data, which were normalized to the thickness of the bonebed layer. And finally the potential association among isolated elements in the Iharkút bonebed were analysed using the spatial querying functionalities of the developed visual basic macro. The presented

methods of spatial analysis can be executed on a geodatabase of the findings, and the results (as maps or 3D line plots) highlight the relationships of vertebrate remains.

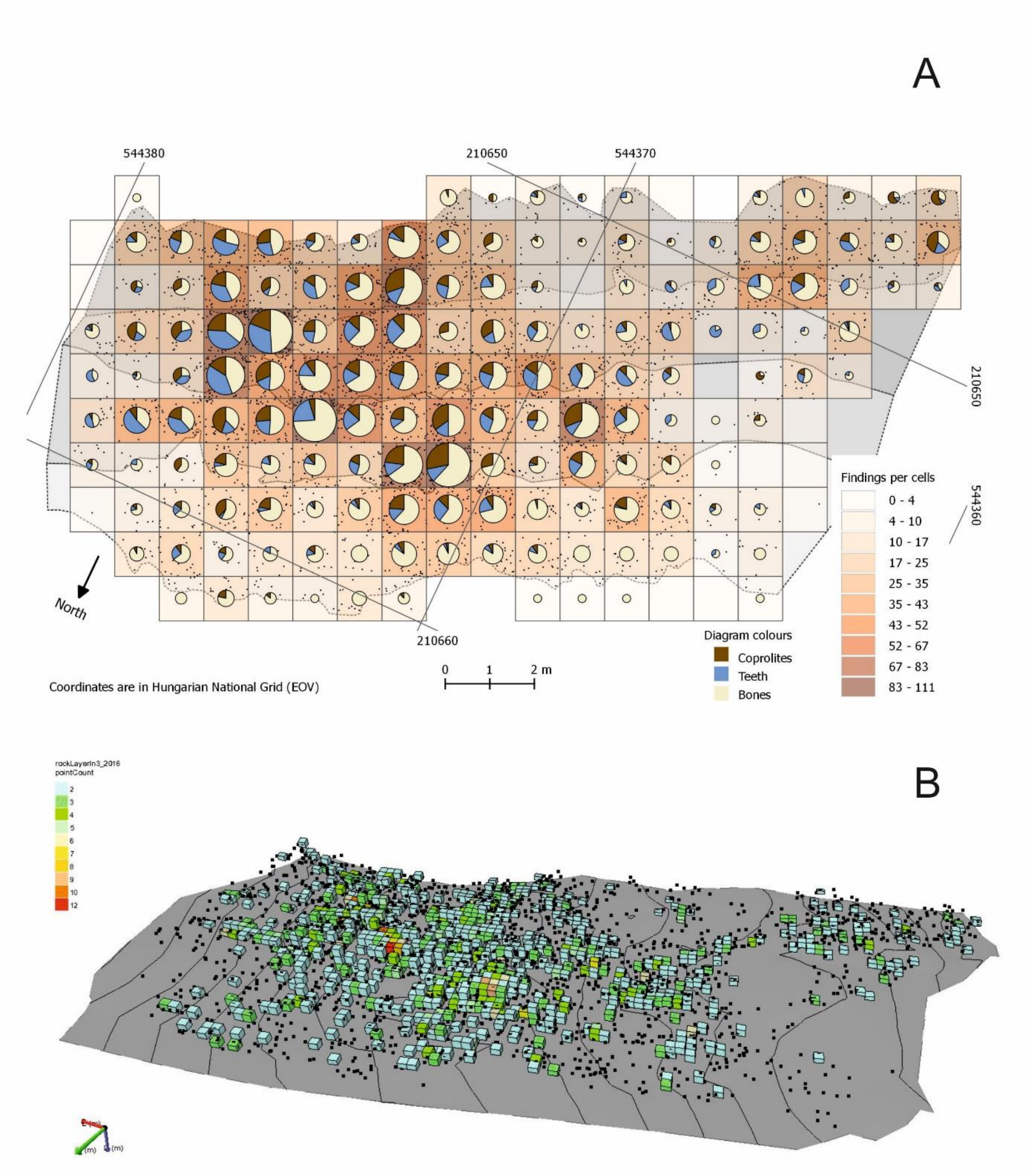


Fig: A) Density and diagram-map of all findings in the Late Cretaceous Iharkút bonebed. B) Visualization of the volumetric model of the bonebed at the Late Cretaceous Iharkút locality (SZ-6 site), showing the density distribution of findings per voxels excluding those cubicles which contained only one fossil, or does not contained any fossils

Taphonomy of axiid decapods within early diagenetic carbonate concretions from the Agrio Formation (Lower Cretaceous), Neuquén Basin, west-central Argentina

Alejandra M. Andrada, Dario G. Lazo and Graciela S. Bressan

Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Ciencias Geológicas, Instituto de Estudios Andinos "Don Pablo Groeber" (IDEAN, UBA-CONICET), Buenos Aires, Argentina
dlazo@gl.fcen.uba.ar

A total of 10 cm-sized ellipsoidal carbonate concretions containing axiid decapod specimens were studied. They come from a thin interval of fine sandstones of the Agrio Formation (Neuquén Basin, west-central Argentina) of early Hauterivian age, based on associated ammonoids. All specimens belong to *Protaxius isochela* Woodward (Axiidea, Axiidae). A total of 25 different specimens were identified including nearly complete individuals (n=5), disassociation units (n=13) and isolated elements (n=7). Half of the concretions contained two individuals and half had three. Chelipeds were the most abundant piece while carapaces and abdomen were present in half of the specimens only. Carapaces are often poorly-preserved showing diffuse contour and grooves. Some of the specimens are preserved in Salter's position and thus they are interpreted as exuviae while others are identified as carcass remains. SEM and EDAX analysis of cuticle revealed presence of massive calcium phosphate and isolated small pyrite crystals (>100 µm) in its inner surface. Thin sections of concretions show a sedimentary matrix composed of fine-grained calcareous sandstone including in some cases parallel lamination and ripple cross-lamination. The observed disarticulation pattern agrees well with patterns previously described in Astacidea, Caridea and Brachyura. It is inferred that the quality of preservation is related to rapid burial of specimens, based on the overall good taphonomic condition, low disarticulation and presence of flagella. The sequence of fossilization of the best preserved specimens would have been as follows: 1) immediately post-mortem phosphatization of cuticle in terms of days probably within burrow systems but before the burrows were infilled with sediment; 2) rapid shallow entombment of carcasses within the first centimeters of infilling sediment and closure of the phosphatization window; 3) anaerobic decay and disarticulation of carcasses and pyrite precipitation; and 4) precipitation of carbonate cement around the remaining carcasses during a pause in sedimentation in the early diagenetic stage. This occurred before compaction of the sediment because the specimens are preserved in 3D. Sin-sedimentary carbonate concretions are usually formed a little below the sediment-water interface during times of low or zero sedimentation rates allowing the carbonate to be produced and inhibiting dilution with siliciclastics. An almost zero sedimentation rate also probably enhanced the phosphatization of cuticles before burial, pointing to alternating episodes of low and high clastic sedimentation.

This is contribution C-133 of IDEAN.

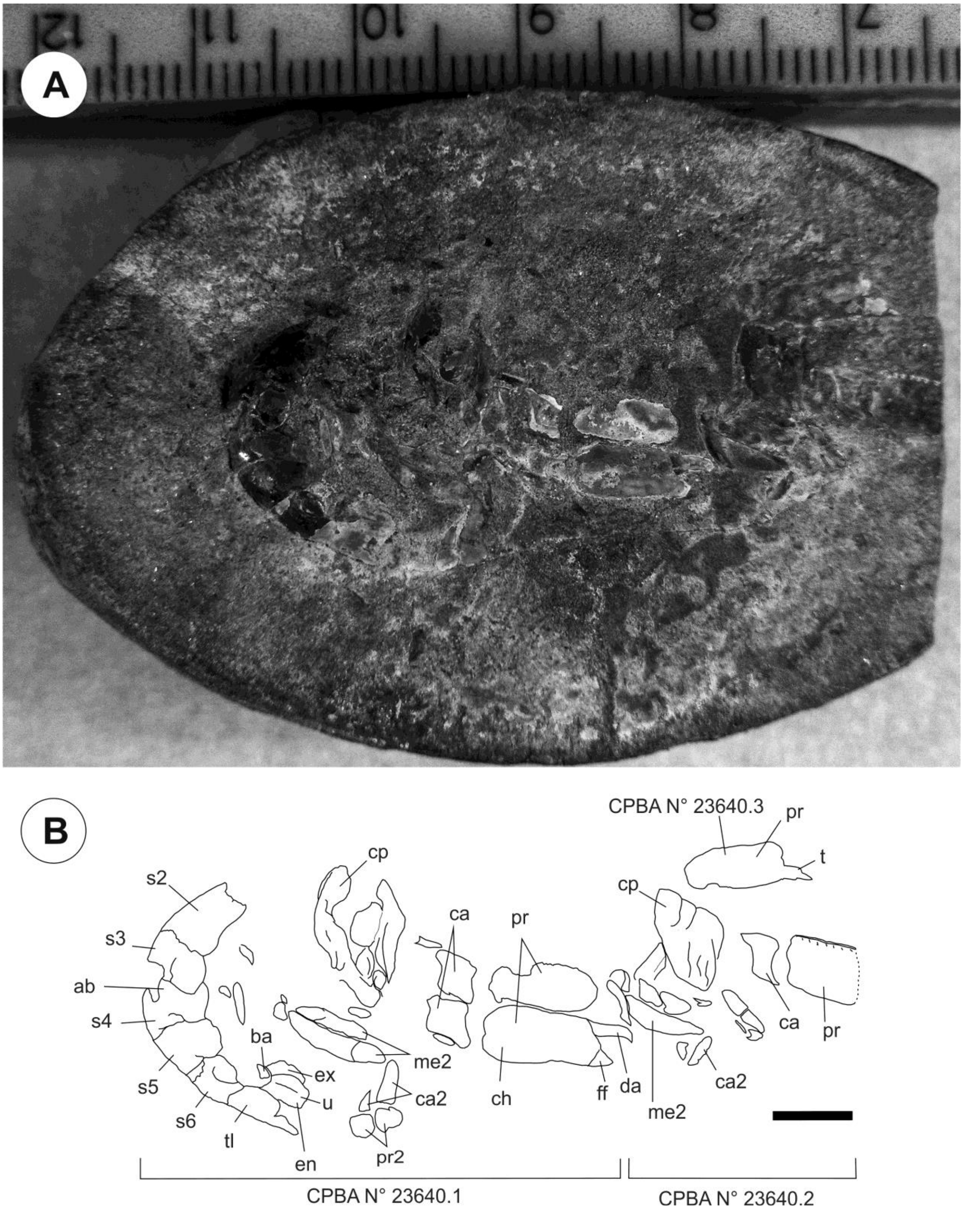


Figure 1: Photo (A) and line drawing (B) of concretion CPBA N° 23640. It shows 3 individuals, as whole body fossil (CPBA N° 23640.1), thoracopods and cephalotorax disassociation units (CPBA N° 23640.2) and isolated propod (CPBA N° 23640.3). There are some fragments that could not be identified because of their poor preservation. Abbreviations: ab, abdomen; ba, basipodite; ca, carpus; ca2, carpus of second pereiopod; ch, chela; cp, carapace; da, dactylus; en, endopodite; ex, exopodite; ff, fixed finger (fragment); me, merus; me2, merus of second pereiopod; pr, propodus; pr2, propodus of second pereiopod; s2-6, abdominal segments 2-6; t, tooth; tl, telson (fragment); u, uropod. Scale bar: 5 mm. CPBA: Colección de Paleontología Universidad de Buenos Aires.

Relations between landlords and tenants: modern macroid/rhodolith growth rate and boring bivalve activity

Davide Bassi[1], Juan C. Braga[2], Julio Aguirre[2], Masato Owada[3], Jere H. Lipps[4], Hideko Takayanagi[5] and Yasufumi Iryu[5]

[1] Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Ferrara, via Saragat 1, I-44122 Ferrara, Italy
[2] Departamento de Estratigrafia y Paleontologia, Universidad de Granada, Campus Fuentenueva s/n, 18002 Granada, Spain
[3] Department of Biological Sciences, Faculty of Science, Kanagawa University, 2946 Tsuchiya, Hiratsuka City, Kanagawa Prefecture, 259-1293 Japan
[4] Department of Integrative Biology and Museum of Paleontology, University of California, Berkeley, California 94720, United States
[5] Institute of Geology and Paleontology, Graduate School of Science, Tohoku University, Aobayama, Sendai 980-8578, Japan

Macroids/rhodoliths form extensive beds in marine shallow-water settings from intertidal zones down to the proximal outer platform, where they play the role of hard-substrates for some invertebrates compatible with their growth characteristics. These beds, characterized by a high biodiversity of organisms thriving on and within the nodules, potentially record the biodiversity of the inhabiting boring organisms and their bioerosion rates.

Five modern macroid/rhodolith beds from 2 to 117 m water depth in the Mediterranean Sea and the Pacific Ocean have been sampled to analyze their boring traces: southern Japan (north Central Ryukyu Islands), eastern Australia (Fraser Island, One Tree Island, Lizard Island), French Polynesia (Moorea), and Southern Spain (Cabo de Gata).

Characteristics of the nodules along with their ichnocoenoses show the complex interplay between the host's growth rate and the boring organisms and their succession. In Recent macroids and rhodoliths from shallow to deep-water settings the five identified ichnogenera (*Entobia*, *Gastrochaenolites*, *Tripanites*, *Maeandropolidora*, and *Rogerella*) characterise two ichnocoenoses, *EGTM* and *TM*, whose bathymetric distributions do not show any clear pattern.

The distinguished ichnogenera make different tiers of borings. High ichnodisparity testifies to a complex interplay among the boring organisms and their succession, which can reflect a balance between the host's growth rate and the boring activity.

The borings were produced during the macroid/rhodolith lifetime and were encased in the host's growth stages. The distribution patterns of *Gastrochaenolites* show that in shallow-water rhodoliths the boring bivalves keep up with the host's surface, whereas in the deeper nodules the boring bivalves have a growth-rate slower than the hosts. The identified deep-water boring-bivalve species comprise small-sized individuals, likely to be only up to a few years in age.

Rare example of boreholes in Lower Jurassic marine shallow-water lithiotid bivalves

Davide Bassi [1], Renato Posenato [1], James H. Nebelsick [2], Masato Owada [3], Enrica Domenicali [4] and Yasufumi Iryu [5]

[1] Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Ferrara, via Saragat 1, I–44122 Ferrara, Italy
[2] Department of Geosciences, University of Tübingen, Hölderlinstrasse 12, 72074 Tübingen, Germany
[3] Department of Biological Sciences, Faculty of Science, Kanagawa University, 2946 Tsuchiya, Hiratsuka City, Kanagawa Prefecture, 259-1293 Japan
[4] Museo di Casa Romei, Polo Museale dell'Emilia Romagna, Ferrara, Italy
[5] Institute of Geology and Paleontology, Graduate School of Science, Tohoku University, Aobayama, Sendai 980-8578, Japan

Clavate (flask-shaped) bivalve borings in hard substrates, including both cemented carbonate sediments and shell substrates, are ascribed to the ichnogenus *Gastrochaenolites* Leymerie, 1842. *Gastrochaenolites* ranges from the Early Ordovician to the Recent. Although this ichnogenus is very common in Cretaceous and Cenozoic shallow-water marine shells, Jurassic records are rather rare.

Abundant and diverse large, thick-shelled bivalves suddenly appeared in the Lower Jurassic along the southern Tethyan and Panthalassa margins giving rise to widespread assemblages such as the Pliensbachian *Lithiotis* fauna. Despite numerous investigations regarding this fauna, no information concerning ichnotaxa occurring in these bivalve shells has been published.

The rare examples of boreholes found within Pliensbachian marine shallow-water lagoonal bivalves from northern Italy represent important data points for the study of sclerozoan evolution. The Pliensbachian *Gastrochaenolites messisbugi* Bassi, Posenato and Nebelsick, 2017 is distinguished by a main chamber circular in section throughout, a smooth, ovate main chamber with a circular aperture.

This is the first record of boreholes and their producers (mytilid bivalves) in one of the larger bivalves of the globally occurring *Lithiotis* fauna, which represents a unique facies in the Lower Jurassic Tethys and Panthalassa.

The presence of mytilid boring bivalves was positively influenced by the presence of thick bivalve shell substrates of epifaunal, free-living forms such as *Opisoma excavatum*, low sedimentation rates, and seasonal or temporal mesotrophic conditions within an overall oligotrophic regime.

Diagenetic compression as a key to interpret life position in brachiopods

Mélani Berrocal-Casero[1], Fernando Barroso-Barcenilla[1,2] and Fernando García Joral[1]

[1] Departamento de Paleontología (Grupo Procesos Bióticos Mesozoicos), Universidad Complutense de Madrid, 28040 Madrid, España - Spain. melani.berrocal@ucm.es
[2] Departamento de Geología y Geografía (Grupo IberCreta), Universidad de Alcalá, 28871 Alcalá de Henares, España - Spain

Partial infilling of the shell is common in brachiopods. Depending on the hydrodynamic conditions and the width of the opening through which infilling take place, usually the foramen, biogenic cavities remain empty or become gradually filled with material commonly finer than the surrounding sediment. The mechanical stability of the preserved elements, their orientation and inclination are also factors that influence the processes of filling. When partial infilling occurs in typical symmetric forms, the shells usually show the anterior part of the shell squashed. As the posterior part of the shell is normally the heavier, and therefore closer to the substrate, it becomes filled more easily than the anterior part, which can remain less infilled or even empty (Fig. 1A). Moreover, if the specimens roll on the seabed before burial, infilling is also most probable for the thicker and heavier posterior part of the shell.

Therefore, the way in which shells are compressed can be used sometimes as a means to interpret the position in which they were buried and infilled, and to infer their life position. However, some previous conditions must be complied before to apply this key:

1. Shells must not show any type of evidence of fragmentation, abrasion or any other sign indicating displacement on the substrate after the death of the organisms; size distributions must also be coherent with a paleodeme.
2. Substrate original conditions must be soft so that fine detritics are sufficiently abundant to allow the partial infilling. If the fine detritics proportion is too low, shells are typically preserved either empty or filled with cement.

Several samples in which these two conditions are fulfilled have been compared. In those in which shells are symmetric, partial infilling implies the compression of the anterior part of the shell as previously described (Fig. 1A). On the contrary, a sample of rhynchonellides with asymmetric commissures show compression only on one of the two lobes in which the shell is divided (Fig. 1B). This difference in preservation has been interpreted as a consequence of the different life position of the shells. The typical symmetric brachiopods lie with the frontal commissure away from the sediment-water interphase. The posterior part of the shell can be partially buried or not, but is the part that appears more filled with sediments. Contrarily, in the forms with asymmetrical commissure, the flattened part is always founded to the larger lobe, whereas the shorter lobe maintains its original volume. This has been interpreted as caused by burial in a laterally inclined position. The taphonomic compression (deformation after burial) of the bigger lobe of the shell observed in some specimens is easily explained if the life position of these individuals were to be more or less inclined, with one lobe buried and the other unburied.

Acknowledgements: The research presented here has been supported in part by a Predoctoral Research Training Grant CT45/15-CT46/15 of the UCM (Complutense University of Madrid), and is a contribution to Research Projects CGL2015-66604 and CGL2015-68363 of the Spanish MINECO (Economy and Competitiveness Ministry).

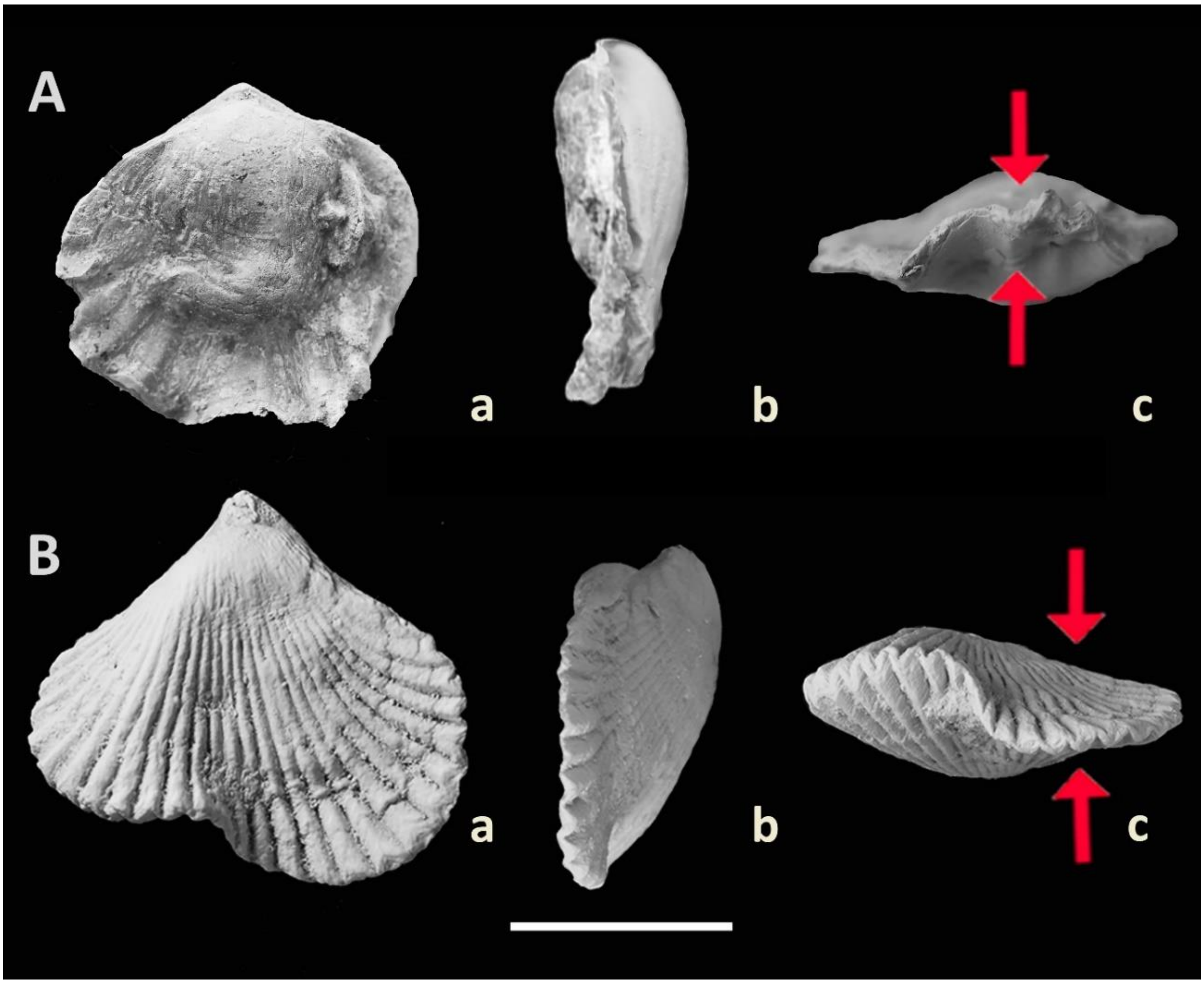


Fig. 1. A: Symmetric rhynchonellide *Soaresirhynchia bouchardi* (Davidson, 1852) from the Lower Toarcian (Jurassic) of the Iberian Range, Spain, showing the compression of the anterior part of the shell. B: Asymmetric rhynchonellide *Cyclothyris* aff. *globata* Arnaud, 1877, from the middle Coniacian (Cretaceous) of northern Spain, showing the compression of one lobe of the shell. Dorsal (a), lateral (b) and frontal (c) views. Scale bar: 1cm.

First data on micropreservation of the Middle Triassic Vertebrate remains of Riba de Santiuste area (Guadalajara, Spain)

Mélani Berrocal-Casero[1], Julia Audije-Gil[2, 3], Juan Alberto Pérez-Valera[1], Vanda F. dos Santos[4] and Manuel Segura[2]

[1] Departamento de Paleontología (Grupo Procesos Bióticos Mesozoicos), Universidad Complutense de Madrid, 28040 Madrid, España – Spain, melani.berrocal@ucm.es
[2] Departamento de Geología y Geografía (Grupo IberCreta), Universidad de Alcalá, 28871 Alcalá de Henares, España - Spain
[3] Departamento de Biología, Laboratorio de Poblaciones del Pasado (LAPP), Universidad Autónoma de Madrid, Madrid, 28049, España-Spain
[4] Museu Nacional de História Natural e da Ciência, Rua da Escola Politécnica, 58 1250-102 Lisboa, Portugal

The Middle Triassic palaeontological sites of Riba de Santiuste area are located in the North-West of the Province of Guadalajara, Central-Eastern Spain. The study area is situated in the Iberian Triassic domain, close to the boundary of Hesperian Triassic domain. It includes a stratigraphic interval in Muschelkalk facies corresponding to detritic-carbonatic mixed deposits of coastal intertidal to supratidal environments. This area is exceptional due to the well preservation of the organic and inorganic sedimentary structures, and by the information that it provides for the reconstruction of sedimentary environments. In these sites, there are numerous fossil plants, bivalves, brachiopods, direct vertebrate remains and vertebrate swim tracks. Recently, the Riba de Santiuste area has provided new anatomical elements of nothosaurs and placodonts (Sauropterigia). The relative stratigraphic position and the palaeontological content of this site suggest a Ladinian age. In order to enrich fossilization knowledge, paleohistological analyses of three bones of sauropterigian from two outcrops of Riba de Santiuste anticline and an outcrop of Sienes have been performed. The macro and micro-preservation of the bones (two connected placodont osteoderms and a fragment of a sauropterigian long bone from the Riba de Santiuste anticline, and a distal euryapsida ulna from Sienes) have been studied. After preparing thin sections of the three bone remains, their structure has been observed and photographed, using polarized light microscopy.

Macroscopically, the bone remains seem to be well preserved, allowing them to be identified. The fragment of a sauropterigian long bone and distal sauropterigian ulna show a similarity in their preservation, which is different of the placodont osteoderms. Although not observed in our sample, other bones from these outcrops present bioerosion. The microstructure of the tissues is exceptionally preserved due to possible differential micropreservation events. The tissular typologies can be well identified in the fragment of the long bone (Fig.1a) and in the fragments of osteoderms. Moreover, the samples present birefringence, and the osteocytes lacunae can be seen. In the long bone remain, fibro-cartilaginous bone can be distinguished in the endosteal area. In the external zone (periosteum), it can be observed part of the tissue, which corresponds to lamellar bone. The osteoderms and the fragment of long bone show microfractures through the lamellar bone in which the sediment has infilled. Nevertheless, in the external part of both samples, the lamellar bone is well preserved and different growth marks can be identified. The fractures are parallel to the growth marks, and in some of them and inside the vascular canals, iron infiltrations can be observed (Fig.1b-c). The studied ulna shows a good micropreservation too. In this sample, the surface show alleatory microcracks (Fig.1c). The vascular canals have iron infiltrations. The internal structure of the medullary cavity is very well preserved. Fibro-cartilaginous bone can be observed in the trabeculae system, which is partially filled by sediment. This work constitutes the first preliminary analysis about the preservation of fossil vertebrate remains from the Middle Triassic of this area, and future additional studies promise interesting taphonomical and palaeobiological interpretations.

Acknowledgements: We are grateful to Dr. Fernando Barroso-Barcenilla from UAH (University of Alcalá). Predoctoral Research Training Grant CT45/15-CT46/15 from the UCM. Research Project CGL2015-66604 and Project PEJ-2014-A-1313668 from the Spanish MINECO (Economy and Competitiveness Ministry).

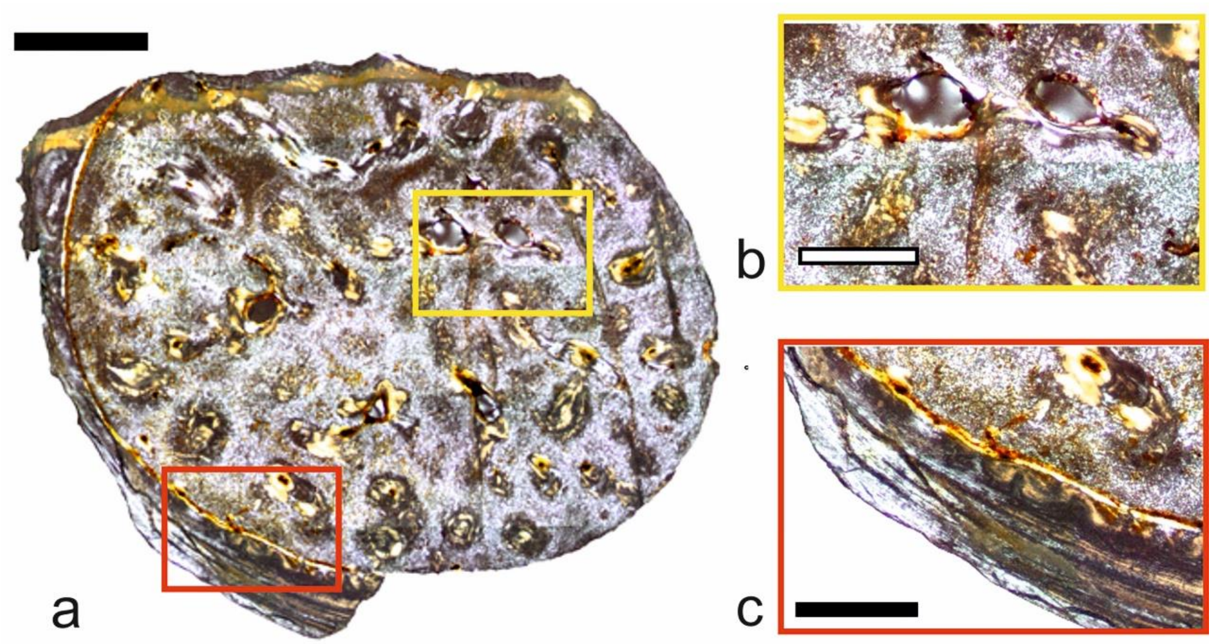


Figure 1. a) Thin section of the long bone from the Middle Triassic of Riba de Santiuste area. Escale bar = 1mm. b) Detail of fibro-cartilaginous bone with infilling of Fe in the vascular canals. Escale bar = 0,5mm. c) Detail of the external lamellar bone with several microcracks. Escale bar = 0,5mm.

Reliability of death assemblages in predicting depositional processes: Insights from a modern tropical siliciclastic marine setting

Madhura Bhattacherjee, Devapriya Chattopadhyay, Bidisha Som and Ammu Sankar

Indian Institute of Science Education and Research (IISER) Kolkata, Department of Earth Sciences, Mohanpur, WB-741246, INDIA

Actualistic studies on paleontologically relevant fauna are an important tool to understand taphonomic processes and to evaluate the extent to which a fossil assemblage represents a biological community. Death assemblages (DA) are characterised by time averaging, which often results in increase in species richness in DAs compared to LAs. The time averaging in DAs depends on factors such as durability of organic remains, sediment burial rate and bioturbation rate. Live-Dead fidelity studies have been used to understand the effect of these biases and to evaluate the reliability of death assemblages in interpreting the community composition of live assemblages. Live-dead fidelity studies in shallow marine settings using molluscan specimens has often yielded conflicting results. While many studies showed good correlation between DAs and LAs in siliciclastic and carbonate tidal flat environments, there is a few studies showing LD mismatch owing to high degree of shell mixing due to post-mortem lateral transport, low sedimentation rate, early cementation and lower rates of bioerosion, which expands the time averaging window contributing to high D/L ratios. Death assemblages are known to have shown variation in composition along an environmental gradient like their living counterparts. Majority of such studies are conducted in subtropical and temperate tidal flats and relatively few in species-rich tropical settings. We evaluated the live-dead fidelity in a complex tropical marginal marine setting and attempted to explain the lateral distribution of DAs using a model based on simple hydrodynamic principles.

Death assemblages of bivalves and gastropods were sampled seasonally from Chandipur-on-sea, situated at the eastern coast of India over a period of 1 year from various subenvironments including beach, tidal flat, estuary, lagoon, sand bar; we compared these DAs with respective LAs wherever applicable. A total of ~27,000 molluscs consisting of both live and dead individuals representing 15 species of gastropods and 49 species of bivalves were analysed. While sampling from tidal flat, estuary, lagoon yielded both types of assemblages, the rest of the samples were devoid of any live fauna.

The DAs are numerically more abundant than the live assemblages and about five times richer than the LAs. We observed insufficient correlation between samples of LAs and DAs indicating low LD fidelity; this contrasts with the findings of previous studies in temperate and subtropical siliciclastic tidal flat settings showing high LD fidelity. The NMDS and cluster analysis reveals a low compositional variation in LAs between the different sub-environments while the DAs did not have environment specific composition. The LAs also show strong seasonal variation in composition indicating the influence of strong monsoon mediated seasonality on community composition. The environment specific nature of LAs and low LD fidelity points to the fact that this area probably derived the dead assemblages from multiple sources through transportation and mixing.

Considering the dead shells as sedimentary particles and using available relationship between grain size and energy of transportation, we developed a model to understand the effect of the transportation on the distribution of dead shells. In this model, we generated the shell size distribution (SSD) for DAs for a specific subenvironment from SSD of LAs using the energy of transportation in that environment. Then we compare the SSD of modelled

DAs with the actual LA from that environment using Kolmogorov–Smirnov test (KS test). A high value of difference (D_1) supports the influence of transportation and mixing in developing the DAs in that environment. We also compared the SSD of modelled DAs with actual DAs from that environment to estimate the contribution of shell transfer between the subenvironemnts in shaping the DAs in an environment. A low value of difference (D_2) points to local transfer of shells as the primary reason while a high D_2 indicates probable mixing of shells from outside the environments and regional transport. High D_1 values for tidal flat and sand bar indicates greater variation in size distribution between the live and dead assemblage that results from the high energy setting of these environment. Low D_1 value of estuary, lagoon and other restricted areas can be contributed to their inherent low-energy environment that restricts the transport of shells. A generally high D_2 across environments, especially in tidal flat and sand bar, indicates the limitation of local transfer of shells as a causal mechanism; the DAs of this area is probably receiving a considerable amount of dead shells by regional transport of through long-shore currents.

This study highlights the influence of local and regional transport in shaping the DAs that are often independent of the live community; the resultant low LD fidelity could be useful in modelling the transport and depositional processes. This also helps us to determine the reliability of fossils in detecting sub environments in close vicinity.

Taphonomic and diagenetic history of the Miocene mollusks in the Pisco Formation Fossil-Lagerstätte (Ica Valley, Peru)

Giulia Bosio[1], Elisa Malinverno[1], Anna Gioncada[2], Karen Gariboldi[2], Daniela Basso[1], Thomas DeVries[3], Claudio Di Celma[4], Sergio Andò[1], Fabrizio Berra[5], Mario Urbina[6] and Giovanni Bianucci[2]

[1] Dipartimento di Scienze dell'Ambiente e del Territorio e di Scienze della Terra, Università di Milano-Bicocca, Piazza della Scienza 4, 20126 Milano, Italy
[2] Dipartimento di Scienze della Terra, Università di Pisa, Via Santa Maria, 53, 56126 Pisa, Italy
[3] Burke Museum of Natural History and Culture, University of Washington, 1413 NE 45th St, Seattle, WA 98105 Seattle, Washington, USA
[4] Scuola di Scienze e Tecnologie, Università di Camerino, Via Gentile III Da Varano, 62032 Camerino, Italy
[5] Dipartimento di Scienze della Terra Ardito Desio, Via Mangiagalli 34, 20133 Milano, Italy
[6] Departamento de Paleontología de Vertebrados, Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Av. Arenales 1256, Jesús María, Lima 14, Peru

The Eastern Pisco Basin outcrops in the Ica Desert (Peru), where the upper Miocene Pisco Formation and the lower Miocene Chilcatay Formation are well known due to the exceptional preservation of fossils of marine vertebrates.
Fossil invertebrates are quite common in these Miocene formations and exhibit different preservation modes suggesting two distinct fossilization pathways. In the early Miocene Chilcatay Formation, studied at some localities as Ullujaya and Roca Negra, invertebrates show a high concentration but a low biodiversity. They are constituted essentially by bivalves, as pectinids and ostreids, barnacles, worm tubes and echinoids. Analyses through the optical microscope, SEM-EDS, Raman spectroscopy and cathodoluminescence allowed us to recognize the mineralogical phases and to distinguish the different diagenetic processes that occurred after the deposition of the specimens. Overall, integrated analyses demonstrate that the fossil shells remains of the Chilcatay invertebrates are constituted by Ca-carbonates and show a quite good preservation. On the other hand, cathodoluminescence reveals that these fossils usually have layers that show different kind of luminescence response, proving that they have pristine carbonate layers but also zones characterized by diagenetic calcite precipitation.
In the late Miocene Pisco Formation, the invertebrate content is limited to few mollusk-rich layers characterized by a high abundance and low biodiversity: mainly bivalves of the families Crassatellidae and Veneridae, and gastropods of the family Turritellidae. The process of the invertebrate fossilization is very dissimilar to that of the Chilcatay Formation: in some localities, as Cerro los Quesos and Cerro Cadena de los Zanjones, mollusks are preserved as internal molds or recrystallized shells, and in some cases, show geopetal structures. Through optical microscopy, SEM-EDS and Raman spectroscopy analyses, we observed that the pristine shell is not preserved: Ca-carbonates are usually absent or occasionally present, as in the oldest depositional sequence. The mineralogical phases are generally represented by dolomite and gypsum, but no-pristine calcite is preserved. Cathodoluminescence analyses, in fact, confirm that the calcite is interested by diagenetic processes also in cases where the pristine structure of the shell seems to be preserved under the microscope. Furthermore, cathodoluminescence allows to distinguish the different cement generations, helping understand the complex diagenetic history of these mollusks.
The clear difference between the preservation of invertebrate fossils in these two formations is probably due to the very distinct depositional environments. The Chilcatay

Formation is composed of sandstones and siltstones interbedded with cobble layers: it is characterized by a shallow marine environment dominated by carbonate factories that underwent transport and the Ca-carbonates could be preserved. Instead, the Pisco Formation is mainly siliceous organized in depositional sequences with sandstone at the base and diatomaceous siltstones at the top: in this relatively deeper environment, the Ca-carbonates are hardly preserved.

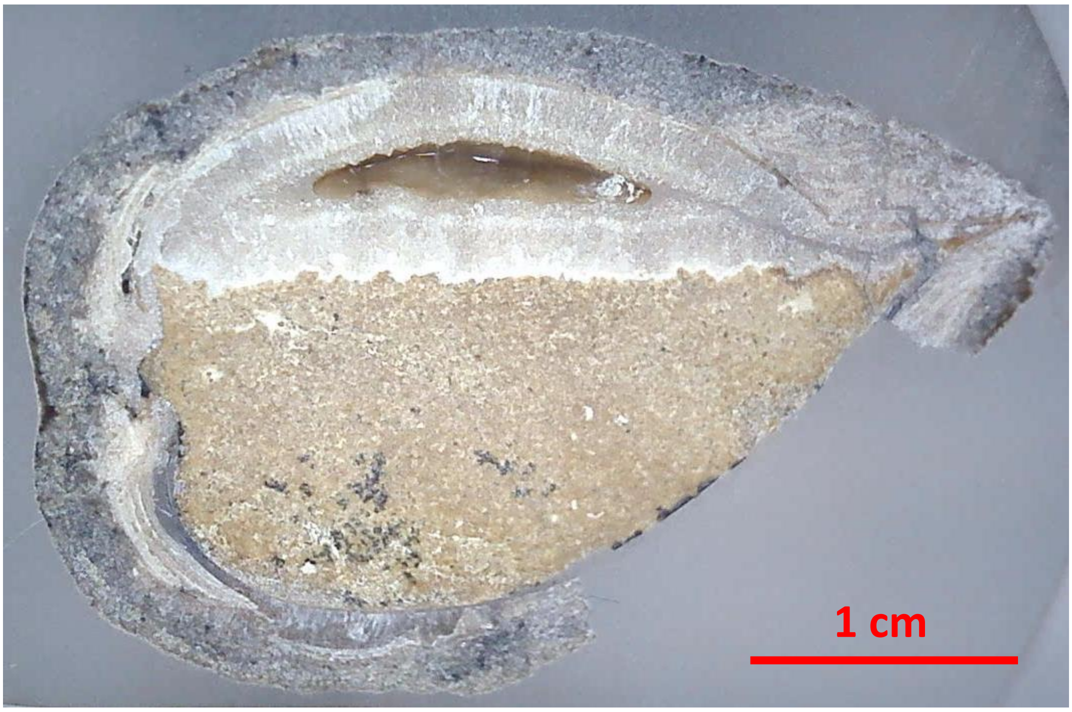


Figure: Inner core of a specimen of Crassatellidae showing a geopetal structure with different mineralogical phases.

Ankylosaur mass death assemblage from the Late Cretaceous of Iharkút (Hungary) and its effect on an ancient river ecosystem

Gábor Botfalvai[1, 2] and Attila Ősi[1, 2]

[1] Hungarian Natural History Museum, Baross u. 13., Budapest, 1088, Hungary; botfalvai.gabor@gmail.com
[2] Eötvös University, Department of Paleontology, Pázmány Péter sétány 1/c, Budapest, 1117, Hungary

The Iharkút vertebrate locality, an open-pit mine in the Bakony Mountains (western Hungary), has provided a rich and diverse assemblage of Late Cretaceous (Santonian) continental vertebrates. The isolated and associated remains represent at least 40 different taxa including fish, amphibians, turtles, mosasaurs, lizards, pterosaurs, crocodilians, non-avian dinosaurs and birds. The sedimentological investigations revealed that the terrestrial deposits exposed by the Iharkút open-pit were formed in an anastomosing fluvial system. The most important vertebrate fossil site (site SZ-6) is interpreted as a lag deposit formed during and episodic high density flash flood event representing a relatively short time interval, i.e., probably within a single rainy season.
The vertebrate assemblage of site SZ-6 includes three main different groups of subsets with widely different taphonomical history. Bone pebbles were theoretically hydraulically equivalent with the dominant size of quartz grains of the channel fill sediment; thus they could have been transported for a long time with the ancient stream from the background area. The second group includes 88% of the Iharkút collection, containing most of the identified isolated bones and teeth, and represents polytypic attritional remains transported and deposited by high density flow during the ephemeral flood events. Besides the rich isolated bone assemblage 11 ankylosaur partial skeletons were discovered in associated or articulated positions from an area of approximately 600 m^2 of site SZ-6. The taphonomical investigation of the ankylosaur skeletal material suggests that the associated and articulated remains represent a mass death assemblage because 1) the skeletal remains have almost uniform taphonomic features; 2) skeletons were found close to each other in the same layer; 3) the material represents a monotaxic assemblage; 4) the closing layer shows rapid deposition (clay clasts and sand with plant fragments, poorly sorted sediment), which is a sedimentological criterion of a mass-killed assemblage. Based on the sedimentological and taphonomical evidences we suggest that the cause of death of the Iharkút ankylosaurs was probably drowning when their herds time to time attempted to cross the flooded river, because 1) the bonebed layer was deposited during the heavy flood event; 2) the structure of their body might have been unfavourable for swimming across the flooded river; 3) ankylosaurs preferred herding lifestyle and drowning is a frequent cause of death in terrestrial herding lifestyle animals; 4) there are no evidences for possible other causes of death e.g. drought, disease, forest fire or miring.
The existence of monotaxic skeletal material in a layer deposited under high energy conditions raises the possibility that all of the ankylosaurs were killed by instantaneous events and the mass deposited carcasses provide important resource pulses for scavengers and the microbial activity, which can facilitate carcass decomposition. A recent study about the annual mass drownings of the Serengeti wildebeest suggests that the mass drownings have large impacts on the nutrient cycling of the river ecosystem. We also propose that the ankylosaur mass death assemblage, along with many other vertebrate fossils, was an important food source for the scavengers, and the large amount of decaying organic material caused reductive, oxygen-deficient environment resulting favourable conditions for

the preservation of hundreds of coprolites and delicate bones (pterosaurs, theropods). The low percentages of skeletal completeness in the ankylosaur skeletal material of Iharkút indicate that the deposited carcasses were exposed to destruction processes (e.g. decay and scavenger) during which the parts of the body disarticulated and certain parts of the skeleton were destroyed. The notable reduction of the skeletons can be caused by the vertebrate scavengers, because more than 2600 coprolites with high phosphorous content were discovered from the same layer indicating a high scavenger activity around the accumulated carcasses.

An exceptional concentration of empty aragonite-shell molds (Quaternary, Almería-Níjar Basin, SE Spain)

Juan C. Braga[1] and Fernando Sola[2]

[1]Departamento de Estratigrafía y Paleontología, Universidad de Granada, Campus Fuentenueva, 18002 Granada, Spain
[2] Departamento de Biología y Geología, Universidad de Almería, 04120 Almería, Spain

Fossil diagenesis of shallow-marine mollusk assemblages generally leads to the dissolution of aragonite shells. If shells dissolve after lithification, they are usually preserved as calcite casts, which are mixed with original calcite shells in fossil assemblages. Calcite casts form as the Ca^{2+}, and CO_3^{2-} concentration in pore water, which could be determined by aragonite dissolution, is supersaturated with respect to calcite. In contrast to the common preservation, the shell concentration studied in the Almería-Níjar Basin consists of a mixture of empty aragonite-shell molds and minor calcite shells of oysters and pectinids. The shell concentration occurs in the Quaternary prograding beds at the top of the Cenozoic infill of the northern part of the basin. The succession from bottom to top encompasses: 1) sandstones with bioclasts (several tens of meters thick), 2) rudstones with varying amounts of siliciclastics, and calcite-shell beds with erosive base intercalated in the upper part (up to 13 m in thickness), 3) rudstone rich in rhodoliths (up to 0.7 m), 4) a shell bed of empty molds (up to 1.5 m), 5) sandstones with trough cross-bedding and microconglomerate lenses (up to 4.5 m), 6) sandstones, microconglomerates, and conglomerates with low-angle parallel cross-bedding (up to 4 m), and 7) red conglomerates, sandstones and clays (up to 20 m). This succession reflects a regressive trend from shallow-marine to continental depositional paleoenvironments. The shell bed studied (number 4) is a hybrid deposit that can be described as a rudstone rich in siliciclastic grains (medium sand to pebble in size), with a fine-grained matrix with up to 45% siliciclastic composition. Fossil components include mainly empty molds of shell fragments of aragonite bivalves. Molds of intact and articulated valves are common and locally abundant. Molds of gastropods and calcite bivalves are minor components. Shell fragments are randomly oriented with a higher proportion of convex-up valves. Cardiids and venerids appear to be the most abundant aragonite bivalves. Deep infaunal bivalves in life position, especially *Panopea*, occur at all levels within the bed. The molds show no sign of compression and can be lined by delicately thin calcite crystals. The shell bed formed on a middle ramp, shorewards of a rhodolith bed and seawards of sand shoals and beach deposits. The concentration presumably took place by shell accumulation under a low sedimentation rate. The deep infaunal bivalves at different levels within the bed and the gradual transition from the underlying deposits rule out an event origin for the concentration. Aragonite dissolution clearly took place after lithification, and the low sediment load (overlying deposits are only up to 30 m thick), probably in combination with the absence of clay in the matrix, prevented the compression of molds. Pore water never reached calcite supersaturation in the bed, except for precipitation of small crystals on the mold surfaces, probably under vadose conditions.

Taphonomic analysis of Lower Jurassic larger-bivalve accumulations in the Trento Platform

Valentina Brandolese, Davide Bassi and Renato Posenato

Department of Physics and Earth Sciences, University of Ferrara, via Saragat 1, 44122 Ferrara, Italy

The *Lithiotis* Fauna (Lower Jurassic) characterizes the Rotzo Formation (Calcari Grigi Group) cropping out in the Trento Platform, a paleogeographic unit of the Southern Alps. The Rotzo Formation represents a tropical lagoon, protected from the sea by oolitic shoals and from the land by marshes. The fauna is distinguished by aberrant larger bivalves with three main distinctive monospecific genera: *Lithiotis*, *Cochlearites* and *Lithioperna.*

The lithiotid bivalves had a relevant sedimentogenetic role in the Pliensbachian shallow-waters making up thick sedimentary bodies ranging in size from tens to hundreds of meters width and few meters high. In particular, *Lithiotis* and *Cochlearites* mounds are characterised by a mud-supported mound core with few shells in life position and with loosely packed shell fabric. Instead, *Lithioperna* could make the mound core with dense packed shell fabric originated by individuals preserved in life position. The mound flanks are distinguished by oblique, imbricated articulated shells. Generally, the flanks constitute the most developed parts of the bivalve mound.

This study aims to assess some taphonomic features via quantitatively analysis in order to distinguish autochthonous and parautochthonous assemblages and the architectural mound features.

The analyses were conducted with photographic and digital elaboration. Each studied outcrop was mapped by photos, which were elaborated by the software AutoCAD 2004.

Six taphonomic proprieties were quantitatively examined: (i) shell/matrix ratio, (ii) shell density, (iii) percentage of articulated and (iv) disarticulated shells, (v) percentage of whole and (vi) fragmented shells. Shell orientation, shell fabric and the geometry of the accumulations were also considered in the analysis.

The taphonomic results indicate that autochthonous bivalve accumulations are characterised by low bivalve density (max 15 individuals/100 cm^2) and by well preserved and articulated bivalves (>10 –15%). Parautochthonous accumulations, such as the storm and inter-mound accumulations, show high bivalve density (> 50 ind./100 cm^2) and high percentages of disarticulated and fragmented bivalves (85 – 90%).

These data were used, along with other parameters such as the shell orientation known from the literature, to identify different and recurrent taphofacies for each of the three genera (*Lithiotis*, *Cochlearites* and *Lithioperna*) in order to distinguish the taphonomic signature of the mound core from the flanks. These taphofacies can be also used to assess differences and similarities among the mounds according to the dominating genera.

Microtaphofacies of Upper Oligocene ramp depositional systems from Northern Italy

Claudia Buhlemann[1], Davide Bassi[2] and James H. Nebelsick[1]

[1] Department of Geosciences, University of Tübingen, Hölderlinstrasse 12, 72074 Tübingen, Germany
[2] Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Ferrara, via Saragat 1, I–44122 Ferrara, Italy

This study is based on thin sections analyzed in Bassi & Nebelsick (2010) whereby 9 different facies were separated within ramp depositional systems located in the western Southern Alps, on the Lessini Shelf, and in the eastern Southern Alps in the Venetian Foreland Basin, Italy. The sediments range from sandstones to coralline algal rudstone. Of special interest are larger foraminferal dominated packstones and grainstones. Minor components include smaller benthic foraminifera, echinoderms, polychaetes worm tubes (*Ditrupa*), bryozoans, bivalves and barnacles. Quartz grains can also be common. Three sections (Covolo Bassa, Monte Costi and Colle) are compared. Thin sections totally dominated by coralline algae have already been intensively analyzed with respect to components and taphonomy.
Point counting for modal analysis was conducted on 48 x 48 mm thin sections with at 300 counts 1 mm apart. Point counts were successively recorded generating continuous modal distribution curves. Larger foraminferal taxa were distinguished as far as possible. Component relationships are analyzed using non-parametric bivariate analysis. For taphonomic analysis, 5 different taphonomic grades (0- no taphonomic effect, 1- low, 2- moderate, 3- high, and 4- very high) were recorded semi-quantitatively for fragmentation; 10 randomly chosen components per thin section were observed and analyzed for abrasion. Micritization was only present in very thin crusts on few components, bioerosion was very rare. In the non–coralline algal dominated sediments, encrustation was not observed. The intensity of abrasion and fragmentation are compared to facies determinations and modal analysis. Taphonomic ternary diagrams are also presented.
Changes in facies ranging from biogenic sandstones to grainstones are, as expected, reflected in the component distributions. Fragmentation rates are generally very high; abrasion rates vary from low to moderate. The sandstone facies shows expected very high rates of abrasion and fragmentation. Biogenic sandstones show a high variation of values also depending on their position within the section. Foraminiferal packstones, bioclastic wackestones and grainstone show somewhat lower values. *Operculina-Ditrupa-Parascutella* Packstones show high amounts of abrasion and fragmentation, while the lowest values were encountered within *Operculina* Sandstones. These first results show how taphonomic variables are dependent on general depositional environment, component distribution and their robustness of biogenic skeletons. In addition, compact larger foraminifera are generally better preserved

Microbial alterations of Late Pleistocene fossil mammal bones from permafrost environments of northern Yakutia (NE Siberia)

Gabriela Calábková[1,2], Martin Ivanov[1] and Jiří Chlachula[3,4]

[1] Department of Geological Sciences, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic
[2] Department of Geology and Palaeontology, Moravian Museum, Zelný trh 6, 659 37 Brno, Czech Republic
[3] Institute of Geoecology and Geoinformation, Adam Mickiewicz University. 61-680 Poznan, Poland
[4] Laboratory for Palaeocology, Tomas Bata University. 762 01 Zlin, Czech Republic

Bones can be exposed to a variety of factors during the fossilization process that are reflected in fossil records by changes in microstructure and chemical composition of bone tissue. Based on these alterations, we can reconstruct the character of the environment and its possible role in the long-term preservation of the fossil material. One of the major factors causing changes in bone microstructure is the activity of microorganisms which attack bone tissue shortly after the animal death. For this reason, microorganism can serve as a clue to reveal the taphonomical history of fossil bones. The presented study is focused on diagenetic changes in bone porosity and chemical composition of bioapatite as a result of past microbial activity. The research was carried out on two fossil metacarpal bones of bison and horse, uncovered by JC from the mid- to late Last Glacial (MIS 3-2) colluvial deposits located within the permafrost area of the central Yana River basin in NE Yakutia, Siberia (70ºN). The perfectly preserved bison bone was taken directly from a solid permafrost ground underlain by massive ice. The horse bone had been released from a frozen wall at another site as a result of seasonal melting of a cryogenic colluvium of a permafrost depression and was exposed on the present surface within the bottom part of the thermokarst sinkhole for some time (presumably in the range of a few /2-5/ years) as evidence by the more weathered surficial bone structure. Due to the extreme annual temperature shifts, destruction of the fossil (as well as modern) skeletal material can be rather rapid once released from the original geological context.

Both fossil samples were analysed under the scanning electron microscope (BSE-SEM), mercury porosimetry (HgIP) and electron microprobe (EMP). BSE-SEM provided evidence of extensive bacterial microboring in the horse bone in several stages. The typical bacterial microscopic focal destructions (mdl) that are made of pores 100–1000 nm in diameter (HgIP) and hypermineralized rims were predominantly captured near the endosteum. The primary bacterial attacks were found only as the empty pores without the hypermineralized rim near the periosteum. The rims were leached out of the bone most probably due to acidic environment what corroborates geochemistry of the sealing deposits. However, these leached attacks were overlapped by typical mdl with hypermineralized rims in some places close to the periosteum. The intensity of bacterial degradation in horse bone was supported by the results of HgIP which indicated a significant increase in pores 100–1000 nm in diameter. Contrary to the horse bone, the excellently preserved bison metacarpus shows the results of HgIP which correspond to the almost fresh bones. The acidic and waterlogged depositional conditions in unfrozen colluvial deposits were documented (EMP) by the presence of vivanite [$Fe_3(PO_4)_2.8H_2O$] that filled the pores inside the horse cortical bone. Moreover, Fe, Sr, Ba and Mn were incorporated into the structure of the bioapatite instead of Ca^{2+} by diffusion from pore water.

Despite the fact that the horse bone was exposed to external factors presumably for a short period of time, the extreme seasonal fluctuations in subpolar climate amounting up to 60-70ºC temperature range (average January temperature -45ºC, average July temp. +15ºC, MAT -15ºC, MAP 190-200 mm/yr) with an accelerated biotic activity during the warm seasons was recorded into to the bone. The local climatic conditions affected the bacterial activities and their final traces within the fossil material. The new elements were incorporated into the bone structure immediately after the bone was released from permafrost. Direct evidence of modification in bone chemistry due to microbial activity may represent vivianite, which is often formed with the participation of bacteria.

How does digestion affect bat bones? An experimental approach

Patricia Canales Brellenthin[1], Yolanda Fernández Jalvo[2] and Paloma Sevilla[1]

[1] Departamento de Paleontología (Quaternary Ecosystems Research Group). Universidad Complutense de Madrid. C/ José Antonio Novais, 12. 28040 Madrid (Spain), pcanal01@ucm.es
[2] Departamento de Paleobiología. Museo de Ciencias Naturales de Madrid. C/José Gutiérrez Abascal, 2. 28006 Madrid (Spain)

Small mammal taphonomy is a topic that has been gaining an increasing importance since Andrews in 1990 published a thorough description of the processes modifying skeletal representation and structural modifications in bone tissue after predation had taken place. The exhaustive analysis of these features has provided a solid basis to other researchers to identify digestion, infer the type of predator involved and to correct possible biases introduced by the predator when the aim of research was to reconstruct past small mammal communities or ecologic characteristics of the habitats from which the fossils came. Both Andrew's publication and subsequent papers published by other authors have focused on the two small mammal groups that are best represented in fossil assemblages, rodents and to a less extent, insectivores.

Bats are not common elements in small mammal fossil assemblages. In the cases when bats are numerous, the assemblages come typically from caves or fissure fillings. Since bats inhabit these environments, their remains are straightaway interpreted as belonging to individuals that lived there and predation is not considered. However, bats are not necessarily cave-dwellers and predation cannot be ruled out when their remains are found in cave assemblages together with other small mammal remains. In these cases, how can we distinguish between bats that were prey and those that died from natural causes? In the few cases where this issue has been addressed, it has been assumed that bat bones and teeth would exhibit similar patterns to those found in insectivores, due to morphological similarities. However, this assumption needs not be true, since enamel thickness and bone structure is not necessarily the same in insectivores and bats.

Here we present the first results obtained from a series of experiments that have been developed to approach this issue. Two sets of unaltered bat bones and teeth were prepared and exposed to the action of enzymes and acids to see the effect of these chemicals on bone tissue and enamel. In order to obtain results that could be easily compared with experiments previously conducted by other authors, the two sets included besides the bat material, some teeth and bones belonging to rodents and insectivores.

Each set was subjected to a different protocol (Figure1). The protocol described by Denys *et al.* in 1995 was followed in Set1, exposing the teeth and bones first to chlorhydric acid and later to protease (***Pronase®***) enzymes. Set2 followed a different and new protocol, in which the teeth and bones were exposed at the same time both to the acid and the enzymes. This has been possible thanks to a new enzyme (commercial name ***Olexa®***) which is active in acidic conditions, enabling to reproduce more reliably the conditions in a predator's stomach, where enzymes and acids work together. Exposure to the chemicals was periodically interrupted to observe the appearance of alterations on the surface of the enamel and/or bones. Observations were done using a binocular stereomicroscope in order to check whether they might be easily identified, as well as with ESEM. The rodent incisors included in each set were used as a reference to identify intensity of digestion according to Andrews and compared to the effect at equivalent stages on the insectivore and bat material.

Acknowledgements. This research is being supported by research projects: CGL2016-80000P and CGL2016-79334P of the Spanish Ministerio de Educación, Cultura y Deporte. The first author is a Programa Becas Chile de Doctorado en el Extranjero grantee, and has received specific funding for the experiments described in this communication from the Spanish Society of Paleontology. We also thank Novozymes Spain SA for providing samples of their enzyme ***Olexa®*** to test its efficiency simulating digestion.

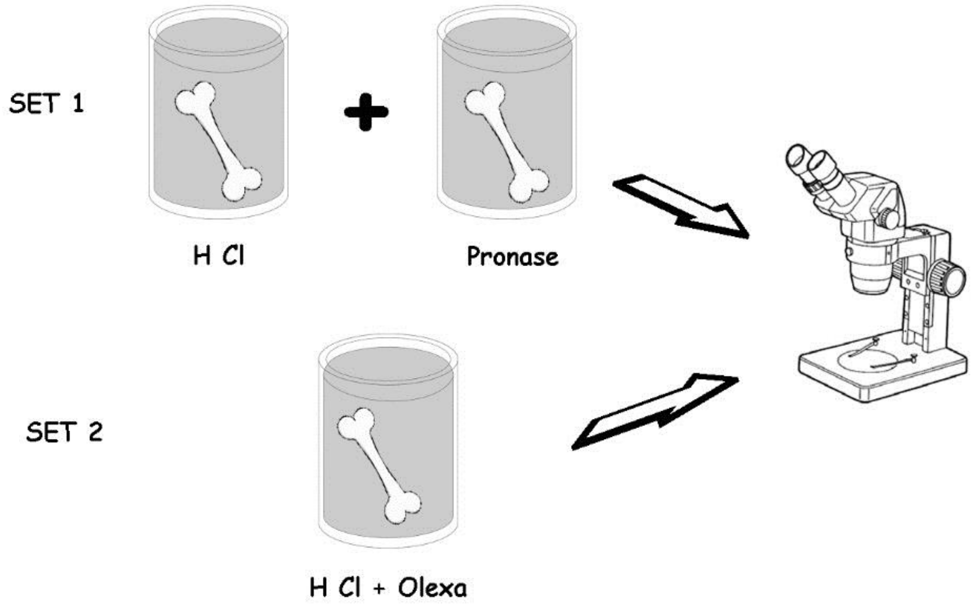


Figure 1. Protocol followed in the experiments. Set 1 followed the standard procedure with an initial HCl exposure followed by protease action. Set 2 was exposed to the simultaneous action of both HCl and protease.

Taphonomy of large marine vertebrates: from modern whale falls to the fossil record

Silvia Danise

Centre for Research in Earth Sciences, School of Geography, Earth and Environmental Sciences, Plymouth University, Drake Circus, PL4 8AA Plymouth, UK

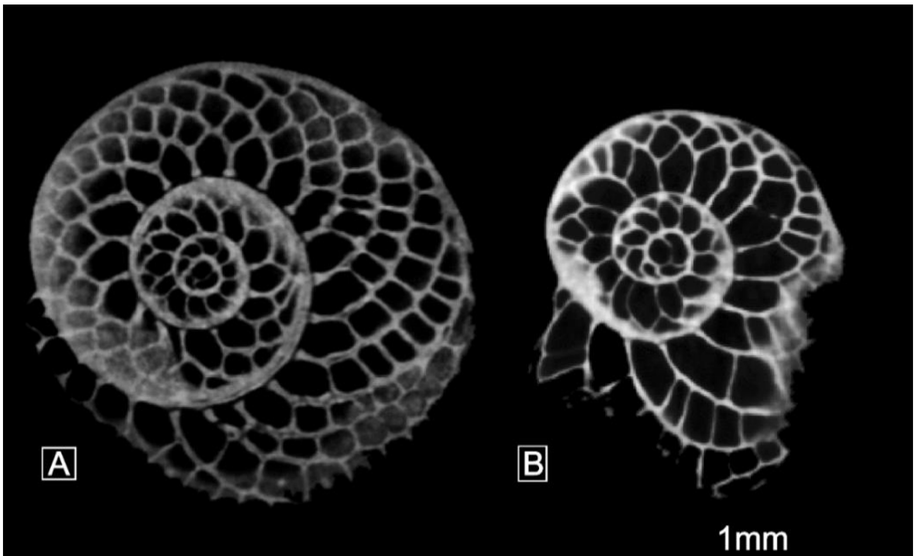
The discovery of whale fall communities in modern oceans in 1987 opened new directions for the study of the taphonomy of large marine vertebrates and the interpretation of their fossil record. Time-series studies on whale falls have shown that heterotrophic and chemosynthesis-based communities consume completely whale carcasses, from mobile scavengers feeding on the flesh to microbial communities relying on the lipid-rich bones. Amongst the many new species discovered on whale falls, bone-eating polychaetes of the genus *Osedax* that have soft root-like tissues that erode the bones to access nutrients, and have widespread geographic and bathymetric distribution, are considered the primary cause of bone disintegration. It has been hypothesised that since its origination, which possibly dates back to the late Cretaceous, *Osedax* had a negative effect on the preservation potential of marine vertebrates in the fossil record. Such an early evolutionary age, which greatly predates the evolution of cetaceans in the early Cenozoic, supports the hypothesis that the Mesozoic carcasses of marine reptiles hosted analogous communities to whale falls. When reconstructing the taphonomic pathways of fossil marine vertebrates it is then essential to take into consideration not only the role of physical factors on bone preservation, such as water pressure, wave energy and sedimentation rates, but their interplay with biotic factors related to whale fall community development. Such a scenario is further complicated by the evolutionary history of large marine vertebrates, and the co-evolution of their associated biota. In this presentation, I will show how a multidisciplinary approach can bring insights into the reconstruction of past physical and biological processes at fossil whale falls, and expand the analysis to the fossil record of large Mesozoic marine reptiles.

Limitation of biometric studies on *Heterostegina* due to mixing of different megalospheric morphotypes

Wolfgang Eder[1], Johann Hohenegger[1] and Antonino Briguglio[2]

[1] University of Vienna, Department of Palaeontology, Althanstrasse 14, 1090, Vienna, Austria, wolfgang.eder@univie.ac.at
[2] Universiti Brunei Darussalam, Faculty of Science, Jalan Tungku, BE1410, Brunei Darussalam

Within biostratigraphic and evolutionary studies morphometric characters of equatorial sections have been broadly applied to define species or subspecies of larger foraminifera (LF). To observe if the recorded morphological differences may rather reflect environmental than evolutionary change, morphometric analysis was applied to equatorial sections of megalospheric extant *Heterostegina* from the reef slope of Sesoko-Jima, NW Okinawa. Post-mortem transport along the water depth gradient was eliminated by only analysing living specimen. This clearly differentiated two morphogroups, which were identified as gamonts (with significantly larger proloculi) and schizonts (with significantly smaller proloculi). While proloculus size is the most obvious delimitator for the morphotypes, other important measured parameters (e.g., number of operculinid chambers, number of chamberlets in 14th chamber) highly correlated with it. The asexually reproducing schizonts dominate in shallower high-energy environments and gamonts in rather low-energy environments. A transition zone between (35 to 55 meters) is recognized by a presence of both generations. Morphology within the morphogroups is quite stable and shows only minute changes with water depth. Hence, the presented environmental morphological trend originates form a proportional mixing of the morphotypes along the water depth gradient. Within the American-Caribbean province this broad morphological adaptability within single localities has already been observed in the Late Eocene *H. ocalana* in the 1950s and was accredited to ecophenotypic plasticity. While in the Tethyan province this morphological trend of internal parameters has been interpreted as evolutionary trend within the Eocene *Heterostegina reticulata* lineage.



Equatorial sections of *H. depressa*. A) megalospheric specimen from 20 meters; morphogroup A_1. B) megalospheric specimen from 60 meters; morphogroup A_2.

Marine mammal preservation in a siliciclastic transgressive succession, Middle Miocene Pisco Formation, Perú

Raúl Esperante[1] and Orlando Poma[2]

[1] Geoscience Research Institute, Loma Linda, California, 92359, USA, resperante@llu.edu
[2] Universidad Peruana Unión, Ñaña, Lima, Perú

The middle Miocene/lower Pliocene Pisco Formation in southern Perú is characterized by a finning upward succession of thick to very thick fine sandstones, siltstones, and diatomaceous and tuffaceous mudstones, with interbedded thin to very thin calcarenites, phosphate and siltstone pebbles, and shell beds. The sequence represents the last marine transgression in the East Pisco Basin, which occurred in pulses marked by the layers of phosphate or siltstone pebbles, some with igneous cobbles and boulders. Previous work by the authors has highlighted the high abundance and remarkable preservation of marine mammals and other vertebrates. Though the vertebrate fossils occur throughout the succession, they are especially abundant and well preserved in the tuffaceous-diatomaceous layers of the top of the Pisco Formation sedimentary succession, which represent accumulation of very fine sediment in the final phase of the marine transgression. Most of the specimens consist of mysticete whales, and also odontocete whales, seals, and other vertebrates. Here we show that marine mammals are also well preserved and abundant in the lower fine sandstones and sandy mudstones that represent the onset and initial stages of the marine transgression.

We surveyed an area of 0.12 km^2 where the bottom layers of the Pisco Formation are well exposed both in plain view and in cross section, and we mapped the fossils exposed within. We examined 52 specimens of fossil marine mammals, consisting of isolated bones and both disarticulated and articulated skeletons. We also found abundant petrified wood and logs (some with *Teredolites*), shark teeth, fish bones and teeth, and abundant invertebrate fossils, mainly molluscs. The bottom layer (layer 1) is 3-10 cm thick and consists of rounded to subrounded phosphate pebbles within a fine sandstone matrix, with bored (*Gastrochaenolites, Trypanites, Caulostrepsis*) calcarenite lithoclasts and igneous boulders and cobbles. Marine mammals are scarce in this layer, and consist of isolated bones and rare disarticulated skeletons showing excellent preservation. Overlying this bottom phosphate pebble layer is a thick layer of massive, structureless fine sandstone (layer 2) with abundant *Thalassinoides* and *Gyrolithes* burrows (*Cruziana* ichnofacies). Marine mammals and petrified wood are abundant, including a 4-m long log riddled with *Teredolites*. Cetaceans in this layer consist of both articulated and disarticulated skeletons showing excellent preservation. Overlying this fine sandstone, the sedimentary succession consists of layers of very fine sandstone and clay matrix-rich, arkosic siltstone with scattered articulated bivalves (*Chione, Miltha*), and rare gastropods. Layer 3 is a very fine sandstone that forms a gentle cliff in the study area. It contains articulated shells, some rounded to subrounded large cobbles to medium igneous boulders, and rare medium to large boulders of bioconstructions of polychaete serpulid worms. Marine mammals are very abundant in this layer, with concentrations of up to one specimen per linear meter of horizontal exposure. The occurrence of *Cruziana* ichnofacies, *Chione* and *Miltha* bivalves, and polychaetes worms attest to well oxygenated bottom waters and sediment. Marine mammal skeletons continue to appear scattered in the overlying fine sandstone and arkosic siltstone layers.

In all the layers where marine mammals occur, the skeletons show various degrees of articulation, ranging from fully articulated to fully disarticulated specimens, and isolated bones (e.g. dentaries, skulls). Bones in disarticulated specimens are associated, including in layer 1, in which the occurrence of turned-over bored lithoclasts, phosphate pebbles and igneous boulders indicate a high-energy environment where water currents and waves potentially could have displaced or destroyed some bones. Regardless the degree of articulation, the bones are in excellent condition, showing no evidence of extensive surface abrasion caused by water currents as could be the case in a shallow-water transgressive environment. A low degree of abrasion is observed under the microscope in both the upper and lower surfaces of some samples. Nevertheless, both the lower and upper surfaces of the bones show a similar degree of preservation. The surfaces lack borings of the type caused by *Osedax* worms observed in modern whale skeletons underwater. There are no fossils (barnacles, bivalves, oysters) attached onto the surface of the bones. No shark tooth marks or evidence of scavenging were observed on the exposed surfaces of the bones.

We examined in thin section samples of bone in contact with sediment from several skeletons to determine the degree of bone modification. In most cases, the outer compact bone layer is intact or has microfractures with little or no disruption of the bone structure. The trabecular bone also shows microfractures derived from compression or shear, which in some bones resulted in a brecciated texture, although the bone retained the overall shape. Microborings produced by bacteria and/or fungi occur in some of the samples, but they do not show a regular pattern of distribution—they do not occur in all the samples of the same skeleton, they may occur on both the upper and the lower surfaces or in just one, and some areas may be densely bored whereas others lack borings completely. The microborings are closely spaced and have a preserved depth of up to 100 μm and 40 μm in width, but most of them are smaller and are about 10 to 20 μm wide and 10 to 40 μm deep.

Bone pores frequently are open, or contain gypsum, anhydrite, calcite or dolomite filling. Other alteration to the bone includes what appears to be replacement in the interior of the bone by dolomite that fills the cancellous bone pores. It is possible that the bone partially dissolved before dolomite cement emplacement, but replacement seems to fit the observed textures better.

Taphonomic process interaction in mesophotic rhodoliths from the Vitoria Trindade Seamount Chain, South Atlantic

Tarcila Franco[1], Davide Bassi[2], Alex Cardoso Bastos[1] and Gilberto M. Amado-Filho[3]

[1] Departamento de Oceanografia e Ecologia, Universidade Federal do Espírito Santo, avenida Fernando Ferrari, 514, 29075-910 Vitória, Brazil; tarcila.af@gmail.com
[2] Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Ferrara, via Saragat 1, I-44122 Ferrara, Italy
[3] Instituto de Pesquisa Jardim Botânico, Jardim Botânico, Rua Pacheco Leão, 915, 22460-030 Rio de Janeiro, Brazil

Encrusting process plays the most important role in the formation of carbonate nodules such as rhodoliths. These nodules present crustose coralline algae (CCA) as the most abundant encrusting organisms of the internal structure. Bioerosion processes are preserved and detectable within the rhodoliths.

The Vitoria-Trindade Seamount Chain (VTSC), located in the South Atlantic Ocean, consists of a linear series of guyots, seamounts and islands, arranged between the parallels 20º and 21º S, extending for 1750 km offshore. For this study, rhodoliths were collected at the Jaseur seamount (66 m and 74 m water depth) and at the Trindade island shelf (65 m water depth). The sites are distant from the shore and present low sedimentation rate.

Encrustation and bioerosion were the most important taphonomic process identified acting in the studied rhodoliths (fragmentation and abrasion may be obliterated by the intense bioerosion). In order to evaluate the influence of the encrusting and bioerosion processes in the rhodoliths, a semi-quantitative analysis was performed on scanned 42 thin sections in which the extension of encrustation and bioerosion was classified as rare, common or abundant throughout each rhodolith. Encrustation and bioerosion were independently assessed.

The results show that encrustation is common on the rhodolith outer parts in all the studied sites, with higher percentages (69% in Trindade at 65 m, 81% in Jaseur at 66 m and 71% in Jaseur at 74 m) comparing with the rhodolith inner parts (46% in Trindade at 65 m, 33% in Jaseur at 66 m and 67% in Jaseur at 74 m). An opposite trend was found for the bioerosion process. On the rhodolith outer parts bioerosion is abundant in all sites (72% in Trindade at 65 m, 85% in Jaseur at 66 m and 77% in Jaseur at 74 m), with lower percentages than in the inner rhodolith parts (90% in Trindade at 65 m, 96% in Jaseur at 66 m and 78% in Jaseur at 74 m).

The results show that the bioerosion is the main taphonomic feature in the mesophotic rhodoliths at the VTSC. All the bioerosion structures correspond to the boring activity of endolithic organisms. The most abundant boring traces are represented by *Entobia* produced by etching sponges. The high dominance of bioerosion process confirms that the boring activities benefit from low sedimentation rates.

In mesophotic environments such as the present study (> 60m depth), encrusting rates are lower when compared to shallower environments due to decreased photosynthetic rates of algae and organisms that perform symbiosis with increasing depth. The intense bioerosion processes found here may be favoured also by the slow growth rate of the encrusting organisms.

The results from VTSC show that an increase in the dominance of bioerosion process is always linked to a decrease in the presence of encrustation process. At 66 m the Jaseur rhodoliths present the highest percentage of bioerosion comparing to the three studied sites. On the contrary, encrustation shows the lowest percentage, being predominant as common in the inner rhodolith parts and rare in their outer. The peculiar characteristics found in Jaseur rhodoliths at 66 m can be explained by the enrichment in nutrient contents in the water column due to the establishment of a Taylor column feature. Others studies demonstrate the increasing of bioerosion rates with the increasing of phytoplankton productivity and nutrient level in the water column, as this characteristics favors the establishment of benthic filtering organisms such as sponges, bryozoans and tunicates that can compete with the encrusting organisms for space, reducing encrustation rates. Moreover, the pattern observed in Jaseur at 66 m is in agreement with other works that indicate the positive influence of the water nutrient enrichment over bioerosion processes and the negative influence on the encrustation processes.

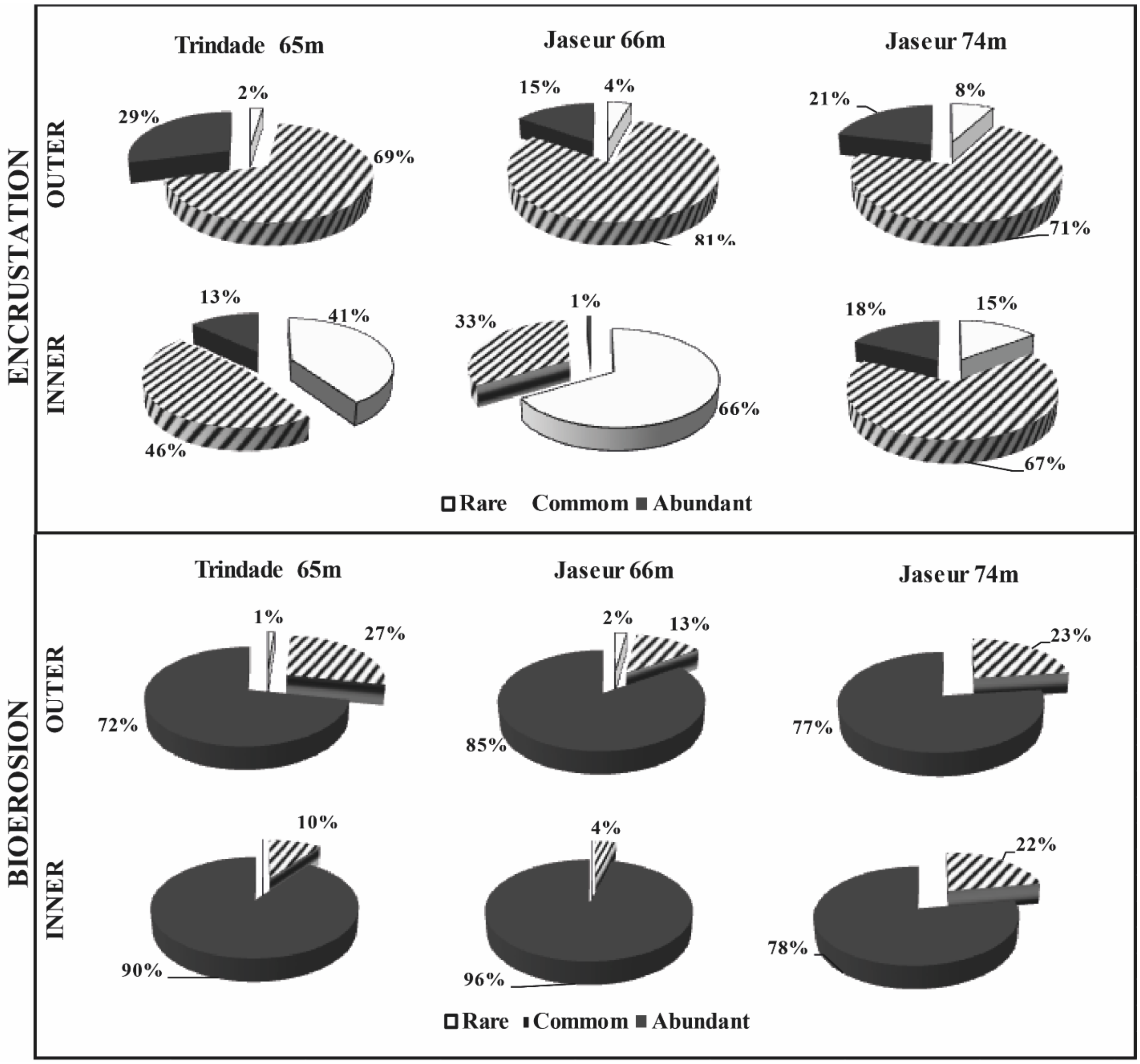


Figure 1. Semi-quantitative analysis of encrustation and bioerosion processes in the rhodoliths collected in the Jaseur seamount and Trindade island shelf.

Animal remains and their potential in prehistorical and historical contexts

Alfred Galik

Austrian Archaeological Institute, Austrian Academy of Sciences, Franz-Kleingasse 1, 1190 Vienna, Austria

Similar to paleontology - archaeozoology deals with a wide range of different animal remains like domesticate and game, fish or shells. The organism remains usually are unearthed in archaeological excavations and serve as potential information source to reconstruct the past. However, in paleontological and geological terms such observations reconstruct wide ranging ecosystems over long chronological periods or regional environments are reconstructed by fossilized and preserved remains of living organisms. Knowledge upon the taphonomical history of the pre-, depositional and post-depositional processes is essential on this behalf. Principally archaeozoology works in a very similar scientific direction and tries to reconstruct the contemporaneous biosphere with animal remains excavated.

However, it involves another additional taphonomic factor – human behavior. Paleoanthropological studies dealing with early humanoid evidences, which already used tools, made fire and are at least partly responsible for the accumulation of the paleontological finds. Pleistocene cave sites as well as open air sites are sources and mirrors of human interaction in paleontological terms. The structures were temporarily settled by hunter and gatherer societies, who left their waste behind. However, anthropomorphic figurines, burial practices or cave paintings allow gathering deeper understanding about the metaphysical and transcendental world of the Paleolithic people.

Archaeozoological finds definitely are younger and start with begin of the Holocene approximately 10.000 years ago. The human animal relationship and interaction stands of course in the main focus of archaeozoology. The processes of animal domestications certainly are a crucial question for the early human-animal relationship, as well as the strategies of early live-stock exploitation. Environmental- and economical- as well as societal historical research questions additionally can be addressed by archaeozoologcial investigations of various animal remains. Human behavior must be taken into account as it can affect the excavated assemblages of biogenic findings.

Usually the archaeozoological finds tell us about the regular support and consumption patterns of prehistoric and historical settlements and towns. Certain preferences in keeping live-stock can indicate demand for special kind of food or meat, while the animals usually wouldn't flourish in the available ecosystem. Special conditions in comparison to the regular nutrition of people illustrate specialized hunting indicating differentiated structured social behavior in the past.

Imported and exotic species in combination with other sciences can lead to complete new and extraordinary historical insights. Typical local breeds and shapes well adapted to their local environment can be compared to imported larger and different looking animal breeds. Wild animals like shells for example can be seen as a human driven proxy for long termed changes of local marine coastal conditions, which are also predestined as markers for exploitation and overexploitation. However, fish was always an important source of animal protein although someone must know where, how and when to catch fishes. Species composition and size distribution can reveal at one hand the ecological conditions of the aquatic catchment area and the effects of heavy exploitation and overexploitation in a local catchment. Last but not least it can be stated that palaeontology and archaeozoology are similar in various kinds of natural sciences investigations and the ambition to reconstruct the taphonomic history of the finds like ammonites, dinosaur bones or pig teeth for example. But the world of archaezoology includes also the development and expansion of human mankind, which finally ended as human dominated era suggested as “Anthropocene”.

Small mammal taphonomy from PRERESA Late Pleistocene riverside site (Madrid, Spain)

Sara García-Morato[1] and Yolanda Fernández-Jalvo[2]

[1] Universidad Complutense de Madrid. Department of Palaeontology. Jose Antonio Novais 12, 28040-Madrid, Spain. sagarc16@ucm.es
[2] Museo Nacional de Ciencias Naturales, José Gutiérrez Abascal 2, 28006-Madrid, Spain

The PRERESA Late Pleistocene site is located southern-east of Madrid. Microfauna is recovered from a silt level of a fluvial terrace on the lower segment of the Manzanares valley. The site is located between two fluvial sequences deposited during the second half of Marine Isotopic Stage (MIS) 5. Manzanares terraces have been frequently studied as they yield abundant lithic industry, macro-vertebrate remains (included proboscidean bones) and traces of human activity on the bones recovered. PRERESA is also important in this respect. Apart from the macromammal remains (Mammoths, aurochs, cervids), micro-vertebrate fossils (amphibians and reptiles) were recovered, which had been the aim of taxonomic studies contributing to the paleoenvironmental reconstruction of the Madrid Pleistocene basin. The aim of this work is to study the taphonomic history of the small mammal assemblages at PRERESA site. Sediments were sieved and sorted, containing remains of rodents (Minimum Number of Elements: MNE=373) and lagomorphs (MNE=372). During excavations an aggregation of small mammal remains was recovered and interpreted as a raptor pellet (most likely several pellets that melted together). Fossilization of pellets or preservation of aggregations of pellets is an exceptional find and the high number of fossils (MNE=253) supports this find as owl pellets. The taphonomic study has considered three main aspects: anatomical representation, fragmentation, and corrosion by digestion. Due to the location of the site on a fluvial system, transport effects and abrasion were analyzed as well. The results obtained show a high representation of cranial elements (especially lagomorphs) as well as a high fragmentation of both cranial and postcranial elements. Digestion observed in this assemblage affects dental remains below 30% in both rodents and lagomorphs (as well as the pellet aggregation) the most frequent digestion degrees are light and moderate, but all samples reach extreme grades of digestion (in molars < 3%). Transport was analyzed using Voorhies groups. All groups are represented in the assemblage, even the most favored to be transported. Group III (cranial remains and the most resistant to transport) was the best represented. The simultaneous presence of all Voorhies groups suggests low or null transport. Results could indicate that the small mammal assemblage of PRERESA were produced by a nocturnal raptor, most likely an Eagle owl (*Bubo bubo*), whose nest or roosting site was near the fluvial channel.

Cycles of brachiopod pavements in a Pliocene mixed carbonate - siliciclastic Prograding Wedge (SE Spain): implications for sequence stratigraphy

Diego A. García-Ramos and Martin Zuschin

University of Vienna, Department of Paleontology, Althanstrasse 14, A-1090 Vienna, Austria

During the Early Pliocene, subaqueous delta-scale clinoforms developed in the Águilas Basin, then a small coastal embayment, in a warm-temperate, mixed carbonate-siliciclastic sedimentary system. Stratal architecture and sedimentary facies are consistent with the Infralittoral Prograding Wedge model. At the scale of systems tracts, this wedge formed first during highstand and later on during falling sea-level trends. Over twenty-five clinothems (parasequences) prograded over a distance of 2 km. Biostratigraphic data from base to top of the synthem indicates a time span shorter than 0.7 m.y. for the whole unit (within planktonic foraminiferal biozone MPl3 of the Mediterranean Pliocene), indicating high-frequency sea-level changes. Clinothems defined by the clinoforms are characterized, from most proximal to most distal parts along the topset to bottomset depth gradient, by four main facies types: At the topset to upper foreset, shoreface sands grade into rhodolith-rich carbonates. The foreset consists of hybrid carbonate and medium- to fine-grained sands, rich in tubes of the polychaete *Ditrupa arietina* and decreasing abundance of rhodolith debris downslope. The toe of the foreset and the bottomset environments consist of mixed packstones, fine-grained sands and silts with dispersed *Costellamussiopecten*. Intense bioturbation completely erased the clinoform surfaces at their foreset and bottomset parts. In these subenvironments, however, cyclic pavements and occasional biostromes of suspension feeders (terebratulid brachiopods, modiolid bivalves and adeoniform bryozoan colonies), glauconite and occasionally *Glossofungites* ichnofacies formed during high-frequency relative sea-level rises. All these features are explained by increased accomodation space in the topset during sea-level rise and concomitant strong reduction of terrigenous input into the foreset and bottomset areas, allowing favorable conditions for the *Terebratula* populations. During stillstand stages, however, accomodation space in the topset is progressively reduced, leading to progradation in the foreset. The abundance of *Ditrupa* tubes at the foreset is consistent with frequent storm-driven siltation events during stillstand sea-level stages, during which terebratulid populations disappeared from the toeset and bottomset subenvironments. The terebratulid pavements are interpreted as obrutionary deposits. It is hypothesized that *Terebratula* density in the pavements peaks with highest intensity of currents in the toeset in agreement with models of offshore along-slope currents in prograding wedges. A counter-clockwise current system in the Águilas Basin might have produced the seaward migrating sandwave fields observed at the southwestern part of the basin.

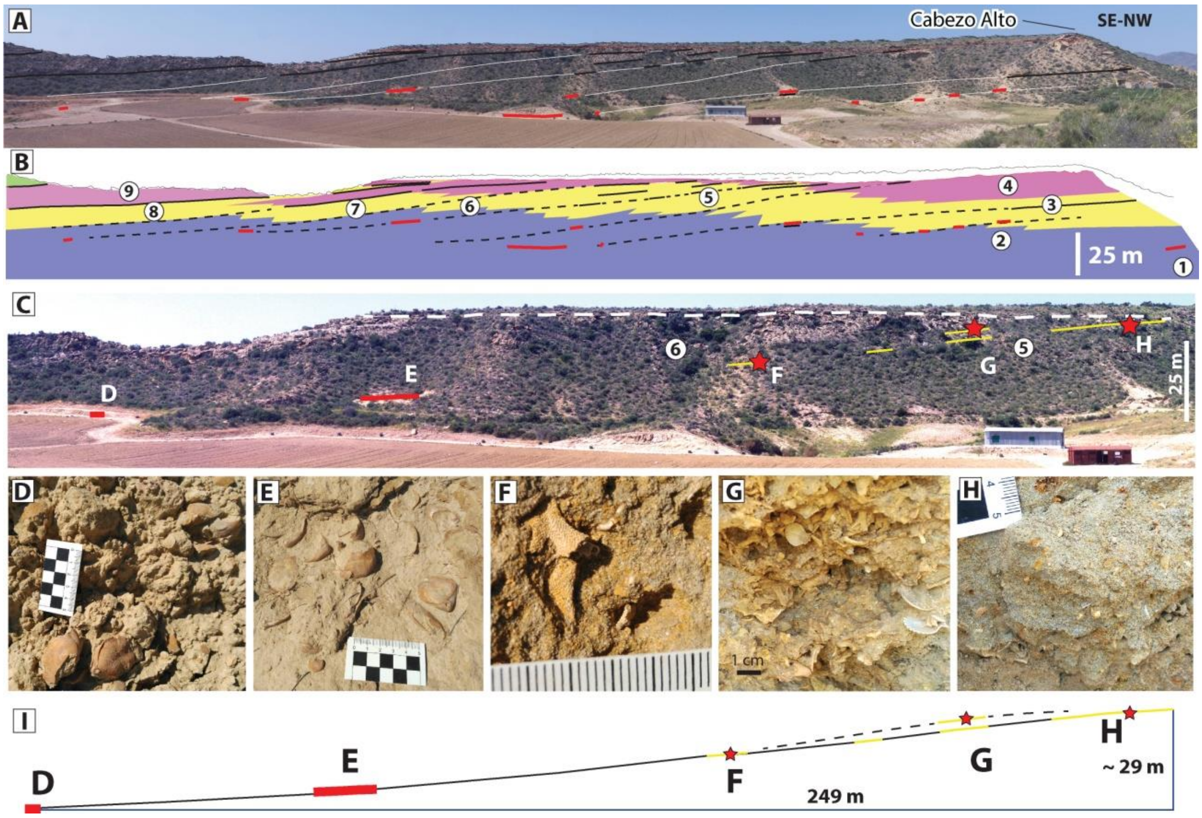


Fig.1.- A) Photomosaic of the basal interval of the Early Pliocene prograding wedge from the Águilas Basin (SE Spain). Bedding planes visible in the field are marked in black, interpreted ones are in white, and bold red are *Terebratula* pavements. B) Main facies types indicated by color codes: from proximal to distal, hybrid carbonate-coarse grained sands (green), hybrid siliciclastic-rhodolith floatstone (pink), hybrid packstone and fine-grained sands with *Ditrupa* (yellow) and hybrid packstone and fine-grained sands with *Costellamussiopecten* (blue). Numbering of the clinothems identified in the Cabezo Alto area is indicated within circles. C) Example of the clinoform separating clinothems 5 and 6, with features across a proximal-distal gradient. Asteriks indicate the spots where the photographs were taken. D) and E) are details of the same pavement at the toeset and inner bottomset of the clinoform. F) foreset *Ditrupa* facies with loosely-packed fragments of adeoniform bryozoans colonies (*Schizoretepora* sp.). G) Detail of the rollover zone with densely-packed concentration of the same bryozoan taxon. H) Outer topset facies with loosely-packed fragments of the same bryozoans, and small fragments of rhodoliths. I) Dimensions of the clinoform from bottomset to topset.

Organic remains from archaeological contexts. Forensic taphonomy applied to prehistoric graves

Karina Grömer

Natural History Museum Vienna, Department of Prehistory, Burgring 7, A-1010 Vienna, Austria, karina.groemer@nhm-wien.ac.at

Organic remains are rare from archaeological sites in Europe due to the prevailing climatic conditions. Here I focus on prehistoric and early medieval burials in Central Europe.

Forensic methods help us to understand the “normal” decomposition process of a body (death – decay – skeletonization), the time-frames and the variables affecting the decay rate including temperature, climate, and access of insects. Under Central European conditions, organic material in a prehistoric burial can be expected to have completely decomposed after 10 years latest.

In rare cases, in graves textiles, leather, but also human skin can be preserved. This typically happens in the contact zone with metal objects, where minerals forming through corrosion of the metal penetrate and thus preserve adjacent organic material. Thus, it is a matter of specific chemical conditions, and micro-climatic conditions such as pH-value, moisture and temperature that the decay process is slowed down or even stopped.

The organic remains attached on the metal objects are analysed using the method of micro-stratigraphy, in the talk some case-studies of preserved textiles and even human skin are presented. Analysis of the timing of the decomposition processes, as well as microstratigraphic succession of the individual organic and inorganic layers facilitate conclusions even in cases where the original burial or find is not preserved (or was not documented) in-situ (e.g., due to grave robbery in ancient time, excavation by non-experts, study of objects in collections).

Learning from the present, understanding the past: drill hole recognition for the fossil record

Tobias B. Grun

Department of Geosciences, University of Tübingen, Hölderlinstraße 12, 72074 Tübingen, Germany

Drill holes in echinoids produced by carnivorous cassid gastropods are often found in dead sea urchin tests recovered from both ancient and Recent sediments. In many cases the aragonite snail shells show a poor preservation potential in the fossil record thereby often making their predatory drill holes in the echinoid skeletons the only indicator of their former presence. Understanding the predation traces that cassids leave in echinoids of Recent environments can fundamentally improve the knowledge of ancient predator-prey interactions and can advance the predator recognition in the fossil record by the traces the predators leave.

The Caribbean sand dollar *Leodia sexiesperforata* is often drilled by the cassid *Cassis tuberosa* around the island of San Salvador, The Bahamas. Drill hole morphology and predatory patterns are described to identify characters that are specific for *Cassis tuberosa* drill holes in *Leodia sexiesperforata*. Drill holes are typically subcircular to elliptical in shape with an average width of 3.5 mm. The drill hole profile can be concave parabolic in regions where the stereom is thick, or, sigmoidal in areas where the stereom is thin. The acid-supported drilling technique can expose the inner of the stereom in areas around the drill hole and drill holes can also feature notches on the drill hole margin. Stereom protrusions reaching into the drill hole lumen are also indicative for acid-supported drilling. *Cassis tuberosa* prefers the oral anterior part of the sand dollar as drilling site, drill holes also occur in other areas on the echinoid test, but in statistically lower numbers. Analyses also revealed that the cassid gastropod might show a preference for larger prey. The results indicate that some drill hole characters and drilling patterns can be used for predator recognition in both ancient and Recent environments, other drill hole characters and patterns are more likely to reflect the substrate or the anatomy of the prey.

Taphonomy as a proxy for stable shell constructions

Tobias B. Grun and James H. Nebelsick

Department for Geosciences, University of Tübingen, Hölderlinstraße 12, 72074 Tübingen, Germany

The fossil record demonstrates that multi-plated echinoid skeletons can survive the often complex pathways of fossilization in considerable numbers. Fossilized remains range from single plates to larger fragments and complete specimens. Clypeasteroid echinoids show an extensive preservation potential due to internal supports and plate interlocking. The sea biscuit *Clypeaster rosaceus* is therefore not only in the focus of paleontological research, but also a role model for bioinspired constructions in civil engineering due to its outstanding preservation potential.

Tests of this echinoid have been analyzed in the natural environment with respect to taphonomic signals of disarticulation or interplate fragmentation (breaking apart along plate boundaries) and intraplate fragmentation. Taphonomic observations of this echinoid allows for the identification of both stabile and weak parts of the skeleton as well as skeletal connections. Disarticulation and fragmentation patterns are studied with respect position on the test, intensity and corresponding taphonomic grades. The observed disarticulation and fragmentation pattern are then compared to the skeletal architecture and reinforcement systems of these echinoids as observed by x-ray micro-computed tomography scan (µCT) and scanning electron microscopy (SEM).

First results show that *Clypeaster rosaceus* predominantly break along the perradiad sutures, which are located within rows of ambulacral plates resulting in up to five pie-shaped fragments. Correlations of the fragmentation patterns with µCT and SEM investigations indicate that test disarticulation follows the less reinforced region in the test where the pie-shaped fragments show a high degree of skeletal reinforcements reflected primarily by internal supports that connect the oral and aboral side of the skeleton.

Taphonomy and population structure of an early Miocene *Crassostrea* shell bed based on the analysis of 3D point cloud data

Mathias Harzhauser[1], Ana Djuricic[2], Oleg Mandic[1], Martin Zuschin[3] and Norbert Pfeifer[2]

[1] Natural History Museum Vienna, Geological Paleontological Department, Austria, mathias.harzhauser@nhm-wien.ac.at, oleg.mandic@nhm-wien.ac.at
[2] Department of Geodesy and Geoinformation, Research Group for Photogrammetry, Vienna University of Technology, Austria, ana.djuricic@geo.tuwien.ac.at, Norbert.pfeifer@geo.tuwien.ac.at
[3] Department of Palaeontology, University of Vienna, Austria, martin.zuschin@univie.ac.at

We present the largest GIS-based data set of a single shell bed comprising more than 10.280 manually outlined objects covering 459 m². The data are derived from a digital surface model based on high resolution Terrestrial Laser Scanning (TLS) and orthophotos obtained by photogrammetric survey, with a sampling distance of 1 mm and 0.5 mm, respectively. The shell bed is an event deposit, formed by a tsunami or an exceptional storm in an Early Miocene estuary. Disarticulated shells of the giant oyster *Crassostrea gryphoides* (Schlotheim, 1813) predominate the composition along with venerid, mytilid and solenid bivalves and potamidid gastropods. The contradicting ecological requirements and different grades of preservation of the various taxa mixed in the shell bed and a statistical analysis of the correlations of occurrences of the species reveal an amalgamation of at least two pre- and two post-event phases of settlement under different environmental conditions.
The analysis of a subset of 1121 complete shells of the giant oyster *Crassostrea gryphoides* suggests that population structure and cohort distribution can be deduced from the shell bed.
Based on center line length and shell surface a growth model was calculated, revealing this species as the fastest growing and largest *Crassostrea* known so far. Non-normal distribution of size, area and age data hints at the presence of at least four distinct recruitment cohorts. The rapid decline of frequency amplitudes with age is interpreted to be a function of mortality and shell loss. The calculated shell half-lives range around few years, indicating that oyster reefs were geologically short-lived structures, which could have been fully degraded on a decadal scale.

The study was financed by the Austrian Science Fund (FWF project no. P 25883-N29 “Smart-Geology für das größte fossile Austernriff der Welt”).

New methods for comparing living associations and death assemblages

Johann Hohenegger

Department of Palaeontology, University of Vienna, Althanstrasse 14, A 1090 Vienna

Living associations (LAs) and death assemblages (DAs) from the same quadrats (samples, sites) can be compared based on total densities, species densities, species richness and heterogeneity (evenness). Only densities, obtained by normalization of absolute frequencies to unit quadrats (sample size), should be used to compare quadrats because species lose their independence from other species represented in the sample when percentages are calculated or counting is stopped after a predetermined number of individuals. New measures for species richness and heterogeneity, based on the fit of individual rarefaction functions using normal (not generalized) Michaelis-Menten functions, were introduced. Various combinations of the above four characteristics enable a better insight into the relations between LAs and DAs. Linearized probabilities of rank correlations clear up the disorder in species abundance between both assemblage types, improving parametric multivariate analyses. The 'Incorporation Value' multiplies similarities in species composition between both assemblages with the proportions of living individuals on total individual numbers, yielding the instantaneous integration grade of living individuals into the death assemblage. Diversity diagrams based on species richness (abscissa) and heterogeneities (ordinate), standardized over all quadrats (samples, sites), simultaneously characterize differences in diversities. The standardized vector between LA and DA in the above-mentioned coordinate systems characterizes differences in species richness and heterogeneity in a combined manner. Finally, the 'Similarity-Diversity Index' weights similarities in species composition between LAs and DAs by the vector length between diversities of both assemblages in the standardized coordinate system. All methods were checked on 105 foraminiferal sample sites from the outlet of the Ria de Aveiro lagoon (Portugal), represented by seven selected sites.

Brachiopod Communities within Tectonic Crevices in the Upper Triassic Dachstein Formation

Julian Huemer[1], Steffen Kiel[2], Jörn Peckmann[3] and Martin Zuschin[1]

[1] Department of Palaeontology, Geozentrum, Universität Wien, UZA II, Althanstraße 14, A-1090 Vienna, julian_huemer@sbg.at
[2] Enheten för Paleobiologi, Naturhistoriska Riksmuseet, P.O. Box 50007, SE-104 05 Stockholm
[3] Institute for Geology, Universität Hamburg, Bundesstraße 55, 20146 Hamburg

Crevices filled with red sediment that contain high-abundance and low-diversity brachiopod assemblages were found within the Late Triassic Dachstein limestone facies in the Dachstein Formation, located in the Steinernes Meer Massif, Salzburg, Austria. The origin of the crevices, which strike similarly with a mean orientation of 238°, is interpreted as tectonic. The crevices and their surroundings were a habitat for brachiopod communities of the genus *Sulcirostra*, which ranges from the Norian to the Pliensbachian. The assemblages were studied regarding a possible relation to hydrocarbon seepage. The aim of this study was the testing of this working hypothesis through microfacies analysis, stable carbon and oxygen isotopes, and consideration of size-frequency distribution-related population dynamics of brachiopods. Samples were taken from four locations. Thin sections were examined with 20-fold magnification, using transmitted light microscopy. Most brachiopod shells are well preserved with many individuals being articulated, thus not showing any sign of exposure to mechanical stress and transportation. Most size-frequency distributions of brachiopods are right skewed, reflecting dominance of smaller individuals and are therefore interpreted as parautochthonous assemblages. Geopetal structures inside brachiopod shells are similarly oriented. Therefore, the brachiopod assemblages are interpreted as parautochthonous deposits. Stable carbon and oxygen isotope compositions were measured from powder samples. The samples were taken from (1) brachiopod shells, (2) their internal cement, (3) the red, fission-filling background sediment and (4) the embedding Dachstein limestone facies. Cements in brachiopod shells from methane-seep paleoenvironments have been reported to inherit the $\delta^{13}C$ composition of methane. Methane has $\delta^{13}C$ values as low as –100‰ (V-PDB). A previous study on a limestone deposit with a mass occurrence of *Sulcirostra* from eastern Oregon reported $\delta^{13}C$ values of authigenic carbonates as low as –24‰, agreeing with a chemosynthesis-based ecosystem nourished by hydrocarbon-rich fluids. With a mean value of 2.63 ($\delta^{13}C$) and little scatter in the stable carbon isotope composition of cements, an adaption to seeps is not supported in the case of the Alpine occurrences of *Sulcirostra*. Instead, it is concluded that the shell accumulations are parautochthonous death assemblages of brachiopods that dwelled in a normal marine environment.

Fig. 1: Red crevice with *Sulcirostra* assemblage within Dachstein limestone facies.

Exceptional preservation of the Paris Biota (Spathian, USA), the oldest Early Triassic marine Konservat-Lagerstätte

Miguel Iniesto[1], Christophe Thomazo[1], Emmanuel Fara[1], Emmanuelle Vennin[1], Nicolas Olivier[2], Gilles Escarguel[3] and Arnaud Brayard[1]

[1] Biogéosciences UMR 6282, CNRS, Université Bourgogne Franche-Comté, 6 Boulevard Gabriel, 21000 Dijon, France
[2] Université Clermont Auvergne, CNRS, IRD, Observatoire de Physique du Globe de Clermont-Ferrand, Laboratoire Magmas et Volcans, 5 rue Kessler, F-63000 Clermont- Ferrand, France
[3] Univ Lyon, Université Claude Bernard Lyon 1, CNRS, UMR 5023 Laboratoire d'Ecologie des Hydrosystèmes Naturels et Anthropisés, 27-43 Boulevard du 11 novembre 1918, 69622 Villeurbanne Cedex, France

The biotic crisis at the Permian–Triassic boundary (PTB) [~251.9 million years ago (Ma)] is depicted as the most severe mass extinction of the Phanerozoic. After this event, Early Triassic (~251.9 to 247 Ma) marine ecosystems have been described as heavily depauperate. Recurrent changes in water temperature, large-scale fluctuations of the global carbon cycle, and severe marine conditions including a combination of ocean acidification, euxinia, and fluctuating productivity made this interval highly unstable. Consequently, marine benthic ecosystems have frequently been assumed as low in diversity, showing a delayed and heterogeneous recovery. However, this assumption may result from numerous bias in the fossil record, especially its poor preservation. Recently, the discovery of the Paris Biota (Idaho, USA), the oldest Early Triassic marine Konservat-Lagerstätte can help to reveal the actual composition of these ecosystems. This complex fossil assemblage from the earliest Spathian (~250.6 Ma) shows a remarkable richness in sponges, brachiopods, bivalves, echinoderms, cephalopods, arthropods, and fishes. Excluding isolated fragments and remains, more than 750 individuals have been already identified. These fossils represent at least seven phyla and >20 orders, which indicate a prompt and quick rediversification after the PTB crisis. The whole constitutes a remarkably complex marine ecosystem.

However, the taphonomy of these taxa remains elusive. Here we present the mineral characterization of three of the most abundant groups: discinoid brachiopods, leptomitid sponges and crustaceans. For this purpose, we combined data from Raman spectroscopy, Fourier Transform InfraRed spectroscopy (FTIR), and SEM-EDXS. In addition, $\delta^{13}C_{org}$ and $\delta^{15}N$ signals of the sediment matrix in direct contact with brachiopods and sponges have been analysed. Although these three groups were preserved in calcium phosphate (Fig. 1B, F and J), the morphology, structuring and size of crystals are highly dissimilar at a micrometric scale. In brachiopods, the microscopic structure of calcium phosphate shows unorganized bacillary-like crystals (~1 µm, Fig.1C and D), while in crustaceans their size is considerably lower (less than 100 nm, and round-shaped (Fig. 1G and H). A similar small crystal size is observed in sponges. However, the microstructure of calcium phosphate in sponges exhibits a well-defined preferential orientation (Fig. 1K and L). In addition, sponges show some compressed but preserved three-dimensional features, with an inner phase better preserved (Figure 1I and J, the black arrow indicates the upper layer while the white one shows the bottom of the fossil). Finally, preliminary data from geochemical analyses suggest a significant $\delta^{13}C_{org}$ deviation in brachiopods compared to sponges (p-value < 0.05). This geochemical discrepancy, as well as clade-dependant features (e.g. mineral size and shape) can be explained by differences in the decay process, e.g. rate of decomposition and/or composition of tissues, and the resultant microenvironments generated. This kind of analyses is essential to describe the taphonomic pathways enabling exceptional preservation. The further comprehension of such preservation would help to understand potential bias on observed diversity signals and their interpretation.

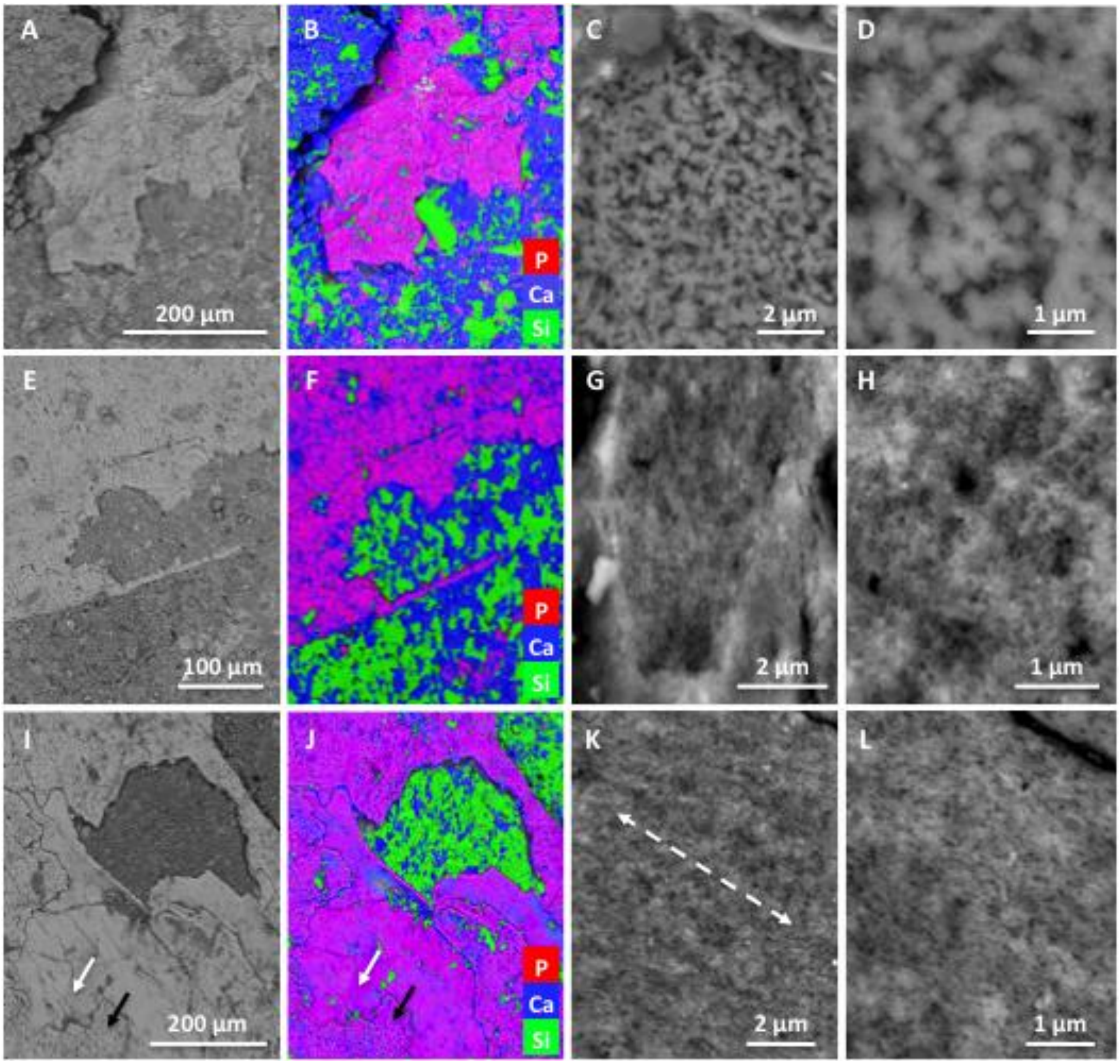


Figure 1: SEM observation of discinoid brachiopod (**A**-**D**), crustacean (**E**-**H**) and leptomitid sponge (**I**-**L**) fossils. **B**, **F** and **J** are EDXS maps showing the location of Ca (blue), Si (green), and P (red). Purple is the result of the overlap of Ca and P signals. Si (green) corresponds with the sediment. **C**, **G** and **K** are the magnification of the calcium phosphate presented in **A**, **E** and **I** respectively. **D**, **H** and **L** show the microstructure of the mineral (x20K). Arrows in **I** and **J** point the three-dimensional preservation, with the bottom layer (white arrow) better preserved (lower degradation). Arrow in **K** indicates the preferential orientation. Images were collected in backscattered and secondary electron modes using a JEOL JSM6400F operating at 15 kV, with a 60 µm aperture at a working distance of ~5 mm. Analyses were performed at a distance of ~15 mm.

The fossil record of igneous rock

Magnus Ivarsson

Swedish Museum of Natural History, Department of Palaeobiology, Box 50007, Stockholm, Sweden

The fossil record of igneous rock constitutes a new and unique paleobiological archive that is largely underexplored with respect to taxonomy, fossilization and taphonomy. In comparison to sedimentary rocks where fossils accumulate during sedimentation, the fossils of igneous rock are concentrated to open pore spaces such as fractures and vesicles and, thus, post-date the formation and cooling of the rock. This record constitutes the fossilized remains of the deep biosphere; microorganisms living at depths in the rock and subsequently become fossilized *in situ*. So far, a majority of the investigations have been carried out on subseafloor basalts but ultramafic rocks as well as continental granites have been shown to contain similar fossils. Currently, the fossil archive ranges from present to 2.4 Ga indicating that these deep environments have been inhabited by microorganisms from, at least, the Paleoproterozoic. The fossils have been interpreted as both eukaryotes and prokaryotes but, surprisingly, a majority of the fossils consist of fungal remains, of which some are the oldest potential eukaryotes. Also, consortia of eukaryotes and prokaryotes are common, which suggests that collaboration between the both might be a prerequisite for colonization of, and survival in deep, extreme environments.

The fossils are usually characterized by a high grade of preservation with respect to both morphology and chemistry. Branching, septa, central strands and anastomoses between branches are all morphologies that normally are preserved. Carbonaceous matter is a common constituent and more complex biomolecules as fatty acids, lipids and even chitin has been detected in fossilized fungal hyphae. Preservation and fossilization of the microorganisms in deep igneous rock is controlled by geochemical conditions and the composition of the fossils differ between different types of rocks. In basalt hosted systems microorganisms are preserved as clays and iron oxides while in ultra mafic rocks the fossils are composed of poorly crystalline phases of carbonaceous matter and trace elements like Ni, Co, Mo, Fe, Mn and S. In continental granites the microorganisms are preserved as carbonaceous material, probably as a result of extensive anoxic conditions. However, transitions between carbonaceous parts and mineralized parts exists, which gives valuable insights into the mineralization processes of microorganisms; how the negatively charged carbonaceous material attracts the positively charged Si, Al, Mg, Fe, Na, Ca cations and sparks subsequent mineralization of, for instance, clays.

Since the igneous portion of the oceanic and continental crust makes up the largest potential microbial habitat on Earth, it is somewhat of a paradox, that our knowledge about life in the subsurface is extremely limited. Studying this biome in vivo is, with a few exceptions, beyond our reach because sample sizes are typically very small and cell numbers low. As a consequence, interpretation of fossilized material is a necessary complement to molecular studies in the exploration of this deep, hidden biosphere. Fossilized material have several advantages over live material. Firstly, it gives us a spatial comprehension of the community structure and microbe-mineral interactions that live material lacks. Secondly, it is easier to prove indigenousness to the rock and exclude modern contamination from seawater and fluids compared to live species. Thus, exploring the deep life of our planet is one of the great challenges of our time, and using fossils as means of this exploration have proven to be a successful strategy.

Harnessing the stratigraphic bias at the section scale: conodont diversity in the Homerian (Silurian) of the Midland Platform, England

Emilia Jarochowska[1], David C. Ray[2], Philipp Röstel[1], Graham Worton[3] and Axel Munnecke[1]

[1] GeoZentrum Nordbayern, University of Erlangen-Nuremberg, Loewenichstr.28, 91054 Erlangen, Germany
[2] School of Geography, Earth & Environmental Sciences, University of Birmingham, Edgbaston, B15 2TT, United Kingdom
[3] Dudley Archives and Local History Centre, Tipton Rd, Dudley, DY14SQ, United Kingdom

Fossil abundance and diversity in geological successions are subject to bias arising from shifting depositional and diagenetic environments, resulting in variable rates of fossil accumulation and preservation. In simulations, this bias can be constrained based on the sequence-stratigraphic architecture. Nonetheless, a practical quantitative method of incorporating the contribution of sequence-stratigraphic architecture in community palaeoecology and diversity analyses derived from individual successions is missing. As a model of faunal turnover affected by the stratigraphic bias, we use the ‘Mulde event’, a postulated mid-Silurian interval of elevated conodont turnover, which coincides with global eustatic sea-level changes and which has been based on regionally constrained observations. We test whether conodont turnover is highest at the boundary corresponding to the 'event' and post-'event' interval against the alternative that conodont turnover reflects habitat tracking and peaks at facies shifts. Based on the previously documented, parasequence-level stratigraphic framework of sections in the northern and central part of the Midland Platform, the relative controls of sequence-stratigraphic architecture, time, and depositional environment over conodont distribution are evaluated using permutational analysis of variance. Of those factors, only the depositional environment contributes significantly to changes in conodont assemblage composition, whereas the postulated 'Mulde event', or genuine temporal change in conodont diversity, cannot be detected. Depending on the binning of the stratigraphic succession, contrasting diversity and turnover patterns can be produced. The simple approach proposed here, emulating partitioning of β diversity into spatial and temporal components, may help constrain the stratigraphic bias even at the scale of an individual section.

Unravelling fossilisation processes in the La Voulte-sur-Rhône Lagerstätte from the study of exceptionally preserved crustaceans

Clément Jauvion[1,2], Sylvain Bernard[1], Pierre Gueriau[3,4] and Sylvain Charbonnier[2]

[1] IMPMC, UPMC-Sorbonne Universités, MNHN, CNRS UMR 7590, IRD, 61 rue Buffon, 75005 Paris, France, clement.jauvion@mnhn.fr
[2] CR2P, Sorbonne Universités, MNHN, UPMC, CNRS UMR 7207, 8 rue Buffon, 75005 Paris, France
[3] IPANEMA, CNRS, MCC, UVSQ, MNHN USR 3461, Université Paris-Saclay, 91192 Gif-sur-Yvette, France
[4] Synchrotron SOLEIL, BP 48 Saint-Aubin, 91192 Gif-surYvette, France

Konservat-Lagerstätten are geological deposits yielding exceptionally preserved fossils, which display fine morphological details (incl. soft tissues) usually not preserved in the fossil record. They therefore consist the most complete source of palaeobiological information (for a given location and time). Nevertheless, the processes leading to exceptional fossilisation are poorly constrained, while this remains necessary to uncover any potential taphonomic biases and assess the robustness of paleontological reconstructions (anatomy, biology, and environment).
Here, we report the geochemical and mineralogical study of exceptionally preserved crustaceans fossilised within carbonate-rich concretions from the Jurassic Konservat-Lagerstätte of La Voulte-sur-Rhône (Ardèche, France). Chemical phase composition was investigated using SEM-EDS and synchrotron-based XRF elemental mapping (X-Ray Fluorescence; Fig. 1B–D). Mineralogical characterisation was performed using powder diffraction (XRD) and mineral distribution inside the fossils was rendered using synchrotron- based XRD mapping (X-Ray Diffraction; Fig. 1E–F).
Combining these techniques allowed identifying the mineralogical phases composing the fossils (Ca-phosphates, Fe-, Zn-, Pb-sulphides, Ca-sulphates, Fe-oxides and Ca-, Mg-carbonates) and the surrounding matrix (Mg, Ca-rich carbonates, clay and detrital silicates), and documented their complex textural relationships. These results allowed the construction of a fossilisation scenario for these exceptionally preserved fossils: phosphates and sulphides precipitated first probably due to bacterial activity in the carcass, this allowed preservation of delicate structures mainly by phosphate coating (with associated sulphides). Mg-calcite cement then consolidated the structures. Iron sulphides were later oxidised in sulphates and iron oxides. Inflows of detrital material seem to be the cause of environmental redox modification. This event does not seem to affect exceptional preservation, reinforcing the assumption that such processes ought to be rapid – i.e. before induration of the sediment.
Eventually, different tissues may have favoured different mineralogical associations, capturing potential stages of the mineralisation process and/or geochemical affinities. This specificity allows assessing potential tissue-specific preservation biases.

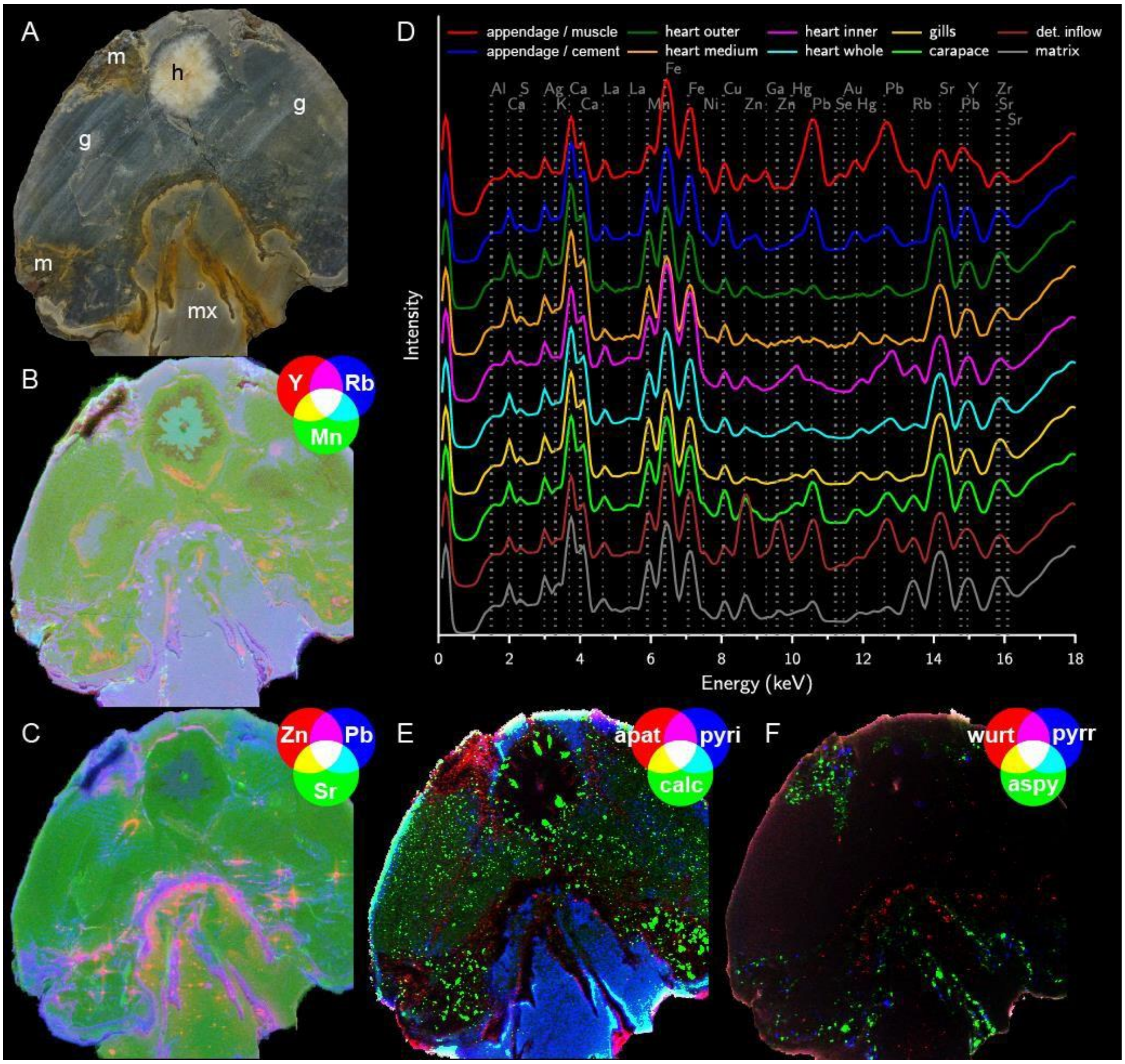


Figure 1: Elemental and mineralogical maps of a transversal section (Thylacocephalan *Dollocaris ingens* VAN STRAELEN, 1923, MNHN.F.A66910). **A**, photograph of the section; **B-C**, XRF elemental maps; **D,** XRF spectra of specific areas with elemental identification; **E-F**, XRD mineralogical maps. **apat**, carbonate chlorapatite; **aspy**, arsenopyrite; **calc**, Mg-rich calcite; **g**, gills; **h**, heart; **m**, muscle; **Mn**, manganese; **m**x, sedimentary matrix; **Pb**, lead; **pyri**, pyrite: **pyrr**, pyrrhotite; **Rb**, rubidium; **Sr**, strontium; **wurt**, wurtzite; **Y**, yttrium; **Zn**, zinc. The section is *ca* 50 mm wide. Photograph: P. Gueriau.

Taphonomic record of Mesozoic crustacean remains – Late Jurassic (Oxfordian) and Early Cretaceous (Valanginian) case studies

Michał Krobicki[1, 2]

[1] Polish Geological Institute – National Research Institute, Carpathian Branch, Skrzatów 1, 31-560 Kraków, Poland; michal.krobicki@pgi.gov.pl
[2] AGH University of Science and Technology, Mickiewicza 30, 30-059 Kraków, Poland krobicki@geol.agh.edu.pl

The fossil record of decapods seems to be very poor when compared to that of most other shelled marine invertebrates. This is mainly due to their poor preservational potential. Their carapaces and chelae have a proportionately large surface relative to their weight, meaning they are easily carried to the sediment surface until they are eventually destroyed. Consequently, these parts are embedded generally only in sediments deposited on low-energy conditions. Bioturbation often destroys the fragile tests even after embedding. In this way, large tests (carapace width over about 5 cm) are positively sorted during taphonomic processes. As a result, decapods have a higher chance to be preserved on uneven bottoms containing low-energy traps ("pockets") in which the tests may be washed in, quickly buried, and preserved in internally poorly sorted and, as a rule, non-bioturbated sediments. Such conditions are widespread only on reefs and reef-like structures.
In the Oxfordian limestones of the southern Poland, shrimps and lobsters occur together with prosopids. These three major decapod crustacean life-groups (the shrimps, lobsters, and crabs) differ basically in their fossilization potential. The first group is represented by actively swimming pelagic forms with a very thin cuticule or exoskeleton. From Plotnick's observations it may be concluded that the fossilisation potential of crabs and lobsters is much higher than that of shrimps. Thus, the presence of shrimps in the small sponge bioherms of massive limestones in the vicinity of Kraków (loc. Szklary) indicates a relatively high probability of fossilisation of decapods in this environment. The cuticle of decapods is composed of chitin and protein, which is frequently calcified. Decomposition of the chitin by fungi, bacteria, actinomycetes, nematodes and protozoa hinders preservation of arthropod remains. In comparison with the so-called fossorial "shrimps" (*Callianassa*, *Ctenocheles*, *Thalassina*, and *Upogebia*), the true shrimps have a lower fossilization potential, while crabs and lobsters have a better one. Warner's model distinguished four modes of life of modern crabs: (1) walking, running, and climbing, (2) swimming, (3) burrowing, and those (4) incorporating camouflage. Prosopids probably belonged to the first and/or fourth group. The analysis of the Upper Jurassic material from southern Poland suggests that post-mortem preburial interactions between organisms and the environment were important factors in the formation of a fossil thanatocenosis. This may be concluded from the observations of a totally accidental occurrences of crab remains in cyanobacterial-sponge bioherms and/or biostromes. The hydrodynamic energy of the environment caused disintegration of individual fragments. After comparing the Oxfordian and Tithonian fossils from Poland with other, mainly Tertiary, examples, a schematic model is proposed to explain the relationships between taphonomic processes and biological-sedimentological factors. Four categories of decapod remains have been distinguished: 1 – kcarapace with legs and abdomen; 2 – carapace without legs and abdomen; 3 – chelae or tips of fingers; 4 – trace fossils. Considering all possible means of destruction, it seems that the intensity of bioturbation and microbiological decay are of the most crucial biostratinomical factors. The higher their

intensity, the lower is the chances for preservation of crab fossils. The carapaces may be completely eliminated from a thanatocenosis and, eventually, even the most resistant elements as chelae or finger tips may be absent. In the analyzed case from the vicinity of Kraków (southern Poland), intensive burrowing and bioturbation are common within platy limestones (e.g., ichnogenus *Thalassinoides*). Glypheoids might have created some or even most of these burrows, despite the absence of their fossils within them. When hydrodynamic energy increased, even living decapods could be crushed into pieces and, therefore, the Jurassic prosopids tended to take refuge within biogenic carbonate buildups, which were largely resistant against mechanical destruction. Contrary to the processes mentioned, any increase in the sedimentation rate was protective, resulting in a positive taphonomic feedback. Jurassic prosopids have never been found within concretions. Consequently, they have been preserved as detached carapacea or limb parts, frequently as casts only. This is the reason for a relatively poor fossil record of the Jurassic prosopids, while, furthermore, some of the species are known from one or few specimens only. This, of course, hinders palaeobiological studies and reconstruction of phylogenetic relationships, precluding possibilities of recognition of variability within species, ontogenesis, aut- or synecology, etc.

Completely opposite example of preservation potential was recorded in the Early Cretaceous (Valanginian) from the Outer Flysch Carpathians (Moravian part; Czech Republic). The holotype of *Woodwardicheles neocomiensis* nov. comb. (polychelidan lobsters) (Audo et al., Journal of Systematic Palaeontology, in print) is preserved flattened dorsoventrally. The surrounding sediment is dark brown and the fossil appears slightly darker. The matrix appears to be a flyschoidal-type of fine-grained mudstones of turbiditic origin. Sedimentological features of hosted rock, visible on a perpendicular cross-section to the bedding surface with crustacean specimen, indicate thin, convolute lamination of cross-bedding structure in minor scale, which have to be interpreted as typical ripplemark structure of turbiditic origin. Additionally, very small muscovite grains occur abundantly on the bedding surfaces. This specimen is exceptionally preserved complete with very fine details such as minute spines on the scaphocerite and antenna. Such an exceptional preservation is rare, especially within such fine-grained quartzite mudstones. The holotype of *W neocomiensis* may represent an exuvia or a body fossil, possibly in life-position. The median line is not well-preserved enough, however, there is no mismatch on either side, suggesting it was in fact intact. Sediments deposited on low-energy conditions and mainly from suspension are preferable for decapods conservation. Rapid burial is necessary against short time which is needed for decomposition and disintegration of crustacean bodies and which are limited to few days. The holotype of *W. neocomiensis* therefore corresponds either to a corpse or an exuvia which was buried very rapid by a fine-grained silty mud from weak turbiditic suspension cloud. This suspension cloud was thin enough not to destroy this polychelid but protected it against destructive effects.

Taphonomy of brittle stars associated with a tempestite bed from the Lower Cretaceous Agrio Formation of the Neuquén Basin, west-central Argentina

Darío G. Lazo[1], Mariano Remírez[2], Ernesto Schwarz[2] and Ben Thuy[3]

[1] Departamento de Ciencias Geológicas, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Pabellón II, Ciudad Universitaria, 1428 Buenos Aires, Argentina, IDEAN (UBA-CONICET)
[2] Centro de Investigaciones Geológicas, Universidad Nacional de La Plata, CONICET, 1900 La Plata, Argentina
[3] Musée National d'Histoire Naturelle, 25 Rue Münster, 2160 Luxembourg, Luxembourg

Exceptionally preserved brittle stars have been recently recorded from the Agrio Formation, Neuquén Basin, west-central Argentina. This basin extends between 32º and 40º S in the Andes foothills of west-central Argentina, covering more than 120.000 km^2 of surface and comprising a continuous Latest Triassic to Early Tertiary sedimentary succession. It holds one of the most complete records of Jurassic and Cretaceous marine invertebrates of South America. The studied ophiuroid specimens were recorded from a single stratigraphic level of the Pilmatué Member, and dated as early Hauterivian age, based on associated ammonoids. The unit has been interpreted as deposited in a mixed clastic-carbonate, storm-influenced shallow-marine setting and has a highly abundant and diverse fossil content including nannofossils, microfossils, palynomorphs and marine invertebrates and reptiles, but extremely scarce echinoderm records except for irregular echinoids, which are locally abundant. The ophiuroids belong to a monotypic association of *Eozonella* sp., which was a widespread group on the continental shelves from the Middle Jurassic to the Early Cretaceous. Specimens are placed at, or near, the base of a single tempestite sandstone bed (up to 5 cm thick), likely deposited in a proximal offshore setting. Two sandstone samples were collected for study and named A and B. Sandstone Sample A includes 6 articulated specimens, while sample B includes 3 articulated ones. Five of them are oriented oral side up while the remaining 4 are placed oral side down. There are also dispersed fragments of arms and isolated ossicles among the mentioned specimens. Dispersed small isolated bivalve shells are also recorded in the same bed in convex-up orientation. Based on thaphonomic evidence, the ophiuroids underwent in situ storm reworking while alive, and were rapidly (and permanently) buried during subsequent sand accumulation. In modern settings brittle stars typically disarticulate shortly after death due to decay of the connecting soft tissues, and thus they are only occasionally preserved articulated in the fossil record. This present finding is key to characterize the taphonomy of asterozoans associated to storm beds, but also provides an insight into Early Cretaceous ophiuroid paleoecology and evolution in the Southeastern Pacific.

CT scanning as a tool for taphonomic analysis of shell beds: a case study on small irregular echinoid concretionary accumulations from the upper Hauterivian of the Neuquén Basin, west-central Argentina

Oscar Emilio Rodrigo Lehmann[1, 2], Osvaldo Velan[3] and Darío G. Lazo[1, 2]

[1] Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Ciencias Geológicas. Buenos Aires, Argentina
[2] Laboratorio de Ecosistemas Marinos Fósiles, Instituto de Estudios Andinos "Don Pablo Groeber" (IDEAN, UBA-CONICET). Buenos Aires, Argentina
[3] Instituto Universitario Hospital Italiano. Buenos Aires, Argentina

Over the last two decades 3D-imaging techniques have been widely used in the reconstruction of fossils, from skulls and bones to the microstructure of delicate carbonized flowers. In general, shell beds lie outside the feasible size range in which these methods provide meaningful data. If a fossil concentration could be studied this way, important information could be easily assessed or quantified. For example, the close-packing of bioclasts and size-sorting could be assessed easily. Also, the percentage in volume of bioclasts relative to the sedimentary matrix and the amount of individuals per volume unit could be calculated in few steps. Here we present a case study using small irregular echinoid concretionary accumulations from the Agrio Formation, upper Hauterivian, Neuquén Basin, west-central Argentina.

The studied carbonate concretions (N= 9) were collected from a single bed in the upper third of the Agua de la Mula Member. They contain a monotypic accumulation of small irregular echinoids belonging to the genus *Caenholectypus* Pomel immersed in a fine-grained matrix. The concretions are ellipsoidal and range in size from 6 to 15cm in length and 4.5-5.5 cm in thickness.

Four concretions (Fig. 1A) were selected to be scanned with a Toshiba Aquilion ONE medical CT scanner, with 120kV, 500mA and a final slide thickness of 0.5mm at the Instituto Universitario Hospital Italiano of Buenos Aires. This resulted in an image stack of 1267 slides that was further digitally processed.

First the density of individuals was estimated using between five and seven 1cm-sided randomly located cubes inside each concretion (Fig. 1B). The number of individuals with at least 50% of volume included in each cube was counted. This number was divided by the volume of the cube, obtaining its density. The mean of all the cubes' densities was used to estimate the density of the whole concentration, which resulted in 4.23 echinoids/cm^3. A digital simulation of an ellipsoid with the dimensions of the concretions filled with smaller ellipsoids with the size of the echinoids produced very similar visual results as those observed in the CTs. This was used as a confirmation for the previous result.

Then, the close-packing of bioclasts was observed across each concretion in two perpendicular directions (Fig. 1C). Following the usual classification, the studied accumulation is densely to loosely packed, with some exceptional patches where it could be described as loosely packed (matrix-supported). This was done considering the nearly hemispherical shape of the echinoids. Finally, the percentage of bioclasts relative to the sedimentary matrix was estimated in two ways. Firstly, the previously obtained density of individuals and their approximate volume were used in conjunction with the volume of the concretions. This approach resulted in an estimated percentage of 56.77%. This value matches closely the lower boundary of the "dense/loose" close-packing category (55%) included in traditional visual guides. The second way was to use the volume of the concretions and the volume of the echinoids after digitally removing the sediment. This method yielded widely varying results, from 30.15% to 47.95%.

The disagreement between these results may be due to an ineffective removal of the sediment from the 3D-images. Some echinoids are filled with the same matrix that surrounds them, while others are devoid of it and cemented internally. This situation complicates the differentiation between the echinoids and the matrix based solely on density, as many digital tools do. However, the echinoids remain visually distinct throughout the concretions.

The previous results are being used to aid the interpretation of the genetic origin of the echinoid accumulation, as well as a quantification of the basic descriptive taphonomic information. Remarkably, these results were accomplished without the destruction of the concretions and preserving the echinoids for further studies.

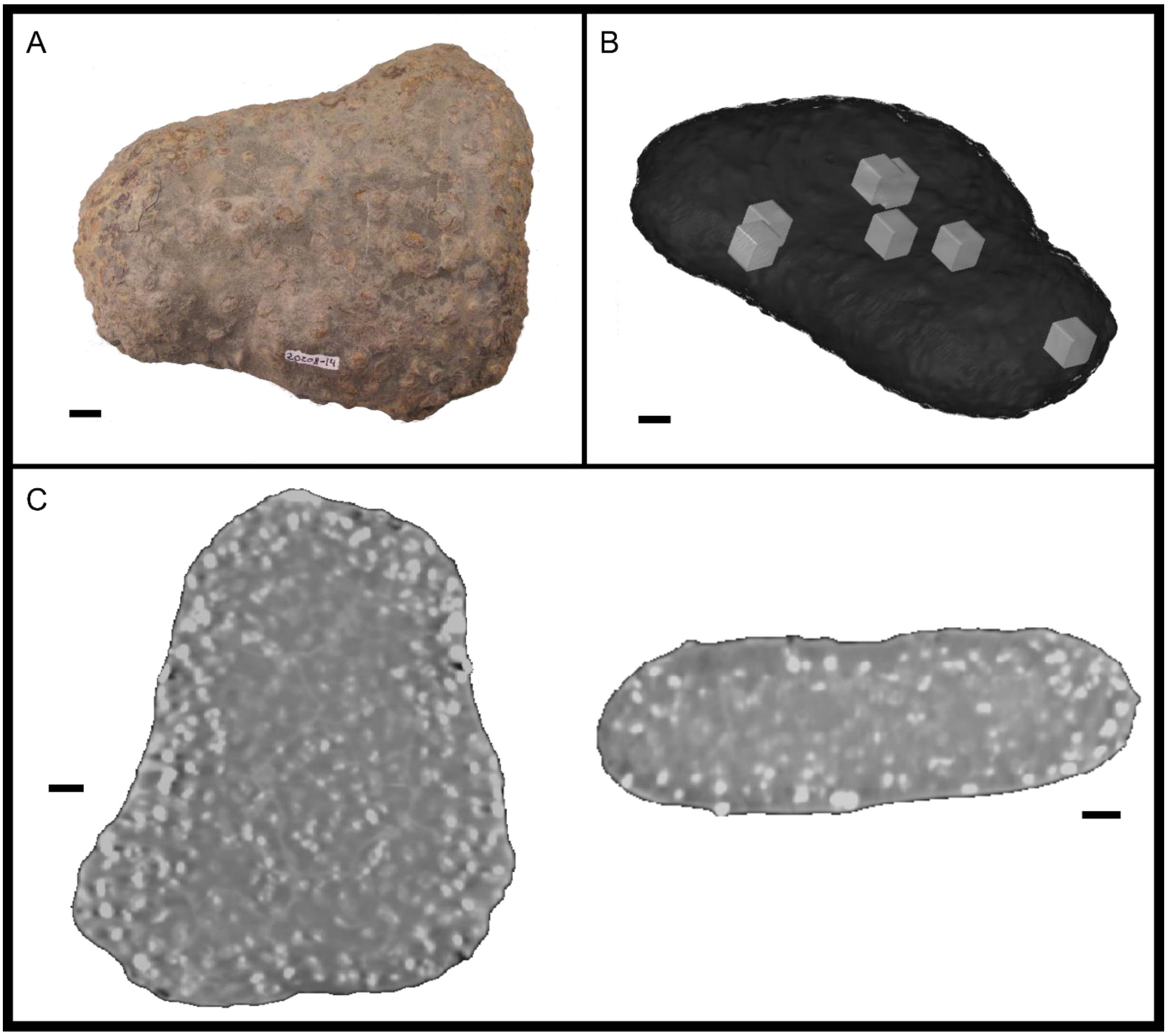


Fig. 1: Small irregular echinoid concretionary accumulation. A: Top external view of one of the scanned concretions. B: The cubes sampled to calculate the density of bioclasts and their position inside the concretion. C: Cross-section (left) and longitudinal section (right) as seen after the scanning. The bar is 1cm.

Nautilid taphomorphs as a source of palaeobiological information: an example from the Upper Cretaceous of Poland

Oksana Malchyk

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

Given that aragonite often dissolves during diagenesis, the fossil record of Nautilida in carbonate facies is mostly represented by moulds (steinkerns) in various states of preservation, which complicates the assessment of the original shell ornamentation in many taxa. This is particularly true for ribbed nautilids, which occurred in many marine ecosystems in Europe during the Late Cretaceous. However, there are also some remarkable exceptions such as the moulds of *Epicymatoceras vaelsense* (the type species of the genus *Epicymatoceras*) from the upper Campanian and lower Maastrichtian (Upper Cretaceous) siliceous limestones (opoka) of Poland. Some specimens preserve details of the original shell ornaments which enables to appraise the systematic position of this nautilid taxon and its reproductive strategies (hatching size).

Both external and internal moulds are present in the studied material and referred to as taphomorph 1 and 2, respectively. The surface of the external moulds (taphomorph 1) reflects – as a negative relief – the imbricated structure of the external surface of the original shell. The ribbed surface of the internal mould (taphomorph 2) reflects the inner shell surface.

Based on the morphology and inferred taphonomy of the specimens, it was concluded that the external ribbing of *E*. *vaelsense* was originally composed of overlapping tile-shaped lamellae of the outer prismatic layer, a character recently suggested to be a synapomorphy of the cymatoceratid clade.

Additionally, the embryonic conch is recognizable in studied specimens of *E*. *vaelsense* on the basis of reticulate ornament and the nepionic constriction observed in some specimens. The diameter of the embryonic conch of *E*. *vaelsense* can be estimated to have been around 30–34 mm, which is close to the maximum range of the hatching size recorded for Cretaceous and younger nautilids.

Thus, this study demonstrates that nautilid moulds (steinkerns) may be a better source of palaeobiological information than is conventionally expected, provided they are carefully interpreted in terms of morphology and taphonomic history.

Sponge borings on the Late Cretaceous nautilids from Poland and western Ukraine: taphonomic implications

Oksana Malchyk, Magdalena Łukowiak and Marcin Machalski

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

The externally-shelled cephalopods may host diverse epibionts and boring organisms (e.g., thallophytes, foraminifers, sponges, bryozoans, polychaetes, phoronids, and bivalves). Here, we present the first record of activity of bioeroding sponges on several Late Cretaceous (late Campanian–Maastrichtian) nautilids from Poland and western Ukraine. The borings, preserved as limestone-infilled casts adhering to internal nautilid moulds, are assigned to two ichnotaxa *Entobia cretacea*, produced probably by the phloeodictyid sponge genus *Siphonodictyon* (=*Aka*), and Entobia isp megastoma? Of uncertain systematic affinities (Clionaidae?). The published records of the activity of boring sponges on recent and fossil nautilid shells are scarce.

The sponge borings studied reval remarkable variation in morphology, partially resulting from taphonomic factors (taphomorphs) and partially reflecting original organisation of the sponge colonies.

In total, 23 nautilid individuals infested by boring sponges were identified amongst 461 nautilid specimens studied. The most commonly infested nautilids in the present material are large specimens of *Cymatoceras* spp. The nautilid specimens excavated by sponges represent different categories of conch fragmentation, mainly phragmocones with a portion of body chamber preserved. In five nearly complete nautilid specimens, the borings appear on both sides of the conch, covering large parts of flanks, venter, and umbilicus.

There is no evidence that sponge infestation took place during the nautilid life, therefore all studied borings are interpreted to have been formed *post-mortem*, at the stage when the empty shells rested on the sea-bottom. A colonization of both sides of of some nautilid specimens by boring sponges indicates occasional movement and overturning of possibly partially buoyant shells during high energy events (e.g., storms).

Taphonomy of the Bullendorf mammoth site in Lower Austria

Oleg Mandic[1], Daria Carobene[1,2], Mathias Harzhauser[1], Ursula B. Göhlich[1], Reinhard Roetzel[3], Christoph Spötl[4], Michael Meyer[4]

[1] Department of Geology and Paleontology, Natural History Museum Wien, Burgring 7, 1010 Wien, Austria
[2] Department of Biology, University of Padua, Via U. Bassi, 58/B 35121 Padova, Italy
[3] Geological Survey of Austria, Neulinggasse 38, 1030 Vienna, Austria
[4] Institute of Geology, University of Innsbruck, Innrain 52, 6020 Innsbruck, Austria

During construction works for the Austrian national highway A5 near Bullendorf in Mistelbach district (Lower Austria), large mammal remains were found in a sandy succession exposed along the fresh cut slope. Several proboscidean dorsal vertebrae and two well preserved tusks have been excavated on site. Unfortunately, molars were absent hampering precise taxonomic identification. Based on the late Pleistocene age of the succession, as inferred from the mollusk assemblage, the remains derive most probably from *Mammuthus primigenius.* The dating is also supported by the presence of horse and reindeer bones in the underlying unit. The proboscidean remains were concentrated in a single layer, without any particular orientation. Some of thoracic and lumbal vertebrae, however, were found still articulated. Tusks were of similar size and in opposite position, indicating that all fossils might belong to the same individual.
To understand and analyze the depositional environment and taphonomic history of the vertebrate remains, the 13-m-thick succession was logged and sampled in detail. Sediment bulk samples for granulometric analyses, mollusk paleontology, and gastropods for stable isotope measurements were stratigraphically collected along the section. Sampling for optically stimulated luminescence (OSL) dating was additionally carried out.
The succession comprises three main lithological units. A 8-m-thick sandy and silty unit is intercalated between well bedded clayey silts with leaf and mammal remains at the base and a 3-m-thick loess package following concordantly on top. Granulometric data show very bad sorting of all samples. The lower boundary of the middle unit represents an erosional surface with mollusk shell lags. Proboscidean remains occur about 70 cm above this surface, in a sandy silt bed showing ripple bedding, root traces and *Pupilla* lenses. The rest of the unit is represented by an alternation at ~1 m scale of well bedded sandy and massive silty sediments. The succession records a floodplain setting, probably influenced by aeolian deposition. The latter is fully represented by the loess on top.
The mollusk assemblages are generally dominated by *Pupilla* species pointing to dry and cold climate conditions and a steppe-like paleoenvironment. A short interval of more humid and moderately cold climate is documented by the presence of a *Galba truncatula* assemblage in the lowermost bedded sand package of the middle unit. Carbon and oxygen isotope analyses of the aquatic gastropod species reveal distinctly lower values than for the land species.
The mollusk assemblages from Bullendorf are indicative of a middle or late Pleistocene age. Based on the high similarity with typical late Pleistocene assemblages from Austria, Czech Republic, Slovakia and Hungary a late Pleistocene (Würmian) age is most plausible constraining the time of deposition to roughly about 115-12 ky. Hence, the mammoth-bearing interval might have captured a climate fluctuation related to one of the Würmian interstadials.

Fig. 1. Mammoth tusk excavated at the Bullendorf site in original position.

Small mammal taphonomy of Unit Xb from El Salt Middle Palaeolithic site of Eastern Iberia

Dores Marin-Monfort[1,2], Ana Fagoaga[2], Cristo M. Hernández[3], Bertila Galván[3] and Yolanda Fernández-Jalvo[1]

[1] Museo Nacional de Ciencias Naturales (CSIC), José Gutiérrez Abascal, 2, 28006 Madrid, Spain; dores@mncn.csic.es
[2] Grup d'Investigació en Paleontologia de Vertebrats Cenozoics (PVC-GIUV). Àrea de Paleontologia, Universitat de València, Dr. Moliner, 50, 46100, Valencia, Spain
[3] UDI de Prehistoria, Arqueología e Historia Antigua, Facultad de Geografía e Historia, Universidad de La Laguna, Campus de Guajara, 38071, La Laguna, Santa Cruz de Tenerife, Spain

The middle Palaeolithic site of El Salt is located in the municipality of Alcoi (Alicante, Eastern of Spain), at 680 m above sea level. Its 6.3 m-thick stratified deposit rests against a 38 m-high Palaeocene limestone wall, formed at a thrust fault and covered with tufa and travertine. The inhabited space at the base of the wall was sheltered by a large roof, which at times of maximum development would serve as a protection to almost the entire surface. The small vertebrates analyzed in this works belongs to the lower part of the stratigraphic unit X (Xb) dated to 52.3 ± 4.6 ka. This subunit consists of horizontally bedded dark brown fine sand containing a high presence of combustion features, abundant faunal remains with anthropogenic alterations, flint flakes and anthropogenically modified cobbles, forming a dense palimpsest of recurrent human occupations. El Salt constitutes an important study centre in the context of the end of the Middle Palaeolithic and the disappearance of the Neanderthals as it could contain one of the latest groups of these humans from that part of the Iberian Peninsula.

Taphonomic analysis provides additional information to taxonomic studies. It can be seen as a destructive process but it explains the different circumstances of life, processes and preservation of fossils. Actually, constitutes a powerful tool for the knowledge of past environments and the formation of the sites. In the present work, a taphonomical study has been taken in order to find out the processes of accumulation of the microvertebrate faunas present in Unit Xb from that site as well as to shed light on the past environment where those groups lived. Around 1800 remains, mainly isolated teeth and disarticulated bone fragments, have been analysed. In order to assess the principal accumulator agent, an analysis of anatomical representation, breakage and digestion has been carried out. Data obtained has been compared with results of assessments from accumulations produced by current European predators of the literature. Results point to the main participation of a nocturnal raptor with a modification category four. In addition, some characters related to their post-burial preservation are evaluated in order to identify any postdepositional modification evidence as the presence of cutmarks, toothmarks, manganese, roots, rounding, polish, weathering, trampling, corrosion, and/or burns. Results were also compared with the modern collections given in the literature.

Depositional conditions of Carnian ammonoid shell-concentrations decoded by applying 3D-visualization-techniques combined with classical taphonomic analyses

Susanne Mayrhofer[1], Alexander Lukeneder[2], Leopold Krystyn[3]

[1] Department for Exhibition and Education, Natural History Museum Vienna, Burgring 7, 1010 Vienna, Austria
[2] Geological-Paleontological Department, Natural History Museum Vienna, Burgring 7, 1010 Vienna, Austria
[3] Department of Palaeontology, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

Within the Taurus Mountains of Turkey, the Upper Triassic Kasımlar Formation includes a huge ammonoid mass occurrence, which bears considerable information concerning its ancient ecosystem. The mass accumulation is deposited within the Taurus Platform Units of South-west Turkey, and named after its most dominant taxon, the Early Carnian (Julian) ammonoid *Kasimlarceltites krystyni*.

While orientation analyses of the more than 3,000 reconstructed ammonoids and 200 segmented gastropods were applied for interpreting their transport history, classical taphonomic aspects, like biofabric, preservation, bioerosion or genetic classification were used to decode the genetic history of the shell concentrations. For the observed extension of the *Kasimlarceltites* beds (at least 5 km^2) a number of 775 million ammonoids and 50 million gastropods were calculated.

3D-visualization-techniques together with classical taphonomic analyses led us to a two-phased genetic history interpretation of the *Kasimlarceltites* concentrations: local water poisoning, most probably caused by oxygen fluctuations or methane degassing, triggered local mass mortality, resulting in primary shell concentrations on the sea bottom. Those were later transported basinward by gravity flows, activated either by sediment instability and/or by seismic activity. The gravity flows caused reworking and redeposition of the shells downslope to their later allochthonous concentrations. The present-day statistically 66.2 % confident NNW/SSE shell orientation points to a source of the shells in the south, from a margin which is no longer preserved.

This study was supported by the Austrian Science Fund (P22109-B17).

Primary dolomite formation on a Triassic coastal alluvial plain

Patrick Meister

Department of Geodynamics and Sedimentology, University of Vienna, Althanstr. 14, 1090 Vienna; email: patrick.meister@univie.ac.at

Large amounts of dolomite occur in deposits of the Triassic Tethys margin. These dolomites consist largely of fine-grained homogeneous mudstone and are thought to have formed on extended tidal flats that were at the same time evaporative, comparable to today's sabkhas along the coast of Abu Dhabi. However, such primary or sedimentary dolomite is rarely preserved in its unaltered state due to intense diagenetic and hydrothermal overprint.
Recently, a transmission electron microscopy (TEM) study of dolomites of the Carnian Travenanzes Formation (south alpine Raibl Group) revealed nano-crystal aggregates (Preto et al., 2015) similar to those found in modern sabkha deposits. Finding such structures in Triassic dolomites suggests that they have not been affected by major diagenetic overprint, as otherwise nano-crystals would have been replaced by coarser crystalline structures.
Our analysis of the dolomites by electron backscatter diffraction (EBSD) mapping revealed a peculiar fabric of micron-scale dolomite crystals with some of them showing domains of inverted c-axes. These features support the interpretation of Preto et al. (2015) that these dolomites haven been incompletely recrystallized during diagenesis. Finding such fabrics in fine dolomite mudstone showing indications of soft sediment deformation provides further evidence that dolomites were spontaneously precipitated and deposited directly from concentrated brine solution.
If dolomites truly show unaltered structures, this would mean we are looking at a true mineral archive that may preserve geochemical signatures indicative of conditions and processes that prevailed in the Triassic depositional environment. Sr-isotope signatures in the dolomites show values near to Carnian seawater (Rieder et al., in prep.), thus ionic concentrations of the brine from which the dolomites formed were mainly marine-derived. Accordingly, the dolomites formed in either peritidal flats or coastal ephemeral lakes, similar to the settings in which dolomite formation is observed today. The setting contrasts with Carnian and Norian dolomites of the Germanic basin that were deposited in extended playa lakes.
In conclusion, nano-crystal structural analysis by TEM and EBSD can provide valuable insight into the quality of preservation and the diagenetic history of carbonate rocks, and presumably also fossils, and thereby help to reveal pristine geochemical archives.

Museum collections *versus* standardized bulk samples: a case study of the Middle Miocene bivalves from Vanzhuliv and the Zhabiak ravine (western Ukraine, Central Paratethys)

Rafał Nawrot[1] and Barbara Studencka[2]

[1] Florida Museum of Natural History, University of Florida, 1659 Museum Road, Gainesville, FL 32611, USA; E-mail: rnawrot@flmnh.ufl.edu
[2] Polish Academy of Science Museum of the Earth in Warsaw, 00-488 Warsaw, Al. Na Skarpie 20/26, Poland

Since the 19th century the Upper Badenian (Middle Miocene) deposits of the western Ukraine have been famous for their fossil content. Especially their diverse and well-preserved molluscan fauna led to numerous taxonomic studies. Extensive collections are housed in numerous European museums and institutions. They provide crucial information on the taxonomic composition of fossil faunas and are often the only source of paleontological data from historically important outcrops that no longer exist. However, it is not clear whether patterns in diversity captured by museum collections are consistent with those derived from field-based quantitative paleoecological studies. Comparison of local species diversities can be problematic if collections do not adequately preserve the relative abundances of taxa, because sample-size standardized richness estimates are sensitive to changes in the evenness of the assemblages.

To evaluate this potential bias, we compared bivalve faunas using data from collections completed in 1930's and 1980's which are stored at Museum of the Earth PAS in Warsaw and at the Institute of the Geological Sciences PAS in Krakow, with data from standardized bulk samples collected by us during extensive field work in 2010's. Two fossiliferous Upper Badenian sites – Vanzhuliv and the Zhabiak ravine (E of Lviv) were chosen for our study. Based on the historical collections from the Vanzhuliv site, 53 bivalve species have been recognized; from the Zhabiak ravine – 74. On the other hand, species richness recorded in the recently sampled material is 61 species from Vanzhuliv and 44 species from Zhabiak. These numbers, however, do not take into account large differences in the number of specimens collected from each locality. Sample-size standardized richness estimates are consistently higher for the Vanzhuliv site compared to the Zhabiak ravine when either bulk-sampled abundance data, or numbers of specimens in the museum collections are used in the analysis. However, this result can be reversed when one locality is represented by the museum collections and the other by bulk samples only. Historical collections from the Zhabiak ravine made by different researchers vary greatly in the identity of the dominant species, shape of the rank-abundance distribution and evenness. Therefore, the magnitude of the differences in species richness and relative abundance patterns between the two localities strongly depends on which collections are used for comparison. These results highlight the potential difficulties in using museum collections as a source of quantitative data for tracking geographical and temporal patterns in local-scale diversity.

Apparent mass extinctions produced by stratigraphic architecture

Rafał Nawrot[1], Daniele Scarponi[2], Michele Azzarone[2], Alessandro Amorosi[2], Jacalyn M. Wittmer[3], Troy A. Dexter[4], Kristopher Kusnerik[1], Roger W. Portell[1] and Michał Kowalewski[1]

[1] Florida Museum of Natural History, University of Florida, 1659 Museum Road, Gainesville, FL 32611, USA, rnawrot@flmnh.ufl.edu
[2] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, University of Bologna, Via Zamboni 67, 40126 Bologna, Italy
[3] Department of Geology, University of Illinois at Urbana-Champaign, Champaign, IL 61820, USA
[4] Gerace Research Centre, University of The Bahamas, San Salvador, Bahamas

Stratigraphic patterns of last occurrences (LOs) of fossil taxa potentially fingerprint mass extinctions and delineate rates and geometries of those events. However, the record of extinction events preserved in local stratigraphic sections may be distorted by sea-level driven shifts in environmental conditions, sediment net accumulation rates, and fossil abundance. Whereas most studies explicitly correct for sampling artifacts (Signor-Lipps effect), the biasing role of stratigraphic architecture has been largely neglected. Using molluscan assemblages preserved in Holocene deposits of the Po Plain (Italy), we demonstrate empirically that stratigraphic architecture exerts a strong control on the position of LOs, and readily produce sudden and stepwise apparent extinction events with false selectivity patterns.

Instead of a gradual backward smearing of LOs expected from the Signor-Lipps effect, we document a strong clustering of apparent extinction events, coincident with abrupt facies shifts in the late transgressive and early highstand systems tracts. This outcome is consistent with recently published simulations of the fossil record that jointly model eco-evolutionary and stratigraphic processes. The sequence of LOs observed in the cores is controlled by the bathymetric preferences of species. If read literally, this relationship could be misinterpreted as a signature of a selective, habitat-specific extinction event.

Using empirically calibrated numerical simulations, we also evaluated the relative importance of biases introduced by random range truncations (i.e., the Signor-Lipps effect), stratigraphic trends in fossil abundance, and environmental preferences of species. The results suggest that gradual backward smearing of LOs would occur only under unrealistic assumptions of continuous and uniform sampling of species with facies-independent distribution. Moreover, even in the absence of any facies specificity of individual taxa, non-random stratigraphic distribution of skeletal concentrations can produce clusters of LOs that mimic sudden or stepwise extinction patterns, because rare taxa are more readily captured in fossil-rich horizons. Thus, distinct LOs patterns can reflect changes in fossil abundance caused by variation in sedimentation rates, fossil preservation, or environmental gradients in hard-part production, all of which are controlled by sea-level changes.

The results demonstrate that facies bias and stratigraphic architecture play an overriding role in controlling the apparent timing of LOs. Methods used to evaluate the extinction dynamics typically aim at correcting the Signor-Lipps effect without accounting for stratigraphic artifacts. Reliance on such methods, without a thorough consideration of environmental and sequence stratigraphic biases, may lead to incorrect inferences on the timing, duration, and selectivity of mass extinctions.

Taphonomy and sedimentation of mass accumulations in siliciclastic dominated environments: A case study from the Miocene echinoid dominated Button Beds in Central California

James H. Nebelsick[1] and Jeffrey T. Thompson[2]

[1] Department of Geosciences, University of Tübingen, Hölderlinstrasse 12, 72074 Tübingen, Germany
[2] Department of Earth Sciences, Zumberge Hall of Science, University of Southern California, 5 3651 Trousdale Parkway, Los Angeles, California, USA 90089-0740 6

Mass fossil accumulations can be common in siliciclastic dominated environments. These occurrences not only allow for detailed paleoenvironmental interpretations, but are also instructive with respect to how organism remains affect sedimentary characteristics and eventually the lithologies of deposits. Of special importance in this regard are the specific taphonomic and diagenetic pathways of the shelly remains which can lead to a variety of fabrics and to the presence of mixed carbonate-siliciclastic sediments.

In this study, the well-known Miocene Button Bed Sandstone Member of the Temblor Formation containing a mass accumulation of sand dollars (clypeasteroid echinoids) from the Central Valley in California is investigated. This study augments previous detailed studies on the stratigraphic setting, sedimentary deposits and echinoid distribution with a special emphasis on the analysis and quantification of taphonomic and sedimentary attributes as measured in the field as well as in numerous thin sections.

The results show various admixtures of quartz dominated siliciclastics and biogenics dominated by sand dollars. Phosphatic components and glauconite can also occur with additional biogenic components represented by pectinid bivalves, oysters, bryozoans and barnacles. Sand dollars show a high range of preservation ranging from complete specimens to highly fragmented tests. The presence of complete specimens allows for packing styles and orientations to be documented and measured. Fragmented echinoid can be especially common and eventually lead to the presence of echinoid grainstones in which syntaxial cements play a key role. Broader comparison to further echinoderm-dominated sediments (encrinites) in the Paleozoic and Mesozoic are made, as well to other sediments dominated by highly disarticulated biogenic components.

Taphonomic bias in limestones and marls – a quantitative palaeontological approach to the genesis of limestone-marl alternations

Theresa Nohl, Axel Munnecke and Emilia Jarochowska

University of Erlangen-Nuremberg (FAU) – Department of Geography and Earth Sciences – GeoZentrum Nordbayern, Section Palaeobiology, Loewenichstraße 28, D-91054 Erlangen. E-Mail: theresa.nohl@fau.de

The origin of limestone-marl alternations it still a matter of discussion. It is well known that a redistribution of carbonate from the marls to the limestones has taken place. The driving mechanisms of this redistribution, however, are under debate, and also the question whether or not a purely diagenetic origin of the rhythm is possible. Our investigations indicate that a selective dissolution of aragonite in the marls provided the cementing carbonate for the limestones. In other words, the limestones contain a significant proportion of diagenetic calcite occluding the former pore space, whereas the marls represent the compacted original calcitic and terrigenous constituents. Such a process should result in specific features that are observable in thin sections. These are: (1) originally aragonitic fossils which are now recrystallized by coarse granular calcite should only occur in limestones; (2) in monotonous successions calcitic fossils should be enriched in marls; (3) in homogenised, i.e. strongly bioturbated, successions different groups of calcitic fossils should be equally enriched in marls compared to the adjacent limestone; (4) strong compaction phenomena should be restricted to marls; and finally (5) in homogenised, i.e. strongly bioturbated, successions components in marls should show an alignment caused by mechanical compaction. These predictions are tested in an ongoing study in limestones and marls from Estonia (Sheinwoodian), Ukraine (Ludfordian), and China (Kungurian) (Fig. 1). High-resolution scans of thin sections are processed in Photoshop©. In the first step, the abundance of all occurring fossil groups in limestone and marl layers are quantified. In a second step, the alignment of components such as ostracode shells is measured. The results are statistically evaluated for both marls and limestones. The first results imply an equal enrichment of calcitic fossils in marl relative to limestone in bioturbated limestone-marl couplets, and a complete dissolution of primary aragonitic fossils in marls. In addition, ostracod shells in the marl show a tendency in their alignment, while in the limestones they are randomly arranged. These results support the hypothesis of selective aragonite dissolution during early diagenesis, but further samples from other outcrops and time intervals will be tested. Nevertheless, the essential role of diagenesis resulting in potential taphonomic biases such as selective dissolution of aragonitic fossils and mechanical breakage of fragile components in marls must be considered when examining and interpreting fossil communities from limestone-marl alternations.

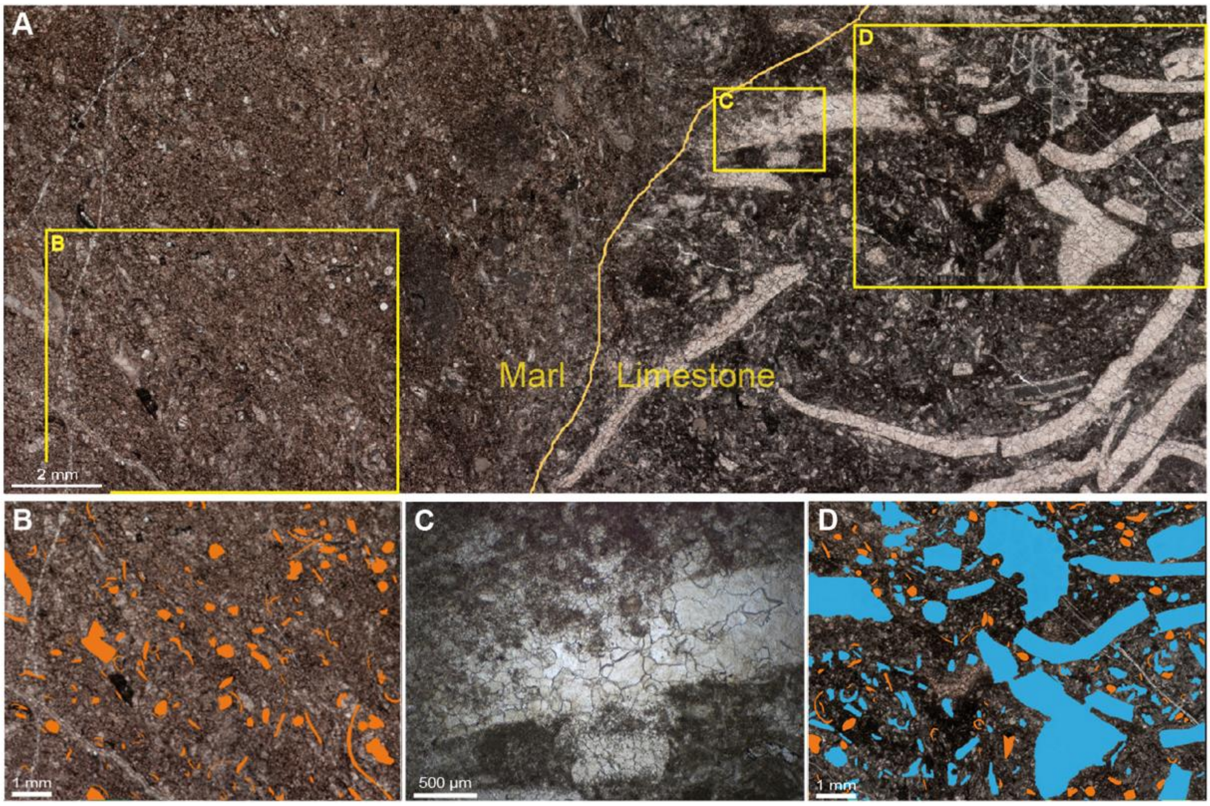


Fig. 1: Thin section micrographs from bioturbated lagoonal sediment of the Permian Chihsia Formation in South China. A: Overview of the limestone-marl boundary with abundant phylloidal algae in the limestone area, B: marl with calcitic components coloured in orange, C: detail of dissolution of originally aragonitic phylloidal algae while converging from the limestone (sharp borders within the limestone) to the marl (dissolved), note the blurred boundaries in the transitional area, D: Limestone with calcitic components coloured in orange and recrystallized aragonitic components coloured in blue.

"Stick 'n' peel": how unusual patterns of disarticulation and loss of completeness in fossil vertebrates originate as a result of carcasses adhering to the substrate during decay

Patrick J. Orr[1], Laetitia B. Adler[1], Susan R. Beardmore[1], Heinz Furrer[2], Maria E. McNamara[1,4], Enrique Peñalver[3] and Ragna Redelstorff[1,5]

[1] UCD School of Earth Sciences, University College Dublin, Belfield, Dublin 4, Ireland
[2] Paläontologisches Institut und Museum der Universität, Zürich, Karl Schmid-Strasse 4, CH-8006 Zurich, Switzerland
[3] Museo Geominero, Instituto Geológico y Minero de España, C/Ríos Rosas 23, E-28003 Madrid, Spain
[4] Present address: School of Biological, Earth and Environmental Science, University College Cork, North Mall, Cork, Ireland
[5] Present address: South African Heritage Resources Agency, Archaeology, Palaeontology and Meteorites Unit, 111 Harrington Street, Cape Town 8000, South Africa

The taphonomic histories of fossil vertebrate skeletons can be both complex and difficult to resolve, even if only examples from exceptional biotas (Konservat Lagerstätten) are considered. Typically, the fidelity with which skeletons are preserved in exceptional biotas is "good to excellent" - even in cases where the non-biomineralised tissues have decayed completely. Crucially, it is, however, unusual that for any biota as a whole, all skeletons are complete and fully articulated. At least a minority, - and often the majority - of taxa within an assemblage show some loss of completeness and articulation.

Potentially, loss of skeletal fidelity as carcasses decay can originate during either transport to the site of deposition, and/or while residing on the sediment surface before burial. In the latter case, the effect of biostratinomic processes, most obviously currents, on the loss of skeletal fidelity is controlled by variables related to the biology of the taxon, environmental conditions, and the physical environment. The effects of a single variable are relatively easy to identify, most obviously the importance of size, shape and density on the likelihood of a single bone being transported. It is, admittedly, more difficult to determine how a suite of potential variables interact as carcasses decay in different situations. Nonetheless, robust generalised taphonomic models have been erected for most combinations of completeness and articulation that fossil vertebrates exhibit, and the majority of exceptional biotas.

Some fossil vertebrates, however, exhibit recurrent patterns of disarticulation and loss of completeness that are more difficult to explain, and not easily accommodated in existing models. Such skeletons are one of two variants. They are incomplete, often markedly so, but the preserved parts are highly articulated. Alternatively, they are complete, or nearly so, but articulation varies markedly between parts of the body. A characteristic feature in incomplete skeletons is the absence of skeletal elements that, on the basis of their larger size and/or greater density, would be predicted to have been retained. Other indicators included discrepancy in the fidelity of preservation between the left and right hand sides of a specimen in lateral aspect; the lower facing, (that in contact with the substrate) will show higher fidelity. Parts of a skeleton may be in the position they would have been in when a complete articulated carcass came to rest originally, but isolated from the rest of the skeleton by gaps that correspond precisely to the lengths of bones that have been displaced or removed.

Here we use a model, termed "stick 'n' peel", that explains how these patterns originate. Fluids released from the carcass while resting on the sediment surface permeate the sediment below and around the carcass. As a result, skeletal elements on the downward facing side of the carcass become adhered to the sediment surface, and are less likely to be remobilized as a result of current activity than others. The pattern of articulation and, especially, completeness is thus not what would be predicted on the basis of the size, shape and density of the skeletal elements.

Unfortunately, the effects of stick ‘n’ peel are difficult to predict *a priori*. Its effects will depend on the biology of the taxon, the orientation a carcass comes to rest in, and even when both these are constant between specimens, the timing of current activity relative to how far decay has progressed (Figure 1). The effects of stick n peel will be strongly heterogeneous – potentially even between the same taxon in a single exceptional biota. Stick ‘n’ peel, however, has been identified in vertebrate fossils in lacustrine and marine settings and is likely to be a common feature of the taphonomic history of many vertebrate assemblages. Specimens becoming adhered to the substrate may also explain the preservation in situ of the multi-element skeletons of invertebrates such as echinoderms, and integumentary structures such as hair and feathers in exceptionally preserved fossils.

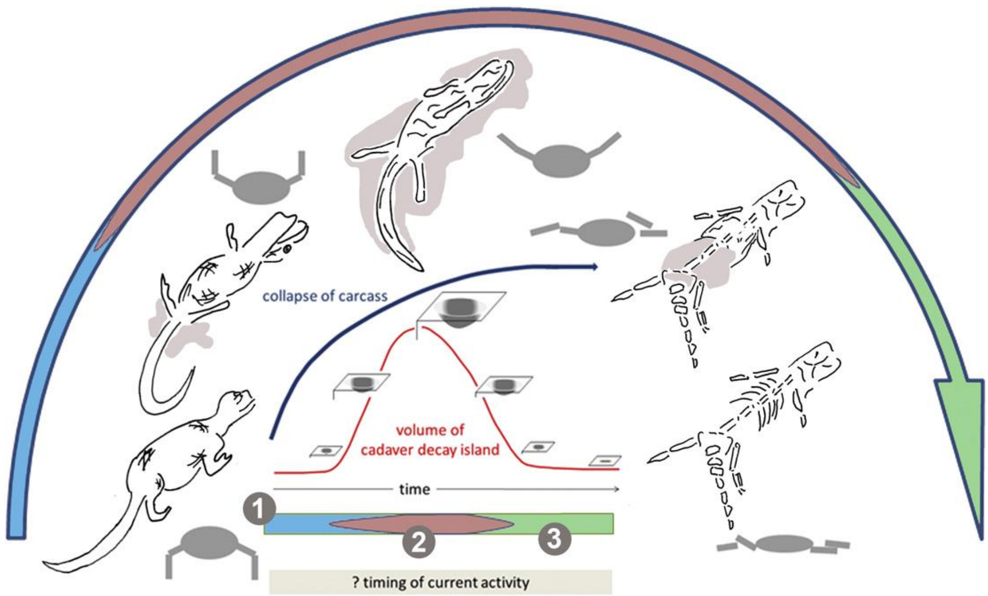


Figure 1. The formation of stick ‘n’ peel textures in vertebrate skeletons reflects how three factors interact: (a) progressive, decay-induced, collapse of the skeleton; (b) development and then loss of the cadaver decay island; (c) the timing of any disturbance of the carcass by current activity. As a result, three intervals over time (1-3) are defined. In 1, the carcass is insufficiently adhered to the substrate and if subjected to current activity remains in situ or moves as a whole. In 3, decay has progressively sufficiently that little or none of the skeleton remains attached to the substrate. Disarticulation and loss of elements in response to current activity is governed by their size, shape and density. During 2, parts of the skeleton are adhered to the substrate and these are less likely to be removed than others by current activity, independent of their size, shape and/or density. Abstract expanded from and image from: Orr, P.J., Adler,L.B., Beardmore, S.R., Furrer, H., McNamara, M.E., Peñalver-Mollá, E., Redelstorff, R., 2016. “Stick ‘n’ peel”: Explaining unusual patterns of disarticulation and loss of completeness in fossil vertebrates. Palaeogeography, Palaeoclimatology, Palaeoecology,. 457, 380-388. DOI: 10.1016/j.palaeo.2016.05.024".

Global weathering: the experiment and the protocols

Alexander H. Parkinson[1], Yolanda Fernández-Jalvo[2] and Peter Andrews[3]

[1] Evolutionary Studies Insititute & School of Geosciences, University of the Witwatersrand, Johannesburg, South Africa
[2] Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Jose Gutiérrez Abascal 2, 28006 Madrid, Spain, yfj@mncn.csic.es
[3] The Natural History Museum. Cromwell Road. 7SW-5BD London. UK

Frequently, the presence of weathering traits on fossil bones has been used as a 'watch' to indicate time of exposure on the ground. This is based on the weathering stage descriptions provided by Behrensmeyer (1978) from Amboseli (Tanzania). This case shown by Behrensmeyer in tropical African climates showed the 5 stages of progressive sequence of weathering (from 0 absent to 5 maximum) that in 10-13 years reach the maximum stage with skeletal elements falling apart. However, several bone weathering monitoring from other parts in the world have shown that speed of weathering modification is increased/reduced by environmental conditions (changes in temperature and humidity, insolation and protection by vegetation) and the body size of the animal and anatomical elements. For instance, in temperate European climates only one third of almost a hundred skeletons showed evidence of incipient weathering after 30 years, none after 8 years of exposure. Desert climates in Abu Dhabi (Emirates) of a camel skeleton exposed in a gully for 15 years only reached stage 3 of weathering, or an elephant carcass in tropical rain forest had complete absence of weathering after 10 years.
We aim to involve researchers from different parts of the world in a simple experiment to compare weathered bones from different climates and environments all over the world, that is, a **Global Weathering Project**. In order to reduce the number of parameters that may influence the data, we have selected a single species that can be present all over the world, i.e. cow (*Bos primigenius*) and a supernumerary skeletal element that reduces the variability of bone responses (i.e. ribs=13 pairs). Ribs, on the other hand, have been used by Beherensmeyer (1978) to distinguish the 5 stage of weathering. We are still setting some aspects of the project. So far, we have participants from South America, Europe (Spain, France, Germany…), USA, South and East Africa, India, Mexico, Israel, Morocco and China, but we aim to get as many areas in the world as necessary to obtain a GLOBAL PROJECT!. Simple experiments, collecting a rib every year is the basis of the experiment, using neutral substrate and setting the experiment close to a permanent standard weather station to control basic parameters. This is the starting of a global experiment that may yield an enormous amount of information!! To know more: **https://www.researchgate.net/project/Global-Weather-Project**

Biotic and abiotic changes of the Mediterranean shelf of southern Israel

Jan-Filip Päßler[1], Kristina Weber[1], Anna Sabbatini[2], Alessandra Negri[2], Jan Steger[1], Martin Zuschin[1], Bella S. Galil[3] and Paolo G. Albano[1]

[1] University of Vienna, Department of Palaeontology, Althanstraße 14, 1090 Vienna, Austria
[2] Università Politecnica delle Marche, Dipartimento di Scienze della Vita e dell'Ambiente, via Brecce Bianche, 60131 Ancona, Italy
[3] The Steinhardt Museum of Natural History, Tel Aviv University, Israel

The South-Eastern Mediterranean Sea is subject to multiple human pressures. The opening of the Suez Canal in 1869 allowed a massive introduction of tropical species from the Red Sea into the Mediterranean, the so-called "Lessepsian invasion". Since the 1960s, the Aswan High Dam has severely curtailed the Nile's sediment and nutrient discharge, and more recently, seawater temperature has risen due to climate change (3 ºC between 1980 and 2013).

In view of the massive modifications of the ecosystem there is an urgent need to delineate ecological baselines to assess the timing, magnitude and dynamics of change. However, most of the data available on biotic and abiotic components of the basin are limited to the last decades, when the pressures were already underway.

With this aim in mind, we collected sediment cores up to 1.25 m in length at 30 m depth off Ashqelon, southern Israel. We sliced them at 1 cm increments and analysed sediment grain size, molluscan, foraminiferan and calcareous nannofossil content of the top and then every five centimetres increments.

The grain size analysis reveals strong changes in the sediment composition throughout the core (see Figure 1). The proportion of sand increases from 5% (45 cm core depth) to 90% (core top). Between 45 and 105 cm, the sediment is almost devoid of sand (5%), showing a prevalence of silt and clay. Below 105 cm, sand increases again to values around 80%. Such variation in the proportion of sand denotes important structural habitat changes. A preliminary estimate of the in- situ/reworked calcareous nannofossil ratio mimics the clay/sand ratio, suggesting the possibility to evaluate variations in the Nile discharge throughout the studied interval.

The gastropod *Cerithidium diplax* (Watson, 1886) is the only alien mollusc found in the core so far and occurs with a single specimen per increment in the upper 12 cm and in the lowest increment at 122 cm sediment depth. Although the lack of specimens between 12 and 122 cm is intriguing, the occurrence of alien foraminifera such as *Adelosina* (*Cycloforina*) *carinatastriata*, *Miliolinella fichteliana* and *Cycloforina quinquecarinata* in the 122 cm sample suggests that the bottom of the core likely postdates the opening of the Suez Canal and the onset of the invasion.

These preliminary results suggest that the Israeli shelf experienced drastic substrate changes with recurrent shifts from mud to sand. Moreover, alien species occur throughout the core suggesting that such environmental changes started later than the opening of the Suez Canal in 1869. An age model for the core will be prepared for better constraining in time and identifying the causes of such changes.

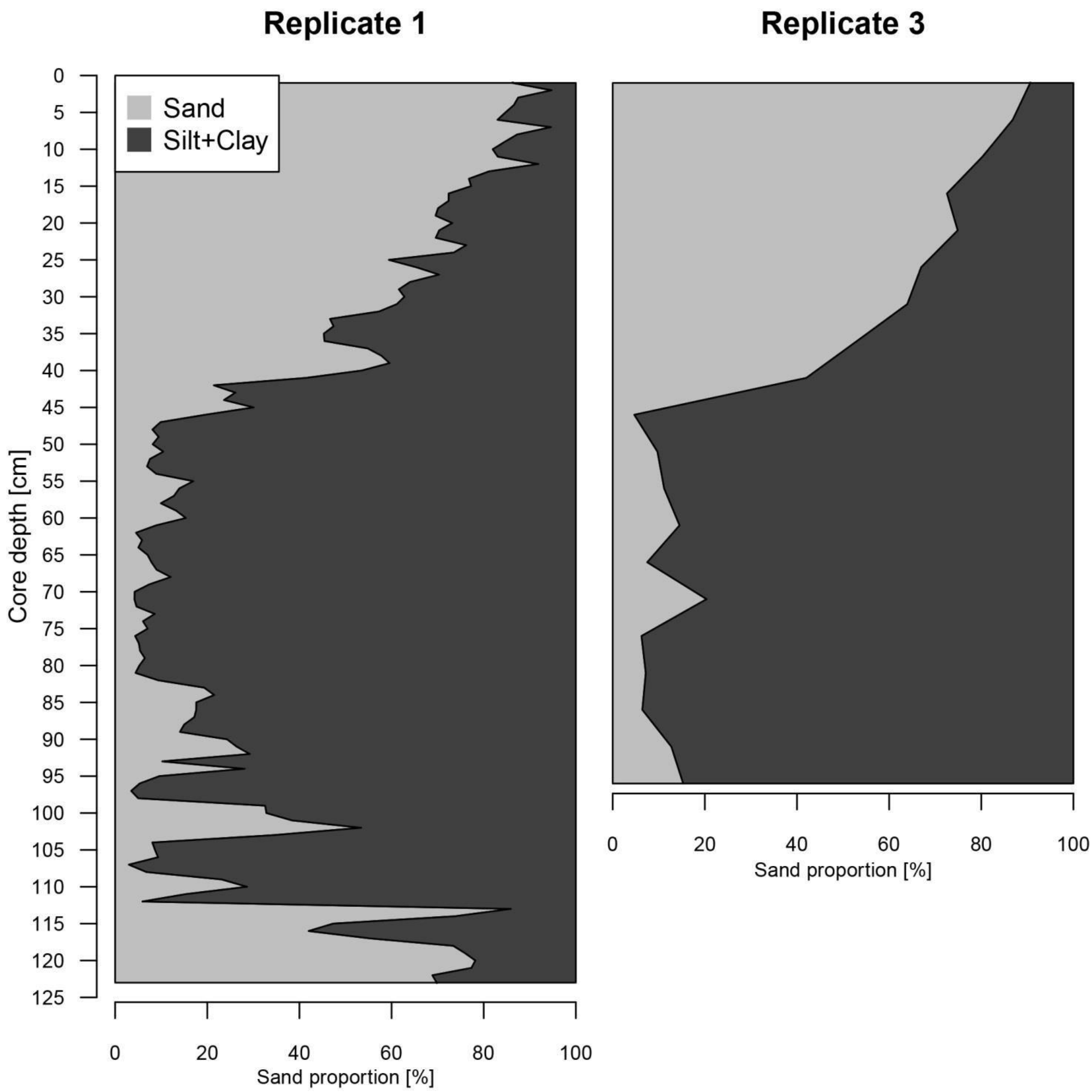


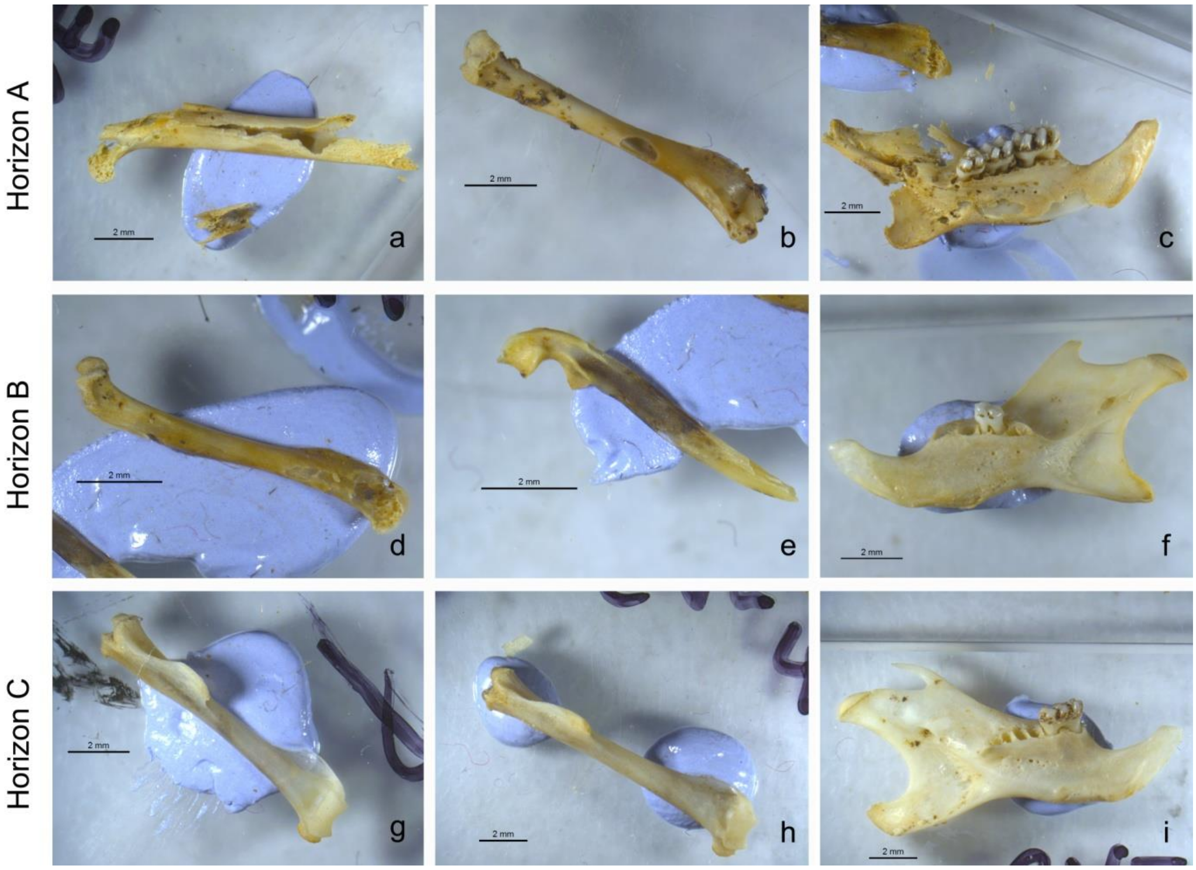
Figure 1: Sediment composition of two core replicates taken at 30 m depth off Ashqelon, southern Israel. Both cores show a decline of the sand fraction from the surface to 45 cm sediment depth, where mud prevails. The longer replicate 1 allows detecting a further increase in sand below 115 cm sediment depth.

Substrates, microbes and preservation

M. Dolores Pesquero, Dores Marin-Monfort and Yolanda Fernández-Jalvo

Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Jose Gutiérrez Abascal 2, 28006 Madrid, Spain, lolap@mncn.csic.es

What can fossils say about their own preservation and fossil environment? Maybe they show us why some survive and become fossils and other are destroyed? An important aspect for fossil preservation is the nature of the substrate which will be decisive for the microbial attack and/or preservation quality. Early diagenesis, a time of a few years after death, is crucial to later fossilization, because the former may "decide" the success of the later. Both pre- and post-burial stages are subjected to a different set of physical, chemical and biological agents that may produce modifications of the morphological structure, which will be decisive to preserve the bone remains. Some structural modifications are diagnostic of particular agents, which otherwise may not be noticed or identified in a fossil association. Soil corrosion not only depends on the pH (acidity/alkalinity), but on rates of humidity, vegetation and microbial activity, being also time-related. So far, we know, at least in temperate climates, that soil corrosion is not directly related to intensity of bacterial attack but to highly humid soils covered by algae and/or bushy vegetation. Edaphic horizons have important environmental signatures and we are doing experimental work to distinguish traits of bones buried in different horizon soils, both wet and damped conditions. When a corpse comes in contact with the soil, and later during burial, bacteria and fungi act as one of the major taphonomic agent during putrefaction, and early and fossil-diagenesis. Furthermore, highly organic soil, such as bat guano, produces a chemical/microbial combination that can be highly destructive to the bone and the accompanying sediment/stones. The action of acid percolation through the sediment may affect drastically bones already buried and fossilized. Finally, vascular plants are also decisive to preserve/destroy bone remains, also before and after burial. In order to interpret the taphonomic signature by soil, microbial action (bacteria and fungi), root-marks we have performed several experiments to understand conditions that favor/harm preservation, i.e. the fossil record. Several dead bodies of mice were buried in different edaphic horizons. Horizon A, highly organic, showed corrosion and abundant insect damage. Horizon B had also the influence of corrosion but a lesser intensity. Horizon C, showed almost no surface damage (see Fig. 1). Other mice buried in contact to the roots of plants, showed the root-mark print on surface and bacterial damage around root perforations in the histological cut section. This combination of modifications suggests the action of bacteria symbiotically associated to roots.



Taphonomic features of mice carcasses buried in different edaphic horizons

Taphonomy of the large foraminifer *Arthrodendron* Ulrich, 1904 based on physical experiments

Katarzyna Płonka[1], Alfred Uchman[1] and Michael A. Kaminski[2]

[1] Institute of Geological Sciences, Jagiellonian University, Gronostajowa 3a, 30-387, Kraków, Poland; katarzyna.filipiak@student.uj.edu.pl
[2] Earth Sciences Department, King Fahd University of Petroleum & Minerals, Dhahran, 31261, Saudi Arabia

Arthrodendron Ulrich, 1904 is a poorly-known, large agglutinated foraminifer. It was classified in the past as a plant, alga, or a trace fossil but its generic affiliation was clarified on the basis of the type specimens. The taxonomic position of *Arthrodendron* is uncertain. It is classified as the suborder *Hormosinina* Mikhalevich, 1980, but its affinity to the extant komokiaceans is still open.
Arthrodendron was often omitted in palaeontological analyses, mainly because of its comparatively large, fragmentary recovery by standard micropalaeontological methods and its preservation on the soles of turbiditic sandstones.
Arthrodendron's body consists of branched chains of large chambers with an imperforate agglutinated wall that lacks biogenic barite crystals. The test was flexible, consisting of many chambers in a meandering series that may branch further. The various species of *Arthrodendron* are distinguished by the predominant chamber shape. The foraminifer lived within the mud as shallow infauna or on the muddy sea floor surface in a deep-sea turbiditic environment. It is a deep-sea organism based on micropalaeontological and ichnological data.
The taphonomy of *Arthrodendron* is also poorly known. The process of artificial formaminifer burial was conducted in a laboratory with use of sand- and mud-like products and cements. Our experiments show ways of branched test preservation and chamber deformation. Six boxes were filled with a muddy substance mixed with slowly congealing cement. Intestine-like pouches (filled with jelly) connected in chains and short branches were placed on the surface of the mud in three boxes and slightly pushed into the mud in the other three boxes. Chain composition was different in all boxes. Sand mixed with slowly congealing cement was put on the mud with the artificial foraminifers in all cases and pressed by a load. On the poster are presented results of these physical experiments.

Taphonomy of lower Aptian (Cretaceous) *Chondrodonta* (Bivalvia) carpets in the Apulia Carbonate Platform (Gargano Promontory, southern Italy)

Renato Posenato, Michele Morsilli, Davide Bassi and Stefania Guerzoni

Dipartimento di Fisica e Scienze della Terra, University of Ferrara, Via Saragat 1, 44122 Ferrara, Italy

Chondrodonta is a Cretaceous oyster-like bivalve with a predominant calcitic, dorso-ventrally elongated and slightly inequivalve shell. It occurs commonly in rudist-bearing limestone, ranging from Barremian to Turonian (Campanian?), throughout the Tethysian and Caribbean carbonate platforms. The valves are preserved often still articulated because of the occurrence of dorso-ventrally elongated and tightly interlocked chondrophores. *Chondrodonta* had a cemented and gregarious life habit and is considered an opportunistic bivalve. Despite the high abundance, widespread geographic distribution and long time-span, the taphonomy of *Chondrodonta* concentrations has been rarely reported in the literature and the few available records are mostly of upper Cenomanian species (e.g., *Chondrodonta joannae*).

This study focuses on lower Aptian *Chondrodonta* concentrations which record the early evolutionary phase and spreading of this bivalve. The studied bivalve beds are located within the lower Aptian interval of the San Giovanni Rotondo Limestone (Gargano Promontory, Apulia Carbonate Platform, Italy). The analysed *Chondrodonta* specimens have a moderately elongated shell, with a spoon- to stick-like outline. This shape reminds that of the Lower Jurassic aberrant lithiotids. Although the *Chondrodonta* shell shape would have been prone to develop aberrant forms, this opportunistic taxon never reached remarked shell morphologies as the lithiotids. Taphonomic signatures were analysed on very good outcrop exposures of *Chondrodonta* bearing beds (Fig. 1).

The main *Chondrodonta* concentration consists of a laterally continuous bed-set, about 1 m thick, subdivided in some decimetre-thick beds, which represent bivalve carpets. The lower bivalve bed overlies a stromatolitic layer, which represented the hard substrate for the early bivalve colonization. Bouquet-like aggregates of *Chondrodonta* individuals in life position occur both at the contact with the stromatolite and throughout the whole bed-set. Each bed contains shells belonging to a single or very few generations and without significant evidences of reworking, bioerosion or lateral displacement. The upper bivalve bed surface shows semi-circular low relief knobs, about 20–30 cm high, ranging in diameter from 1.5 to 3 m (Fig. 1A). The knobby surfaces are made up by vertically oriented shells, often arranged in bouquet-like aggregates (Fig. 1B and C). On the basis of taphonomic signatures, the studied *Chondrodonta* shell beds represent biogenic concentrations, mostly produced by mass mortality events and affected by very rapid burial processes. These lower Aptian accumulations, widespread along different geographical provinces, record unstable and stressed marine environment and can be related to the Selli oceanic anoxic event (OAE 1a).

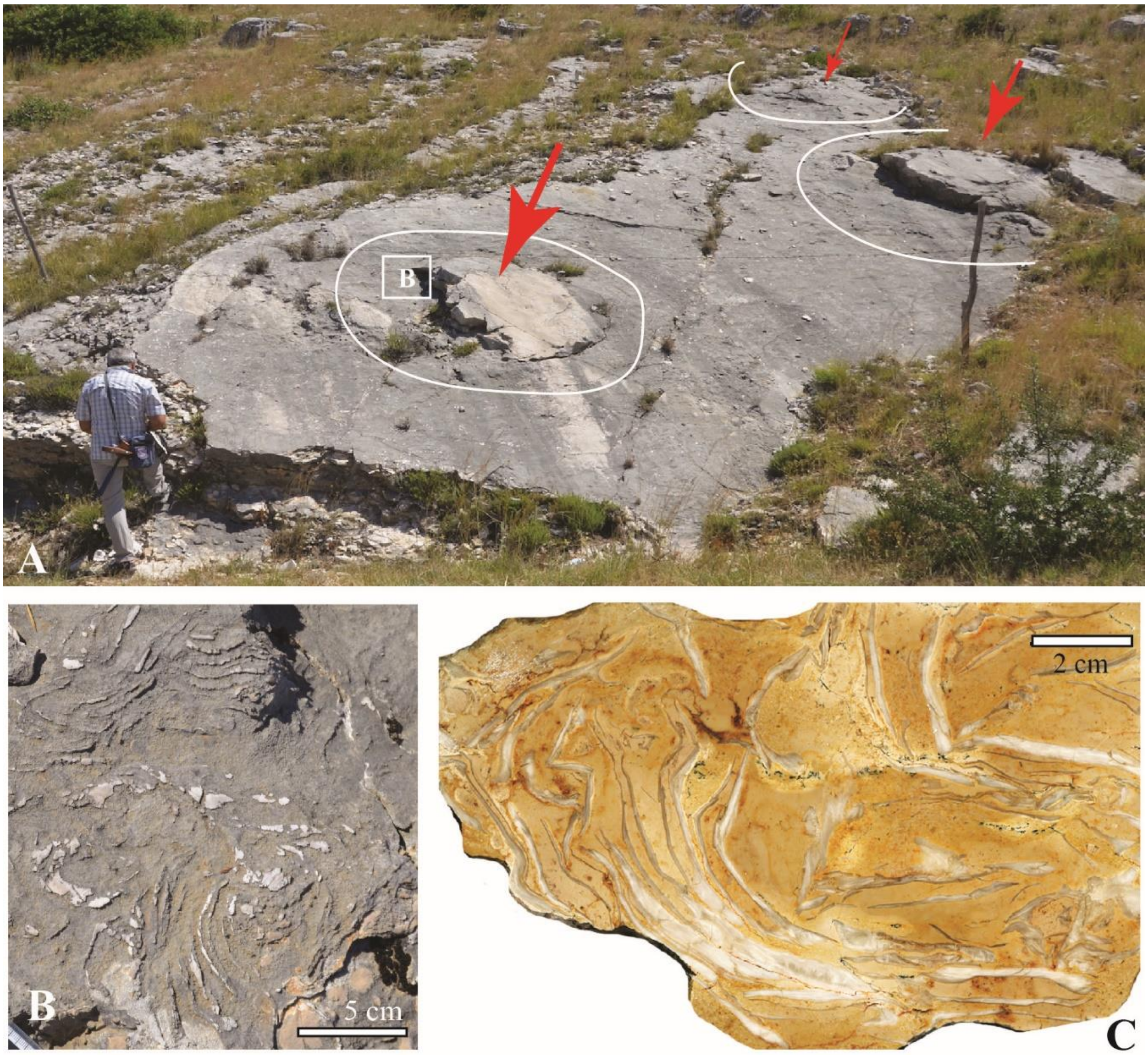


Fig. 1 – **A**, upper bed surface of *Chondrodonta* beds with low relief knobs originated by bouquet-like aggregates of autochthonous shells (detail in **B**); **C**, polished section perpendicular to the bed surface of a bouquet-like aggregate (Borgo Celano, Gargano Promontory, San Giovanni Rotondo Limestone, lower Aptian).

Combining experimental taphonomy, laser-stimulated fluorescence imaging, and exceptional fossils: fish eyes from Las Hoyas (Early Cretaceous, Spain)

Francisco José Poyato-Ariza[1], Hugo Martín-Abad[1], Anabel López-Archilla[2], Michael Pittman[3], Miguel Iniesto[4], Thomas G. Kaye[5] and Ángela D. Buscalioni[1]

[1] Unidad de Paleontología, Departamento de Biología, Universidad Autónoma de Madrid, 28049 Madrid, Spain
[2] Laboratorio de Ecología Microbiana, Departamento de Ecología, Universidad Autónoma de Madrid, 28049 Madrid, Spain
[3] Vertebrate Palaeontology Laboratory, Department of Earth Sciences, The University of Hong Kong, Pokfulam, Hong Kong
[4] Biogéosciences UMR 6282, CNRS, Université Bourgogne Franche-Comté, 6 Boulevard Gabriel, 21000 Dijon, France
[5] Foundation for Scientific Advancement, Sierra Vista, Arizona, 85650, USA

The Las Hoyas fossil site is a part of the La Huérguina Formation that records upper Barremian continental sedimentation at the Southwestern Iberian Basin. It has been interpreted as a seasonal subtropical wetland system without marine influence. This fossiliferous beds are formed by finely laminated limestones composed almost entirely of calcium carbonate. The lithosome shows two basic facies associations, representing two extremes of transitional progressions. One facies consists of positively graded millimetric laminae produced by underflow currents and decantation of allochthonous detrital, with fine carbonatic particles and vegetal debris. This facies would have been deposited under a persistent but shallow water column during seasonal flooding wet periods. The other extreme consists of stromatolite-like laminae and would represent periods of low water level conditions (drier periods) with growth of benthic microbial mats. Taphonomic analyses comparing the fossils preserved with the corresponding facies associations indicate that the "drier facies" with microbial mats contain abundant fossil specimens exquisitely preserved but low taxonomic diversity, whereas the "wetter facies" have less fossil specimens not so well preserved, but the taxa are highly diverse.

Experimental Taphonomy in fish

Actuotaphonomical experiments have shown that fish carcasses must have been protected from disarticulation in a matter of days, which is coherent with the model of microbial mats growth. As a consequence of this key biostratinomic process, fishes from Las Hoyas have been preserved mostly articulated and complete, showing perfect anatomic detail even in very juvenile specimens, even with some soft tissue remains. These include muscle, unidentified abdominal organs and, quite often, eyeballs.

An actuotaphonomical approach to the study of the fossilization is especially suitable for understanding the biostratinomic factors and processes that influenced decay. By comparing the stages of pre-burial decay of fish carcasses in experiments under controlled conditions we can identify the effect of environmental factors and the sequence of decay. Three experimental sets of studies were designed in order to explore fish decay: (1) transport, (2) stagnant freshwater and, (3) microbial mat sealing.

Transport implies abrasion, loss of scales and damage to the tips of fin rays, even at low energy conditions. The decomposition of corpses in stagnant freshwater includes swelling, disarticulation, disconnection, and dispersion of skeletal elements. Necrokynetic movements within the water column can begin as soon as 48 hours after the death of the individual, depending on its size. The loss of soft tissues and the disarticulation of skeletal structures usually starts out a few days after death but is delayed up to 10-15 days if the carcasses are left completely undisturbed in stagnant freshwater. Regarding the eyes, their coloration begins to change in the first hours, so that after a few days it is difficult to identify the different structures. Later, the inner circle corresponding to the pupil gets disfigured, until the eye finally decays like the rest of the soft tissues.

Experiments #1 and #2 indicate that Las Hoyas fish did not suffer events of transportation and that the carcasses experienced a short biostratinomic phase. Other than that, only experiment #3 with microbial sealing resulted on exceptional preservation of the carcasses. The formation of a microbial *sarcophagous* by the upper layer of the microbial mat promotes the conditions that preserve body integrity. Hydration of organs as well as their volume are sustained. During the first week, this exceptional preservation occurs within an alkaline but oxygen depleted environment. Afterwards, alkalinity remains but the environment turns oxic in the long run. The microbial nature of the sarcophagous not only covers the body but also generates negative impressions of scales and enables the replica of structures such as the fish eye layers. Strikingly enough, fish eyes remained clearly recognizable even after 24 months within the mat, and the lens and structural layers were still discernible. The observation of these areas at higher magnification revealed that each layer was a replica formed by numerous short rod-shaped bacterial (2.7x 1.5µm) cells embedded in the microbial EPS. The original tissues of the eye are also preserved as observed with RMI after 9 and 27 months. Therefore, exceptional preservation in microbial mats is guaranteed in different manners.

Eyes with Laser-stimulated fluorescence (LSF) imaging

Fish fossils at Las Hoyas often show eyeball preservation observable under normal light. In previous studies a carbonaceous black film of dark organic remains occurs in small primitive teleosteans; it has been discussed as eye melanosomes or coccoid bacteria. Later on, LSF images were collected using standard LSF protocols. Fish specimens were imaged with 405nm, 500mw lasers. A Nikon D810 camera was fitted with a long pass blocking filter to block the intense laser light. The laser's collimated beam was translated into a vertical line by a Laserline Optics Canada lens. The laser line was mechanically swept back and forth over the specimen during the photo's time exposure in a dark room. The images were post processed in Photoshop CS6 for sharpness, colour balance and saturation. A specimen of the small actiopterygian fish *Pleuropholis* sp. that had never showed eyeball preservation under normal light revealed details of the eyes. Under LSF the color is intense, and different parts of the eye anatomy and preservational features can be distinguished. The specimen shows a protrusion that can be interpreted as a broken crystalline lens. The color newly revealed spreads on the whole area of the eyeball; it most likely represents the *stratum argentum*, a distinctive layer that in many groups of chondrichthyan and osteichthyan fishes contains different types of metals and crystals. This new dark, irregular color visible with the LSF technique is not preserved as any sort of black carbonaceous film, as in the cases studied earlier, but as an impregnation in the matrix probably corresponding to the wall of the original microbial mat sarcophagous. The LSF technique, then, can reveal new details not only of the anatomical but also of the preservational features of fossil specimens.

Abundant taxa determine beta diversity

Vanessa Julie Roden and Wolfgang Kiessling

GeoZentrum Nordbayern, Section Palaeobiology, University Erlangen-Nürnberg, Loewenichstraße 28, 91054 Erlangen, Germany. E-Mail: vanessa.roden@fau.de

Understanding the principles of diversity assembly is important to improve our knowledge of past and current changes in biodiversity. Beta diversity, the variation of community composition, is essential in characterizing diversity partitioning at multiple scales. For most diversity indices, a complete list of taxa needs to be obtained for each sample, and for abundance-based indices, the specimen counts of each taxon are necessary. To determine alpha diversity, simplified diversity indices have been developed that require less information, such as the Berger-Parker dominance index and the Margalef index. However, no simplified measure of beta diversity has yet been developed.

Using four fossil paleo-community as well as two recent datasets of benthic marine communities that vary strongly in size and diversity, we explore whether the measure of beta diversity can be simplified based on the concept of the ecological significance of dominant taxa. We focus on the mean pairwise proportional dissimilarity, or relative Bray-Curtis dissimilarity, which expresses overall heterogeneity of samples in a dataset and is among the most widely used and robust measures of beta diversity. To assess how beta diversity changes when varying amounts of information are included in its calculation, we computed the mean proportional dissimilarity using only the n most abundant taxa from each sample. The values converge rapidly with increasing n, and the standard error of the mean dissimilarity of the complete matrix, which includes abundance counts of all taxa, is reached between n=2 and n=10. We also test the correlation between the dissimilarity matrix derived from the complete community composition matrix and the one derived from a degraded matrix, in which only the n most abundant taxa are included. Correlation coefficients increase rapidly, reaching Spearman's rho values > 0.9 at n = 3 to n = 11. The correlations are all highly significant, even with only the single most abundant species considered in each sample (n = 1). Using genus-level data yields similar results as with species abundances.

To test which factors affect the accuracy of the beta diversity estimates, we tabulated the correlation values against ecological indices. The mean evenness, number of samples or the number of specimens comprising the datasets do not significantly affect the strength of the correlation among the 40 datasets (6 original datasets and 34 subsets derived from the original datasets using cluster analysis). However, datasets with low mean sample-level as well as gamma Shannon entropy, a low number of species, and a low mean dissimilarity tend to yield higher correlation values (figure 1). These factors are related to the number of species shared between assemblages. The likelihood of the assemblages to share the most abundant species is lower when there are more species in the dataset and the dissimilarity is higher. We assume that more shared species characterize the community composition better when only the most abundant species are considered.

To assess the importance of count data, the approach is repeated after converting abundance to presence-absence data. Although species abundance information is more accurate, presence-absence data can also provide a good depiction of beta diversity for most datasets when considering only the most abundant species. A higher number of species need to be included to give results comparable to those derived from abundance data.

When using abundance counts, including only the five most abundant taxa for each sample depicts the dissimilarity patterns very well for most datasets. The beta diversity estimates are usually statistically indistinguishable from the estimate of the full community. When using datasets with a very high mean dissimilarity (≥ 0.9), we recommend considering the ten most abundant taxa. Species as well as genus counts can be used. To attain a good depiction of dissimilarity without including abundance counts, the 20 most abundant taxa should be identified per sample before calculating the binary dissimilarity.

Including only dominant species is intuitive and depicts the beta diversity structure very well. With this method, large samples can be processed and analyzed with less time and effort, allowing ecologists and paleobiologists to produce more data on diversity patterns, hopefully yielding greater knowledge on the changes of biodiversity through time and understanding current diversity structures.

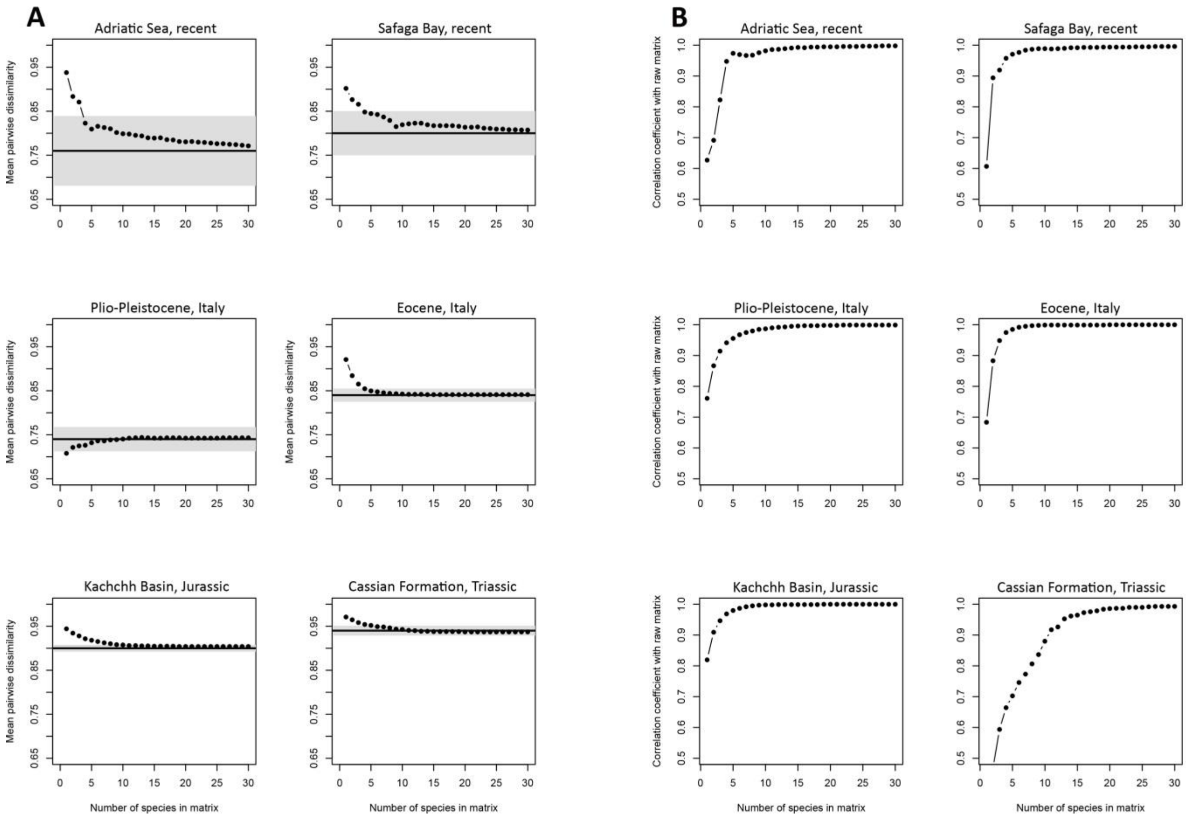


Fig. 1: (A) Mean pairwise proportional dissimilarity among samples in each dataset using abundance data. Points depict dissimilarity for the n most abundant species from each sample included in the species composition matrix. Lines depict mean dissimilarity of the complete species composition matrix. Grey boxes indicate the bootstrapped standard error of the mean dissimilarity. (B) Correlation coefficient (Spearman's rho) between the dissimilarity matrix generated from the complete community composition data and the matrix generated from degraded data, using only the n most abundant species of each sample. All values are highly significant ($p < 0.001$).

Taphonomy of the Late Pleistocene marine molluscan assemblages from Uruguay

Alejandra Rojas, Mariana Demicheli and Sergio Martínez

Departamento de Paleontología, Instituto de Ciencias Geológicas, Facultad de Ciencias, Universidad de la República, Iguá 4225, CP 11400, Montevideo, Uruguay. Email: alejandra@fcien.edu.uy

Late Pleistocene assemblages of marine invertebrates crop out both in the west (Puerto de Nueva Palmira and Zagarzazú deposits) and east (La Coronilla deposit) coasts of Uruguay. They were originated during interglacial/interestadial episodes, most likely within the MIS 5, and are characterised by their abundant and diverse molluscan content. The study of these assemblages has relevance in the reconstruction of the fauna and paleoenvironments of the Uruguayan coast and Southwestern Atlantic during the Late Pleistocene. Recently, an intense collecting effort allowed to improve the knowledge on the paleontological composition, and on the paleoecology, paleobiogeography, and geochronology of the Pleistocene assemblages. Taphonomic observations and paleoecologically relevant taxa and ichnotaxa yielded information on paleoenvironmental parameters and depositional environments too. Taphonomic data was gathered in the field and in the laboratory during sample processing.

The Puerto de Nueva Palmira deposit is composed of medium to coarse sand, occasionally including pebbles. Shells are densely packed. Multiple lateral samples were taken from each three layers of shell accumulation. Articulated bivalve specimens are very scarce; most shells were found disarticulated and fragmented. As an exception, few specimens of fragile shells were found unbroken. The grade of abrasion was variable but intact shells were almost absent. Many shells showed fresh fractures while others presented rounded borders. Many were so abraded that original morphological features were almost lost. Samples from this deposit included specimens of different sizes, being micromolluscan species very scarce and also badly preserved. Molluscan content showed little variation among the sampled layers. Regarding the proportion between right and left valves of *Ostrea equestris*, a higher number of right valves were recorded per sample.

The Zagarzazú deposit is composed by a fine sandy matrix that occasionally includes small granules, overlaid by a green clayish layer. Several samples were taken from the sandy layer in order to evaluate the existence of lateral variations. Shells are generally well preserved and bivalves are frequently in life position or articulated (*Tagelus plebeius*, *Macoma constricta*, *Mactra isabelleana*, *Anomalocardia brasiliana*). Most valves are entire, but large, fragile and thin-shelled species can be fragmented. Abrasion is almost absent; entire shells and shell fragments show angular borders. Micromolluscs and juvenile specimens are recorded, generally well preserved. Considering the more abundant bivalve species (*Mactra isabelleana*), similar proportion of right and left valves were recorded in all studied samples, but in one of them, left valves of *Ostrea equestris* clearly outnumber right valves.

La Coronilla deposit is composed by a grey-greenish clayey fine sand. Multiple lateral samples were taken from three different layers of shell accumulation. Shells are very abundant and well preserved. Articulated or in life position bivalve specimens are commonly found (e.g., *Tagelus plebeius*, *Mactra isabelleana*, *Atrina seminuda*, *Trachycardium muricatum*, *Anomalocardia brasiliana*, *Corbula caribaea*, *Tellina gibber*, *Ostrea equestris*). Shells are frequently unbroken although shell debris occurs. Fragmentation is more common in fragile and thin-shelled species (e.g. *Macoma uruguayensis*, *Bulla occidentalis*, *Barnea lamellosa*) and in epifaunal taxa (e.g. *Bostrycapulus* *odites*, *Tegula patagonica*, *Plicatula gibbosa*, *Brachidontes* sp.). Abraded shells are almost absent; specimens preserve sharp borders. Regarding shell size, small specimens from medium sized species are recorded (such as *Ostrea equestris*, *Pitar rostratus*, *Chione subrostrata*, *Anomalocardia brasiliana*). Micromolluscs are very abundant and represent the majority of the taxa recorded in the assemblage. For *Ostrea equestris*, right valves double left ones.

According to taphonomic signatures, lithological composition and paleoecological inferences, the Puerto de Nueva Palmira records the deposition in a high energy, wave-dominated environment. Shells experienced intensive transport. Compared to Zagarzazú and La Coronilla, this assemblage includes more epifaunal hard substrate dwelling taxa that live in high energy environments close to the coastline (e.g., *Diodora patagonica*, *Lottia subrugosa*). The record in Puerto de Nueva Palmira of species that prefer pelitic substrates, evidences the transport of their shells to a shallower, wavy environment. Zagarzazú and La Coronilla assemblages were deposited in a proximal, low energy, protected from waves environment. The taphonomic traits of the shells indicate the almost absence of transport. In Zagarzazú, the record of *Thalassinoides* isp. indicates the deposition near the coastline. Especially for the La Coronilla assemblage, molluscan depth ranges suggests that a mixing of species from different depths occurred. The majority of the La Coronilla and Zagarzazú molluscan species live in soft and fine substrates, and according to the taphonomic traits recorded we infer that they lived in or near the burial site. Several evidences point to the development of shell-bottoms in La Coronilla: a) an abundant record of hard substrate taxa and specimens, including the preservation of epibionts still attached to the shelled substrate (e.g. cementing bivalves, balanids, annelid tubes); b) the abundant record of *Entobia* isp., which suggests the occurrence of sedimentation-free lapses during which the sponges established on the shelly substrate and c) the presence of *Radulichnus inopinatus* on shells, indicating a low energy environment and the permanence of shells on the sea floor. In addition, its record on valves of infaunal species, suggests that their exhumation from the sediment was more likely due to the action of bioturbating organisms than to the action of physical agents.

The present study shows how taphonomic traits complement paleoecological information in the reconstruction of the paleoenvironmental and depositional scenario of the Late Pleistocene molluscan assemblages from Uruguay.

Late Pleistocene fossiliferous marine deposits from Uruguay. 1-2: Puerto de Nueva Palmira; 3-4: Zagarzazú; 5-6: La Coronilla.

Comprehension of small compression!

Lucía Rueda Domínguez, Dolores Pesquero, Dores Marin-Monfort and Yolanda Fernández-Jalvo

Museo Nacional de Ciencias Naturales (CSIC). José Gutiérrez Abascal 2. 28006 Madrid, yfj@mncn.csic.es

Wonderwerk Cave (South Africa) is an important site given the presence of human activity from 2Ma to the Holocene. The microfauna recorded at the site has shown the presence of likely controlled fire 1Ma and 1.5Ma based on the high temperatures recorded on bones and the distribution of well-defined heating places. Nevertheless, the microfauna presents a very high destruction that called the attention to the taxonomists. Initially it was considered a poor post-excavation processing. After indications of burning, the exposure to fire was added to be cause of this high breakage rate. However, this fragmentation affected areas at the site that did not show signs of fire.

Effects of postdepositional agents are frequently destructive in microfauna, and, therefore, difficult to interpret. Trampling, for instance, is indicated on macromammals by the presence of microstriations, but how can it be recognized in microfauna?. Andrews (1990) did some experiments on the effects of trampling by large mammals (72kg) walking on single pellets put into plastic bags up to destruction of pellets. This experiment was repeated with different types of pellets, conditions (wet/dry) and substrate type (hard/soft). The pattern that rose from these experiments have been contrasted by experiments carried out at the **Laboratory of Experimental Taphonomy (LET)** from the Museo Nacional de Ciencias Naturales (CSIC). For this purpose, a "material testing equipment" (ZWICK 5kN) was used with a special load cell 500N (650 grams, equivalent to the weight of adult owls) that has allowed us to repeat the experiments under identical conditions as many times as needed. Results obtained from this experiment confirmed the pattern established by Andrews (1990) increasing information on the resistant values of each skeletal element experimented, mainly jaws, long bones, astragali and calcaneii. We then have compared experimental results with archaeological samples from Wonderwerk cave site (South Africa). After this taphonomic experiment we could confirm that the cause of such destruction was trampling by raptors and other animals that inhabited the cave, including humans.

Death, Destruction & Mayhem – Anoxia revisited

Michael Stachowitsch

Dept. of Limnology and Bio-Oceanography, and Dept. of Paleontology, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

If there's something weird and it don't look good, Who you gonna call?
Your local marine biologist!
(Ray Parker Jr., Ghostbusters)

The composition and functioning of most marine ecosystems both past and present are fairly well known based either on fossil remains or surveys of living faunas and floras – coupled with the application of generally valid ecological principles. Equally, explanations have been forwarded for most shifts in or collapses of marine communities in Earth's history – explanations involving a restricted palette of mostly long-term processes. Today, this palette has been considerably expanded by comparatively short-term anthropogenic impacts involving direct habitat destruction and the many facets of pollution. One factor, however, has spanned the eras: oxygen deficiency.

Hypoxia and anoxia today combine an inherent, historical sensitivity of many shallower water bodies with a human promoter, namely anthropogenic eutrophication. Of the many forms of pollution, eutrophication alone – and its ultimate symptom oxygen depletion – is capable of severely modifying and extinguishing most macrofauna over large areas. Whether anoxia is seasonal, periodic or episodic, the result is mass mortality. Currently, nearly 500 so-called 'dead zones' have been identified worldwide, the largest spanning thousands of square kilometers.

The soft bottoms of the Northern Adriatic Sea serve as a case study. They are characterized by high biomass macroepifauna communities composed of aggregated filter- and suspension-feeding organisms (dominated by sponges, ascidians and brittle stars) and thus also resemble epifauna-dominated ancient shallow sea ecosystems. Such multi-species clumps or bioherms grow on shelly fragments and play a vital role in stabilizing the overall ecosystem by converting pelagic biomass into benthic biomass. Progressive hypoxia and anoxia cause visible, predictable changes in the behavior of the epi- and infauna and lead to a distinct sequence of mortalities. The meiofauna (copepods, foraminifera) and sediment geochemistry also undergo clear changes. The process can best be described by 'rapid death, slow recovery', and the 'of–on', all-or-nothing aspect of anoxic events permits little adaptation by benthic organisms. This calls for expanding the term 'extreme environment' to include affected shallow coastal seas.

Recolonization requires the availability small hard substrates, and the encrusting growth on such elements provides interesting taphonomic clues. Differentiating tolerant and sensitive species, combined with knowledge about life histories and growth rates, can help detect past collapses, gauge current benthic ecosystem status and predict recovery trajectories.

Taphonomy of the sauropod dinosaur *Austrosaurus mckillopi* type individual: a short-lived saurian deadfall in the Early Cretaceous Eromanga Sea

Caitlin E. Syme[1], Stephen F. Poropat[2,4], Jay P. Nair[3] and Travis Tischler[4]

[1] School of Biological Sciences, The University of Queensland, St Lucia, Australia
[2] Department of Chemistry and Biotechnology, Swinburne University of Technology, Hawthorn, Australia
[3] School of Biological Sciences, The University of Queensland, St Lucia, Australia
[4] Australian Age of Dinosaurs Museum of Natural History, Winton, Australia

Remains of terrestrial non-avian dinosaurs, and in particular sauropods, are not commonly found in marine deposits. However, terrestrial dinosaur remains have been recovered from sedimentary units deposited in what was the Early Cretaceous epicontinental Eromanga Sea of Eastern Gondwana. One such specimen is the type series and only known individual of *Austrosaurus mckillopi* (QM F2316 + KK F1020), found in the Lower Cretaceous (upper Albian) marine Allaru Mudstone near Richmond, Central West Queensland, Australia. This specimen comprises an articulated axial series (the posteriormost cervical vertebra and first five dorsal vertebrae, associated with five left and one right dorsal rib, and additional vertebral fragments).

The cervical and dorsal vertebrae were preserved effectively in articulation, and a moderate to high degree of articulation could be inferred between the dorsal vertebrae and the dorsal ribs. However, the specimen is incomplete, with only ~6–7% of the neck, ~38–50% of the trunk, and ~23–30% of the ribs represented. The high degree of articulation, coupled with the low level of completeness, suggests the carcass drifted out to sea during the bloat or active decay stage, presumably when the carcass was positively buoyant due to the entrapment of endogenous decay gases. It then disarticulated into discrete portions while floating, possibly as a consequence of scavenger activity. A portion of the carcass comprising the base of the neck and the trunk, held together by partially decayed soft tissues, detached and sank to the ocean floor left side down. As it lay below wave-base, seafloor currents were not strong enough to move the partially disarticulated dorsal ribs.

The Allaru Mudstone was deposited in the cool, shallow, oxygenated, near-normal marine waters of the Eromanga Sea, which had a rich benthic inhabiting and benthic feeding community (including abundant molluscs, crustaceans, ostracods, echinoderms, elasmosaurids, and protostegid turtles). Only fossils of the molluscs *Inoceramus* sp. and *Beudanticeras* sp. were preserved in matrix adhering to the cervical and dorsal vertebrae of QM F2316. This suggests that the carcass remained unburied during the advanced decay stage, long enough for some benthic colonisation to occur, but not long enough for encrusting biota to bioerode skeletal elements. Other terrestrial dinosaur fossils preserved in the Allaru Mudstone include ornithopods such as *Muttaburrasaurus* sp., ankylosaurs such as *Kunbarrasaurus ieversi*, and a possible dicynodont, also without encrusting biota. This suggests a mechanism for transport of terrestrial remains into the sea—most likely river currents flowing into the sea from the active volcanic mountain chain in the east—and sedimentation rates high enough to bury whole carcasses, or portions thereof, of large-bodied vertebrates prior to the formation of advanced saurian deadfalls.

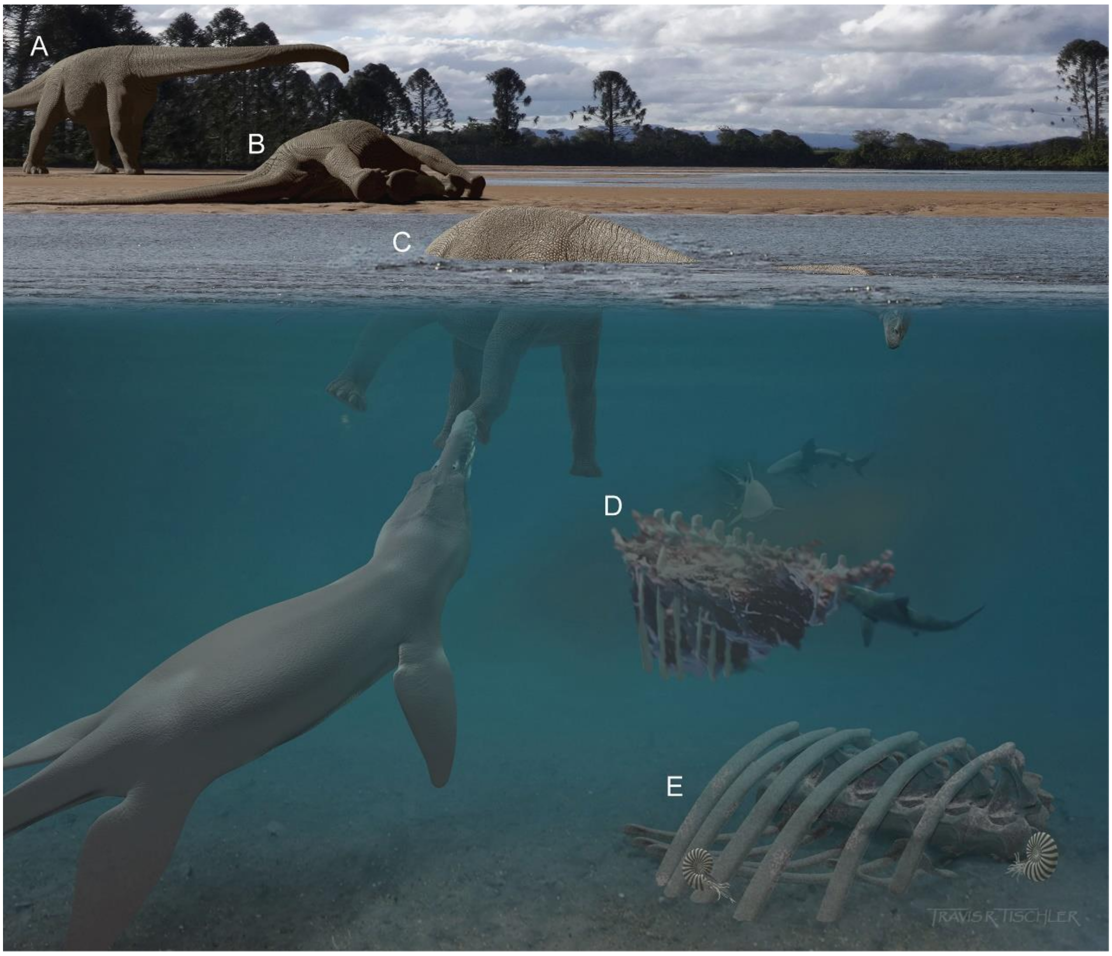


Figure 1. Possible taphonomic pathway for the type and only known individual of *Austrosaurus mckillopi* (QM F2316 + KK F1020). (A) The sauropod lived in a terrestrial environment and (B) died near a river or shoreline. Its carcass bloated and was washed out to sea. The carcass floated at the water's surface and was scavenged while undergoing active decay. A portion of the carcass containing vertebrae and ribs then detached (D) and sank to the ocean floor, where it (E) continued to decay and was colonised by molluscs prior to burial during the advanced decay or skeletal remains stage. Artwork by Travis Tischler.

First occurrence of shallow-water macroids on the southern coast of Brazil

Frederico Tapajós de Souza Tâmega[1,2], Paula Spotorno-Oliveira[2], Ricardo Coutinho[2], Paula Dentzien-Dias[1], Leandro Manzoni Vieira[3] and Davide Bassi[4]

[1] Laboratório de Geologia e Paleontologia, Instituto de Oceanografia, Universidade Federal do Rio Grande, Av. Itália Km 8, 96203–900, Rio Grande, RS, Brazil
[2] Instituto de Estudos do Mar Almirante Paulo Moreira, Divisão de Biotecnologia Marinha, Rua Kioto 253, 28930–000, Arraial do Cabo, RJ, Brazil
[3] Laboratório de Estudos de Bryozoa (LAEBry), Departamento de Zoologia, Centro de Ciências Biológicas, Universidade Federal de Pernambuco, Av. Prof. Moraes Rego 1235, Cidade Universitária
50670–901 Recife, PE, Brazil
[4] Dipartimento di Fisica e Scienzedella Terra, Universitàdegli Studi di Ferrara, via Saragat 1, I–44122 Ferrara, Italy

Macroids are organic centimeter-sized (>10 mm) coated grains formed predominantly by encrusting metazoans or protozoans, sometimes associated with calcareous algae. There is no documented information regarding present-day or fossil macroids on the coast of Rio Grande do Sul State, Brazil. This work was carried out at Hermenegildo (33°39'53''S – 53°06'28''W) and Concheiros (33°32'49''S – 53°06'28''W) beaches, Santa Vitória do Palmar. The macroids were found scattered and collected along the beach backshore in an area of approximately 5 km^2. The *Coral Point Count* with Excel extension program was applied to compare the biotic composition of the macroids between inner part and the living surface via one-way ANOVA. The relative coverage of macroids and faunal groups were estimated by point-counting (50 random points) on 20 macroids sampled images. The dimensions of the long, intermediate and short orthogonal axes were measured from each macroid to determine the sphericity. Seven isolated macroids specimens were sectioned using a geological saw and successively polished in order to prepare petrographic sections.
Bryozoans and cnidarians are the dominant organisms and share 95-40% in all sampled macroids. Molluscs and polychaetes are minor components and either appears less than 5%. The main forming macroid species are the bryozoan *Biflustra* sp. and the cnidarian *Cladocora debilis* Milne Edwards and Haime, 1849. Bioerosion occurs throughout the macroids, from the inner part up to the outer surface. The identified ichnospecimens of *Gastrochaenolites* preserved the boring bivalves such as *Lithophaga patagonica* (d'Orbigny, 1847). Significant differences between relative cover and associated fauna were detected in the sampled macroids (bryoliths; ANOVA $F=22.83$, $p\leq0.0001$; and coraliths; ANOVA $F=486$, $p\leq0.0001$). The bryoliths sizes ranging from 26.0 to 10.5 cm (mean: 17.6 cm) for the long axis ($n=16$) with shapes ranging from sub-spheroidal, sub-discoidal to sub-ellipsoidal and for coraliths sizes ranging from 10.0 to 6.0 cm (mean: 8.25 cm) with shapes ranging from sub-spheroidal to sub-discoidal. The inner bryolith massive arrangement, generally asymmetrical, is dominated by bryozoans, growing on the bivalve *Crassostrea rhizophorae* (Guilding, 1828) and *Ostrea puelchana* d'Orbigny, 1842.

Evaluating mixing, burial and production of mollusks during the Holocene on the NE Adriatic shelf (southern Gulf of Trieste)

Adam Tomašových[1,] Ivo Gallmetzer[2], Alexandra Haselmair[2] and Martin Zuschin[2]

[1] Earth Science Institute, Slovak Academy of Sciences, Dúbravska cesta 9, 84005, Bratislava, Slovak Republic
[2] Department of Palaeontology, University of Vienna, Althanstrasse 14, A-1090, Vienna, Austria

Carbonate production on the microtidal, northeastern Adriatic shelf, which is protected from siliciclastic input and bathed by meso- or oligotrophic waters, and seasonally or inter-annually affected by eutrophied plumes and mucilages, is dominated by non-vegetated, skeletal molluscan sediments at depths below 15 m. Even when not directly affected by siltation, benthic communities in this ecosystem suffered from pollution, reduced water transparency, trawling, and hypoxia events in the 20th century, leading to mass mortalities of benthic invertebrates. However, impacts of these stressors on the rate of carbonate production at temperate latitudes are unknown. Here, we assess production, burial, and stratigraphic mixing of two bivalve species that contribute to skeletal production – *Gouldia minima* and *Corbula gibba* - during the Holocene in two 1.5- m-long cores in the southern part of the Gulf of Trieste. The cores are formed by a 90 cm-thick transgressive interval and a 60 cm-thick highstand interval. First, we find that assemblages of both species co-occurring in 5 cm-thick increments in both intervals are time-averaged to millennia but their age distributions show weak overlaps (*C. gibba* shells are older on average by >1,000 years) in most of the core, indicating significant environmental condensation. This condensation is not only driven by low rate of sedimentation but also by bioturbational mixing. Second, one of the major contributors to carbonate sands, *Gouldia minima* increased in abundance at the transition between the transgressive and highstand phases, remained frequent during the highstand, but declined markedly to almost zero levels over the past ~100 years. In contrast, *Corbula gibba* was frequent during the transgressive phase, declined to low levels during the highstand phase, and increased in abundance over the past 100 years. This resurgence by *C. gibba* is only partly compensating for the decline of *G. minima*. We note that these recentmost changes in abundance of *G. minima* and *C. gibba* cannot be detected with downcore trends in abundance due to condensation and mixing, but become apparent in both cores on the basis of (1) age-frequency distributions, showing a complete disjunction in production timing of the two species, and (2) live-dead mismatch in composition of molluscan assemblages. Molluscan species associated with macroalgae or seagrass are frequent in the uppermost core increments but are strongly under-represented in living assemblages. These results indicate that the molluscan production was significantly reduced in the 20th century, probably due to combined effects of trawling, pollution, and mucilages, and a large portion of the surficial bioclastic carbonate records the ghost of past production.

Taphonomy and Late Pleistocene-Early Holocene mammal extinction (southern Uruguay, South America)

Martin Ubilla[1], Andrés Rinderknecht[2] and Mariano Verde[1]

[1] Facultad de Ciencias, Instituto de Ciencias Geológicas, Dpto. Paleontología, Uruguay
[2] Museo Nacional de Historia Natural de Montevideo, Uruguay

The persistence in the Holocene of several medium to large mammals in South America is a matter of discussion. Human interaction and climate are commonly invoked as possible causes of decimation. Most evidences suggest that most of mega-mammal and some medium sized mammals vanished in late Pleistocene. Nevertheless, some could have persisted into the Holocene in the continent. In this sense, reliable numerical ages are in need, in particular taxon-age based on tooth or bone sampling. However, due to radiocarbon methodological constraints can provide ages that in fact could be older, many Holocene radiocarbon ages are under revision, in particular in bones. Examples of persistence of mega and medium sized mammals are available in some localities of the Argentinean pampean region (Buenos Aires province) (large glyptodonts *Doedicurus* and *Glyptodon*, large ground-sloths *Megatherium* and *Glossotherium*, the horse *Equus neogaeus*, the large laminii *Hemiauchenia*, the giant armadillo *Eutatus seguini*, among others), some of which are now under criticisms. In the absence of taxon-age (mainly due to preservation constraints), taphonomic features of the mammalian remains accompanied by ages of the sedimentary-bearing beds, contribute to the interpretation about synchronicity between fossil remains and sedimentary beds.
Outcrops located in southern Uruguay (Santa Lucía river Basin) (Figure) provide a suitable scenery to discuss this issue. Additionally, they provide examples of local extinctions associated to shifting range. There is available a set of radiocarbon (mostly wood and organic fraction of soil) and Optically Stimulated Luminescence (OSL) ages (sedimentary levels) encompassing the latest Pleistocene to early Holocene (last 30 to 7 ka). In particular, sedimentary beds aging with early Holocene carry many bones and teeth of extinct medium to large mammals. The sedimentary facies were originated predominantly under fluvial-lacustrine conditions and include: a) orange to red fining up conglomerates and coarse to fine sandy beds up to 13 m in height, b) facies up to 2-3 m high including light brown to green grayish sand, clayey silt and sandy silt with reworked loess occurring along with some paleosoils and c) lenses of less than 1 m high with dark clay and fine to medium sand, predominantly green in color with fine parallel and cross-stratification. The last two facies are fossiliferous. The following taphonomic features were considered: articulated bones, partially articulated or isolated bones, complete or broken isolated bones, abrasion, fragmentation, coloration pattern, adult/subadult condition, ichnology (earthworm aestivation chambers, bioerosion, among others). The studied outcrops encompasses the 12 to 8 ka interval and yield a set of osteological and dental remains (ca. 90 specimens housed at the Intendencia de Canelones Collection-IC) including some extinct mammals. The top of one section yields bones along with earthworm aestivation chambers (Figure). Bioerosion and rhizoliths are congruent with an autochthonous assemblage. The sedimentary chronological framework and taphonomic features observed in outcrops (like articulated material of almost complete skeletons, a complete carapace associated with caudal tube, very well-preserved skulls, no abrasion, coloration pattern, bioerosion shared by many bones including different ontogenetic stages, etc.), suggest the persistence into the early

Holocene in southern Uruguay of the giant armadillo *Eutatus seguini*, *Glyptodon* sp., the large deer *Morenelaphus brachyceros*, *Equus* (*A.*) *neogaeus*, the laminii *Hemiauchenia* sp., *Lama* sp., and *Vicugna* sp. The last two taxa are still living elsewhere in South America illustrating local extinctions. Due to likely reworking from older beds, some taxa recorded (*Doedicurus*, the Patagonian mara *Dolichotis* cf. *D. patagonus*) were ruled out and assumed to belong to latest Pleistocene beds.

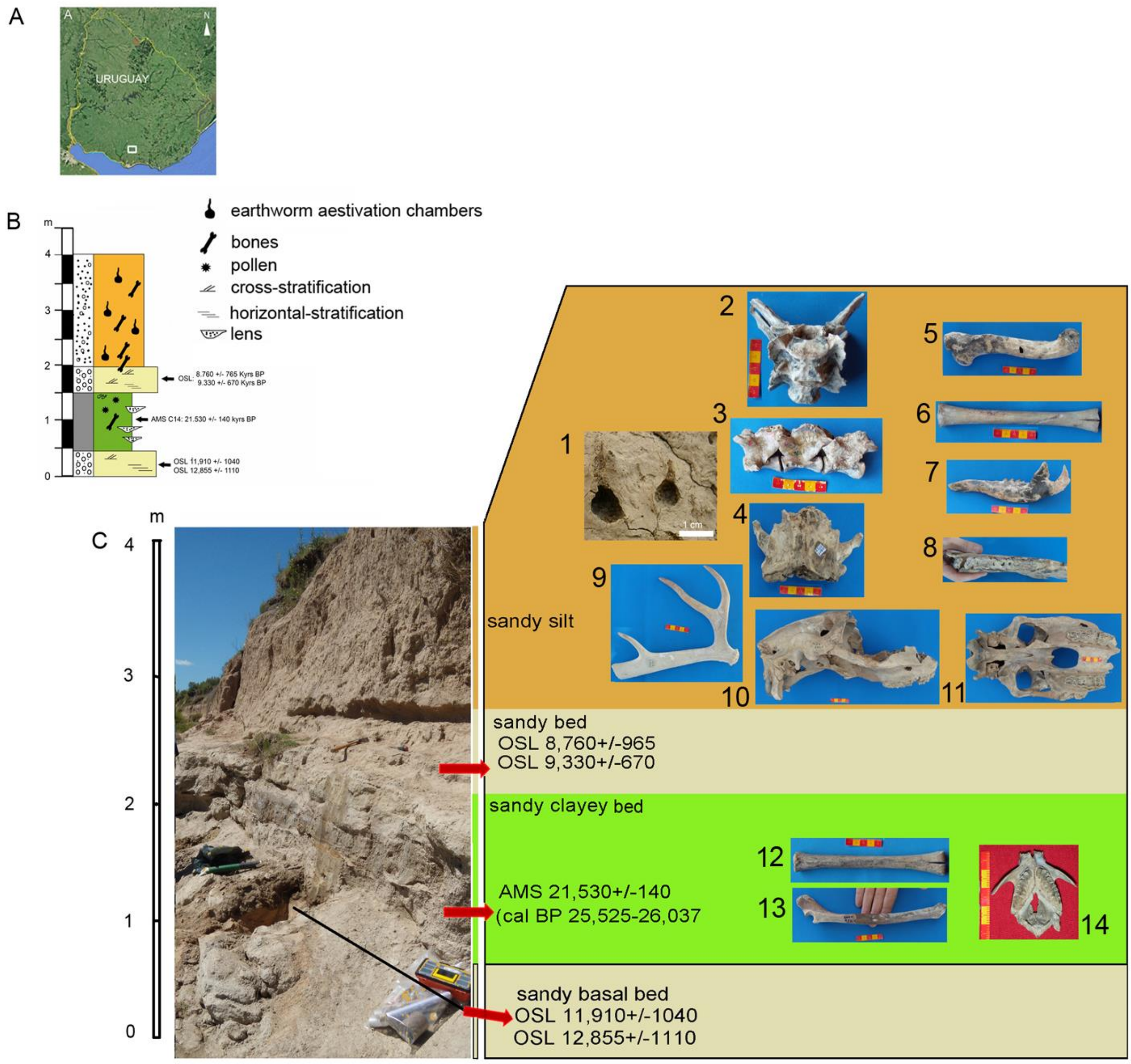


Figure: A) Geographic location of outcrops at Santa Lucía Basin, southern Uruguay; B) Selected stratigraphic section illustrated in C, with some sedimentary features; C) the selected sedimentary section of the Santa Lucía Basin including OSL ages and a selected set of studied material: 1: earthworm aestivation chambers, 2-3: articulated vertebrae, 4: posterior region of skull, 5: humerus of *Lama* sp. with bioerosion, 6: metapod of *Lama* sp. (sub-adult specimen) with bioerosion, 7: left mandible of *Eutatus seguini*, 8: portion of mandible of *Equus neogaeus*, 9: antler of *Morenelaphus* sp. with bioerosion, 10-11: lateral and palatal view of part of skull of *Equus neogaeus*, 12-13:metapod (sub-adult specimen) and radio-ulna of *Lama* sp.; 14: part of skull of *Dolichotis* cf. *D. patagonus*. The radiocarbon age from the sandy clayey bed is based on enamel deer interpreted as a reworked material.

Post-mortem encrustation patterns of *Clypeaster rosaceous* tests from San Salvador, The Bahamas and their effects on preservation potentials

Sven Zille, Tobias B. Grun and James H. Nebelsick

Department of Geosciences, University of Tübingen, Hölderlinstraße 12, 72074 Tübingen, Germany

Clypeaster rosaceous represents common secondary substrates for post-mortal encrustation and bioerosion. Tests of these clypeasteroid echinoids have been collected from the Bahamian Island of San Salvador. The oral and aboral surface show different morphologies, with the flattened oral surface containing the periproct and (highly indented) peristome as well as simple straight food grooves, while the doomed aboral surface contains the inflated petals with ambulacral pores. Both surfaces are characterized by numerous sunken tubercles which are larger on the oral side. This study aims to: (1) establish the number and degree of post-mortem encrustation and bioerosion on the echinoid test surface, (2) ascertain the succession of infestation, (3) compare oral and aboral test sides and (4) analyze the effect of encrustation on the preservation potential of these multi-plated shells.

A number of different taxa contribute to both encrustation and bioerosion. Encrusters include coralline and fleshy algae, foraminifera, serpulids and rare corals. Bioerosion is found in larger and smaller holes as well as slit-like *Rogerella* which is attributed to boring cirripeds. Coralline algae can be pervasive covering the whole specimens and often showing protuberances. Fleshy algae can also be present as variously thick thalli. Encrusting foraminifera can be clearly separated into two taxa: flattened white to grey *Planorbulina* and red to pink upright growing *Homotrema*. Especially the latter show different states of preservation ranging from dark red, upright growing forms to heavily eroded, pink forms. *Planorbulina* is often found in early stages of encrustation while *Homotrema* predominates on heavily encrusted test. Three different growth forms of serpulids are present: long thin tubes, shorter thicker tubes (often showing a sculptured surface) as well as enrolled *Spirobis* types. Most serpulids are found on the oral side of the echinoids and show conspicuously growth around the tubercles. Differences in encrustation are, in part, clearly present between the oral and aboral test sides, especially in less encrusted forms.

Taphonomy and paleoenvironmental conditions of whales skeletons in cross section from Cerro Tinajones and Cerro el Buque near of the base in the Pisco Formation (The miocene/pliocene), Ocucaje, Ica Perú

Orlando Alan Poma Porras[1] and Kevin E. Nick[2]

[1] Centro de Recursos en Geociencia, Universidad Peruana Unión, Ñaña, Perú; opoma@upeu.edu.pe
[2] Earth and Biological Sciences Department, Loma Linda University, Loma Linda, California 92350, USA

The Pisco Formation in Peru contains many fossil whale in Miocene to Pliocene Formation whit sandstone, siltstone, and tuffaceous and diatomaceous mudstone. The presence of whale fossils in cross section is not very common; in this study, we documented the special occurrence of specimens of whale fossil in cross section in the hill tinajones and the hill the Buque to the south of the town of Ocucaje, Ica at Southern Peru. The bone surface is uniformly affected by microborings that are closely spaced and have a preserved depth. The fossil whales there are partially articulated and disarticulated specimens in cross section. The bones show fracture due to posterior processes like two faults that affect the skull and ribs of a specimen. We observe the following characteristics: The sedimentary composition of the outer and inner sediment, Are secondary mineral precipitations observed inside the bone. Bone conservation status. Is micro-fragmentation observed due to compaction? Detailed description of bone-sediment surface contact. Are there signs of erosion? Is there evidence of micro perforations? In the oriented samples, is there a difference between the upper and lower part of the bone? The results of the thin section analysis of a vertebrae including epiphysis show that: One of the larger pieces of bone examined at about 3 cm thick. The sediment is a clay, matrix-rich, arkosic siltstone. The matrix also is partially replaced by extremely fine crystals of dolomite. Most of the bone is cancellous and the pores do not contain sediment. The cortical rim appears to be intact enough around the bone to prevent infiltration of sediment into the interior. A cross section of a possible nutrient foramen does contain silty sediment through its entire length of about 1.5cm. The bone surface is uniformly affected by microborings that are closely spaced and have a preserved depth of up to 100 um in depth and 40 um in width, but most of the microborings are smaller and are about 10 to 20 um wide and 10 to 40 um deep. Microborings also occur through the length of the nutrient foramen. It is likely that much of the cortical bone surface is reduced in thickness because the borings were so closely spaced that material fragmented away. The evidence for this is seen where microborings are not very deep and the surface of the bone is irregular. Other alteration to the bone includes what appears to be replacement in the interior of the bone by dolomite that fills the cancellous bone pores. It is possible that the bone partially dissolved before dolomite cement emplacement, but replacement seems to fit the observed textures better. Another form of alteration is fracturing of the surface of the bone that is observed across a projection. The fractures predate or a coincident with cementation by dolomite. Some spalling of the cortical bone surface is also present locally. The slivers are also cemented to the bone by dolomite.

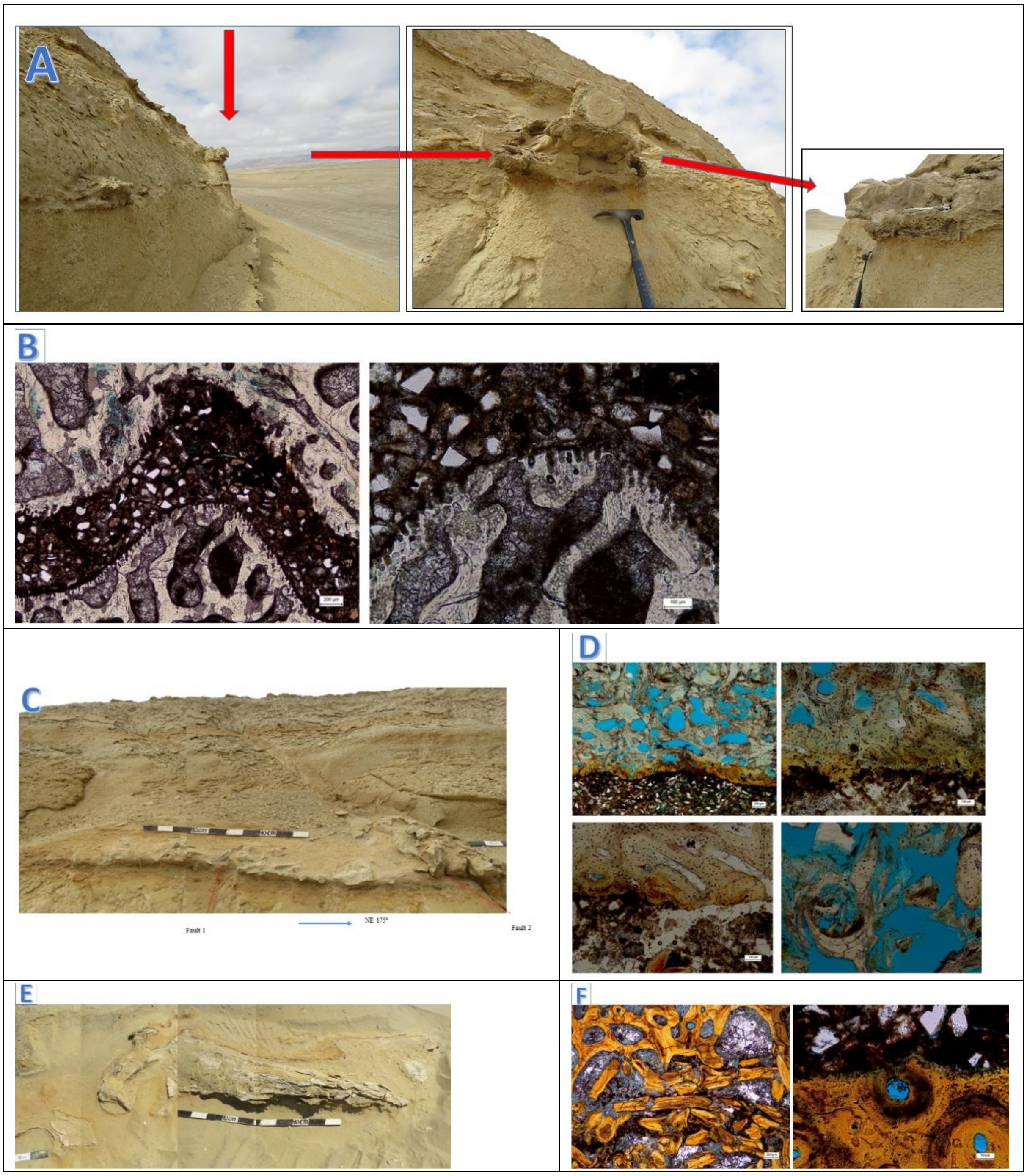


Fig. 1. Fossil whales in cross section. A) Whale OP-17-3. Vertebrae articulated with partial skeleton preserved; B) The bone surface is uniformly affected by microborings that are closely spaced and have a preserved depth of up to 100 um in depth and 40 um in width .C). Whale OP-17-4, this whale is affected transversally by two faults. D) Locally on the upper surface are areas that have microborings. Portions of the upper contact are smooth and show little evidence of erosion. The lower portion of the bone is crushed. Pores and interparticle spaces in the lower portion of the crushed bone do not contain sediment except very near the contact. E) Whale OP-17-5. We can see skull, ribs and mandibules. The sediment has carbonate cemented mudstone. F) A small amount of contact with both upper and lower sediment are present in the thin section.

The Sedimentary composition of the outer and inner sediment is a clay, matrix-rich, arkosic, and siltstone. The matrix also is partially replaced by extremely fine crystals of dolomite, siltstone to very fine sandstone with dark clay matrix. The bone surface is uniformly affected by microborings. The alteration to the bone includes to be replaced in the interior of the bone by dolomite.

Author index